

# BIOLOGY PROGRAM 2014-2015 ASSESSMENT REPORT

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## ABSTRACT

This is a report of the assessment of the Biology Program. It focuses on two aspects: learning outcomes and student assessment. The biology learning outcomes are addressed in a number of courses throughout the four years of a biology major's career at Quincy University. Bonaventure Learning Outcomes are also met via any biology course that a QU student would take. Biology student performance on the Educational Testing Service-Major Field Test (ETS-MFT) is also presented and discussed. The ETS-MFT is the metric that the Biology Department uses to assess student acquisition of knowledge of the biological sciences. Lastly, this report discusses potential changes to improve the conditions for the biology program to become more efficient in providing education to a non-homogeneous student body.

## INTRODUCTION

The assessment of the Biology Program is highly invested in both the University and Program missions. The program mission is an extension of the QU Mission and extends the sentiments in the mission into biological realm. In order to preserve the ideas within the missions, both the program goals/objectives, and learning outcomes have been developed. In order to assess whether we are meeting the expectations of our program as garnered through the mission and goals, this report addresses two main aspects of them: the application of the learning outcomes in the courses and the success of our students who have been educated under them. Below are the mission statements, program objectives, and program learning outcomes.

### QUINCY UNIVERSITY MISSION STATEMENT

*Quincy University stands as a Catholic, independent, liberal arts institution of higher learning in the Franciscan tradition. Inspired by the spirit of Francis and Clare of Assisi, we respect each person as a sister or brother with dignity, value, and worth. We work for justice, peace and the integrity of creation. We prepare men and women for leadership and for the transformation of the world by educating them to seek knowledge that leads to wisdom. We welcome and invite all to share our spirit and life.*

### PROGRAM MISSION STATEMENT

*The mission of the Biology Program at Quincy University is to provide an excellent undergraduate biology education in the Franciscan liberal arts tradition. Our curriculum embraces the breadth of the discipline and provides students with lecture based, problem based, and hands on examination of the material. The Biology Program is dedicated to preparing students to pursue rewarding careers in biology and related disciplines. It is our sincere desire that students will use their abilities and training to promote the growth of biological knowledge and its application for the benefit of the environment, humanity, and society.*

### PROGRAM GOALS/OBJECTIVES

- Students will demonstrate knowledge of the basic principles at work in the natural world through biological science perspectives.
- Students will demonstrate knowledge of the basic principles at work in the natural world through physical science perspectives.
- Students will critically evaluate scientific arguments.
- Students will understand the limits of scientific knowledge garnered through experiences with the scientific method and discovery-based science.

### PROGRAM LEARNING OUTCOMES

Students will be able to:

- Demonstrate an understanding biology at the cellular level
  - Distinguish between prokaryotes and eukaryotes
  - Know the functions of organelles
  - Depict and/or explain cell structure
- Describe and/or illustrate the structure and function of organs and organ systems
- Explain metabolism at various levels

- Describe the phylogenetic relationships between major groups of organisms
- Expound the central place of evolution in biology
- Solve application problems in various biological fields
- Elucidate biological concepts in written and oral forms
- Exhibit laboratory/research skills
  - Recognize a variety of experimental designs
  - Design an experiment
  - Analyze experimental data

## MATERIALS AND METHODS

This report contains two parts: one reflects which learning outcomes are met by individual courses; the other reflects student outcomes based on the Educational Testing Service-Major Field Test.

### *LEARNING OUTCOMES AND BIOLOGY CURRICULUM*

To assess where the biology curriculum addresses each of the biology program learning outcomes, the biology faculty determined what outcomes were relevant to their own courses, as well as an overall discussion regarding specific outcomes. The results are presented for all regularly offered courses within the Biology curriculum.

### *EDUCATIONAL TESTING SERVICE-MAJOR FIELD TEST*

For over ten years, the primary means of final senior Biology major assessment has been the Educational Testing Service-Major Field Test (ETS-MFT). The ETS-MFT is a widely used external summative instrument that provides a detailed breakdown of student knowledge into sub-disciplines. Data analysis includes the mean for all students compared to that of national averages presented by ETS in 2014 MFT Comparative Data Major Field Test for Biology DAK-4GMF ([https://www.ets.org/s/mft/pdf/acdg\\_biology.pdf](https://www.ets.org/s/mft/pdf/acdg_biology.pdf)).

#### *Cohort for ETS-MFT*

The twenty Biology majors who took the final assessment include students attaining either a B.A. in Biology, a B.S. in Biology with an Environmental Concentration, a B.S. in Biology with Secondary Education Certification, a B.S. in Biological Sciences with a Pre-Medical Sciences Concentration, a B.S. in Biological Sciences with a Pre-Physical Therapy Concentration, or a B.S. in Biological Sciences.

### *TOP FOUR/BOTTOM FOUR*

An in-house subset of students taking the ETS-MFT was used to compare the top four students and bottom four students of the class of 2015 to highlight the disparity in the most advanced and the least advanced graduating students. Average ETS-MFT for the top four and bottom four were calculated. Average Biology GPA was also calculated.

#### *Pearson Correlation of BIO-GPA and ETS-MFT*

MFT scores and Biology course GPAs from the top four and bottom four were used to calculate the Pearson Correlation Coefficient using the equation:

$$r = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2} \sqrt{\sum_i (y_i - \bar{y})^2}}$$

To calculate the r-value, individual ETS scores and GPAs were used for each of the top four or bottom four rather than the overall average.

## RESULTS

### *LEARNING OUTCOMES ADDRESSED BY CURRICULUM*

As expected, the learning outcomes are covered by the biology curriculum. Every biology graduate is exposed to material that addresses all of the learning outcomes. Because each student must take at least 39 semester hours of biology from the 100-level to the 400-level (Tables 1 through 4) in order to graduate with a B.A. or B.S. in Biology/Biological Sciences, they will encounter subject matter/written and oral exercises/laboratory/etc. that

ensures that they have had at least minimal exposure to material that encompasses the learning outcomes (see Table 5), as well as the overall program goals and the Bonaventure Program learning outcome and university goals. Furthermore, students who are not biology majors, but are taking courses to fulfill the Bonaventure Program requirements and learning outcomes/university goals in the life sciences arena are met through any biology course. However, the vast majority of non-majors take BIO111 – Life Sciences or BIO105 – Human Biology.

**Table 1: 100-Level Courses**

	Outcomes Addressed by Course			
	BIO105	BIO111	BIO150	BIO151
Biology Student-Learning Outcome	Human Biology	Life Sci	Principles I	Principles II
Demonstrate an understanding biology at the cellular level	X	X	X	X
Distinguish between prokaryotes and eukaryotes	X	X	X	X
~Know the functions of organelles	X	X	X	X
~Depict and/or explain cell structure	X	X	X	X
~Describe and/or illustrate the structure and function of organs and organ systems	X	X	X	
Explain metabolism at various levels	X	X	X	X
Describe the phylogenetic relationships between major groups of organisms		X		X
Rationalize the central place of evolution in biology		X	X	X
Solve application problems in various biological fields	X	X	X	X
Elucidate biological concepts in written and oral forms	X	X	X	X
Recognize a variety of experimental designs	X	X		
Design an experiment	X	X		
Analyze experimental data	X	X	X	X

**Table 2: 200-Level Courses**

	Outcomes Addressed by Course					
	BIO210	BIO221	BIO232	BIO280	BIO282	BIO283
Biology Student-Learning Outcome	Marine Biology	Invertebrate Z	Microbiology	Med Terms	A&P I	A&P II
Demonstrate an understanding biology at the cellular level			X	X	X	X
Distinguish between prokaryotes and eukaryotes	X		X	X	X	
~Know the functions of organelles			X		X	X
~Depict and/or explain cell structure			X		X	X
~Describe and/or illustrate the structure and function of organs and organ systems				X	X	X
Explain metabolism at various levels			X		X	X
Describe the phylogenetic relationships between major groups of organisms	X	X	X			
Rationalize the central place of evolution in biology	X	X	X			
Solve application problems in various biological fields			X	X	X	X
Elucidate biological concepts in written and oral forms			X	X	X	X
Recognize a variety of experimental designs			X		X	X
Design an experiment			X			
Analyze experimental data			X		X	X

**Table 3: 300-Level Courses**

	Outcomes Addressed by Course														
	BIO305	BIO310	BIO321	BIO327	BIO328	BIO330	BIO335	BIO340	BIO350	BIO354	BIO356	BIO357	BIO358	BIO360	BIO376
Biology Student-Learning Outcome	Genetics	MBT I-III	Entomology	Ecology	Adv Topics A&P	Dev Bio	Journal Club	Organic Evolu	Molecular Bio	Pathophysiology	Tropical Ecology	Environmental	Environmental	Neurobiology	Emerging Infe
Demonstrate an understanding biology at the cellular level	X	X			X	X	X		X	X				X	X
Distinguish between prokaryotes and eukaryotes	X	X			X				X						X
~Know the functions of organelles	X	X			X	X	X		X	X				X	
~Depict and/or explain cell structure	X	X			X	X	X		X	X				X	
~Describe and/or illustrate the structure and function of organs and organ systems	X	X			X	X	X			X				X	X
Explain metabolism at various levels	X		X		X				X			X		X	
Describe the phylogenetic relationships between major groups of organisms	X		X	X				X							
Rationalize the central place of evolution in biology	X			X		X		X	X		X	X	X		
Solve application problems in various biological fields	X	X		X	X				X	X	X	X	X	X	X
Elucidate biological concepts in written and oral forms	X			X	X	X	X	X	X	X	X	X	X	X	X
Recognize a variety of experimental designs	X	X		X	X	X	X		X		X			X	X
Design an experiment		X		X		X	X					X	X	X	
Analyze experimental data	X	X		X	X	X	X		X			X	X	X	X

Table 4: 400-Level Courses

	Outcomes Addressed by Course									
	BIO400	BIO410	BIO415	BIO433	BIO435	BIO436	BIO440	BIO47X	BIO480	BIO497
Biology Student-Learning Outcome	Methods of Teaching	Immunology	Comparative	Endocrinology	Plant Field Bio	Vertebrate Bio	Bioinformatics	Cadaver	Independent	Senior Seminars
Demonstrate an understanding biology at the cellular level		X	X	X			X	X	X	
Distinguish between prokaryotes and eukaryotes							X		X	
~Know the functions of organelles		X		X			X		X	
~Depict and/or explain cell structure		X	X	X			X	X	X	
~Describe and/or illustrate the structure and function of organs and organ systems		X	X	X			X	X		
Explain metabolism at various levels			X				X			
Describe the phylogenetic relationships between major groups of organisms			X		X	X				
Rationalize the central place of evolution in biology	X		X		X	X	X		X	X
Solve application problems in various biological fields		X	X	X			X		X	
Elucidate biological concepts in written and oral forms		X	X	X	X	X	X	X	X	X
Recognize a variety of experimental designs	X	X		X			X		X	X
Design an experiment	X								X	
Analyze experimental data	X	X		X			X		X	

Table 5: All Courses

Biology Student-Learning Outcome	Number of Courses				
	100-Level	200-Level	300-Level	400-Level	Total
Demonstrate an understanding biology at the cellular level	4	4	9	6	23
Distinguish between prokaryotes and eukaryotes	4	4	5	2	15
~Know the functions of organelles	4	3	8	4	19
~Depict and/or explain cell structure	4	3	8	6	21
~Describe and/or illustrate the structure and function of organs and organ systems	3	3	8	5	19
Explain metabolism at various levels	4	3	6	2	15
Describe the phylogenetic relationships between major groups of organisms	2	3	4	3	12
Rationalize the central place of evolution in biology	3	3	8	7	21
Solve application problems in various biological fields	4	4	11	5	24
Elucidate biological concepts in written and oral forms	4	4	13	9	30
Recognize a variety of experimental designs	2	3	10	6	21
Design an experiment	2	1	7	2	12
Analyze experimental data	4	3	11	5	23

## STUDENT ASSESSMENT VIA ETS-MFT

## Total Cohort

Below are the data from the ETS-MFT (Table 6). The total score and four sub-scores in biology are presented for the previous twelve years. Data for two years are lacking.

Table 6: Average ETS-MFT scores for the past twelve years years years years years.

Year	Average Total score	SD	N	%Rank	Cell Biology	SD	Molecular Biology & Genetics	SD	Organismal Biology	SD	Population Biology, Evolution & Ecology	SD
2003	155	15	10		56		53		50		61	
2004	152	9.9	11		51		48		53		57	
2005	NA	NA	NA		NA		NA		NA		NA	
2006	NA	NA	NA		NA		NA		NA		NA	
2007	150	14	9		47		48		53		54	
2008	140	12	14		46		42		41		40	
2009	143	10.7	7		46		44		43		46	
2010	138	7	9		39		40		37		43	
2011	144	12	20		49		43		46		45	
2012	143		27		46		44		46		42	
2013	145	11.4	23	14	46	11.1	44	12.5	48	12.0	45	9.8
2014	149	10.6	27	29	54	10.2	46	8.9	51	10.4	48	11.1
2015	151	8.2	20	38	51	7.9	50	8.5	55	9.5	49	9.7

The data above represent the average scores and sub-scores for a subset of the class of 2015 Biology majors at Quincy University. Not all students who graduated in 2015 are included in this assessment as they may have taken the ETS-MFT last year. Generally, students who hold senior status taking the senior seminar course will take the exam during that year even though they continue their education for another year. The average total score (Table 6) reflects a 38<sup>th</sup> percentile rank, where 38% of the institutions scored below QU students, compared to institutional means for Biology-MFT collected from seniors at 509 domestic institutions from September 2010 to June 2014, provided by ETS as “Institutional Means Total Score Distribution” for Biology (DAK-4GMF) ([https://www.ets.org/s/mft/pdf/acdg\\_biology.pdf](https://www.ets.org/s/mft/pdf/acdg_biology.pdf)). For sub-score percentile ranks for cell biology, molecular biology & genetics, organismal biology and population biology, evolution & ecology, the average for students fell within ranks of the 41<sup>st</sup>, 33<sup>rd</sup>, 58<sup>th</sup>, and 27<sup>th</sup>, respectively.

At QU, the diversity of academic aptitude within the biology student population is reflected in the average mean score for all students. For the twenty students in this cohort, the range of scores was from 137 to 167.

### *Top Four/Bottom Four Analysis*

Below are the results of the Top Four/Bottom Four Analysis (Table 7).

**Table 7: Top Four/Bottom Four 2015**

	Average Total score	SD	N	Cell Biology	SD	Molecular Biology & Genetics	SD	Organismal Biology	SD	Population Biology, Evolution & Ecology	SD
<b>TOP</b>	160	7.4	4	58	7.4	61	4.0	65	6.4	53	12.4
<b>BOTTOM</b>	147	9.9	4	45	9.6	48	6.6	49	15.4	46	9.1

As seen in Table 7, there is a difference between the top academic performers in the class and the weakest performers. With the top performer averages falling into the 67<sup>th</sup>, 63<sup>rd</sup>, 72<sup>nd</sup>, 81<sup>st</sup>, and 48<sup>th</sup> percentile ranks for average total score, cell biology, molecular biology & genetics, organismal biology and population biology, evolution & ecology respectively. For the bottom four performers, the percentile ranks were 31<sup>st</sup>, 25<sup>th</sup>, 36<sup>th</sup>, 36<sup>th</sup>, and 26<sup>th</sup> for average total score, cell biology, molecular biology & genetics, organismal biology and population biology, evolution & ecology respectively.

### *Pearson Correlation of BIO-GPA and ETS-MFT*

In 2014 to assess whether the Biology Program could predict which students would perform the best and the weakest on the ETS-MFT, we compiled data on composite ACT and Biology GPA (BIO-GPA) from each student in the top four and the bottom four. We found that the BIO-GPA was a good predictor of the top four or bottom four scores on the MFT. Additionally we found that the composite ACT and BIO-GPA were strongly correlated. Here we will solely look at the correlation between BIO-GPA and performance on the ETS-MFT. The average BIO-GPA for the top four was 3.85 and for the bottom four 2.28. For this year’s top four/bottom four analysis, the Pearson Correlation Coefficient was 0.58, where 0.0 is no correlation and 1.0 is highly correlated.

## **DISCUSSION**

### *BIOLOGY CURRICULUM SPANS LEARNING OUTCOMES*

As presented in the results, the learning outcomes at both institutional and program levels are covered by the courses offered for non-majors and biology majors. As presented in Tables 1-5, the breadth of the curriculum and the inherent nature of science education address each of the learning outcomes several times throughout the course of a student’s tenure at QU in the Biology Program. Professors teaching the courses reported the learning outcomes that were covered in their courses. In Table 5, it is evident that the biology learning outcomes are addressed and assessed by the professors teaching the courses. Furthermore, that learning outcomes are revisited in a number of courses attests to the most prevalent themes in biology and the sciences. Multiple exposures to the central tenets of biology (and the sciences in general) give students and professors the time to build on comprehension of learning outcomes, application of learning outcomes, and critically thinking about learning

outcomes, therefore, students who are prepared to achieve the highest levels of knowledge at QU will meet those learning outcomes. Weaker students will be exposed and will have a sufficient understanding of the underlying tenets of biology to graduate seeing that they meet several benchmarks in the biology program including at least a 2.0 GPA in biology courses. Lastly, non-majors will meet the Bonaventure Program Learning Outcomes because they will be exposed to at least two science classes that will address the overarching themes in the sciences: first, the scientific method and experimental design, and second, the physical composition of the living and the non-living (not zombies).

#### *STUDENT ASSESSMENT VIA ETS-MFT*

Over the past decade, the ETS-MFT has been a major tool of assessment of QU students. To see whether students are attaining levels of comprehension comparable to that of 508 other institutions that use this metric, comparison of the data from our cohort of 20 students and that of other institutions can provide insight as to where our very small cohort falls within the larger spectrum of universities across the United States of America. Because of a relatively small sample size, we are more affected by the disparity in the student scores. However, our average score of 151 puts us in the 38<sup>th</sup> percentile which has remained fairly consistent over the past few years and even edged upwards a bit, possibly a good indication of the momentum that the science programs have gained over the past few years. On slightly more statistical note, the standard deviation among the cohorts over the past three years has gotten smaller. The standard deviation is a measure of the variation of scores from the mean. This may indicate that there is less variability in the scholastic capacity of the students or that the mode of instruction has become more cemented to provide a stronger understanding of the basic tenets of each of the subjects within biology.

#### *TOP FOUR/BOTTOM FOUR ANALYSIS*

The analysis of the perceived best and worst of the class of 2015 shows that disparity exists in those sub-cohorts. For the best, the percentile ranks for total score falls into the 67<sup>th</sup> percentile rank and represents what kinds of students that QU can attract. As a program, we feel that this is a respectable place for our students to rank seeing that we have limited resources in a number of areas. Even with our weakest students, they place in at least the bottom quartile, which in itself for weaker students is commendable, i.e., not the 1<sup>st</sup> percentile.

In the Pearson Correlation of BIO-GPA and ETS-MFT score, the value was much less than that of last year. Perhaps the BIO-GPA is not a good indicator, or more likely the cohort which was chosen for the weakest students was biased towards students who did not perform well in classes due to other influences such as class attendance and perception of student interest in the class. Furthermore, it could be due to chance that students perceived as the weakest actually are good multiple choice test takers. Multiple choice exams and how to take them has been a subject that the biology faculty have tried to incorporate in their instruction.

#### *PROGRAM CHANGES BASED ON ASSESSMENT*

As with any report card of how our students are doing, it does not always reflect the entire story. It is clear to the biology faculty that we have a very disparate group of students. This challenge can make providing instruction to a non-homogeneous group very difficult since it forces professors to teach to the middle. This is fine for students in the middle, a possible burden, or too didactic for students at the top, and at times too challenging for the students at the bottom. It would be optimal to teach to the top quarter of each class, so that they can be challenged to an extent that would help them grow, but it would be devastating for those at the bottom who have a true affection for biology.

To help our weakest students, we will continue to encourage them to use the resources of the SSC. Most students are well aware that the tutors have developed good study habits, have had instructors multiple times, and understand what types of questions may appear on exams. We will also encourage the middle of the pack to utilize the SSC. And as always, we encourage students to utilize their professors to help them comprehend and acquire higher knowledge. It is probably the most vital tool that the biology program can provide.

Seeking outside resources such as grants to assist the at-risk students and basic science research are also being addressed. This takes man/woman hours to do. The biology faculty are a limited resource. All biology faculty teach full time and two biology faculty members regularly teach overloads to accommodate the needs of the university at the expense of time that could be dedicated towards seeking outside funding and/or providing more one-on-one or

small group interactions with students and/or research. Provided that the biology program is to continue to grow, faculty members involved in grant writing or research must be allowed time to do so either through compensation for extra time or course release. Likewise, faculty members in the sciences have lab courses that require extra time to prepare and disassemble, in addition to lab instruction. If the university provided a person or persons to assist in lab organization and maintenance, it would help free up time for other faculty endeavors. On a similar note, at least one additional faculty member in the biology program would allow for proper time allotted to courses, grading, lab preparation, research, the addition of more courses and sections, and university service.

Another aspect that has been underutilized with the ETS-MFT is the more complete reports that the metric can give us. Next year we would like to purchase the extras in order to tease out the finer details as to where our students are exceling and where they are stagnant. This could lead to more demonstrable changes in courses that address “holes” in them or in the program in general. Some of these may be easy fixes that we are unable able to see with the limited report that we get. Furthermore, using the information that ETS provides we may be able to better use the metric to refine our learning outcomes to meet the end metric that we use to assess student success in acquisition of biological knowledge.

The Biology Department will continue to provide a solid education in the biological sciences. We will continue to tweak instruction and the methods we employ. As a group, we have frequent discussions of subjects within our disciplines, about pedagogy, and truly aspire to become the best educators that we can. We are proud of the students that we have and, of course, see tremendous growth in them from the time that they are freshmen to when they are seniors. The placement of our students in professional and graduate schools is on target and we see that many of our students who do not seek further education are placed in employment shortly after graduating. Overall, the students that graduate from QU with a Biology degree are prepared and reflect that the biology program has prepared them for post-QU prospects.