Andrews University

# Department of Biology Self-Study

Submitted by the
Department of Biology
March 1, 2023

*Acknowledgments*: This document was prepared with the valuable input from the following individuals at Andrews University: Laura Carroll (Institutional Assessment), Maya Wilson (CAS Dean's office), Paulette Johnson (James White Library), Maxine Umana (Honors), Sally Norton (ITS), Rahel Wells (Religion & Biblical Languages dept.), Tom Goodwin (Biology) & James Hayward (Biology) and the biology department faculty.

# Table of Contents

# List of Tables and Appendices

# List of Figures

# Criterion 1: Mission, Impact, History, and Demand

## 1. How does the program contribute to the mission of Andrews University and the Seventh-day Adventist Church?

The Department of Biology identifies its mission as providing "transformational education in the biological sciences for a diverse student population, set in the context of a Seventh-day Adventist Christian worldview," an education centered on seeking knowledge, affirming faith, and preparing students to "change the world." These commitments closely parallel the University's mission statement, which likewise emphasizes, "seek, affirm, change" as transformational elements of Seventh-day Adventist education at Andrews University.

Three elements of our Department's mission-driven contribution deserve particular comment: transformational education, service to a diverse student population, and a Seventh-day Adventist commitment.

### *Transformational Education*

The historic success of the Department in transforming average students to achieve above-average outcomes was the motivation for two National Science Foundation grants: STEP grant # 0336596 (funded 2003) to "clone" the biology program's success in developing an interdisciplinary Behavioral Neuroscience program; and STEP grant # 0724516 (funded 2007) to evaluate outcomes and elucidate processes responsible for student success. Analysis of student success in the biology program found that more than 90% of interviewees felt that they were the focus of the positive relationships that were apparent in the departmental culture and in interactions with their biology faculty mentors and teachers. (*Promoting the Success of Biology Majors: Support, Mentoring, Community, Analysis, Transformation.* John Stout, Larry Burton, David Mbungu, Jimmy Kijai. Unpublished manuscript). We are thankful for this recognition, but we realize that such success must not be assumed. Indeed, rapid growth in student numbers from 2000 to 2011 (see Fig. 4.1) made it more challenging to provide this nurturing environment, and student learning may have suffered as a result.

A more immediate challenge to the department's supportive culture has been the impact of the COVID-19 pandemic on social interactions with students. As soon as it was prudent the department took steps to reinstate social gatherings and events such as meals and vesper events that have helped foster departmental belonging, connectedness and maintain a positive attitude.

A key student experience that has been observed to foster transformational education has been the involvement in undergraduate research (see Section 11 for a formal description of this student experience). Numerous students have shared unsolicited comments with faculty on the positive impact of research on their academic journey and professional development. Here is a representative quote from a student:

"I wanted to let you know that I've been accepted into the Philadelphia College of Osteopathic Medicine incoming Class of 2022. I could not have embarked on this journey without the research and publication opportunity you provided. I want to thank you for the valuable advice you gave me regarding work ethic, study habits, and note organization. Your advice helped me achieve academic success in my masters program at Drexel University and I will definitely be applying your advice in medical school. I will always be grateful for the time you invested in my academic journey and all of your support."- Biology BS major 2018.

Similar sentiments have been shared by students who have travelled to other cultures as part of their biological education at Andrews U. Specifically the Cuban Field Ecology course has provided an environment for student-student & student-faculty bonding. The following student comments from the 2017 course survey for the class illustrate the impact of this experience:

"The planning of the entire study tour through a country that is unpredictable was incredible. Although chance may have played more a role than actual preparation, this teacher was very professional and reliable. His very presence reassures me that everything will be ok, especially on our expeditions through the wilderness. I really can't thank him enough for his hard work and dedication to his students."

"We had a lot of activities to do, assignments were made clear, we were able to learn the information from a Christian Standpoint as well. Our teacher made everything very exciting and I was able to apply class content in the field."

## *Serving a Diverse Student Population*

Sharp contrasts exist between the distributions of ethnicities of undergraduate Biology majors at Andrews compared with those of all undergraduate students in the United States (Fig. 1.1). At least two trends are noteworthy: First, far higher proportions of blacks and Asians are represented among Andrews Biology students than at the national undergraduate level. Second, from 2015 to 2019 the percentage of both black and Hispanic students increased with the greatest gains seen with black students.

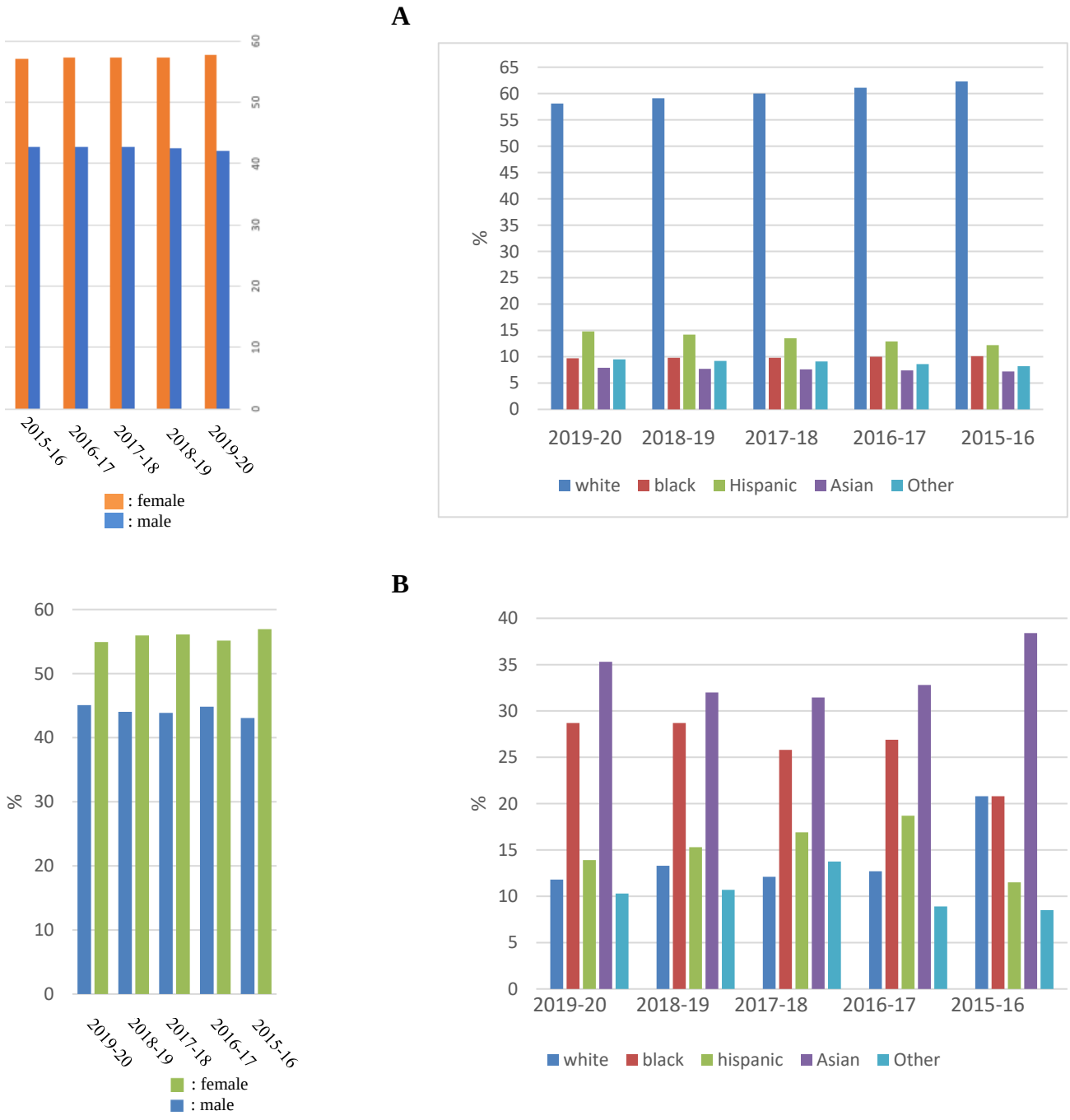



**Figure 1.1.—Ethnic and sex composition (%) of undergraduate students in the United States (A) in comparison with that of Andrews University undergraduate Biology majors (B). Data taken from the National Center for Education Statistics (A) and Andrews University Banner- July 2022 (B).**

The gender composition of Andrews Biology students differs somewhat from national averages. Over the past 5 years the gender composition of our students has fluctuated without

exhibiting any particular trend, averaging 56% females and 44% males. By contrast, between 2015 and 2019, 57% of undergraduate students nationally were females and 43% were male. Thus, Andrews' undergraduate Biology student population is slightly more evenly distributed gender-wise than the national undergraduate distribution.

How can we best serve this diverse student population? We will continue to explore this question. Diverse faculty members serve as important role models for students. We believe that our ethnically (African, Caribbean, Caucasian, Chinese, Latin American) and gender (male and female) diverse biology faculty are vital in this area.

## *Seventh-day Adventist Commitment*

We serve the church in multiple ways. First, we actively seek to help our students engage the complex issues at the interface of science and Adventist faith in ways that honor both science and faith. One required course Historical and Philosophical Biology focuses on this interconnection. We also will require RELT385, a religion course that focuses on bioethics from a Christian perspective.

Second, we primarily serve Seventh-day Adventist students. From 2015-16 to 2019-20, the percentage of our students who described themselves as Seventh-day Adventist increased from 82.8% to 89%.

Third, we successfully prepare many of our students for academic and health-related careers that serve the church and world. As one example, 74% of our majors who applied for medical school during the last 10 years successfully gained acceptance to a school of their choice, with most of them choosing Loma Linda University. This compares to the national average of ~45%.

Lastly as an educational institution for the general Conference of Seventh-Day Adventists we serve the worldwide SDA church. This is reflected in the ~14% of biology majors at Andrews University that are international students/non-US citizens (Table 1.1).

| **Academic Year** | % of biology majors that are international/non-US citizens |
|---|---|
| 2015-16 | 12.1 |
| 2016-17 | 13.2 |
| 2017-18 | 11.3 |
| 2018-19 | 13 |
| 2019-20 | 21.2 |
| **Mean** | **14.2** |

**Table 1.1—Percentage of biology majors at Andrews University that are not US citizens (2015-2019).**

# 2. How does the history of the program define the contributions of the program to Andrews University?

The Department of Biology at Emmanuel Missionary College, the precursor of Andrews University, was formed in 1938 with Burton H. Phipps as chair. Prior to 1938, courses such as General Zoology were taught by instructors affiliated with a "Science Department" or other such

designations. At all Seventh-day Adventist institutions, coursework in the sciences was offered due to the need for qualified medical personnel, particularly physicians, who graduated from accredited professional schools.

The Department has grown and matured in multiple ways since its establishment more than 75 years ago. The number of faculty has increased from 1 professor with a master's degree to currently 8 professors, all with Ph.D. degrees. This growth in expertise parallels a growth of course offerings and emphases. Andrews offered a Biology major beginning with a simple curriculum. Undergraduate students majoring in Biology today, however, enjoy a variety of emphases and electives, including courses that provide training in light and electron microscopy, genetics, biostatistics, bioinformatics, field ecology, medical microbiology, mammalogy, and other up-to-date tools, conceptual frameworks, and methodologies.

Growth in numbers of faculty, curriculum diversity, and quality paralleled concomitant increases in numbers of majors. Figure 2.1 illustrates growth in numbers of majors, which more than doubled between 1980 and 2019 with the highest numbers of majors occurring between 2005-2014.

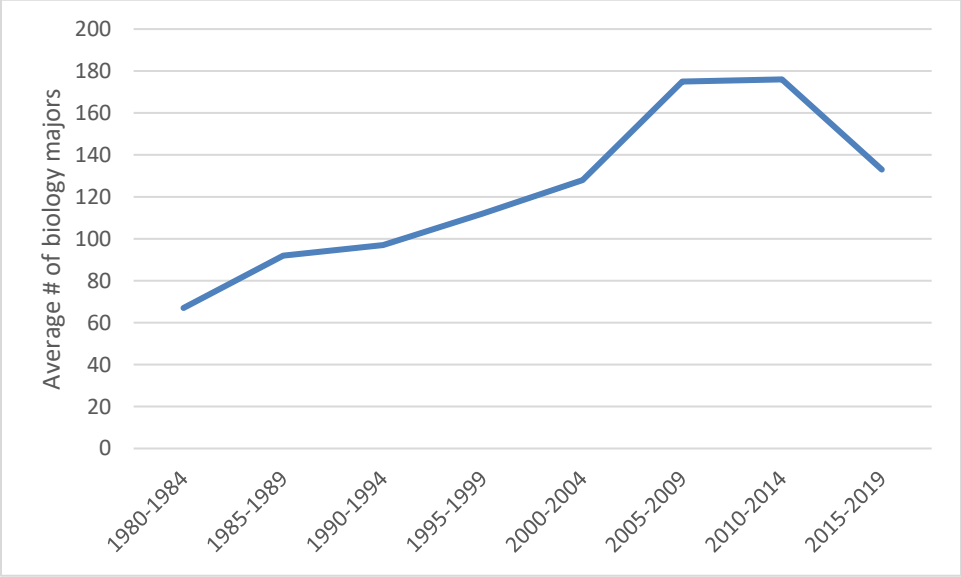



**Figure 2.1—Growth in numbers of Andrews University Biology majors, 1980–2019**

## *Foundations of Biology*

The Department's entry-level course is titled Foundations of Biology. Unlike many college-level biology courses which constitute 8 semester credits, Foundations of Biology is a two-semester, 10-credit laboratory course. Given the large proportion of students interested in medically-related professions at Andrews, some of whom do not major in Biology, this course provides solid and comprehensive treatment of the biological sciences at the freshman level. Many Andrews University graduates who today are medical professionals look back on this course as pivotal to their learning experience. This course provided them with excellent preparation for the Medical College Admissions Test (MCAT) and Dental Aptitude Test (DAT).

Harold Heidtke designed Foundations of Biology and taught/co-taught the course for over 30 years. We attribute the course's comprehensiveness and rigor to his foundational planning and implementation. Due to growth in student numbers, currently the course is taught in two sections. Instructors in both sections are working to implement active learning techniques in the classroom. The first semester involves a professor with expertise at the molecular/cellular scale of biology, whereas the second semester is taught by professors with expertise at the organismal scale of biology. Laboratories continue to focus on hands-on experiments and observations and have not resorted to computer-based simulations. Students are introduced to the scientific enterprise with opportunities in research design and data analysis.

## *Biology Core Curriculum*

The Biology Core of 27 credits, taken by all Biology majors, has been modified and honed through the years to track modern trends in biology. It has long included Foundations of Biology, along with Genetics, General Ecology, Cell and Molecular Biology, Historical and Philosophical Biology, courses that emphasize key concepts in contemporary life science. In the past decade courses that provide students with tools and perspectives important to their future have been added, including Biostatistics and Research Design and Scientific Communication.

The cognate core has long consisted of full years of General Chemistry, Organic Chemistry, and Physics (either General Physics or Physics for Scientists and Engineers) and starting in 2014, the General Education Cognate 3-credit course entitled Bioethics and Christian Faith (RELT385) taught by the Department of Religion is also required.

## *Programs of Emphasis*

Under leadership of John F. Stout in 1985, the Department began to group course offerings into more specific programs than simply Zoology and Botany. Currently, the Department offers Bachelor of Science programs with courses grouped according to specific emphases. These include emphases in Neuroscience, Biological Science and Biomedical. In addition, the Department offers a minor in Biology.

Designation of programs of emphasis has attracted students to programs designed for specific interests and career goals. The Biomedical option (introduced in 1985) is by far the most popular program, which reflects the large proportion of our students interested in pursuing medicine or dentistry. This option has provided these students with strong preparatory courses prior to entrance to professional school. We commonly hear from former students who have gone to medical and dental programs, that they were better prepared as a result of their program at AU than their peers from other undergraduate programs.

## *Master of Science in Biology Program and Strong Research Emphasis*

In addition to the Bachelor of Science program in Biology, since the mid-1960s the Department has offered a Master of Science in Biology. This program was initiated as part of a larger push by then-president Richard Hamel to expand graduate education at the newly-formed university. This decision made AU an attractive option for newly-minted Ph.D.'s courted by the department.

In addition to strengthening offerings at the undergraduate level, the move to offer a graduate program proved essential to the professional productivity of faculty. The research programs of faculty now could be continued with involvement by graduate students. Moreover, the emphasis on research spilled over quite naturally to the undergraduate level. Vertical integration of research in the Department is common, with faculty mentoring graduate students, and graduate students mentoring undergraduates in lab and field. Masters-level students, for their part, are prepared for acceptance into Ph.D. programs or for successful employment in biology-related industrial or academic positions. (Issues related to the graduate program are discussed under Question 19.)

## *Overall Contributions to Andrews University*

The Department of Biology actively reinforces in students the University's motto of "Seek Knowledge, Affirm Faith, Change the World" in a variety of tangible ways. Learners are presented with current knowledge of the almost bewildering array of sub-disciplines that characterize contemporary life science.

***Seek Knowledge.—***Students graduate from our program armed with a detailed knowledge of biological "facts", experienced in contemporary biological techniques and concepts, and functioning as intelligent and informed participants in an on-going conversation about the intersection of biological science and society.

***Affirm Faith.—***Students in our program are continually reminded of God's creatorship, challenged to create for themselves a coherent personal faith, and encouraged to share their faith through commitment to human health, ethical conduct, and creation care.

***Change the World.—***Virtually all of graduates enter professions which make tangible differences in the lives of others and the well-being of the planet. They accomplish this by enhancing the physical well-being of patients they will attend to in their practices, and by passing along crucial information and attitudes to future generations of students as teachers.

# 3. How does the program contribute to the academic success of Andrews University?

Academic success at a university can be measured in a variety of ways. The most important measure of success is the degree of career success achieved by its graduates. The Department of Biology has prepared thousands of its majors for careers in medicine, dentistry, teaching, and research. Alumni have made and continue to make major contributions to society through the provision of health care, the teaching of young people, and the generation of new concepts and information through research productivity. Foundations of Biology (BIOL 165-166) serves biology majors, but also other students with life-science or pre-professional goals. In fact the majority of students in the class were not declared as biology students when completing the course (Fig. 3.1). Additionally, through service courses such as Microbiology and Anatomy and Physiology, the Department has contributed significantly to the education of thousands of students majoring in nursing, physical therapy, clinical laboratory sciences, physical education, and other majors. The department's general education courses such as Environmental Science, Principles of Biology and Human Biology have contributed to the general education of non-

science majors. Every biology major, in turn, takes courses in other departments, thus boosting the success of the University overall. Finally, participation in the broader scientific community increases the value and visibility of the institution.

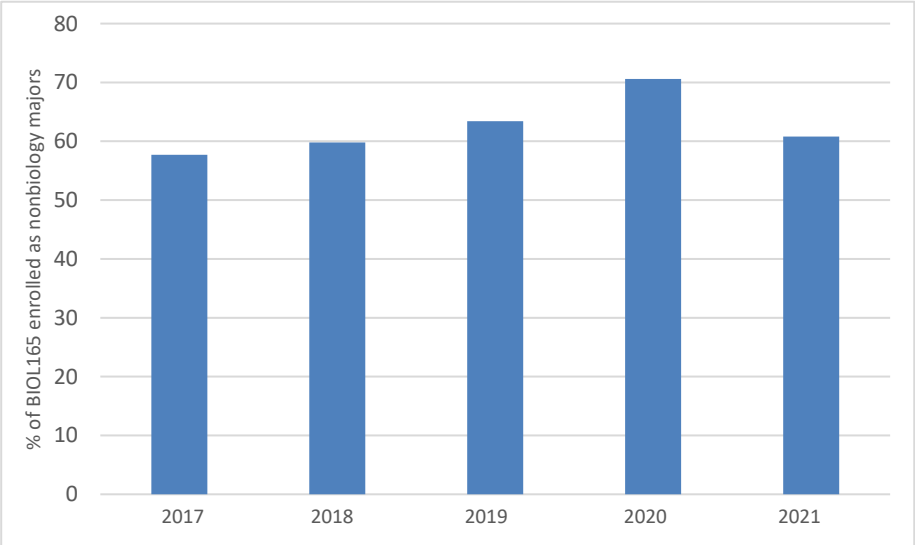



**Figure 3.1—Proportion of students in BIOL 165 who were not declared as biology majors when taking the course, 2017-2021.**

## *Enrollment Numbers and Credit Hours Generated*

Biology major enrollment has increased over the past 40 years since 1980. Enrollment has declined from a high of 212 in 2010 to 115 in 2020 (Figure 2.1/Table 3.1). Reasons for the decline are unknown, although it appears more pre-professional students are selecting majors other than biology (based on the proportion of BIOL165 students who are biology majors; Fig 3.1). Campuswide declines in enrollment may also explain this reduction in the number of biology majors. We continue to monitor enrollment trends closely.

Our primary competitor for students in this major within the Adventist system is Southern Adventist University. But we commonly enroll students from Southern's "territory" as well, so the net impact of losses to Southern on our program is hard to quantify.

Table 3.1 shows enrollment numbers and credit hours generated by undergraduate Biology majors and non-majors in the Department from 2015 to 2020.

**Table 3.1—Undergraduate enrollments and credit hours in the Department of Biology from 2015–2020. Credits rounded to nearest whole numbers.**

| Year | Majors enrolled | Total UG credits | No. graduated |
|---|---|---|---|
| 2015-16 | 129 | 2938 | 22 |
| 2016-17 | 137 | 2934 | 24 |
| 2017-18 | 123 | 3254 | 25 |
| 2018-19 | 146 | 3344 | 16 |
| 2019-20 | 131 | 3121 | 18 |
| 2020-21 | 115 | 2863 | 32 |

Graduate enrollment in the Department from 2015 to 2020 is highlighted in Table 3.2.

**Table 3.2—Graduate enrollments and credit hours in the Department of Biology from 2015-2020. Credits rounded to nearest whole numbers.**

| Year | Grad students enrolled | Total grad credits | No. graduated |
|---|---|---|---|
| 2015-2016 | 6 | 61 | 2 |
| 2016-2017 | 5 | 45 | 2 |
| 2017-2018 | 8 | 126 | 1 |
| 2018-2019 | 10 | 119 | 0 |
| 2019-2020 | 8 | 71 | 5 |
| 2020-2021 | 3 | 48 | 4 |

Graduate enrollment has also declined. One reason for this may be the relatively non-competitive financial package our Department could offer prospective graduate students. This package was less attractive than what is offered by Loma Linda University and Walla Walla University, the only two other Seventh-day Adventist institutions that offer graduate programs in biology. In response to the enrollment decline, the Department implemented a new financial package for graduate students around 2006 which, along with other changes to the graduate program, should make our offering more attractive to prospective students. Travel restrictions have contributed to the ability of international students to enroll on the biology graduate program. Anecdotal evidence from conversations with other SDA institutions of higher learning suggest that the presence of a graduate program in biology at Andrews U. is not a widely known fact suggesting that the program would benefit from a wider exposure. Unfortunately financial cuts in recruiting budgets helps contribute to the decreased number of students applying to the biology graduate program.

## *Research Visibility*

The Department of Biology has a tradition of research that reaches back to the 1960s. Numbers of peer-reviewed publications over the past 5 years by departmental faculty and students are summarized in Figure 3.2. The average yearly output of peer-reviewed publications from 2016 to 2020 was 5.4. Although not high, this value represents a steady involvement of faculty in research output. New faculty members are hired with an expectation that research productivity will be given high priority.. Thus, we suspect that the yearly research productivity of the Department will be sustained in future years.

Peer-reviewed publications are important for several reasons including providing 1) an objective measure of departmental contributions to the wealth of human knowledge and understanding, 2) an indication that faculty are subject specialists in their areas of teaching, and 3) visibility of the University as an active participant in the academic community. Each of these

services enhances the academic success of Andrews University and increases the value of all degrees from this institution.

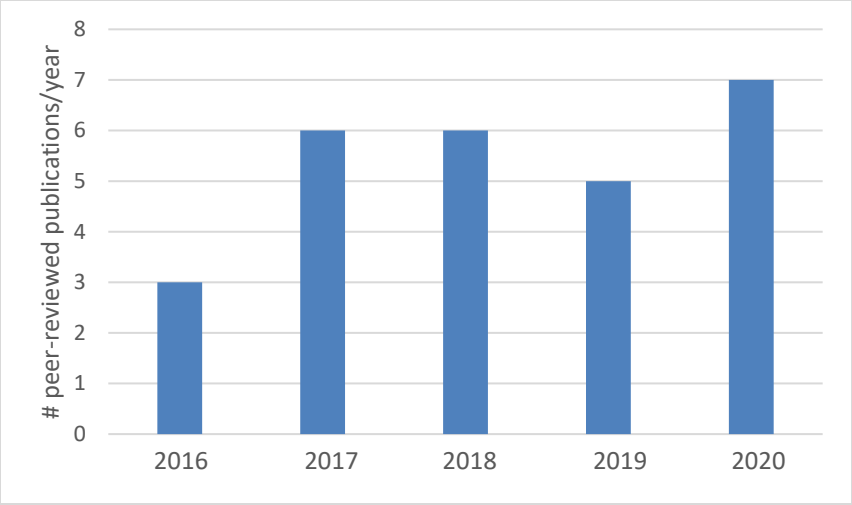



**Figure 3.2—Yearly output of peer-reviewed publications by Andrews University Biology faculty and students. Only papers appearing in recognized scholarly journals are listed. Faculty members also publish articles for general audiences in journals which may or may not be peer-reviewed.**

Peer-reviewed publications represent only one avenue for communication of research results to the broad scientific community. Figure 3.3 highlights numbers of talks and posters presented by Biology faculty and students at professional meetings.

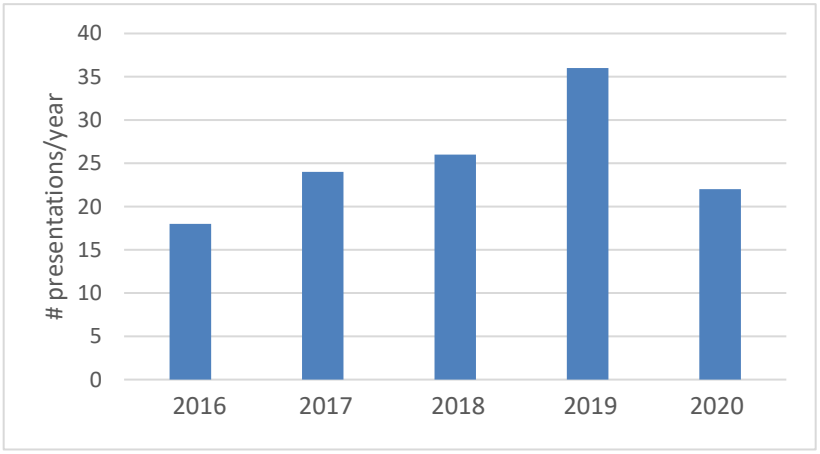



**Figure 3.3—Yearly output of posters and oral presentations presented by Andrews University Biology faculty and students at scientific meetings, symposia, and professional conferences.**

The average number of annual presentations of 25.2 from 2016-202 is encouraging. Often, oral and poster presentations are developed into manuscripts for submission to peer-reviewed journals. A trend toward more presentations at meetings may suggest an increase in numbers of peer-reviewed publications in the near future. Recent faculty research and grant-writing productivity is summarized in Appendix 1.

## *Alumni Contributions*

Alumni of the Department of Biology provide significant financial support for our program (see data under Question 5). This financial support underwrites important aspects of our program, including equipment acquisition, upgrading of facilities, and financial assistance for students. Career success and career satisfaction of our graduates is responsible for this support which strengthens the University as a whole and enhances academic success of all students who take courses offered by the Department, whether they are majors or not.

# 4. What is the state of demand for graduates of – and employment in – the program?

A high percentage of Biology graduates pursue graduate or professional degrees immediately after earning their bachelor's degree. Seventy percent of Andrews biology graduates who applied to medical school from 2008–2021 were accepted, 1.6 times the national average, and more than 90% of those who apply to graduate programs are admitted. These admissions include doctoral programs at prominent schools such as the University of British Columbia, Louisiana State University, Vanderbilt University and Dartmouth College.

Employment data for persons trained in the biological sciences is strong and rising. For example, the U.S. Bureau of Labor Statistics Occupational Outlook Handbook (http://www.bls.gov/ooh) projects an average growth rate of 8% for all occupations between 2020 and 2030. But the projected percent change in employment during this same period for dentists is 8%, physicians and surgeons 3%, chiropractors 11%, optometrists 9%, podiatrists 2%, and veterinarians 17%. These are the professions that employ many of our graduates.

Table 4.1 summarizes the latest available (May 2021) United States government employment data for professions that employ most of our graduates.

**Table 4.1. Employment data for professions chosen by biology graduates in the United States. This table focuses on professions employing Andrews University Biology graduates. These are the latest available data from the U.S. Bureau of Labor Statistics, Occupational and Employment and Wages, May 2021** (https://www.bls.gov/oes/current/oes_stru.htm#25-0000).

| Occupation/labor code | No. employed in U.S. | Employment rise (%) | Mean hourly wage ($$) | Mean annual wage ($$) | Wage Rise (%) |
|---|---|---|---|---|---|
| Anesthesiologist/29-1211 | 31,130 | 8.1 | 159.22 | 331,190 | 2.0 |
| Family Medicine/29-1215 | 102,930 | 3.3 | 113.43 | 235,930 | 1.7 |
| Internal Medicine/29-1216 | 58,260 | 3.4 | 116.44 | 242,190 | 1.8 |
| Obstetrician/gynecologist/29-1218 | 21,570 | 10.1 | 142.41 | 296,210 | 2.2 |
| Pediatrician/29-1221 | 33,620 | 7.1 | 95.40 | 198,420 | 3.5 |
| Psychiatrist/29-1223 | 25,520 | 3.5 | 120.08 | 249,760 | 2.1 |
| Surgeon/12-1249 | 29,590 | 5.2 | 143.17 | 297,800 | 2.6 |
| Chiropractor/29-1011 | 35,810 | 2.5 | 39.06 | 81,240 | 1.4 |
| General Dentist/29-1021 | 108,680 | 3.3 | 80.37 | 167,160 | 1.8 |
| Oral/Maxillofacial Surgeon/29-1022 | 5,330 | 12.3 | 149.74 | 311,460 | 3.7 |
| Orthodontist/29-1023 | 5,140 | 11.4 | 128.50 | 267,280 | 6.0 |
| Prosthodontists/29-1024 | 790 | 30.4 | 69.10 | 143,730 | 18.3 |
| Optometrist/29-1041 | 38,720 | 3.6 | 60.31 | 125,440 | 1.2 |

| | | | | | |
|---|---|---|---|---|---|
| Physician Assistant/29-1071 | 132,940 | 1.6 | 57.43 | 119,460 | 0.6 |
| Veterinarian/29-1131 | 77,260 | 1.0 | 52.84 | 109,920 | 0.7 |
| Medical Research Scientist/19-1042 | 108,550 | 1.7 | 50.02 | 104,050 | 0.9 |
| Zoologist/Wildlife Scientist/ 19-1023 | 15,930 | 3.1 | 33.80 | 70,300 | 0.6 |
| Microbiologist/19-1022 | 19,430 | 3.9 | 42 | 87,820 | 1.4 |
| Conservation Scientist/19-1031 | 22,550 | 2.0 | 32.81 | 68,230 | 0.8 |
| Postsec. Biol. Science Teacher/25-1042 | 47,690 | 0.3 | N/A | 98,710 | 0.3 |
| Secondary Science Teacher/25-2031 | 1,020,240 | 1.0 | N/A | 69,530 | 0.5 |

As noted above, the demand for graduates from this program will remain robust over the next 10 years. Physicians, dentists, and other health professionals who earn biology degrees will be needed in increasing numbers as the Baby Boomer population ages. The AAMC predicts a total physician shortage of between 37,800 and 124,000 physicians by 2034 (https://www.aamc.org/media/54681/download). Thus, it is doubtful that our recent drop in enrollment is due to decreased market demand for Biology majors overall.

# Criterion 2: Program Quality

## 5. How do available human and physical resources relate to what is necessary to have a strong program of high quality that mentors students to succeed?

Twenty-first-century biological science is highly diverse and technically challenging. Excellent teaching and training in this area requires significant investments in human resources, equipment, supplies, and other resources. With rising costs, it is a continual struggle to maintain a strong program. But with the support of alumni and administrators who value our contributions to the University program, we have been able maintain particularly strong undergraduate and graduate programs in Biology.

### *Human Resources*

We have enjoyed, and we continue to enjoy, excellent, well-trained, and committed faculty. Long service by our faculty has been one of the Department's strengths. Another measure of our stability is the fact that in its 76-year history, the Department has changed chairs only seven times.

Figure 5.1 shows cumulative five-year maximums in numbers of Biology faculty at Andrews from 1920 (before a formal department was formed) to 2021. Note that the numbers of faculty have grown from only one to a maximum number of 11 in 2010. In 2012 five biology faculty either retired and left to work elsewhere representing the largest turnover in biology faculty in recent history. Thoughtful hiring practices led to the replacement of these faculty. Indeed, careful hiring has characterized this Department's history. Since the 1960s, we have been careful not only to hire good teachers, but to hire good teachers who value research. As of 2022 the 8 biology faculty members have worked a collective 104 years at Andrews University.

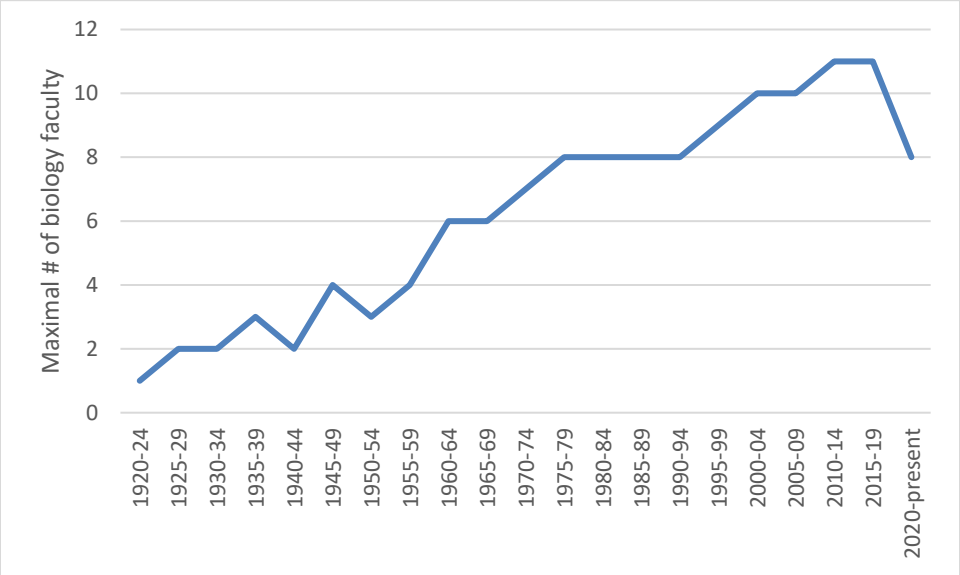



**Figure 5.1—Andrews University Biology faculty (budgeted positions) from 1920 to 2021.**

The research commitment on the part of faculty provides several benefits, not the least of which is the opportunity for students to participate at every level of the research process. For example, from 2015-2020 nineteen current or former biology students were authors on published papers. Over a 5 year time period over 100 oral and poster presentations presented at scientific meetings involved student authors (Fig. 3.4). Participation in the research process is formative for students and enhances their ability to enter graduate and professional school. A number of our former students are now professors at leading research institutions, including the University of Michigan, Mayo Foundation for Medical Education and Research, Auburn University, Cardiff University, and University of Connecticut. Many others are physicians and dentists with successful practices, and as a result of their experience in the Department of Biology, have learned to understand and value research as providing an important foundation for their careers.

## *Physical Resources*

The Department of Biology is housed in Price Hall, which consists of three floors plus a greenhouse "Andrews Botanical Conservatory"/animal facility penthouse in the University's Science Complex. Price Hall was completed in 1973, and houses offices for the 8 Biology faculty members. In addition to an office, each faculty member is assigned a research laboratory. The building contains seven teaching laboratories, a lecture hall that seats 142 students, and a

smaller classroom that holds approximately 40 students. A conference room is used for small seminar-type classes, meetings, and study. The Natural History museum contains a wide variety of biological specimens on display as well as scientific study collections. Additional rooms house scanning and transmission electron microscopes, darkroom, and a field equipment storage area.

With funds provided by alumni and the administration, the Department updates its equipment on a regular basis. For example, within the last 30+ years the Department has rotated through three scanning electron microscopes and two transmission electron microscopes. The Keyence computer-operated fluorescence microscope was acquired in 2018. Light and dissecting microscopes are relatively new. The Department also owns phase contrast and epifluorescence microscopes. Cell and molecular biology teaching and research is supported by an array of up-to-date equipment, including thermocyclers, laminar flow hoods, a $CO_2$ incubator, centrifuges, microcentrifuges, electrophoresis apparatus, Powerlab Intermediate Teaching Kits, and miscellaneous software.

A fourth-floor penthouse contains the spacious Andrews Botanical Conservatory with four large rooms plus a work area. An adjacent animal care facility contains four research labs and a cage-cleaning room. The Andrews Botanical Conservatory is well-maintained and contains a wide variety of tropical, desert, and temperate plants. Currently, the animal care facility requires new cage-cleaning apparatus plus a new ventilation system to meet with government requirements before it can be utilized to capacity.

Forty-nine-year-old Price Hall is in need of remodeling, including new tables in the teaching labs, attention to the leaking roof of the Andrews Botanical Conservatory and new flooring in select rooms including Price Hall 106, the Harold Heidtke amphitheater which is the largest teaching space in the department. Of particular concern are the labs used for teaching large, first year courses such as Anatomy and Physiology and Foundations of Biology: Price Hall 229 and 240. These labs have outdated lab benches and storage space. We will discuss the need for immediate upgrade of these labs in Section 15.

In the past a new research and development wing was envisioned for the Science Complex. Preliminary architectural plans have been drawn up. This facility would provide laboratory and office space for faculty and student researchers. Construction of this facility would occur in conjunction with the building of an atrium at the front of the Science Complex. The atrium would serve as an area for exhibit and facilitate social interaction.

## *Alumni Support*

Quality education in the biological sciences costs a great deal of money. Lab equipment is expensive and needs to be updated on a regular basis. Laboratory space sometimes needs to be renovated. Outstanding students must be rewarded with scholarships. The University provides what funds it can, but these funds are limited and insufficient to maintain the quality of education students deserve and have come to expect. Our alumni have provided crucial support in this area. Over the past 10 years, alumni have contributed more than a half million dollars to the Department of Biology (Fig. 5.2). The dept. has recently also benefited from more targeted donations. Alumni have provided financial support for establishing a scholarship fund for female graduate students (2020) and for the renovation of the Natural History Museum (2021).

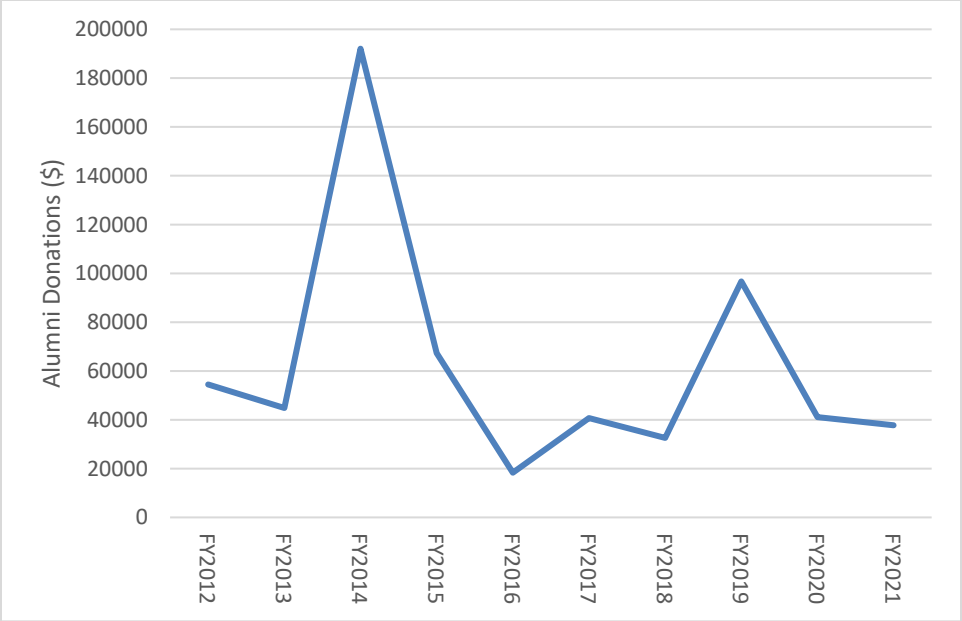



**Figure 5.2—Fiscal year revenue provided by Andrews University Biology alumni, 2012–2021.**

# 6. What library resources are necessary for the program, and to what extent are they available and utilized?

## *Library Resources Necessary for the Program*

Biological knowledge is growing extremely fast. Analysis of publications in the Life Sciences shows a current annual growth rate approaching 5% (Fig. 6.1) Clearly the challenge faced by libraries at educational institutions is daunting, to say nothing of the challenge faced by students seeking information on a particular topic. A given library is capable of providing physical access to a mere sliver of information onsite. Fortunately, numbers of online, open-access journals are rapidly expanding. (Although care must be used in which ones to trust; increasing numbers of these e-journals are run by for-profit, overseas, fraudulent organizations). Funding organizations such as the National Institutes of Health mandate open access to information generated from funded research, and many non-open-access journals now publish online enhancing accessibility.

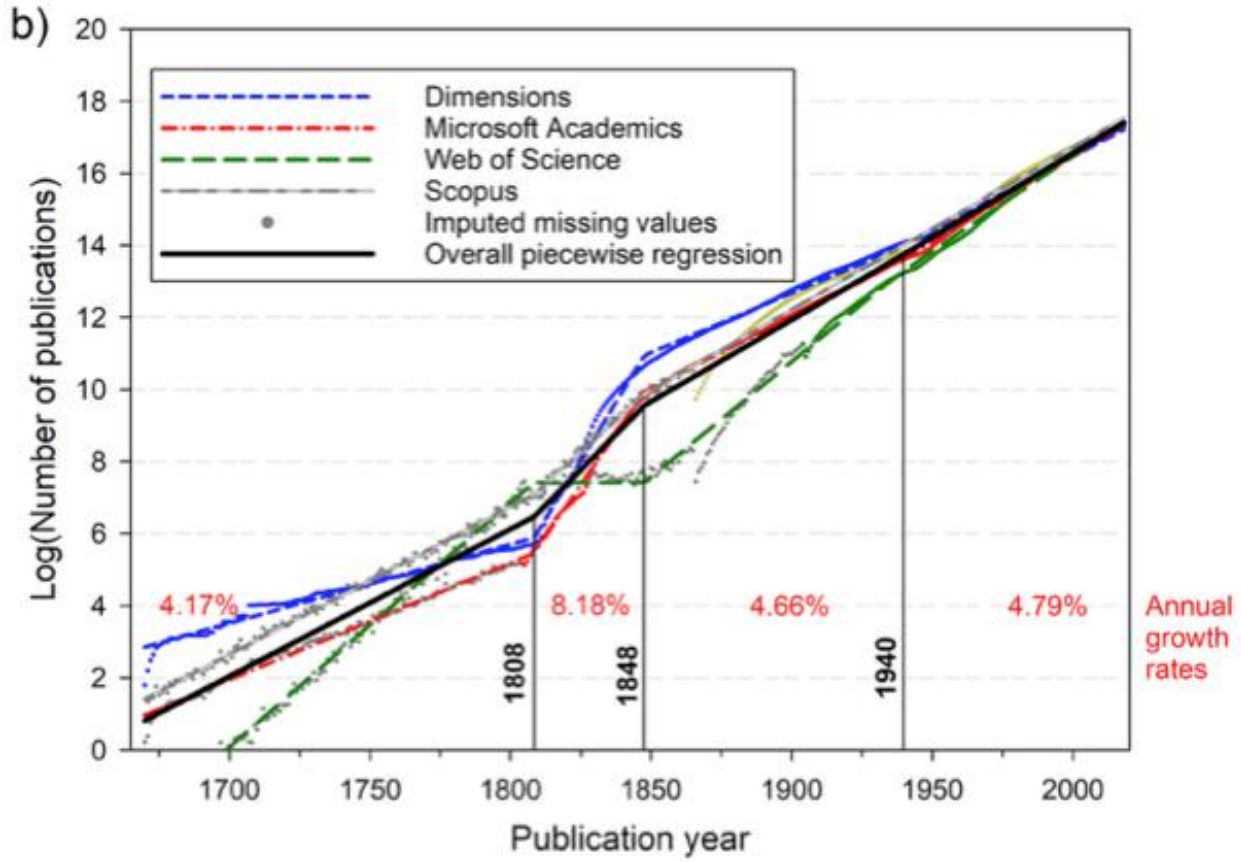



**Fig. 6.1. Growth of scientific knowledge in the life science publication based on 4 databases. Taken from: Bornmann, L. et al. 2021. *Growth rates of modern science: a latent piecewise growth curve approach to model publication numbers from established and new literature databases*. Humanities and Social Sciences Communications 8:224**

Andrews University is located only 21 miles from the University of Notre Dame which offers a Ph.D. program in biology. Biology journal holdings at Notre Dame are substantial. Other regional research libraries include those at Western Michigan University (60 miles distant) and Michigan State University (135 miles distant). Moreover, James White Library (JWL) at Andrews University, which houses three-quarters of a million volumes, is a member of the Midwest Collaborative for Library Services (MeLCat) which provides access to books, audio recordings, and video recordings owned by 433 libraries, including 51 academic institutions. The interlibrary loan service provided by JWL provides access to nearly journal articles owned by any library.

Table 6.1 highlights JWL book holdings by decade of publication. It is important to realize that books typically represent secondary sources of information in the sciences.The JWL subscribes to a number of electronic resources for books in the life sciences. For example E-book Central have more than 4722 titles in Biology that are accessible through the JWL website.

**Table 6.1—James White Library biology book holdings by decade of publication. The following Library of Congress Classification was used: General Biology: QH301-QH705; Botany: QK; Zoology: QL; Physiology:QP; Microbiology: QR; Human Anatomy: QM. Data as of July 5, 2022.**

| Decades | General Biology | Botany | Zoology | Microbiology | Physiology | Human Anatomy |
|---|---|---|---|---|---|---|
| 1970 | 540 | 401 | 987 | 130 | 531 | 42 |
| 1980 | 313 | 238 | 741 | 129 | 448 | 77 |
| 1990 | 513 | 231 | 732 | 247 | 628 | 37 |
| 2000 | 1097 | 366 | 1598 | 332 | 965 | 75 |
| 2010 | 824 | 309 | 1629 | 268 | 904 | 96 |
| 2020 | 2 | 4 | 8 | 15 | 15 | 6 |
| | | | | | | |
| **Totals** | **3289** | **1549** | **5695** | **1121** | **3491** | **333** |

**Table 6.2—James White Library book budget allocation for the Department of Biology over the past 5 years.**

| Fiscal Year | Biology Book Budget Allocation | Biology Book Expenditure |
|---|---|---|
| 2017-18 | $3,273.90 | $2,258.00 |
| 2018-19 | $3,273.90 | $346.62 |
| 2019-20 | $3,273.90 | $1,921.87 |
| 2020-21 | $2,095.29 | $922.25 |
| 2021-22 | $976.23 | $289.43 |

Biology, as a discipline, is largely journal dependent in terms of accessing published biological information. Thus journal access is critical to the life sciences. Although the JWL does not currently subscribe to print journals in life science the library has electronic access to 1473 journals in General Biology, 1305 Journals in Human Anatomy, 3762 journals in Zoology, 1033 journals in Physiology, and 952 journals in Microbiology. All are accessible through the JWL website via electronic collections such as JSTOR, Academic Search Complete, Science Direct, Springerlink, EBSCO-EJS, Oxford Journals online and Wiley Online library. Collectively the annual (2022) cost for these 7 resources is $229,594. Thus, it can be argued that the access to biological literature by biology students and faculty has markedly increased in recent years as a result of electronic resources. Many journals have free full-text access 6 months after publication so the resulting access to biological information is immense.

## *Comparison with Benchmark Institutions*

Table 6.3 compares numbers of library resources at benchmark institution libraries. The availability of both print and electronic resources at Andrews University compares favorably with other institutions with Andrews ranking 3rd out of the 10 institutions in terms of total library collections (physical and electronic). In comparison with benchmark institutions, the JWL print

collection is by far the largest. How the print collections in the life sciences compare is impossible to tell from these numbers.

**Table 6.3—Library resources of benchmark institutions as of spring 2022 (select eJournal collections) or 2020 (total physical and electronic collections). Source: IPEDS Data Center. +: resource available at institution, -: resource not available at institution.**

| Andrews Univ. | Southern Adv. U. | La Sierra University | Walla Walla U. | Wheaton College | Denison University | Messiah University | Allegheny College | College Wooster | Seattle Pacific U. |
|---|---|---|---|---|---|---|---|---|---|
| **Total Physical library collections (books, media & serials:** 702,712 | 188,234 | 567,196 | 168,466 | 420,657 | 505,942 | 252,170 | 275,063 | 473,619 | 236,043 |
| **Total Electronic library collections (books, databases, media & serials):** 1,634,054 | 318,350 | 262,735 | 695,934 | 220,428 | 2,198,756 | 914,012 | 884,737 | 2,387,409 | 480,875 |
| **Wiley:** + | - | | + | + | + | - | + | + | - |
| **Springerlink:** + | + | | _ | + | + | + | + | + | - |
| **Sage:** + | + | | + | + | - | + | + | - | - |
| **Science Direct:** + | - | | + | + | - | + | - | + | - |

## *Extent to Which Library Facilities Are Utilized*

Table 6.4 shows usage of select electronic resources in biology. It is important to realize that both print and electronic resources connected to the Life Sciences are also utilized by students in Medical Laboratory Sciences, Nursing, Public Health, Physical Therapy, and other majors. Utilization of the primary literature by Biology majors and faculty at the University is impossible to track given online access to many of these sources through non-library search engines such as Google Scholar and full-text access at journal-specific websites.

**Table 6.4—eJournal collection usage (Jan.-Dec. 2021) for select Life Science Resources (James White Library).**

| eJournal Collection | Total Searches | Total Items Viewed or Downloaded |
|---|---|---|
| Wiley | 35,225 | 10,555 |
| Springerlink | 10,344 | 8,410 |
| Sage | 3,261 | 2,829 |
| Science Direct | 12,699 | 9,002 |

As indicated by Table 7.4, literature searches, research papers, poster presentations, and oral presentations are required in a variety of upper division courses in Biology. Moreover, students who present talks and posters or who serve as coauthors on peer-reviewed papers also must access the literature. Thus, it is fair to say that library facilities and online search engines are heavily used by Biology students and faculty in the course of their educational and research activities.

## *Interconnectedness of Library Needs and Use*

Library books, journals, and search engines useful to the Department of Biology benefit other departments, in the same way library resources most useful to other departments benefit Biology. Topical overlap is common and interdisciplinary thinking and activity is *de rigueur* in academe today. Thus, biologists do research and thinking that overlaps with that of physics, chemistry, nursing, physical therapy, medical laboratory science, behavioral science, mathematics, engineering, and other fields. Consequently, library resources connected to one department will benefit many other departments.

# 7. How rigorous is the curriculum for the preparation of graduates with skills necessary to adapt to changing environments and technology within their field? How well does the program engage students in collecting, analyzing, and communicating information, and in mastering modes of inquiry or creative work?

## *Description of Program and Curriculum Rigor*

A student who majors in Biology at Andrews can take any one of three "emphases", each of which features a specially-designed curriculum: Biomedical, Biological Sciences & Neuroscience. All emphases feature a Biology Core, Cognate Core, Andrews Core Experience (ACE) Cognates, and a set of upper division courses consistent with the chosen emphasis.

***Biology Core.—***The Biology Core features a set of courses that emphasize both theoretical and practical aspects of contemporary life science. Students who complete these courses are prepared to take more specialized, upper-division electives, and they obtain the skills and experience necessary to adapt to the rapidly-changing technologies associated with science and science-related professions.

Theoretical aspects are covered in Foundations of Biology (10 credits), Research Seminar in Biology (features scientists reporting on current research; 0 credits) General Ecology or Field Ecology (3 credits), Genetics (3 credits), Cell and Molecular Biology (3 credits), and Historical and Philosophical Biology (3 credits). All these courses except Biology Seminar feature weekly laboratories that provide experience in data collection, data analysis, and careful observation of biological processes. Foundations of Biology features a comprehensive treatment of life, from

the molecular to the ecological scale. Many university foundational courses in biology, usually titled "General Biology", consist of 8-credits. Our 10-credit course provides an exceptionally rigorous introduction to the discipline. General Ecology, Genetics, Cell and Molecular Biology, and Historical and Philosophical Biology provide more in-depth coverage of the major theoretical ideas in contemporary life science.

More practical aspects of the practice of biology are emphasized in two additional core courses, Biostatistics and Research Design (3 credits) and Scientific Communication (2 credits). These two courses provide students with an opportunity to develop the analytic and communication skills important in the practice of modern science.

***Cognate Core.—***In addition to the Biology Core, majors are required to successfully complete full-year courses in General Chemistry (8 credits), Organic Chemistry (8 credits), and either General Physics (8 credits) or the calculus-based Physics for Scientists and Engineers (10 credits). All cognate core courses feature weekly labs in which students learn basic procedures associated with the practice of each of the sciences addressed. It should be noted that our Department of Chemistry program, in which majors take 16 science cognate credits, is approved by the American Chemical Society, the only chemistry program in the Seventh-day Adventist system that enjoys this approval. The majority of biology majors also take Biochemistry I (4 credits) giving them enough credits for a chemistry minor.

***General Education Cognates.—***The ACE Cognates have been chosen from a broader slate of possibilities to provide graduates with the ethical, quantitative, and social skills necessary to excel in today's competitive workplace.

Bioethics and Christian Faith (3 credits) is a course designed to give students an opportunity to wrestle with bioethical issues in the context of Christian faith. The course is taught by Rahel Wells Ph.D.. She has both B.S. and M.S. degrees in biology which make her especially well-suited to teach this course.

Biology majors are required to take one 4-credit course in mathematics. They are encouraged to take Calculus I, but they may take Precalculus if they are not prepared for calculus. A facility with mathematics, and particularly calculus, is important and often necessary for contemporary work in the biological sciences ranging from molecular scales to ecosystem scales of complexity.

Premedical students enrolled in the Biomedical Emphasis program are required to take both Introduction to Psychology (3 credits) and Principles of Sociology (3 credits), with the recognition that the successful practice of medicine involves interpersonal skills as much as technical expertise and knowledge.

***Upper Division Electives.—***The various areas of emphasis feature clusters of upper division courses that round out the biology knowledge and experience base of students. The total course credits for these electives range from 12 to 15, depending on the emphasis. Students can draw on the expertise of other departments in their choice of elective credits including the chemistry/biochemistry dept., School of Rehabilitation Sciences and the department of Sustainable Agriculture. Through our affiliation with Walla Walla University students can also take coursework at the Rosario Beach Marine Laboratory during the summer semester. Details concerning specific classes can be found in the current academic bulletin.

## *Comparison of the Andrews B.S. Biology Program with Benchmark Programs*

Comparisons in Table 7.1–7.3 are for B.S. in Biology programs. Credit hours for nontraditional programs (such as at College of Wooster) are estimated where possible. Credit hours are shown as semester values (1 quarter credit = 2/3 semester credit).

**Table 7.1—Features of benchmark institutions. (No adjuncts, emeriti, or visiting professors reported; school enrollments based on 2020 *U.S. News and World Report* data; numbers of B.S. in biology majors based on Fall 2021 data from the respective department chairs/registrars). Faculty numbers as of July 2022.**

| Data category | Andrews Univ. | Southern Adv. U. | La Sierra Univ. | Walla Walla Univ. | Wheaton College | Denison Univ. | Messiah University | Allegheny College | College of Wooster | Seattle Pacific Univ. |
|---|---|---|---|---|---|---|---|---|---|---|
| No. of under-grads enrolled | 1,647 | 2,384 | 1,745 | 1,545 | 2,265 | 2,258 | 2,614 | 1,667 | 1,924 | 2,702 |
| No. of B.S. majors in Biology | 105 | 205 | 154 | 103 | 137 | 115 | 164 | 88 | No data | 294 |
| Percent of students who are B.S. in Bio majors | 6.4% | 8.6% | 8.8% | 6.7% | 6.0% | 5.1% | 6.3% | 5.3% | – | 10.9% |
| Master's in Biology program | Yes | No | No | Yes | No | No | No | No | No | No |
| No. faculty with PhD degree | 8 | 7 | 9 | 7 | 6 | 15 | 10 | 13 | 13 | 12 |
| No. faculty with Master's degree | 0 | 2 | 0 | 0 | 1 | 0 | 2 | 1 | 0 | 0 |
| No. faculty with MD or DVM degree | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| B.S. Biol student to biology faculty ratio | 13:1 | 19:1 | 17:1 | 15:1 | 20:1 | 7:1 | 14:1 | 6:1 | – | 23:1 |
| Total no. of Biology faculty: | 8 | 11 | 9 | 7 | 7 | 16 | 12 | 14 | 13 | 13 |

**Table 7.2—Comparison of biology core and elective courses among benchmark institutions.**

| Andrews Univ. | Southern Adv. U. | La Sierra Univ. * | Walla Walla U. * | Wheaton College | Denison Univ. | Messiah University | Allegheny College | College of Wooster ** | Seattle Pac. U. * |
|---|---|---|---|---|---|---|---|---|---|
| Foundation course: 10 credits | General Biology: 8 credits | General Biology: 10 credits | General Biology: 8 credits | Gen Bio equiv: 12 credits | General Bio equiv: 12 credits | General Bio equiv: 9 credit | General Bio equiv: 8 credits | Foundations of Biology: 4 credits | General Biology 10 credits |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Biostatistics & Research Design: 3 credits | Biological Analysis 3 credits | Biostatistics: 2.7 credits | Biostat-istics: 2.7 credits | Modeling Systems of Life: 4 credits | | | Investigative Approaches in Biology: 4 credits | Research Skills in Biology: 4 credit | Biology Cornerstone Seminar: 0.7 credits |
| Scientific Commun-ication: 2 credits | | Gen. Biology Seminar: 0 credits | Introduction to Biol Research: 1.3 credits | | | | | | |
| | | Sophomore Biology Sem: 1.3 credits | Journal Club: 0.7 credits | | | | | | Scientific Literature: 0.7 credits |
| General Ecology: 3 credits | General or Field Ecology 3 credits | General Ecology: 3.3 credits | General Ecology: 2.7 credits | | | Ecology: 4 credits | | Gateway to Ecology, Evolution, and Organ Bio: 4 credits | |
| Genetics: 3 credits | Genetics: 4 credits | Genetics: 3.3 credits | Cell Biology II: 2.7 credits | Genetics: 4 credits | | Genetics: 4 credits | | | Genetics: 3.3 credits |
| Cell & Molec. Bio: 3 credits | Cell & Molec. Bio: 4 credits | Cell & Molec. Bio: 3.3 credits | Cell Biology I: 2.7. credits | | | | | Gateway to Molec. & Cell. Biology: 4 credits | Cell Biology: 3.3 credits |
| | | Develop-mental Biology: 3.3 credits | | | | | | | |
| Historical & Phil. Bio: 3 credits | Issues in Nat. Sci. & Relig: 3 credits | | Phil. of Origins & Speciation: 2 credits | | | | | | Evolutionary Mechanisms: 3.3 credits |
| | | Colloquium: 0 credit | Colloquium: 0 credits | | | | Junior Seminar: 4 credits | Junior Ind Study & Biostats: 4 credits | Biological Research & Proposal: 2 credits |
| Biology Seminar: 0 credits | | Biology Seminar: 1.3 credits | Senior Seminar: 1.3 credits | The Integrated Biologist: Senior capstone: 2 credits | | Capstone: 3 credits | Senior Seminar: 6 credits | Senior Ind. Study Thesis: 8 credits | Nat. Science Seminar: 1.3 credits |
| Electives: 15 credits | Electives: 9 credits | Electives: 16 credits (choose one emphasis) | Electives: 17.3 credits | Electives: 14 credits (take one cluster of choice) | Electives: 15 credits (5 300-level courses) | Electives: 16-20 credits | Electives: 12 credits (3 300-level courses) | Electives: 20 credits (5 300-level courses) | Electives: 10 credits |
| TOTALS: 37-45 cred | 42 credits | 25.3 credits + 16 (emphasis) = 41.3 total * | 42 credits * | 36 credits | 32 credits (8 courses) | 36-40 credits | 34 credits | 48 credits | 34.7 credits |

**Table 7.3—Comparison of Cognate Core requirements at Andrews University with requirements at benchmark institutions. (Included are mathematics and statistics courses which at Andrews University are considered part of the General Education Core).**

| **Andrews Univ.** | **Southern Adv. Univ.** | **La Sierra Univ.** | **Walla Walla Univ.** | **Wheaton College** | **Denison Univ.** | **Messiah Univ.** | **Allegheny College** | **College of Wooster** | **Seattle Pac. Univ.** |
|---|---|---|---|---|---|---|---|---|---|
| General Chemistry: 8 credits | General Chemistry: 8 credits | General Chemistry: 10 credits | General Chemistry 8 credits | General Chemistry: 8 credits | Intro-level Chem: 8 credits | General Chem: 8 credits | General Chem equiv: 8 credits | General Chem: 8 credits | General Chem: 6.7 credits |
| Organic Chemistry: 8 credits | Organic Chemistry: 8 credits | Organic Chemistry: 6.7 credits | Organic Chemistry: 8.7 credits | Principles of Organic Chemistry: 8 credits | Organic Chem: 4 credits | Organic Chem: 8 credits | Organic Chem: 4 credits | #Organic Chem: 4 credits | Organic Chemistry: 10 credits |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Physics: 8 or 10 credits | General Physics: 8 credits | General Physics: 10 credits | General Physics: 8 credits | | | Intro. to Physics I or II OR Gen Physics: 4 credits | | #Physics: 5 credits | (recommended, not required Physics: 10 credits) |
| Precalculus /Calculus: 4 credits | Statistics or Precalculus: 3-5 credits | Calculus I: 2.7 credits | Precalculus: 2.7-3.3 credits OR Calulus for Life Sciences I & II: 5.3 cr | | | Intro Stats & Calculus I or Intuitive Calc with Applications: 6-7 credits | Calc I with Precalc OR Calculus I: 4 credits | #Calculus: 4 credits | Intro Stats for Sciences 3.3 <u>and</u> Calculus: 3.3 credits= 6.6 credits |
| Biochem: 4 credits | | | | | Science cognate courses: 4 = 16 credits | Problems in Philosophy or Hist. of Phil: 3 credits | Science/Math electives: 8 credits | | Choice of Quat Analysis <u>OR</u> G Chem III & Inorganic Qualitative Analysis <u>OR</u> Biostats: 3.3 credits |
| TOTALS: 32-34 cred | 22-23 credits | 29.4 credits (44) | 27.4-30 credits | 16 credits | 28 credits | 29-30 credits | 24 credits | 12-13 credits | 26.7 credits |

***Comments on Features of Institutions.—***Of the 10 schools compared, Andrews has next to the smallest overall undergraduate enrollment; undergraduate enrollment at Walla Walla is somewhat smaller. Yet, of the 10 schools, only Andrews and Walla Walla offer master's degree programs in biology. Total numbers of faculty in the compared schools range from 7 to 16. Thus, the 8 Biology faculty members represent an intermediate-sized department in comparison with benchmark institutions. Moreover, the Biology major/Biology faculty ratio of 13 to 1 is also intermediate for the schools compared. Each of the Andrews Biology faculty has an earned Ph.D. degree.

Among the institutions for which data are available, the percent of all enrolled undergraduates who are B.S. in Biology majors is intermediate; one of every 16 undergraduates at Andrews University is a Biology major.

***Comments on Biology Core and Electives.—***Comparisons between Andrews University Biology Core with those of other institutions are complicated by considerable variability in course and curriculum structure. Although most of the benchmark institutions feature more traditional programs, Denison, Allegheny, and especially Wooster possess programs that depart significantly from traditional curricula.

Andrews, like Walla Walla, features a core curriculum in which course content and sequence is quite constrained. Indeed, curricula of these two institutions exhibit the most similarities among those compared, an understandable outcome given that eight Andrews faculty were either students or faculty members at Walla Walla (Chobotar, Hayward, Ritland, Snow, Stout, Thoresen, Woodland, Zdor).

Seven of the 10 institutions compared, including Andrews, offer special coursework in research and/or biostatistics, three require ecology, six require genetics, four require cell biology, and all but one requires a senior capstone course. Developmental biology is required only by La Sierra, although Messiah teaches a combined course in genetics and development.

Three of the four Seventh-day Adventist institutions require courses that focus on philosophies related to the history of life. This emphasis arises out of a traditional interest in this topic from a doctrinal position. The non-SDA institutions offer more standard courses in

evolutionary biology. This no doubt contributes to the fact that Andrews students perform less well in this area on the Major Field Test than in other areas of the test.

Biology credit requirements for the B.S. degree at the 10 schools range from 32 to 48. Andrews, with Walla Walla, is at the high end of this range, whereas Denison Univ. is at the low end. Denison and Wooster seem to allow the most flexibility in their program, whereas Andrews and Walla Walla are the most rigidly structured.

***Comments on Cognate Core, including Mathematics and Statistics.—***All 10 programs require 8 to 10 credits of general chemistry in the cognate core. All (including Andrews) but two of the programs require 8 to 10 credits of organic chemistry; the remaining two require only 4 credits of organic. Seven of the 10 programs (including Andrews) require a full academic year of physics; Messiah College requires only one semester of physics. Seven of the 10 programs require a term of either statistics or calculus; three (including Andrews) allow students to take only precalculus or Quantitative Skills (Wheaton only). Three of the 10 programs (including Andrews) require biochemistry. Total cognate core and mathematics requirements range from 18 credits (Wheaton) to highs of 32 to 36 credits at Denison, Andrews, and Seattle Pacific.

Biology majors at Andrews are as well trained as students from any of the other nine schools in general and organic chemistry, physics, and biochemistry. Unless they elect to take calculus, however, they may be less well trained in mathematics than students at La Sierra, Allegheny, and Wooster.

***Assessment of Curriculum Rigor.—***The Department of Biology offers a rigorous program in contemporary life science. Evidence that graduates leave the department with skills necessary to adapt to changing environments and technologies in their fields is derived from several sources: 1) Our majors perform well above the national average on the Major Fields Test (see Table 9.1); 2) our former majors excel in their professions as is indicated by a high rate of annual financial giving by alumni in support of the department (see Fig. 5.2); and 3) our preprofessional graduates commonly report they are better prepared for their professional programs than most of their peers.

## *Engagement of Students in Collecting, Analyzing, and Communicating Information, and in Mastering Modes of Inquiry and Creativity*

***Laboratory Experiences.—***Most biology courses at Andrews feature a laboratory component. Many laboratory exercises are designed to engage students in collecting, analyzing, and communicating scientific information. This process begins in Foundations of Biology in which students are required to produce formal laboratory write-ups for several experimental labs during the year. Moreover, first year students gain experience with probability theory and simple statistical testing. Table 7.4 details the types of student experiences featured in Andrews University's Biology courses.

**Table 7.4—Student experiences in courses with data handling and creativity.**

| Course | Lab reports | Literature searches | Research projects | Research papers | Poster presentations | Oral presentations |
|---|---|---|---|---|---|---|
| Foundations of Biology | X | | | | | |
| Human Biology | X | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Genetics | X | | X | | | |
| Cell and Molecular Biol | X | X | | | | X |
| General Ecology | X | X | X | X | | |
| Developmental Biology | X | | X | | | X |
| Biology of Bacteria | X | | X | | | X |
| Molecular Genetics | | | | | | X |
| Medical Microbiology | X | X | | X | | X |
| Animal Behavior | X | | | | | |
| Neurobiology | X | | X | | | |
| Neuropsycho-pharmacology | X | X | X | X | X | X |
| Paleobiology | | X | X | | | |
| Systems Physiology | | X | X | X | X | X |
| Genomics, Proteomics, & Bioinformatics | | | X | | X | |

***Biostatistics and Research Design (BIOL 280).—***This 3-credit course features probability, basic study design, descriptive statistics, sampling, contingency tables, t-tests, one- and two-way analysis of variance, correlation, and simple linear regression. Computational exercises will use Excel and SPSS statistical packages. Students completing this course will use what they have learned to collect and analyze data collected in upper division courses taken during their junior and senior years.

***Scientific Communication (BIOL 305).—***This 2-credit course provides a practical introduction to communication in science, including the development of fundamental skills required to convey information in the form of grant proposals, oral presentations, and research articles. Prerequisites for Scientific Communication include two semesters of English Composition and one course in Communication Skills.

***Senior Honors Project (HONS 497).—***From 2005 to 2013, 32% of graduating Biology majors graduated as Honors students. One requirement of the Honors program is completion of a research project. The original research project is designed and completed in consultation with a faculty mentor. Undergraduate research stipends of $1000 in support of this research can be applied for through the University's Office of Research and Creative Scholarship. Honors students communicate the results of their work in three ways: a poster presentation, an oral presentation, and a written report.

***Non-Honors Research Projects.—***Biology majors not enrolled in the Honors program commonly elect to do a research project. These students are eligible for undergraduate research stipends of $1000 just like the Honors students. These students are expected to present their results in the form of a written report, and also have an opportunity to present a poster presentation of their work.

***Presentations at Scholarly Conferences.—*** Over a 5 year time period over 100 oral and poster presentations presented at scientific meetings involved student authors (Fig. 3.4).

***Coauthorship in Peer-reviewed Publications.—*** From 2015-2020 nineteen current or former biology students were authors on published papers.

***Assessment of Data Handling, Modes of Inquiry, Communication, and Creative Involvement.—***Biology majors begin to gain experience collecting, analyzing, and communicating information during their freshman year in Foundations of Biology laboratories. In their sophomore and junior years, majors take two courses specifically designed to give students experience with experimental design, sampling, data analysis, and communication of results. Moreover, laboratories in most upper division courses feature opportunities for students to become involved with data collection, analysis, and communication in which they make use of the skills learned in these sophomore and junior methodology courses.

All Biology majors gain experience in mastering modes of inquiry and creativity in required courses. In addition, a large proportion of our students enroll in the University's Honors program which requires significant creative involvement in original research in collaboration with faculty mentors. Of the total of 344 students who graduated as a JN Andrews Scholar from 2012-2022 84 or 24.4% were biology majors. In fact of all the academic majors represented in the Honors program students with a biology major are the largest single major represented. At the very least, each resultant project results in an Honors thesis which is permanently housed in the James White Library. In addition, many projects end up as peer-reviewed publications or as components of peer-reviewed publications for which students serve as co-authors with their mentors.

In short, our program provides significant opportunities for students to hone their skills in the collection, analysis, and communication of scientific information and the mastering of modes of inquiry and creativity.

# 8. How do the various measures of outputs and research and teaching productivity contribute to and demonstrate the quality of the program?

## *Output of Graduates*

An important measure of output is the number of undergraduate students enrolled each year in the Biology program and the number of seniors each year who graduate with a Biology degree (Table 3.1). Yearly numbers of majors increased dramatically during the early 2000s, and then experienced a decline following the 2010-2011 academic year. But numbers of majors continue to be more than twice as high as they were during the 1970s and early 1980s.

Graduate student numbers (Table 3.2) have declined in recent years, due in part to a non-competitive financial package offered to prospective students. This problem has been addressed and a financial package is in place which is considerably more competitive with those of Loma Linda University and Walla Walla University, our chief competitors for graduate students.

From 5.1% to 10.9% of students are B.S. in Biology majors at the nine institutions for which data are available. The 6.4% of Andrews University undergraduates who are biology majors represents a mid-point in this distribution. Thus, our productivity in terms of relative

numbers of biology majors is respectable and representative, and indicates the attractiveness of our program to students.

## *Teaching Output*

Tables 3.1, 3.2, and 7.1 report measures of teaching output. Of special interest in the context of Question 8 is how our program compares with others in terms of biology student to faculty ratios. Numbers of biology students per faculty member range from 6.1 to 23.1 for the nine institutions for which we have data; Andrews has 13.1 biology students per biology faculty member. The two institutions that have graduate programs in biology, Walla Walla University and Andrews University, have similar biology student: biology faculty ratios.

## *Research Output*

Figures 3.3 and 3.4 provide data on research output by Andrews University faculty and students from 2016 to 2020. Many of these publications and presentations include students as coauthors. From 2015-20 nineteen current or former biology undergraduate students were coauthors on published papers.

The data reported in the last paragraph represent low to modest levels of research output for a department of 8 faculty members, all with Ph.D. degrees. These numbers suggest that Andrews Biology faculty members devote considerably more attention to teaching and advising than to research. Certainly this might be expected – perhaps even desired – for a department that serves primarily undergraduate students. However, with the increasing emphasis on the value of research and critical thinking in higher education, our level of research output should be improved. Any increased emphasis in this area, however, should not interfere with the teaching quality for which the Department of Biology is known. But it is important to remember that some of the best teaching occurs in a research setting.

With the exception of one faculty member all biology dept. faculty have successfully advanced to the rank of Professor demonstrating that they have satisfied university-wide standards of scholarship. The department has benefited from several external grants (Appendix 1) and recognition with Dr. Daniel Gonzalez-Socoloske being granted the status of National Geographic Explorer in 2022, a rare distinction among SDA biologists. Most importantly, new research opportunities will provide crucial training for our students.

# 9. How well are students meeting the program's learning outcomes? How do your program's student learning outcomes support the University curricular and co-curricular goals?

## *Expected Student Learning Outcomes*

As part of its Mission Statement, the Department of Biology has developed a series of five expected student learning outcomes for its students. Each of these outcomes is listed below with

a response as how the Department is facilitating achievement of the outcome. A curriculum map for where these outcomes are introduced and developed in depth in the core curriculum is presented in Appendix 2.

### *1. Demonstrate an integrated understanding of biological science*

**"As a group in comparison to other institutions, Andrews University Biology students will score: ≥ 80 percentile on the Major Field Test (MFT) composite score, with an aspiration to be ≥ 90th percentile; and ≥ 70th percentile in each of the four subscores of the MFT (Cell Biology, Molecular Biology & Genetics, Organismal Biology, Population Biology and Evolution) – with aspiration to be ≥ 80th percentile."**

The most objective measure of learning outcomes consists of scores by senior biology majors on the Major Field Test for Biology published by the Educational Testing Service (ETS). This 2-hour test consists of 150 multiple-choice questions. Questions are grouped into four sections: 1) cell biology; 2) molecular biology and genetics; 3) organismal biology; and 4) population biology, evolution, and ecology. Questions evaluating analytical skills constitute approximately 25% of the test and are distributed among the four sections.

Table 9.1 provides percentile scores for Andrews University Biology seniors as groups for 10 academic years, 2011–2021.

**Table 9.1—Percentile group scores for Andrews University Biology seniors, 2011-2021. Yellow: incomplete senior student cohort due to COVID-19 pandemic.**

| Academic Year | Cell Biology | Genetics & Molecular Biology | Organismal Biology | Ecology & Evolution | Analytical Skills | Composite Score |
|---|---|---|---|---|---|---|
| 2011-2012 | 97 | 96 | 98 | 78 | 92 | **94** |
| 2012-2013 | 84 | 80 | 88 | 66 | 81 | **83** |
| 2013-2014 | 93 | 87 | 98 | 88 | 91 | **94** |
| 2014-2015 | 76 | 90 | 93 | 80 | 83 | **89** |
| 2015-2016 | 97 | 96 | 98 | 87 | 97 | **97** |
| 2016-2017 | 77 | 87 | 86 | 70 | 75 | **80** |
| 2017-2018 | 97 | 87 | 89 | 75 | 87 | **91** |
| 2018-2019 | 85 | 89 | 87 | 49 | 69 | **82** |
| 2019-2020 | 79 | 59 | 83 | 51 | 54 | **70** |
| 2020-2021 | 90 | 91 | 88 | 70 | 80 | **86** |

***Cell Biology.—***Andrews University Biology seniors scored at the 90th percentile or higher for 5 of the past 10 years. These results suggest that our Foundations of Biology and Cell and Molecular Biology courses are doing an outstanding job preparing our students.

***Genetics and Molecular Biology.—***The lowest percentile achieved in this section of the exam was 59th percentile. However for the rest of the past 10 years, however, the group score was at or above the 80th percentile, and reached at least the 90th percentile during four years.

Thus, our courses in Genetics and Cell and Molecular Biology have done an above-average job preparing our students.

***Organismal Biology.—***Excluding the first year of the COVID-19 pandemic (2019-20) seniors averaged a percentile of 92 with three years of performing at the 98$^{th}$ percentile: the highest percentile achieved of the five sections for the past 10 years.

***Ecology and Evolution.—***The lowest score for this section was 49$^{th}$ percentile. Scores on this section of the exam tend to average lower from year to year than for other sections. There are two possible reasons for the somewhat lackluster performance on this section during some years. First, almost all our students are oriented toward some medically-related field and sometimes fail to see the importance of ecology to their life goals. Second, most of our students come from religiously conservative homes and schools, and as such have been under trained in concepts of evolutionary biology. In light of these results efforts have been to reinforce the understanding of evolutionary biology in BIOL435.

***Analytical Skills.—***Questions related to analytical skills are scattered throughout the other four sections of the exam. This area has exhibited the most variability over the years (54-97 percentile). It is our hope that the required Biostatistics and Research Design course and an emphasis in quantitative reasoning in a variety of classes students will improve in their analytical skills.

***Composite Scores.—***Composite percentile scores ranged from the 82$^{th}$ to 94$^{th}$ percentiles (excluding 2019-20). These results suggest that, in comparison with students at other schools, Andrews University Biology seniors achieved much better than average learning in Biology for each of the past 10 years. Thus, overall, our students are receiving an excellent education and they are meeting Learning Outcome 1 of the Biology Department exceptionally well. Clearly there are places we can improve, particularly in the areas of ecology and evolutionary biology and analytical ability.

***2. Apply scientific methodology to create and assess scientific knowledge***

**"As a group in comparison to other institutions, Andrews University Biology students will score: ≥ 80 percentile on the Major Field Test (MFT) analytical skills score."**

As seen in Tab. 9.1 Andrews University biology students scored equal to or greater than 80$^{th}$ percentile between 2011-21 (excluding 2019-20). As a department we continue to look for an additional assess tool for this PLO, perhaps a course-based indicator.

***3. Communicate scientific understanding effectively***

**"Each biology major will present a well-grounded research proposal, both orally and in writing, that effectively addresses a meaningful, testable question or hypothesis."**

Each biology major takes BIOL305: Scientific Communication typically during their last two years of their degree program. In this class students write and orally present a research proposal, both of which are evaluated by the two assessment tools (See Appendix 4). Table 9.2 shows student performance on the required research proposal for BIOL305. With students earning an average percentage of over 80% on this assignment we believe biology majors at Andrews University are developing effective communication skills in their scientific training.

**Table 9.2—Student performance on the required research proposal assignment in Scientific Communication BIOL305.**

| Semester | Research Proposal Score (%) |
|---|---|
| Spring 2022 | 93% |
| Spring 2021 | 79% |
| Fall 2020 | 86% |
| Spring 2020 | 93% |
| Spring 2019 | 80% |
| Fall 2018 | 83% |
| Spring 2018 | 87% |
| **MEAN** | **86%** |

***4. Integrate faith and science in light of personal faith commitments***

**"A final essay, prepared with feedback during the term, in BIOL 435 – Historical and Philosophical Biology, that asks students to identify what was most meaningful, challenging, and growth-enhancing things they learned in the semester in light of faith commitments; and to bring their personal metaphor of science and faith to bear on this discussion"**

We use this essay as a "check point" to assess how well students apply a mature understanding of this relationship to a relevant issue. Preliminary analysis student scores on this essay showed that most students earned an A grade on the essay with many showing thoughtful reflection in their writing. Anecdotal evidence based on course surveys and exit interviews with senior suggests that BIOL435 is serving its purpose in helping students integrate faith and science. The following was shared with Dr. Tom Goodwin by a 2021 graduate "I wanted to thank you for teaching Historical Bio and encouraging us to do the hard work of searching for deeper answers and holding fast to our faith. This attitude of approaching difficult matters of faith and science is one that has allowed me to engage in meaningful deep conversation with my peers here that have differing viewpoints. It has helped me become a better follower of Jesus."

**" >80% Biology majors will agree or strongly agree that faculty "taught me how Christian faith and ethics relate to my field" on Question 9.7 on the Senior Survey"**

Although data are limited from the Senior Survey, from 2015-20 biology seniors met the target metric for this PLO concerning faith and science integration (Table 9.3).

**Table 9.3—Percentages of biology senior students who agreed or strongly agreed to Question 9.7 on the Senior Survey that "faculty taught me how Christian faith and ethics relate to my field".**

| Academic Year | % Seniors agreeing to Ques. 9.7 on Senior Survey |
|---|---|
| 2015-16 | 95% |
| 2016-17 | 80% |
| 2017-18 | 95% |
| 2018-19 | 94% |
| 2019-20 | 89% |

| | |
|---|---|
| | **Mean: 90.6%** |

***5. Practice ethics and professionalism in science***

**"At least 90% of our graduating seniors will report that the Biology curriculum and program significantly enhanced their understanding of and commitment to Christian ethics and professionalism in the practice of science."**

See Table 9.3 for quantitative data concerning biology senior student assessment in this area. In addition students in the Bioethics and the Christian Faith course complete the following bioethical credo class assignment:
"*Personal Bioethical Credo*--This essay is to structure a personal ethical credo within your own life as a prospective Christian medical and/or biological professional. This will apply the Christian worldview values to your profession and is to be 4-5 pages (double-spaced, using 12 point Times New Roman font; with 1 inch margins). The paper should be no less than 4 full double-spaced pages, contain no spelling/grammatical errors, and follow all guidelines for papers in the AU Bulletin. Your essay will be evaluated on the thoughtfulness and insight it displays, consideration of what you have learned in the course, and its application to your life, both as an individual and as a professional. (fulfills SLO 1, 5, 6; PO 3, 5) " Source: RELT385 course syllabus Spring 2022.

**Table 9.4—Student performance on the Personal Bioethical Credo assignment in RELT385.**

| Academic Year | Average class score (%) on bioethical credo assignment (N= students in class) |
|---|---|
| 2017 | 88.4 (38) |
| 2018 | 94.9 (25) |
| 2020 | 91.2 (43) |
| 2021 | 85 (35) |
| 2022 | 93 (49) |
| | **Mean: 90.5** |

Based on both the RELT385-based and Senior Survey-based metrics students are meeting the target metric for the PLO concerning ethics and professionalism.

## *How Biology Student Learning Outcomes Support University Curricular and Co-curricular Goals*

Andrews University's curricular and co-curricular goals perhaps are best summarized in its motto of "Seek Knowledge, Affirm Faith, Change the World".

***Seek Knowledge.—***The University's Andrews Core Experience is designed in line with one of two pillars of American higher education: "broad encounter with varied perspectives and the exposure to knowledge gained from many disciplines." The second pillar is the chosen major, in which the student focuses on a particular area of study and develops important skills associated with that discipline. The Department of Biology supports both pillars in three ways: 1) It offers General Education credit for several of its courses, including Principles of Biology,

Human Biology, and Environmental Science 2) it offers in-depth education and training in a wide variety of life science sub-disciplines; and 3) it offers several courses, such as Vertebrate Zoology and Neurobiology, which have a service component allowing students to put their academic experience into practice in serving others.

Thus, direct support for the University's first goal of "Seek Knowledge" is provided by the Department's Student Learning Outcomes of "Demonstrate an integrated understanding of biological science", "Apply scientific methodology to create and assess scientific knowledge", and "Communicate scientific understanding effectively".

***Affirm Faith.—***Biology faculty members proactively promote faith perspectives in their courses. They accomplish this in part by making connections between faith and course content whenever appropriate. Also, faculty members take a personal interest in the spiritual health of their students by talking with students about spiritual issues and showing Christian concern when students are struggling with personal, academic, or spiritual problems. Finally, the Department requires all Biology majors to take Historical and Philosophical Biology and Bioethics and Christian Faith. Both courses focus on religious, spiritual, and ethical issues which are faced, or will be faced, by students in college, post-graduate school, and in their professions.

Thus, support for the University's second goal of "Affirm Faith" is actively provided by the Department's Student Learning Outcome 4, "Integrate faith and science in light of personal faith commitments".

***Change the World.—***Biology majors most commonly go into medically-related, teaching, and/or research professions. These professions are directly involved with benefiting the health of individuals, teaching important concepts to children and young adults, promoting environmental sustainability in the world, and providing new information benefiting the endeavors of humankind and the quality of the natural world. No professions are more important in changing the lives of people and the enhancing the health of the ecosystem on which all life depends. In addition, while they are still college students, many of our majors choose to serve as student missionaries to begin changing the world in very personal ways before they graduate.

The research of Dr. Gonzalez-Socoloske and his students with Michigan endangered species (Massasauga rattlesnake) and neotropical marine mammals (manatees and dolphins, etc.) directly contributes to "changing the world" in the area of conservation biology while students *are still enrolled* at Andrews University in addition to further impacts made by these students as they move on to graduate study and research.

Thus, support for the University's third goal of "Change the World" is supported by all five of the Department of Biology's Student Learning Outcomes, but in particular "Practice ethics and professionalism in science".

## 10. How successful are program graduates in seeking graduate and professional admission? What is the level of satisfaction among students, alumni, and employers of alumni with the program and its outcomes?

### *Success of Graduates in Admission to Graduate and Professional Schools*

Sixty-three percent of Andrews University biology graduates who applied to medical school from 2017 to 2021 were accepted (Table 10.1). This is 1.4 times the national average. More than 90% of those who apply to graduate programs are accepted. Typically multiple different graduate institutions (mostly medical schools) are where graduating biology seniors attend. Institutions such as Loma Linda University medical/dental school, University of Kansas medical school, UAB School of Dentistry and the Medical College of Wisconsin are included on the list where biology graduates attend.

**Table 10.1—Numbers of Biology majors who applied to medical schools, and numbers and percentages of these applicants who were accepted into AMCAS medical schools from 2017 to 2021. *Only numbers of institutions reported by graduating biology seniors are reported. **Number of distinct graduate institutions attended.**

| Year | Biology Med School Applicants | Med School Acceptances (AMCAS) | Percentage of Applicants Accepted | Number of Institutions attended by Biology Graduates* |
|---|---|---|---|---|
| 2017 | 9 | 6 | 67% | 3 |
| 2018 | 12 | 8 | 67% | 3 |
| 2019 | 13 | 12 | 92% | 8 |
| 2020 | 17 | 8 | 47% | 7 |
| 2021 | 12 | 7 | 58% | 1 |
| **Totals** | **63** | **41** | **63%** | **13**** |

Part of this success is due to excellent advising on the part of the Biology faculty. Our faculty members take a deep interest in the success of each of our students. If an advisor does not think a student is prepared for successful admission, the student is advised to take additional courses, participate in a bridge-type program, or do a graduate degree before applying.

Another part of this success derives from the excellent classroom, laboratory, and research preparation students receive. We commonly hear back from alumni who have entered professional school who tell us they feel better prepared than their peers.

## *Levels of Satisfaction among Students, Alumni, and Employers*

Several years ago, the National Science Foundation provided funds to evaluate the Andrews University Biology program. Results of the study were released in a report to NSF entitled "Uncovering Antecedents of STEM Success at Andrews University" in 2012. The study consisted of two parts, one devoted to "processes" leading to student success and satisfaction, and the other devoted to "outcomes". The processes study involved one-on-one interviews with 113 Biology alumni and current Biology majors. The sample represented all major ethnic groups, males and females, and preparation levels. A brief summary of the results of the processes study is presented in Table 10.2.

**Table 10.2—Percentages of student and alumna interviewees who mentioned seven characteristics of the Andrews University Biology program that impacted student success and experience with the program.**

| Factor | Total % (n=87) | Female (n=66) | Male (n=37) | African American (n=35) | Asian American (n=16) | European American (n=38) | Latino American (n=13) | Under-prepared (n=42) |
|---|---|---|---|---|---|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Transformational Processes | 94.3% | 95.5% | 91.9.% | 100% | 87.5% | 92.1% | 92.3% | 95.2% |
| Student-Faculty Relationships | 94.3% | 97.0% | 89.2% | 94.3% | 93.8% | 92.1% | 100% | 92.9% |
| University Context | 85.1% | 84.8% | 86.5% | 91.4% | 100% | 71.1% | 92.3% | 90.5% |
| Departmental Climate | 86.2% | 81.8% | 89.2% | 82.9% | 100% | 78.9% | 84.6% | 81.0% |
| Educational Attitudes Profs | 67.8% | 66.7% | 70.3% | 71.4% | 75.0% | 60.5% | 69.2% | 69.0% |

***Transformational Processes.—***A high percentage of interviewees believed that the Biology professors focused on student success, served as motivators, and spent time supporting student efforts to achieve success.

***Student-Faculty Relationships.—***A high percentage of interviewees mentioned the importance of personal attention and holistic support provided by Biology faculty.

***University Context.—***A high percentage of interviewees mentioned that Biology professors saw students as a priority. Professors made time for students outside of class and took an interest in their personal lives.

***Departmental Climate.—***A high percentage of interviewees mentioned the importance of the Department of Biology's supportive environment.

***Educational Attitudes of Professors.—***More than half of interviewees mentioned that Biology professors were supportive.

In short, results of the study support the view that students enrolled in the Biology program and alumni who graduated from the program who participated in the study were highly satisfied with the support they received from the Biology faculty and with the overall climate of the Department.

Evaluating the level of satisfaction on the part of employers with our graduates is problematic given that most of our students end up as self-employed professionals or as members of professional practice groups.

# 11. How have the above data contributed to decisions for program improvement? What impacts have the evidence-based changes had on student learning and student success?

## *How Learning Outcomes Have Contributed to Program Improvement*

Learning outcomes as indicated by the results of the Major Field Test in Biology suggest that we are doing many things right. Our graduating seniors as a yearly group score at the 86$^{th}$ percentile as a 10 year average (Table 9.1). Thus, in terms of basic transmission of biological knowledge and understanding, we seem to be functioning well above most institutions involved in the training of biology majors. This is not to say improvements are unnecessary, and as the MFT results indicate, we have accomplished our task better with some subdisciplines than with others.

***Program Improvement with Strategic Faculty Hiring.—***One of the challenges in maintaining quality occurs when faculty leave the department. The most recent departure is the retirement of Dr. Denise Smith who was instrumental in coordinating laboratories in the largest classes taught by the department (BIOL165/166 & BIOL221/222). As a molecular biologist she was a key contributor in teaching Molecular Genetics and mentoring students in cancer research. The department has adapted to her loss and relies on our most recent hire, Dr. Brian Wong, to carry on the torch in mentoring students in cancer research. His expertise in histology and microbiology is key in teaching students headed into healthcare careers. In hiring new individuals, we wanted to maintain the strengths we have built through the years. We also wanted to enhance areas that needed improvement.

Another area of strength has been neuroscience in which we offer an emphasis in this area. Faculty hiring in this area with Dr. Benjamin Navia joining the department in 2013 has increased student opportunities on neuroscience. He joins Dr. David Mbungu, also a neurobiologist, in maintaining strength in this area. Dr. Navia teaches Neurobiology and his key contributions on campus were recognized with him receiving the Bruce E. Lee Service Award spring of 2022.

Major Field Test scores in Organismal Biology and in Ecology and Evolutionary Biology have tended to be weaker than scores for other subdisciplines. Thus, we were keen to enhance student performance in this area. To this end, Dr. Daniel Gonzalez-Socoloske, a recognized expert in manatee ecology, was hired in 2013. He brings his expertise in ecology to the General Ecology and Field Ecology courses and has been instrumental in creating field experiences for students in Cuba and Florida.

***Program Improvement by Increasing Faculty Diversity.—***Until 2001, all faculty in the Department of Biology were non-Hispanic, white males. In that year we were able to hire a black female, Dr. Marlene Murray, and a black male, Dr. David Mbungu. Further faculty hiring has increased our Departmental diversity even more. We currently enjoy the expertise of one female and seven males, including two blacks, two Hispanics, one Asian and three non-Hispanic whites. We view this increase in diversity as a very positive improvement in our program, diversity which is more reflective of our student body.

***Program Improvement through Enhancement of Student Analytical Skills.—***Major Field Test scores in Analytical Skills by groups of Biology seniors have exhibited a large range – 54$^{th}$ to 97$^{th}$ percentile in the past 10 years. Given the importance of analytical skills in all areas of science, we have found low-scoring years to be disappointing. In response, a three-credit Research Design and Biostatistics course in the Biology core was implemented which provides our majors with a much better background in processes of data gathering and analysis. Students who have taken BIOL280 have shared anecdotally with the biology dept. how the class has prepared them for their experience in graduate school and on admission tests such the MCAT.

In addition, the Department of Mathematics offered Calculus I for Biology for 10 years prior to the retirement of the biomathematician Dr. Shandelle Henson who taught at the same level as the regular Calculus I course except that example problems and applications are from the life sciences. This course, recommended but not required of our majors, attracts many of our better students, and provides important analytical training.

***Program Improvement by Formalizing the Undergraduate Student Research Experience***- The biology dept. has a rich heritage of fostering research experiences for undergraduate students. To help facilitate these experiences in 2016 the department started a formal process for undergraduate student involvement in research. Dr. Ben Navia coordinates

this program which typically involves 20-30 annually. The process involves a formal student application for involvement in research, selection of a research mentor and monthly meetings to help bring students together to share about their research. These activities directly address Student Learning Outcome #2: Apply scientific methodology to create and assess scientific knowledge and Student Learning Outcome #3: Communicate scientific understanding effectively. The great majority of these students go on to present their work either in writing or orally in a professional venue.

# Criterion 3: Financial Analysis

## 12. What is the relationship between the cost of the program and its income and how has that been changing over time?

The Department of Biology is an income generator for the College of Arts and Sciences. Table 12.1 provides cost and income data for the department over the past six years.

**Table 12.1—Income, cost, and contribution to margin data for the Department of Biology, 2015-2020.**

| Year | Net Tuition Revenue | Costs | Contribution to margin | Contribution to margin (%) |
|---|---|---|---|---|
| FY2016 | $ 1,897,210 | $ 977,234 | $ 919,976 | 48.5% |
| FY2017 | $ 1,857,438 | $ 841,423 | $ 1,016,015 | 54.7% |
| FY2018 | $ 1,955,401 | $ 826,211 | $ 1,129,189 | 57.7% |
| FY2019 | $ 2,062,562 | $ 818,423 | $ 1,244,139 | 60.3% |
| FY2020 | $ 1,956,604 | $ 880,361 | $ 1,076,243 | 55.0% |
| FY2021 | $ 1,621,082 | $ 823,787 | $ 797,294 | 49.2% |

Income exceeded costs during all years with yearly increases in Contribution to Margin ($) for 5 of the 6 years.

In addition to income generated by tuition, the department has enjoyed approximately 1.1 million dollars in extramural NSF grant funds which have benefited Biology students and faculty. These funds have been used primarily to support costs associated with research and to support a study of factors enhancing the academic success of Biology majors.

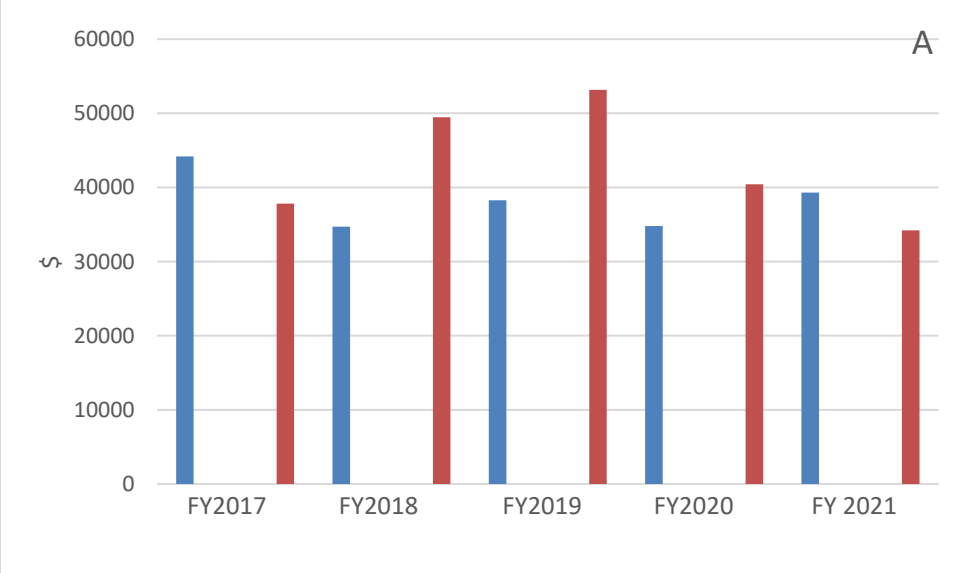
Finally, alumni make significant yearly contributions to the department. From 2012 to 2021, alumni contributed $571,361 to the department, an average of $57,136 per year (see Fig. 5.2). These funds are used for student scholarships, special equipment items, and facilities upgrades.

## 13. What is the (financial and other) impact of the program on the University and, based on trends, how is that likely to change in the future? How adequate is University support to maintaining the health of the program?

As noted under Question 12, income generated by the Department of Biology during each of the past six years always exceeded costs and contributed to the bottom line of the College of Arts and Sciences, and thus to the University.

In addition to serving Biology majors, the Department of Biology functions as a service department for students majoring in nursing, physical therapy, clinical laboratory science, nutrition, and other majors that require biology credits. Moreover, many pre-medical and pre-dental students major in fields other than Biology but must take Foundations of Biology offered by our department. Enrollment by non-majors in these courses is large, especially in Anatomy and Physiology and in Microbiology. Finally, non-majors take courses such as Principles of Environmental Science and Human Biology to fulfill general education science credits. If the Department of Biology were to disappear from campus, the reduction in enrollment would be significant.

Adequacy of budgetary support for departmental expenses is essential for maintaining program quality. The two largest instructional expenditures in the biology dept. are student wages and general/lab supplies. Fig. 13.1 shows budgeted funds and expenditures in these 2 areas for the past five fiscal years. Efforts have been made to align expenditures with budgeted funds but as seen in the figure expenditures typically are greater than budgeted funds resulting in the use of restricted funds to make up the difference.



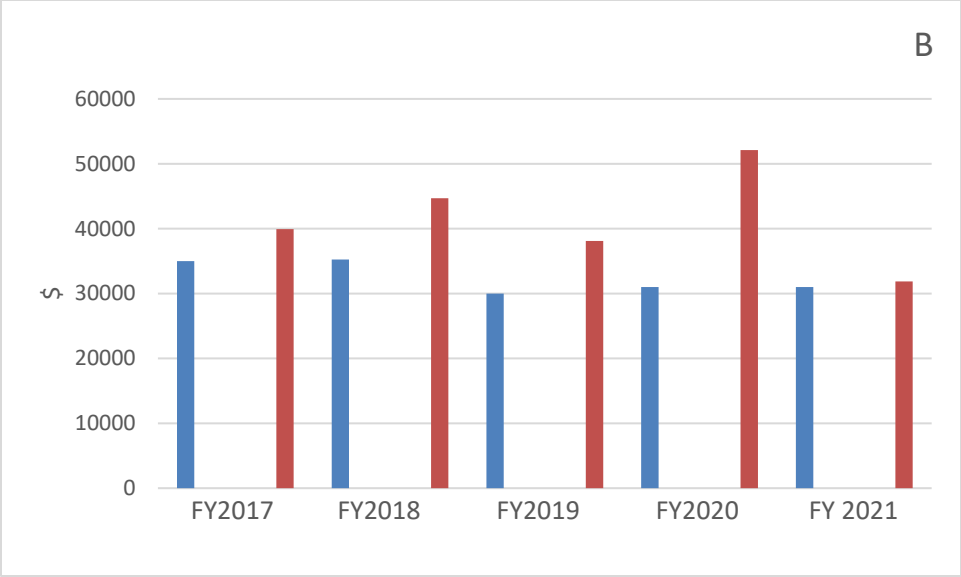



**Figure 13.1–Budgeted funds (blue) and expenditures (red), FY2017-2021 for Student Wages (cost code 9250: A) and General/Lab Supplies (cost code 9507/9510: B).**

A graver cause for concern is lack of adequate support for capital improvement and facility upgrades, which has forced us to depend on restricted funds to help cover costs for equipment purchases and the renovation of departmental spaces for teaching, research and student study. We are concerned by this trend, especially given that restricted funds are *not* intended to cover rehabilitation of worn-out teaching space. This need is being revisited with the Dean of CAS and we hope this issue will be rectified. The department is using restricted monies to fund the renovation of Price Hall 316 (summer 2022) to create a more inviting and versatile space for student research called the Biology Research Collaboratory- an activity that directly targets multiple Student Learning Outcomes.

The tendency to severely underfund capital expenses and facility rehabilitation and upgrade will likely impact our ability to attract quality students and future faculty, if not rectified. Carpet in Price Hall 106, a room utilized by not only the biology dept. but the honors program and other academic units on campus has deteriorated badly and compares unfavorably with new carpet in the rest of the Science Complex. Some department research space, notably the Animal Care Facility, is no longer functional. Estimates of upgrade costs for this facility are around $200,000. Over the past 3 years Dr. Peter Lyons has used departmental funds to create an inviting space in the Andrews Botanical Conservancy (ABC). Unfortunately a leaking glass roof limits usage of the facility at time and creates possible safety hazards. The department is looking for creative ways to utilize this space that will benefit students beyond the biology dept. and the community at large. The current vision is to create an Inspiration Center : a commons space for interdisciplinary use that integrates the ABC and associated rooftop space.

In summary, without alumni support, University support in maintaining the health of the Biology program would prove insufficient. As noted earlier, alumni support has allowed the Department to maintain quality lab equipment in face of rising costs and changing technology, and has provided start-up funds and space renovation for new faculty. We do not believe, however, that it is proper to apply these funds for maintaining decent quality laboratory and other mission-critical space.

# Criterion 4: Strategic Analysis

## 14. What are the strengths of the Biology program?

### *Faculty Strengths*

Aside from having an earned Ph.D. degree and a commitment to a Seventh-day Adventist faith perspective, at least two criteria are applied to every candidate for a permanent faculty position in the Department of Biology: 1) The candidate must be able to communicate well and express a strong commitment to teaching undergraduate and graduate students. 2) The candidate must demonstrate an established research record and a passion for doing research. Application of these hiring criteria over the past several decades has led to development of a remarkably stable faculty of excellent teacher/scholars.

As evidence of the stability of the Biology faculty, the following statistics tell a lot. In the 94 years since 1920, Andrews University has employed only 40 biology faculty. The Department was formed in 1938. In the 84 years since that time, only eight chairs have led the Department, including Dr. Robert Zdor, who assumed the responsibility in 2018. Currently, the Biology faculty consists of 8 Ph.D.s trained in diverse areas of life science. As noted following Question 11, the current faculty includes a woman, along with black, Asian and Hispanic minorities (Table 14.1). Each faculty member has published in the peer-reviewed literature.

**Table 14.1—Gender, ethnicity, teaching expertise, and Ph.D. training area of faculty members in the Department of Biology. This table illustrates the diversity of the current faculty which suggests the future, broad-based direction of the Department. (Year): the year the faculty member joined the biology dept.**

| Name | Sex | Ethnicity | Select Teaching Areas | PhD |
|---|---|---|---|---|
| Gonzalez-Socoloske, Daniel (2013) | M | Hispanic | Ecology, Biostatistics | Ph.D. Ecology 2013. Duke U. |
| Goodwin, Thomas (1994) | M | White | Paleontology, Phil. of Science | Ph.D. Biology 1990. U. Kansas |
| Lyons, Peter (2012) | M | White | Cell and Molecular Biology | Ph.D. Biochemistry 2006. Dalhousie U. |
| Mbungu, David (2001) | M | Black | Neurobiology, Entomology | Ph.D. Entomology 1993. U. California |
| Murray, Marlene (2001) | F | Black | Genetics | Ph.D. Biology 1999. Wayne State U. |
| Navia, Benjamin (2013) | M | Hispanic | Neurobiology | Ph.D. Biology 2005. Loma Linda U. |
| Wong, Brian (2016) | M | Asian | Histology, Microbiology | Ph.D. Biology 1992. Loma Linda U. |
| Zdor, Robert (1991) | M | White | Bacteriology, Development | Ph.D. Plant pathology 1989. U. Missouri |

## *Student Strengths*

A significant strength of our Biology student body is the ethnic diversity they represent (see Figure 1.1). This diversity provides a rich learning environment for all our students who benefit from close interactions with students of other backgrounds and races.

Our students represent a wide range of scholastic abilities. One of the strengths of the program has been its capacity to improve the academic skills of marginal students to competitive levels. This was part of the motivation for National Science Foundation support of the study designed to evaluate student success and satisfaction in our program (see response to Question 10). This study found that personal attention on the part of faculty constitutes one of the most important influences to bring students to higher levels of achievement.

The Department also attracts significant numbers of students who enter our program with highly developed academic skills. It can be a challenge to reach the needs of students both with weak and strong backgrounds in science, but the departmental record suggest this is what happens.

Opportunity for research involvement plays a significant role in the scholastic development of both initially weak and strong students. Successful completion of a research project builds confidence and draws students into deep engagement with science. Each year, several of our students present the results of their work at professional meetings and serve as coauthors on peer-reviewed publications.

## *Curriculum Strengths*

As noted in the response to Question 7, our curriculum is strong and compares well with benchmark institutions. Our cognate core includes two years of coursework in chemistry, taught by faculty in the only Seventh-day Adventist department of chemistry that enjoys American Chemical Society accreditation. Cognate core courses in physics are taught by excellent teachers with substantial track records in research. The Foundations of Biology course provides a more comprehensive treatment of life science than many first-year biology courses. Courses in Research Design and Biostatistics and Scientific Communication provide students with skills crucial for success in today's high tech, competitive world. Historical and Philosophical Biology teaches students to wrestle with tough ethical and philosophy of science issues in the context of faith. Yearly Major Field Test results for our seniors reported in Table 9.1 provide objective evidence of the strength of our curriculum. Our seniors as a group have scored between the 82$^{th}$ and 94$^{th}$ composite score percentile for the past 10 years.

## *Facility and Equipment Strengths*

The Department of Biology enjoys fairly adequate research equipment and space. As noted below, however, teaching facilities need to be significantly upgraded.

## *Alumni Strengths*

Department of Biology alumni provide strong support for our program. Not only do alumni provide significant financial support (see Fig. 5.2), they also provide moral support in the form of letters of appreciation, and frequent comments applauding the quality of education they received from the Department. As of Jan. 2023 a graduate of the master's program in biology at Andrews U., Kieran Taylor, has moved into the position of alumni relations coordinator with the intention of cultivating STEM alumni connections to the university. This bodes well for the biology dept. and its rich network of alumni.

# 15. What are the weaknesses of the Biology program and what plans are in place to address them?

## *Faculty Weaknesses*

For the most part, all major areas of biology can be covered adequately by our current faculty. The one area that is not covered by faculty expertise is systematic botany. Student demand in this area has been minimal. However students needing coursework in this area can take HORT226: Plant Systematics and ID offered by the Dept. of Sustainable Agriculture. This arrangement appears to be serving the needs of students in this area.

Although each faculty member exhibits research interests and expresses a desire for involvement in research, teaching and personal responsibilities have occupied the primary focus of several individuals. An increase in the number of graduate students will help to facilitate departmental scholarship but faculty members also need to work toward publication with undergraduates, with fellow faculty members, and with colleagues at other institutions to fulfill this responsibility. Peer-reviewed publications serve as the most important evidence that faculty members at a graduate institution are productive and effective mentors.

Based on the faculty of the department it is predicted that 50% of the current faculty will be retiring in the next seven years. With this in mind it is important to have a succession plan for faculty hiring and continuity in leadership in the department. Dr. Tom Goodwin teaches two key core classes for biology majors (BIOL305 and BIOL435) so it will be crucial for the department to be able to cover these classes with the departure of Tom.

## *Student Weaknesses*

Andrews University does not have an "open admission" policy, but we do admit students with diverse academic backgrounds and abilities. As a result, some of our beginning courses exhibit bimodal grade distributions: We always have some exceptionally talented students but we also work to improve the skills of students who are less well prepared. Over the years, we have exhibited significant success in helping students will lower achievement early on in their programs improve their success as they proceed to their senior year. It was this success that was of interest to the National Science Foundation, which led to its support of a study designed to find out how our program achieved this accomplishment. Efforts to target student intervention early in the university experience have focused on supporting students in BIOL165 which is

often taken during a student's first semester at Andrews University. This support has taken a number of forms. From 2015-17 the teachers of BIOL165 (Peter Lyons and Robert Zdor) sponsored an academic bootcamp called BioBoost during freshman orientation week providing students exposure to course content and study skills prior to the start of the class. Although the program did effectively foster student comradery participants in BioBoost did not differ from nonparticipants in academic accomplishment in BIOL165 and thus the program was discontinued. Current efforts in the BIOL165 are focused on implementing active learning practices in the class and offering a 1 credit Study Skills class to help equip students with effective study skills and practice for BIOL165.

## *Curriculum Weaknesses*

As indicated by comparative curriculum data presented following Questions 7, and by learning outcome data presented following Question 9, the Department of Biology appears to offer a strong curriculum. The Biology faculty would like to see our Major Field Test (MFT) scores in Organismal Biology and in Ecology and Evolution improve. An ad hoc Biology curriculum subcommittee has been studying our curriculum to make sure all areas of life science are covered adequately and in an integrated fashion.

We also have been concerned about low scores in MFT in Analytical Skills during some but not all years. We have made a concerted effort to help our students realize the importance of developing their analytical skills. This effort has included 1) implementing a 3-credit course in Biostatistics and Research Design, 2) encouraging more Biology majors to take Calculus I for Biology, and 3) incorporating more opportunity for formal data analysis in labs and research projects.

## *Facility and Equipment Weaknesses*

Research equipment in the Department is adequate. Teaching facilities, however, including classroom and laboratory spaces are in need of upgrade. As one faculty member has noted, "The first impression one might get walking through our department is that of a 1970s second-hand store." Laboratory tables in Price Hall 229 and 240, used by the first year courses Anatomy & Physiology and Foundations of Biology need to be replaced. The Department would benefit from an intermediate-sized classroom conducive for group work and active learning activities. Equipping this space with technology to foster remote student participation would be a valuable asset to the department. The amphitheater carpet looks shabby when compared with those in the spaces occupied by the Mathematics and Physics Departments and the Chemistry Department.

First impressions are important. Renovation of the biology lobby in the past 10 years has helped with the esthetic appeal to Department of Biology but this same attention needs to be applied to teaching laboratory spaces. High school students who visit the university with an interest in pursuing a degree in Biology see these teaching spaces in need to updating. Conversations with the CAS dean and plant services are currently underway concerning plans for addressing the above concerns.

## *Enrollment Weaknesses*

As noted in Figure 3.2, the number of students enrolled in the B.S. in Biology program at Andrews University has been on the decline since fall 2010, when enrollment peaked at 204. Enrollment has dropped nearly 50% since that time. College of Arts and Sciences enrollment as a whole has declined as well. The reason for the decline in majors is unclear. The rise and fall around the 2010 peak may have been a fluke. More aggressive recruiting efforts could have accounted for this. It does appear that student caliber has risen since the peak, but this is only a subjective impression. Anecdotal observations suggest that current recruiting efforts for STEM in general can be improved.

Regardless of the reason for the downturn in numbers of Biology majors, the entire STEM unit of the College of Arts and Sciences is attempting to do a better job at recruiting qualified students. We have hired a half-time STEM recruiter, Monica Nudd, who is enthusiastically involved in promoting our Department. The department hired a professional videographer in 2019 to produce a high- quality promotional video for the department for marketing purposes which is currently available online. The department has been active on social media (Facebook and Instagram) in an effort to reach prospective students. Our faculty members are involved in visiting SDA academies such as Loma Linda Academy and Spencerville Academy which have been sources of biology majors for the department.

## *Financial Weaknesses*

Due to the large number of labs associated with our courses, our Department has significant need for student laboratory assistants, laboratory equipment, and supplies. All this costs a great deal of money. Some of this is offset by laboratory fees collected from each student for each lab course. As noted following Question 5, our alumni have partnered with our administration in providing necessary funds for high quality equipment and facilities.

In some ways we are more fortunate than many departments in that significant numbers of our alumni are health professionals who are well positioned financially. Their support has been crucial for maintenance of a top-quality program. Financial support from the University, however, is subject to the vagaries of enrollment and the economy. We are somewhat buffered from these vagaries thanks to financial support from our alumni, but we would be unable to continue our program without significant and continued support from the financial administration of the University.

Due to funding reductions in 2020 the biology dept. lost its full-time administrative assistant. Since that time the departments of Physics, Sustainable Agriculture and Mathematics have donated hours to provide ~20 hours /week of assistance to the biology dept. for managing purchases,/financial statements, overseeing the student labor workforce and assisting with other departmental tasks. Although this arrangement covers some of the basic needs of the dept. it has hampered the mission of the dept. with a lack of a consistent presence in the departmental office for students and faculty. A full time administrative assistant helps foster the culture of the department and helps students to feel at home in their academic major. This sense of belonging is particularly needed during these times of pandemic when emotional stress on students is high. The department sees this lack of an administrative assistant as a direct threat to student retention and success.

# 16. What opportunities are likely to present themselves to the program in the coming years, and what changes and resources are necessary to take advantage of them?

## *Opportunities for Growth and Expansion*

Most of our Biology majors are headed into a medically related field. As the Baby-boomer generation ages and as population continues to increase, more and more opportunities will be available for medical specialists. As the data in Table 4.1 suggest, all professions which attract biology majors and are monitored by the federal government are expected to show modest to large gains in job openings over the next decade.

This projected growth in opportunities for Biology majors, however, must be considered in relation to trends in attendance at Seventh-day Adventist institutions of higher education. Regardless of an increase in rate of job opportunities, as enrollment at Adventist schools drops we will experience a drop in students enrolled as Biology majors. In short, it is important for the Department of Biology to remain flexible in the face of financial uncertainty.

The physical resources available to the Department must be maintained and seriously upgraded, regardless of future trends. The Department has occupied Price Hall for the past 49 years. The building shows multiple signs of serious wear, especially of laboratory teaching space and, more generally, of mechanical systems. The Department needs significant, ongoing University support to address these challenges. A new research and development wing could alleviate some of the crowding now experienced by the Department and open up opportunities for research and office space, but will not substitute for upgrading our current space.

## *Roles for Restructuring and Technological Innovation*

As noted above, the Department of Biology must remain nimble in face of oncoming change. And given that the practice of life science is increasingly dependent on technology, the Department must find ways to keep up. Alumni support is crucial, but so is support from the administration.

## *Relation to Distance Education*

By its very nature, biological education is difficult to carry out effectively at a distance. Biological education consists of a great deal of hands-on work in the lab. It is possible that some such lab work could be administered long-distance, but nothing can substitute for teacher involvement during lab activity. Moreover, research is a crucial component of our program. Without the involvement of on-site mentors and necessary equipment, it is unlikely that research projects would be very effective if mentoring occurred long distance. Life science departments across the United States and around the world are grappling with these real and substantial challenges to implementing distance education. No one to our knowledge has yet found an adequate solution. Currently, we can only continue to monitor progress for this educational trend.

With the need to accommodate remote, off-campus students during the COVID-19 pandemic the biology dept. has gotten a flavor of how best to serve these students in specific classes. Dr. Marlene Murray who teaches BIOL371: Genetics has been trained in developing courses that are user-friendly for distance education and believes that BIOL371 may be a candidate class for such an offering. Histology (BIOL465) has also been modified/revised in order to effectively serve online/distance education students.

## *Relation to Cooperative and Collaborative Relationships with Other Institutions*

Cooperative and collaborative relationships with other institutions are important to biologists, particularly for expanded research opportunities, but also for extended learning environment opportunities.

The Department of Biology has enjoyed a long-term relationship with Walla Walla University's Rosario Beach Marine Laboratory. Many summers, Andrews U. supplies one teacher for the summer program at Rosario Beach, and some of our Biology majors take coursework there for Andrews University credit. This arrangement broadens the academic and research options available for our students, Andrews University, and Walla Walla University. Other schools offer summer research internships for undergraduates, which involve our students.

Most of the Department's faculty members enjoy research collaborations with faculty at other institutions. These collaborations have the benefit of establishing the reputation of Andrews University as an institution involved in significant research. Often Andrews students are involved in these research endeavors which provides a broadening opportunity for them as well.

## *Resources Needed to Leverage Opportunities*

Space is an important resource: both quantity and quality. The biology dept. is currently pursuing renovations to enhance the impact and usability of the Andrews Botanical Conservatory and adjacent roof space (spearheaded by Dr. Peter Lyons) as well as the Natural History Museum (NHM: coordinated by Dr. Daniel Gonzalez-Socoloske) but these efforts require funding beyond the biology departmental budget. With the help of Roshelle Hall (Adjunct Assistant Curator) and the Office of Research and Creative Scholarship, grant funds are being sought from the Berrien Community Foundation (Fall 2022) for improving the NHM. Money is always necessary and always in short supply. Gifts and extramural grants can provide significant help in this regard. Time for creative work must also be available. Extramural grants, Faculty Research Grants, and the University's sabbatical policy are helpful in providing release time.

# 17. What threats may negatively impact the program in the coming years, and what changes and resources are necessary to mitigate them?

## *Description of Threats*

***Financial Threats.—***Currently, all institutions of higher learning are faced with financial threats. These threats are rooted in the vagaries of the American market-based economy, disproportionate levels of inflation associated with higher education costs, changing values on the part of potential students, and the increasing popularity of online courses and tuition-free offerings at institutions of higher learning. Changing demographic patterns of the Seventh-day Adventist Church present an added challenge.

The increasing popularity of online courses may be less a problem for the sciences than other disciplines, although this remains to be seen. Students, perhaps out of necessity, have become progressively more pragmatic and are looking for ways to streamline their education so as to reach career goals more directly. Non-traditional forms of higher education may be appealing to students who may view these educational venues as more efficient and less expensive means of achieving career goals.

The demographic characteristics of the Seventh-day Adventist Church in North America are undergoing significant change. Today, Adventist converts are more likely to come from less educated and lower socioeconomic groups for which Adventist higher education is not a priority nor financially feasible. Moreover, as Seventh-day Adventists become more assimilated into the broader culture, it is becoming more acceptable to attend institutions which provide less costly access to education or which are deemed educationally superior to Adventist institutions.

***Philosophical and Cultural Threats.—***Driven by certain popular media, political forces, and religious entities, anti-intellectualism has achieved almost sacred status among elements of American culture. Science generally and biological science in particular are seen as especially threatening. GMOs, vaccinations, evolutionary biology, DNA testing, environmentalism, and a variety of other concepts, products, and procedures emerging out of biological laboratories and thinking are perceived as detrimental to human physical, moral, and spiritual well-being.

Biology – indeed all of higher education – holds significant stake in the outcome of the "culture wars" that swirl around and within these issues. How these issues are addressed in the classroom feeds back into the general culture of North America and constituencies of the University.

## *Changes and Resources to Mitigate Threats*

***Financial threats.—***Vagaries of the American economy and inflationary forces must be dealt with by careful spending and use of resources on the part of the Department. Purchase of quality equipment during good times, and proper maintenance of this equipment at all times is one defense against economic downturns. Careful hiring is another defense.

In face of the threat of online courses and tuition- free courses at competing institutions, the Department must market itself in such a way as to convince prospective students that they will obtain a superior education in a more traditional university setting with personalized, face-to-face instruction, lab-based instruction with professors who operate at the cutting edge of their disciplines. The opportunity to carry out research in our Department is a benefit that cannot be duplicated in a non-traditional setting and must be highlighted in our marketing to both Adventist and non-Adventist students.

Brazil with more than 1 million SDA members represents a potential area for recruiting efforts. Resources for capitalizing on our existing departmental connections to that country

would be money well spent in order to maximize the numbers of students from Brazil who attend Andrews U. Similar ventures with South Korea may also prove to be fruitful.

The demographic-shift threat is serious. Enrollment at feeder institutions (primarily Adventist academies) is on a decline. Marketing our services to non-SDA Christian students in our region could help mitigate these negative trends.

***Philosophical and Cultural Threats.—***Philosophical threats are somewhat intangible and difficult to control, given the powerful influence of popular culture. Our Department should make every effort to educate constituencies on how to distinguish fact from theory and theory from conjecture. We should continually work to help our constituencies recognize benefits derived from careful thinking and science-based decision-making within a Christian context.

## 18. What should be the future direction of your program and what steps and resources are necessary to take your program in that direction? How might changes and trends in technology, student demographics, and enrollment impact this direction?

### *Future Direction of Program*

In the future, the Department of Biology should continue to offer a strong, broad-based education in the life sciences to prepare students for post-graduate professional programs such as medicine and dentistry, and for graduate programs in biology. It is important for the Department to remain broad-based without narrowing its focus on, say, either field biology or molecular biology. Moreover, the Department should continue to exhibit strengths in both teaching and research; both processes are important for fostering student excellence.

Table 14.1 lists the gender, ethnicity, teaching expertise, and doctoral training of Biology faculty members. The contents of this table are suggestive of the future, broad-based direction of the Department and demonstrates our commitment to maintaining both human and subject matter diversity..

A significant issue concerns the future of the Department's graduate program. Resources are available to continue with a strong graduate program, but an increase in enrollment in the program is a crucial need. To that end, Dr. Marlene Murray, the current Biology graduate coordinator as of July 2022, has led the Department through a review of the existing program resulting in recommendations for change. These recommendations are highlighted under Question 19.

### *Resources Necessary to Achieve Goals for Future*

To maintain the strength and diversity of our program, it is important that we retain our strong faculty. In order to retain our strong faculty, we must maintain strong student enrollments. The recent decline in numbers of majors is of concern to us. We are extremely appreciative of the efforts of Monica Nudd as STEM recruiter. We hope her work and our increased efforts at reaching out to prospective students and surrounding schools will pay off. Obviously, continued good funding is important for retaining faculty and for supporting recruitment efforts. This

funding will also include a budgeted position for a full-time administrative assistant for the biology dept.

## *Impact of Various Changes on Future of Department*

Probably our biggest concern at present is enrollment, both at the undergraduate and graduate levels. If enrollment drops too far, we will be unable to defend replacements for future retirements. Although we are ramping up our recruiting efforts, we are somewhat at the mercy of demographic trends in the Seventh-day Adventist Church, particularly in Adventist academies which traditionally have served as our primary feeder institutions.

Refurbishing existing facilities and the addition of a new research and development wing to the Science Complex will greatly enhance our need for added space and enhance the research capabilities of our students and faculty. Moreover, plans are in place to upgrade the Biology website make it more appealing, accurate, and informative.

# 19. What is the status of the Master of Science in Biology degree program at Andrews University?

## *Master of Science Program in Biology*

The Department of Biology has offered a Master of Science Degree in Biology since the mid-1960s. In the nearly half century of its existence, well over 100 students have completed this program. Many of these individuals completed Ph.D. degrees at leading research universities. Others earned medical degrees. Still others went on to secondary teaching and other careers.

As part of their annual Salary Survey, the National Association of Colleges and Employers analyzed which master's degrees created the biggest increase in earnings for graduates, known as a differential. They found that in 2021, a master's in biology creates the biggest differential, with graduates earning approximately 86.5% more after their advanced degree. This data suggests that maintaining the only graduate program in the STEM division at Andrews University is important in equipping graduates in the workforce.

The Master of Science program entails three major components: coursework, comprehensive exams, and thesis research. The coursework may involve some 400-level "swing" courses with 500-level "graduate-level" courses. Graduate students who take 400-level courses may have to complete work for these courses beyond what is required for undergraduate students. Comprehensive exams involve testing students for their knowledge of biology and their capacity to reason with biological concepts. The thesis research involves doing original research under the mentorship of a thesis advisor and guidance committee.

The Master of Science in Biology typically takes a minimum of two years to complete. The first year is devoted primarily to coursework, whereas the second year involves more focus on research and thesis completion. Comprehensive exams usually are taken after completion of the second semester of coursework.

Financial support for graduate students is offered through tuition waivers and pay for work either as teaching assistants or research assistants. Teaching assistantships are offered by the Department of Biology whereas research assistantships may be offered to the student by a thesis advisor with access to extramural grant funds.

Under the leadership of Dr. Marlene Murray, the Biology graduate program coordinator, the Department is reexamining its graduate program to make it more attractive to potential students and to tap into new markets. The next section summarizes changes the Department plans to make in the program.

## *Graduate Program Reenvisioning*

The biology dept. has taken specific steps to consider ways to increase enrollment. One such way is to offer an accelerated 4+1 program where students earn a M.S. degree in biology after 5 years. This route to the degree requires careful planning on the part of the student and early engagement in research that will become their thesis research. The department feels that this option may attract a few students into the program annually particularly those who need additional training beyond their undergraduate degree as they prepare for professional training. The 4+1 program has been approved and will be implemented along with a marketing campaign promoting this option.

In the summer of 2022 the biology dept. polled 953 K-12 educators across North America at SDA institutions concerning the desirability of pursing additional training in biology and their plans concerning graduate study. Ninety three individuals responded to the survey with the majority indicating that they plan to continue to teach as they pursue additional classwork/training in STEM/biology. 63% of the respondents prefer online asynchronous classes. 38% indicated a desire to further their education in biology indicating multiple subdisciplines within biology as areas of interest to study. Due to this level of interest the department is exploring the feasibility of offering a certificate program for those who already have a MS/MA degree or desire further training in biology.

The possibility of collaborative arrangements with other academic entities is being explored. One specific example is a possible collaboration between the Biology and Community and International Development graduate programs in the MSCID degree.

# 20. What recommendations are suggested by this program review?

1. Increase recruitment and retention efforts to maintain strong enrollment.

2. Maintain excellent relations with alumni, students, and prospective students.

3. Maintain current faculty numbers and strategically prepare for faculty replacements to provide excellent coverage of biological science and training in research.

4. Reinstate funding for a full-time administrative assistant for the biology dept.

5. Maintain strong alumni support.

6. Increase financial support by University administration, especially for capital improvement and facility upgrades which are severely underfunded.

7. Increase the research output and publication of faculty and students.

8. Continue to contribute to the financial bottom line of the College of Arts and Sciences and University as a whole.

9. Encourage Biology faculty to seek extramural funding for research.

10. Keep the departmental website informative and departmental social media up to date and attractive to prospective students.

11. Strengthen the M.S. in Biology program offered by the Department and increase the numbers of students in that program.

12. Broaden our recruitment efforts to include non-SDA Christians and SDAs from outside of North America.

13. Prioritize the value of field study and tours in the transformational educational experience of students.

14. Foster community engagement & collaborative relationships using facilities such as the proposed Inspiration Center and NHM as well as shared curricular experiences.

# APPENDIX 1 – Research Productivity and Grantsmanship 2017-2022, Department of Biology Faculty. *Italics*: AU student. **Bold:** AU biology faculty (includes adjunct)

Publications (2022):

*Amanda M. Moore*, Adam Hartstone-Rose, and **Daniel Gonzalez-Socoloske**. Review of sensory modalities of sirenians and the other extant Paenungulata clade. *The Anatomical Record* 305(3): 715-735, 2022.

*Erika Bauza Nowotny*, **Peter J. Lyons**, & **Daniel Gonzalez-Socoloske.** Identification of the Eastern Massasauga Rattlesnake (*Sistrurus catenatus*) through genetic analysis of shed skin. *Conservation Genetic Resources* 14:291-297, 2022

Lyons PJ. 2022. Isolation and Functional Analysis of a Pancreatic Enzyme in an Introductory Student Lab. CourseSource 9. doi:10.24918/cs.2022.39.

Publications (2021):

**Atkins, G. J., Hayward, J. L.,** and Henson, S. M**.** 2021. How do gulls synchronize every-other-day egg-laying? Wilson Journal of Ornithology 133(2):226-235.

Polski, A. A., Osborn, K. J., **Hayward, J**. L., Joo, E., Mitchell, A. T., Sandler, A. G., and Henson, S. M**.** 2021. Egg cannibalism as a foraging tactic by less fit glaucous-winged gulls (Larus glaucescens). Wilson Journal of Ornithology 133(4):552-567.

Miriam Marmontel and **Daniel Gonzalez-Socoloske**. Editorial: Fresh faces, a new look, and a bright future for LAJAM. *Latin American Journal of Aquatic Mammals* 16(1):1-2, 2021.

D. N. Castelblanco-Martínez, D. H. Slone, S. S. Landeo-Yauri, E. A. Ramos, A. Alvarez-Alemán, F. L. N. Attademo, C. A. Beck, R. K. Bonde, S. M. Butler, L. J. Cabrias-Contreras, D. Caicedo-Herrera, J. Galves, I. V. Gómez-Camelo, **Daniel González-Socoloske**, D. Jiménez-Domínguez, F. O. Luna, Y. Mona-Sanabria, J. B. Morales-Vela, L. D. Olivera-Gómez, J. A. Padilla-Saldívar, J. Powell, J. P. Reid, G. Rieucau, and A. A. Mignucci-Giannoni. Analysis of body condition indices reveals different ecotypes of the Antillean manatee. *Scientific Reports* 11:19451, 2021.

Anmari Alvarez-Aleman, **Daniel Gonzalez-Socoloske**, Boris Garcia-Dulzaides, and Leandro Rodriguez-Viera. First report of Pygmy Killer whales (*Feresa attenuate*) in Cuba. *Aquatic Mammals* 47(1), 71-75, 2021.

**Daniel Gonzalez-Socoloske**. Finding the elusive manatee with sonar. *Isana* 74: 22-26, 2021.

Publications (2020):

**Gordon J. Atkins**, *James Yoon*, *Kristin Lee*, *Rachel Koo*, *Kristin Chung*, *John Zdor*, *Darley Magno*, *Eun Byeol Cho*, *Cassie Kim*, **Daniel Gonzalez-Sokoloske** and **Benjamin A. Navia**.

Nanoinjection of neurotransmitters into the prothoracic ganglion of female cricket Acheta domesticus changes phonotactic selectivity. *Physiological Entomology* 45(4), 131-139, 2020.

M. Cartmill, K. Brown, C. Atkinson C, EA Cartmill, E. Findley, **Daniel Gonzalez-Socoloske**, A. Hartstone-Rose, J. Mueller 2020 Marsupial gaits and the evolution of diagonal-sequence walking in primates. *American Journal of Physical Anthropology* 171(2): 182-197.

**Daniel Gonzalez-Socoloske**, Nicolas P. Tippery, Nelly del Carmen Jiménez-Pérez and Donald H. Les. New record of Bacopa egensis (Plantaginaceae) for the flora of Mexico. *Journal of the Botanical Research Institute of Texas* 14(2), 395-403, 2020.

*R. Christian McDonald, Matthew J. Schott*, *Temitope A. Idowu*, and **Peter J. Lyons**. Biochemical and genetic analysis of Ecm14, a conserved fungal pseudopeptidase. BMC Molecular Cell Biology 21(1), 86 (16 pages), 2020.

Ashley C. McGrath, David J. Varricchio, and **James L. Hayward.** Taphonomic assessment of material generated by an arboreal nesting colony of Great Blue Herons (*Ardea herodias*). *Historical Biology* 32, April 13, 2020. Online

*Mindy McLarty*, **Daniel Gonzalez-Socoloske**, AnMarie Alvarez-Aleman, J. Angulo-Valdes. 2020 Manatee habitat characterization using side-scan sonar. *Journal of the Marine Biological Association* of the UK 100(1): 173-179.

*Sumiko K. Weir*, Shandelle M. Henson, **James L. Hayward**, **Gordon J. Atkins**, *Ashley A. Polski*, *WayAnne Watson*, and *Amanda G. Sandler*. Every-other-day clutch-initiation synchrony as an adaptive response to egg cannibalism in Glaucous-winged Gulls (*Larus glaucescens*). *Wilson Journal of Ornithology* 132(3), 575–586, 2020.

**James L. Hayward**. Booth, Ernest Sheldon (1915-1984). *Encyclopedia of Seventh-day Adventists* (online), 2020.

**James L. Hayward**. Brown, Robert Henry (1915-2013). *Encyclopedia of Seventh-day Adventists* (online), 2020.

**James L. Hayward**. Burdick, Clifford Leslie (1894-1992). *Encyclopedia of Seventh-day Adventists* (online), 2020.

**James L. Hayward**. Clark, Harold Willard (1891-1986). *Encyclopedia of Seventh-day Adventists* (online), 2020.

**James L. Hayward**. Coffin, Harold Glen (1929-2015). *Encyclopedia of Seventh-day Adventists* (online), 2020.

**James L. Hayward**. Couperus, Molleurus (1906-1998). *Encyclopedia of Seventh-day Adventists* (online), 2020.

**James L. Hayward**. Hare, Peter Edgar (1933-2006). *Encyclopedia of Seventh-day Adventists*(online), 2020.

**James L. Hayward**. Kellogg, John Harvey (1852-1943). *Encyclopedia of Seventh-day Adventists* (online), 2020.

**James L. Hayward**. Marsh, Frank Lewis (1899-1992). *Encyclopedia of Seventh-day Adventists* (online), 2020.

**James L. Hayward**. Price, George McCready (1870-1963). *Encyclopedia of Seventh-day Adventists* (online), 2020.

**James L. Hayward**. Ritland, Richard Martin (1925-2019). *Encyclopedia of Seventh-day Adventists* (online), 2020.

Publications (2019):

**Shandelle M. Henson**, Robert A. Desharnais, Eric T. Funasaki, Joseph G. Galusha, James W. Watson, and **James L. Hayward**. Predator-prey dynamics of bald eagles and glaucous-winged gulls at Protection Island, Washington, USA. *Ecology and Evolution* 9(7), 3850-3867, 2019.

**Daniel Gonzalez-Socoloske** and Leon David Olivera-Gomez. Food choice by a wild free-ranging Antillean manatee *Trichechus manatus manatus* in Tabasco, Mexico. *Journal of Marine Animals and Their Ecology* 11(1), 19-32, 2019.

**Daniel Gonzalez-Socoloske.** Why nature matters: Seventh-day Adventist education in the Anthropocene. *Journal of Adventist Education* 81(3), 28-34, 2019.

**H. Thomas Goodwin** and James O. Farlow. A new late Neogene ground squirrel (Rodentia, Sciuridae) from the Pipe Creek Sinkhole biota, Indiana. *Proceedings of the Indiana Academy of Science* 128(1), 73-86, 2019.

**Robert E. Zdor.** Visualizing nutrient effects on root pattern formation. *The American Biology Teacher* 81(8), 582-584, 2019.

Publications (2018):

*Linnea C. Burke*, *Hazel O. Ezeribe*, *Anna Y. Kwon*, *Donnel Dockery*, and **Peter J. Lyons**. Carboxypeptidase O is a lipid droplet-associated enzyme able to cleave both acidic and polar c-terminal amino acids. *PLoS One* 13(11), e0206824, 2018.

Maria C. Garcia-Guerrero, Javier Garcia-Pardo, Esther Berenguer, Roberto Fernandez-Alvarez, *Gifty B. Barfi*, **Peter J. Lyons**, Francesc X. Aviles, Robert Huber, Julia Lorenzo, and David Reverter. Crystal structure and mechanism of human carboxypeptidase O: Insights into its specific activity for acidic residues. *Proceedings of the National Academy of Sciences of the United States of America* 115(17), E3932-E3939, 2018.

**Peter J. Lyons**. Editing life: Modern biology and biblical principles. *The Journal of Adventist Education* 80(2), 30-39, 2018.

B. S. McLean, K. M. Helgen, **H. Thomas Goodwin**, and J. A. Cook. Trait-specific processes of convergence and conservatism shape ecomorphological evolution in ground-dwelling squirrels. *Evolution* 72(3), 473-489, 2018.

*Kelly M. McWilliams*, *Amanda G. Sandler*, **Gordon J. Atkins**, **Shandelle M. Henson**, and **James L. Hayward**. Courtship and copulation in Glaucous-winged Gulls, *Larus glaucescens*, and the influence of environmental variables. *Wilson Journal of Ornithology* 130(1), 270-285, 2018.

**Benjamin A. Navia**, **David Mbungu**, and Anneris Coria-Navia. Student perception on the study of evolution in a general biology course in a Christian college. *Journal of Research on Christian Education* 27(3), 225-242, 2018.

Publications (2017):

**Gordon J. Atkins** and **James L. Hayward**. Predation by common ravens (*Corvus corax*) on eggs of rhinoceros auklets (*Cerorhinca monocerata*) and kleptoparasitism by bald eagles (*Haliaeetus leucocephalus*). *Wilson Journal of Ornithology* 129(2), 387-389, 2017.

**Gordon J. Atkins**, *Ashley A. Reichert*, **Shandelle M. Henson**, and **James L. Hayward**. Copulation call coordinates timing of head-tossing and mounting behaviors in neighboring glaucous-winged gulls (*Larus Glaucescens*). *Wilson Journal of Ornithology* 129(3), 560-567, 2017.

**H. Thomas Goodwin** and Robert A. Martin. Ground squirrels (*Rodentia, Sciuridae*) of the late Cenozoic Meade Basin sequence: Diversity and paleoecological implications. *Journal of Paleontology* 91(6), 1244-1257, 2017.

**James L. Hayward**, **Shandelle M. Henson**, Jennifer Bové, Chris Bové, and *Cory J. Gregory*. Daily and annual habitat use and habitat-to-habitat movement by Glaucous-winged Gulls at Protection Island, Washington. *Northwestern Naturalist*, Winter 2017, 180-189.

*Rashida S. Smith*, Lynelle M. Weldon, **James L. Hayward**, and **Shandelle M. Henson**. Time lags associated with effects of oceanic conditions on seabird breeding in the Salish Sea region of the Northern California Current System. *Marine Ornithology* 45, 39-42, 2017.

Carole Wolford-Hunt, **Marlene Murray**, Tevni Guerra, and Kristina Beenken-Johnson. Analysis of endocrine response to perceived difference in cross-cultural interactions. *Journal of Global Engagement and Transformation* 1(2), no page, 2017.

Faculty Research Grants:

External:

**Shandelle M. Henson** and **James L. Hayward**. *RUI: Collaborative Research: Climate Change, Cannibalism, and Reproductive Synchrony: The Effect of Food Shortages on Life History Strategies of Marine Organisms*. National Science Foundation (2014-2021).

**Daniel Gonzalez.** *Can Sonar Technology Aid in the Detection and Monitoring of the Vulnerable Amazonian Manatee?* Fulbright US Scholar Program. (2020-2021).

**Daniel Gonzalez.** National Geographic Society. (2022).

Internal (2019-22-new and renewals):

**Daniel Gonzalez**, *Phase III of Amazonian Manatee Detection with Side-scan Sonar*
**Peter Lyons**, *Structure and Function of Carboxypeptidase O: A Unique Metalloprotease*
**Marlene Murray** and Desmond Murray, *Design and Development of Novel Hybrid Pharmaceuticals for Bipolar Disorder*
**Brian Wong**, *Selective Induction of Apoptosis by Aqueous Extract of Chinese Medicinal Herbs Scutellaria Barbata and Oldenlandia Diffusa in HCT 116 Colon Cancer Cells and CCD 841 CoN Colon Epithelial Cells*.
**Benjamin Navia**, *Control of Phonotaxis in Female Cricket Acheta Domesticus by Call Selective Neuronal Processing and Molecular Regulation: The Role of First Order Neurons in the Prothoracic Ganglion and the Effect of Male Exposure*.
**Robert Zdor**, *Exploring the Clay Composition of Sand Mixtures on the Suppressive Effect of Mustard Seed Meal on Velvetleaf Growth*
**Tom Goodwin**, *Variation in Diet by Season, Age, and Gender in Thirteen-lined Ground Squirrels (Ictidomys tridecemlineatus)*

# APPENDIX 2 – Curriculum Map of Student Learning Outcomes

Curriculum map for core learning outcomes: BS Biology. Courses are listed in approximate sequence that they will commonly be taken. X = explicit introduction; XX = focused development. Note that SLOs 2-4 will be engaged throughout the curriculum. The curriculum map only depicts where explicit introduction and focused development take place.

| | Freshman | | | Sophomore | | | Junior/Senior | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Learning Outcome** | BIOL285[1] | BIOL165 | BIOL166 | BIOL371 | BIOL372 | BIOL280 | BIOL305 | BIOL340 | BIOL4 | RELT385 |
| SLO 1A: Integrated Understanding: Cell Biology | | X | | | XX | | | | | |
| SLO 1B: Integrated Understanding: Genetics/Molecular Bio | | X | | XX | XX | | | | | |
| SLO 1C: Integrated Understanding: Organismal Biology | | | X[2] | | | | | | | |
| SLO 1D: Integrated Understanding: Pop Bio, Evolution, Ecology | | | X | | | | | XX (pop bio/ecol) | XX (evol) | |
| SLO 2: Apply Scientific Method. to Create/Assess Knowledge | | X | | | | XX | | | | |
| SLO 3: Communicate Scientific Knowledge Effectively | | X | | | | | XX | | | |
| SLO 4: Integrate Science and Faith in Light of Personal Faith | | | X | | | | | | XX | XX |
| SLO 5: Practice Ethics and Professionalism in Science | X | | | | | | XX | | | XX |

[1] Taken 5 times during 8 semesters of program (0 credit; attend and report on ≥ 3 assemblies/term of registration).

[2] This subtheme is not engaged in-depth elsewhere in the biology core. However, the majority of our students (~90%) take the Biomedical Science emphasis which requires them to choose 3 of the following 5 courses: Systems Physiology, Human Anatomy, Histology, Biology of Bacteria, Developmental Biology. Given that most of these are organismal in nature, and that most students elect to take Systems Physiology, most of our majors will have strong coverage in SLO 1C.

## APPENDIX 3 – Select Biology Restricted Fund Use for Equipment and Space Renovation, 2019-2023 Fiscal Years

| | Restricted Funds Used (Approximate) | | | |
|---|---|---|---|---|
| Fiscal Year | Equipment | Space | Total | Description |
| 2022 | $8,064 | $20,608.15 | $28,672.15 | • Renovation of PH210: flatscreen/2 white boards + hallway white board ($3,356.23)<br>• Ultracentrifuge rotor cost ($8,064)<br>• Whiteboard purchase for Biology amphitheater (3,927.19 + labor)<br>• Cricket colony habitat heat/cool repair ($13,324.73) |
| 2023 | | $53,916.46 | $53,916.46 | PH314/316 renovation into common research space ($49053.33 + 4,863.13) |
| 2019 | $92,317.68 | | $92,317.68 | • Physiology Power Lab purchase<br>• Keyence Fluorescence Microscope purchase |
| **Totals** | **$100,381.68** | **$74,524.61** | **$174,906.29** | • Note: This only includes costs associated with equipment and renovation/repurposing of space. Restricted funds have additionally supported operations over budget (e.g., faculty development, supplies for research) |

## APPENDIX 4: Assessment tools used in evaluating the student research proposal in BIOL305: Scientific Communication

***Oral Presentation: self- assessment tool***

You will use this checklist for two purposes:

- As a guide when you give your peers' feedback after their oral presentation. (You will not need to complete it at this point; just use it as a guide.)
- To do your own self-assessment after your practice session. **You will complete the checklist and turn it in as your self-assessment assignment.**

**For your self-assessment complete the following checklist after your practice oral presentation (but not during the session; give your attention to your peers during that session!).** Your self-assessment will consider what your peers shared after your presentation as well as your own reflections. For each criterion:

- Mark an X in one box before each criterion
- Make a comment about what went well or not for that criterion (on the right of each row in the checklist)
- Provide summary comments at the end: overall what went well and what needs to be worked on for the final presentation.

| Yes | Mostly | Not Yet | Criteria | Comments |
|---|---|---|---|---|
| | | | Organization: Presentation is clear, logical, organized. Listener can follow reasoning with ease. | |
| | | | Style: Level of presentation appropriate for audience. Presentation a planned conversation, paced for understanding. Speaker comfortable and can be heard by all. | |
| | | | Communication aids enhance presentation.<br>• Clear, readable font<br>• Clear, simple visuals that focus on main point | |
| | | | Content: Presentation is accurate; explanations of key concepts and theories help readers follow the storyline. | |
| | | | Use of language: Sentences are complete and grammatical; they flow together easily; words well-chosen and express intended meaning. Oral and body language convey respect and fairness. | |
| | | | Responsiveness to audience: Clarifies, restates, responds to questions. Summarizes when needed. Body language projects comfort interacting with audience. | |

General observations about what went well and what needs improvement:

***Written Proposal: evaluation rubric***

Rubric for proposal review–All writing has an intended audience and purpose. The proposal assignment has an intended audience of fellow classmates and the purpose of convincing these classmates to "support" the proposed research. Keep this audience and purpose firmly in mind as you review proposals, guided by the following rubric.

| Criterion | Proficient (=100% poss. pts.) | Intermediate (=50% poss. pts.) | Not Yet (=0% poss. pts.) |
|---|---|---|---|
| The title is informative, specific, concise (**2 pts)** | Yes | Indicates general area but not the specific focus; or is too wordy | Absent or uninformative |
| The summary concisely (no more than 1 page) summarizes the context of your study leading directly to your specific research question; shows how this question leads to your specific research hypotheses or aims; and indicates briefly how you will address these aims. (**4 pts)** | Yes; meets all criteria for a focused summary | Incorporates all elements of the summary (context, question, hypotheses/aims, methods), but one of these elements is too general or lacks clarity. | One or more of the elements of the summary is missing, or two or more of the elements are too general or lack clarity. |
| The background effectively reviews the relevant peer-reviewed literature, showing how it directly bears on the research question being proposed. The section ends with a clear statement of the specific research aims or hypotheses of the proposed study. **(10 pts)** | Yes; meets all criteria for an effective background section | Peer-reviewed literature is reviewed as a context for the proposed research but some elements of the review seem off-topic; or, the section ends with a vague statement of research aims or hypotheses. | Literature review is irrelevant to the research question or the literature used is poor quality (some not peer reviewed), or the research aims/hypotheses are missing or unintelligible. |
| The research aims or hypotheses to be tested are scientifically meaningful, testable, fill a clear knowledge gap, and can be addressed with proposed methods. **(4 pts)** | Yes; meets all criteria for research aims or hypotheses | The research aims or hypotheses are scientifically relevant and testable, but it is not clear if the aims or hypotheses fill a knowledge gap, or it is unclear if the aims or hypotheses can be addressed with proposed methods | The research aims or hypotheses being addressed are not relevant scientifically or are not testable or clearly do not fill a knowledge gap or cannot be addressed with proposed methods. |
| The proposed research section clearly and unambiguously describes how each hypothesis or aim will be addressed; explains why chosen methods will be used; clearly indicates the controls and sample sizes of experiments and statistical tests to be performed; anticipates and addresses limitations of study design; and grounds the proposed methods in relevant literature. **(10 pts)** | Yes; meets all criteria for a robust proposed research section. | Most aspects of the proposed research are adequately described, are likely to address the specific aims or hypotheses, and are grounded in the literature; but there is some ambiguity in one or two areas. | The proposed research section either fails to explain how hypotheses will be tested or the explanations are unintelligible or the proposed methods will not address the hypotheses to be tested. |
| The proposal uses peer-reviewed sources well, cites them properly in-text and in the Literature Cited section following proper format, makes sure all in-line citations are | Yes; meets all criteria for effective source use and citation. | Uses peer-reviewed sources but in one or two cases cites sources that are not peer-reviewed; or a few errors occur in citation format, or one or two cases of in-line | Multiple cases of use of non-peer-reviewed sources or common errors in citation format or more than two cases of in-line citations not in Literature |

| | | | |
|---|---|---|---|
| present in the literature cited (and vice versa), and never plagiarizes or quotes. (**4 pts)** | | citations not in the Literature Cited section (or vice versa), or occasionally quotes sources | Cited (or vice versa) or ANY EXAMPLE OF PLAGIARISM in source use or commonly quotes from sources |
| The proposal flows as a seamless argument advancing the purpose of the proposal from beginning to end, with each word, phrase, sentence, and paragraph clearly and unambiguously contributing to a well-supported argument. (**6 pts)** | Yes; meets all criteria for a seamless, well-supported argument | The argument of the paper generally flows well, but there are one to a few places in which inappropriate or ambiguous word choice, lack of transitions, or sentence/paragraph structure get in the way of following the argument or where elements of the argument lack adequate support. | The argument of the paper is generally difficult to follow due to inaccurate or ambiguous word choice or lack of transitions or difficult sentence or paragraph structure or other issues; or there are multiple cases in which the argument lacks support. |
| The proposal was well-edited for spelling, grammar, and other conventions of effective writing. **(4 pts)** | Yes; well-edited. | The proposal has a few (less than 5) spelling errors or violations of writing conventions, and these generally don't impact meaning. | The proposal has multiple (>5) spelling or writing convention errors, with errors commonly getting in the way of meaning. |