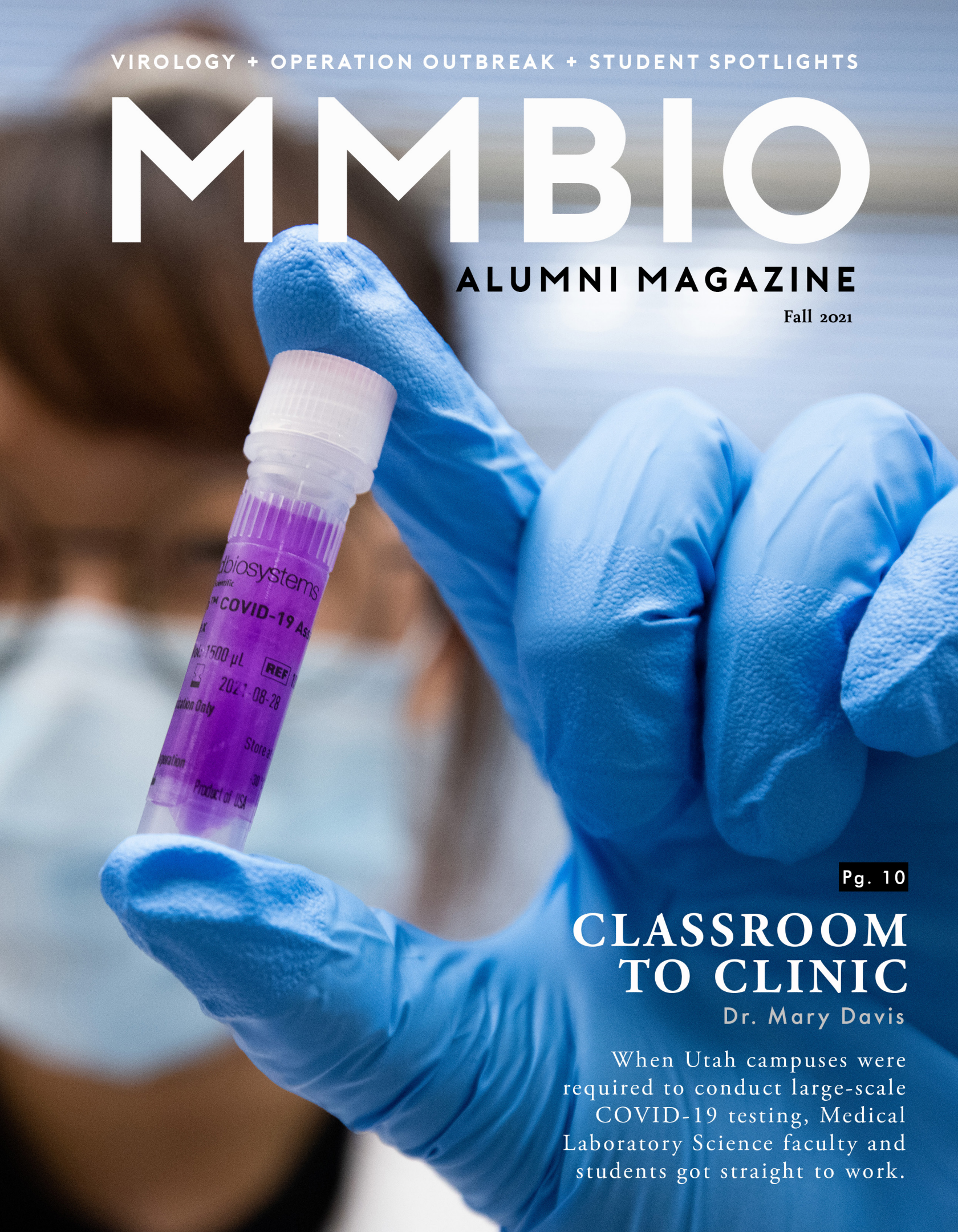
VIROLOGY + OPERATION OUTBREAK + STUDENT SPOTLIGHTS

MMBIO

ALUMNI MAGAZINE

Fall 2021



Pg. 10

CLASSROOM TO CLINIC

Dr. Mary Davis

When Utah campuses were required to conduct large-scale COVID-19 testing, Medical Laboratory Science faculty and students got straight to work.

CHAIR'S CORNER

Joel Griffitts
Department Chair

Opening Doors

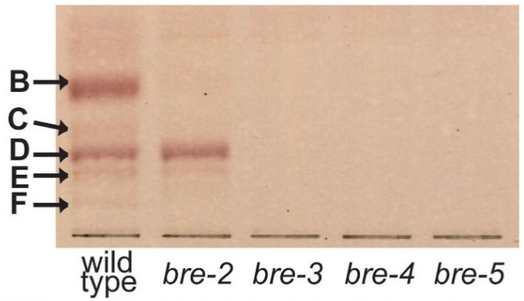
In graduate school, I spent hundreds of days and nights toiling to understand the mode of action of a class of toxins that had mystified researchers for decades. These toxins are created by certain bacteria and are effective against invertebrates like insects and nematodes and, if understood, could be used to protect animals and plants. I'll always remember one particular night from those years: I had applied lipid molecules derived from nematodes onto a small analytical glass plate coated with a layer of fine silica particles. Some lipids were from unmutated, wild-type animals, and some were from mutants that had toxin resistance.

The plate was then sprayed with a chemical for detecting sugar-linked lipids and placed in a lab oven for development of the color reaction. Five minutes later, I opened the oven door and saw to my elation that wild-type animals produced a series of these sugar-lipids, while toxin-resistant mutant animals (referred to as 'bre' mutants in the accompanying figure) were defective in making these lipids.[1] That experience of linking the toxin-resistant trait with a specific lipid receptor opened the doors that ultimately led to where I am now.

This discovery was not mere luck. Careful investigation and contemplation over several years, with plenty of missteps and dead ends along the way, had led to the lipid samples, the glass plate, the spray-on reagent, and the opening of the oven door. It was the investment in manual and mental effort that made this moment so exciting.

While Henry B. Eyring was studying physics, he recalled his father becoming frustrated with him upon learning that he didn't spend much of his free time contemplating the mathematics that would be so important to a career in physics. Observing this, his father remarked: "Well then, Hal, you'd better get out because you'll be competing with people where this is their life, and they'll be as bright as you are. You better go find something that you think about when you don't have to think about it, when it's just a joy to you."[2]

In graduate school, I learned that biology research is a joy to me. I might have learned this during my undergraduate years, but I was too occupied with traditional courses and exams. In MMBio, we are redoubling our efforts to provide more open-ended, project-based activities that will tempt students to think about their studies when they don't have to. This emphasis on experiential learning is meant to cultivate ingenuity, collaboration, and confidence in the face of uncertainty. For our students, with their diverse career paths, we trust that these attributes will open doors for a lifetime of learning and faithful service.



The oven-baked plate revealing sugar-linked lipids, especially the smudge labeled 'B,' that act as receptors for the invertebrate-active toxin Cry5B.

References:

1. Griffitts JS, Haslam SM, Yang T, Garczynski SF, Mulloy B, Morris H, Cremer PS, Dell A, Adang MJ, Aroian RV. Glycolipids as receptors for Bacillus thuringiensis crystal toxin. Science. 2005 Feb 11;307(5711):922-5. doi: 10.1126/science.1104444. PMID: 15705852.

2. "President Henry B. Eyring: A Legacy of Learning and Testimony." Church Newsroom, The Church of Jesus Christ of Latter-Day Saints, 4 Feb. 2008, newsroom.churchofjesuschrist.org/additional-resource/president-henry-b-eyring-a-legacy-of-learning-and-testimony.

Features


p. 10

p. 18


p. 24

10 MLS PROGRAM HEADS BYU COVID RESPONSE
As the pandemic surged, Medical Laboratory Science faculty and students were at the forefront of the fight to keep BYU healthy and safe.

18 OPERATION OUTBREAK
A year after the COVID-19 outbreak was declared a pandemic by the World Health Organization, another virus struck hundreds of BYU students... or at least their phones.

24 A VIROLOGIST'S VIEW OF THE PANDEMIC
Dr. Brian Poole discusses the COVID-19 pandemic from his perspective as a trained virologist.

28 LABORATORY BREAKDOWN
MMBio Labs pursue a wide diversity of biological phenomena. Have a look at current research summaries.

PLUS...

4 The Microbe

16 Professional Tracks

26 History of MMBio

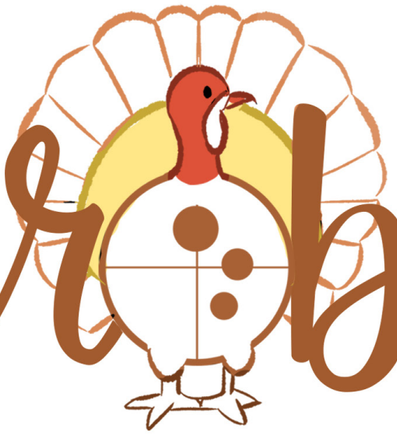
Editors
Kevin Johnson *Joel Griffitts*
Terri Moser *Ashley Krause*

Writer
Maya Mortensen

Photographers
Forrest Stull
BYU Photo

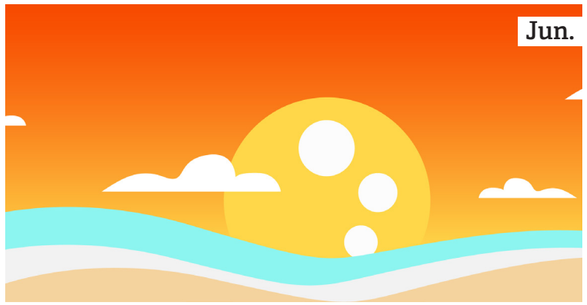
Magazine Design
Forrest Stull *Joy Asiado*
Jaren Sloan *Ashley Krause*

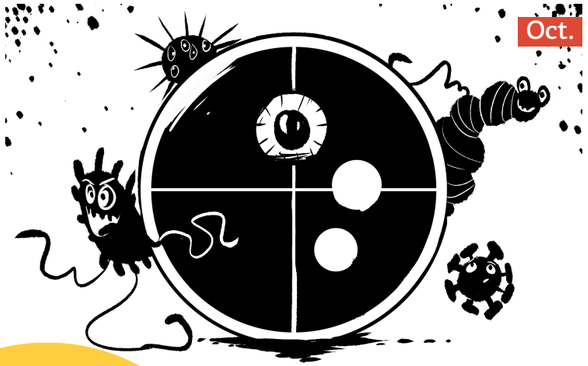
microbe

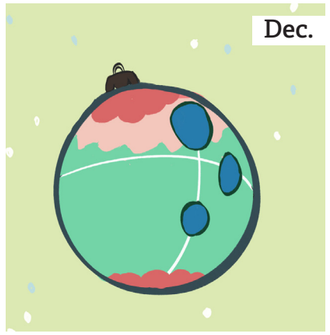


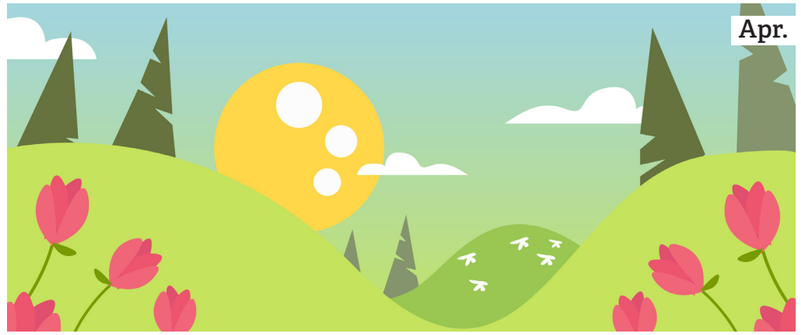
Nov.

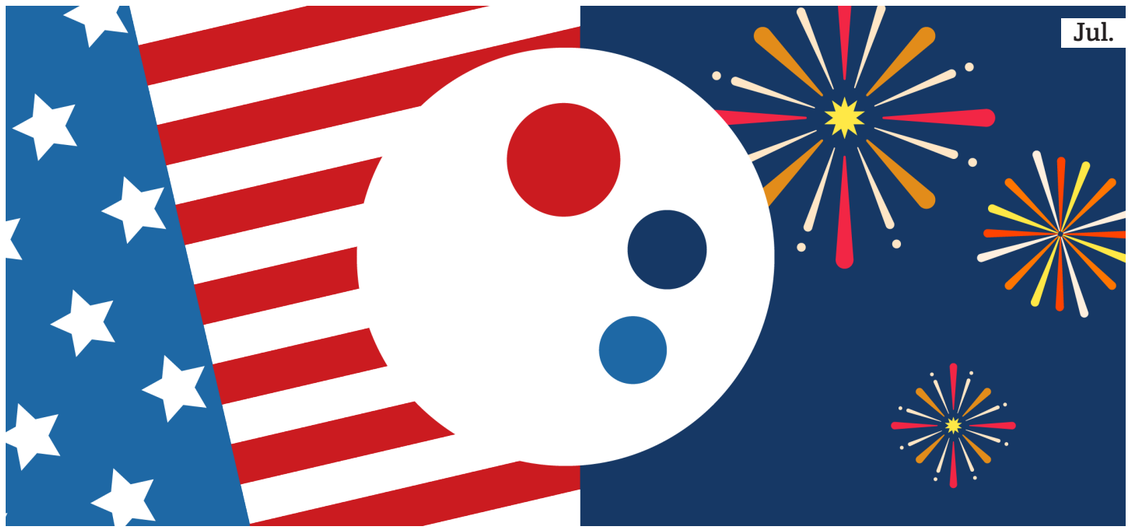
A 12-month collection of banners made by Forrest Stull for the MMBio Monthly Newsletter, "The Microbe"

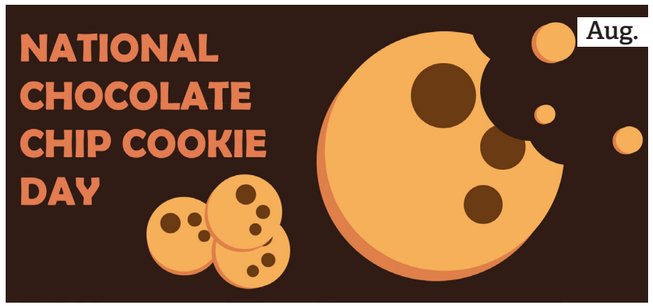












PHAGE HUNTERS:
Discovery-Led Learning


Dr. Julianne Grose

The image that comes to mind for most people when they think of a laboratory class in college is a list of procedures, possibly expired reagents, and the same sets of skills acquired semester after semester. For participants in the Phage Hunters course at BYU, however, lab class means collaboration in teams, publications, poster presentations at conferences, and real-life discoveries in the study of the most abundant biological agents on Earth.

THE ORIGINS

Phage Hunters is a two-semester course offered by the MMBio Department taught by Dr. Julianne Grose and Dr. Don Breakwell that guides students through the process of discovering new species of bacteriophages, viruses capable of infecting bacteria. The course began as a program created by the Howard Hughes Medical Institute to engage university students in research about these impactful microbes. Dr. Hope and Dr. Breakwell of the MMBio Department initially heard about the program, petitioned to bring it to BYU, and received training on how to teach it. Dr. Grose worked with bacteriophages in college, so her expertise was also critical for the successful execution of this new program.

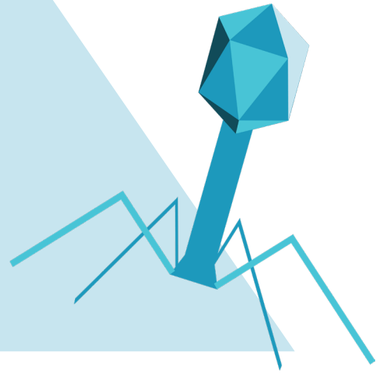
In the first semester, students are exposed (often for the first time) to working in a lab. They learn aseptic technique, how to design an experiment, how to troubleshoot when their experiment goes awry, and how to read and communicate research, all while isolating and identifying novel bacteriophages associated with humans. In the second semester, students annotate the genomes of the bacteriophages they isolated and identified using bioinformatics programs to ready the genome for submission into GenBank, an open access genetic sequence database. Over the course of this process, students write and publish papers on their discoveries and present their work at national conferences.

THE IMPORTANCE

There are an estimated 10^{31} (ten nonillion) bacteriophages on Earth right now, more than any other biological entity. Many are able to destroy pathogenic bacteria, which would be revolutionary in the fight against diseases caused by antibiotic resistant bacteria. The World Health Organization predicts that by 2050, 10 million deaths a year will be the result of antibiotic resistant infections. Phage research hopes to address this by finding bacteriophages that can kill disease-causing microorganisms without antibiotics.

Dr. Grose estimates that the Phage Hunters program at BYU allows 75 students per year the opportunity to be involved in phage research. This means every new academic year, 75 students get to be a part of real research. Dr. Grose and Dr. Breakwell teach students lab protocol and biology concepts, while managing an ongoing research project with grants and publications. Although this course involves much more work for students and professors, Dr. Grose believes the learning gains far outweigh the costs.

"I'm a big proponent for hands-on learning, and that's why I teach Phage Hunters. It's far more work than teaching a standard discussion-based class, but I don't teach any standard discussion-based classes anymore. The reason I don't is because I've been converted," she said. "The way to learn things is through application."



A LEARNING REVOLUTION

Samuel Flor, a past participant and a teaching assistant for the class, echoes Dr. Grose's sentiments. "There are a lot of classes that offer hands-on work, but it becomes meaningful when you can apply it to a research project," he said. "It's not just meaningful for a midterm or a final."

Phage Hunters walks students down from the living entity scale to the molecular scale, allowing students to understand the requirements of life in a complete way. Bacteriophages only have 60-70 genes, compared to bacteria which have 2000-4000 genes, making phages the perfect model to study how biology works at each level. "I hope that it helps the basic concepts of biology come to life and increase [students'] understanding of them," Dr. Grose said.

For Ashley Smith Ward, her experience taking Phage Hunters in the MMBio Department taught her about herself. "Phage Hunters taught me a lot about how I am as a scientist--how I work through challenging situations, how I problem solve, how I work with other people," she said. "It also helped me learn lab skills. I had no research experience beforehand."

"It was cool seeing what it was like working in a lab using hands-on skills. And also, how to communicate scientific information. I feel like you learn that in a lot of other classes too, but in Phage Hunters you work on a project for one whole semester with a small group, and at the end, you get the opportunity to present at national conferences... we presented at the National SEA-PHAGES Symposium," Ward added.

Dr. Grose believes that learning how to assess information is one of the most important takeaways from this class. "In this day and age, memorization is just not as important anymore because you can look so much up on the internet. But what is important is your ability to know truth, to be able to go to the right sources for truth, and to analyze and think scientifically about what you find," she said. Dr. Grose hopes that students who participate in Phage Hunters learn to evaluate the conclusions drawn by peer-reviewed resources.

Dr. Grose's own college research experiences inform how she teaches her own students. She mentioned, "I had no clue how much we didn't know until I took a genetics course my senior year of college and joined the professor's research team. This was pivotal to my understanding of how many questions were unanswered, and how many lifeforms were still unidentified and uncharacterized." Involvement in research as a student was one of the factors that propelled her forward in her career as an educator and researcher. In addition to BYU students, Dr. Grose has invited and taught high school students in Phage Hunters, many of whom went on to go to BYU and become teaching assistants for the program. She has also helped mentor high school science fair teams that have gone on to win competitions.

Dr. Grose is also inspired by the "a-ha" moments she experienced as a new scientist and believes Phage Hunters gives her students the same opportunities to witness real discovery. "I think too often students are taking classes and reading from textbooks, and they assume we know all this stuff and that there's not that much more to discover. Phage Hunters gives them a glimpse of what we don't know and what we don't understand," she said.

ON THE HORIZON

For now, Phage Hunters is the crowning jewel of the MMBio Department's portfolio of experiential learning. Its discovery-based model has already proven to help cultivate scientific thinking for students and contribute real data to the scientific community. Discovery-based mentored research like Phage Hunters is only the start of a revolution in student engagement and microorganism research. "Each of these life forms is shaping our planet," Dr. Grose said. "Each has the potential to improve our understanding of life or contribute to solving problems on our planet. And life is full of surprises."

AGAR ART

2020 WINNERS

Every year, the MMBio Department invites students from all majors across the university to create art out of harmless bacteria painted onto plates filled with agar gel and nutrient broth. The bacteria grow on the plates and within one to two days, participants' colorful masterpieces are revealed!

WINNERS

First Place: Rylie Rasmussen
Second Place: Milvia Goulding
Third Place: Daniel Schaeffer

2020 WINNERS

HONORABLE MENTIONS

Brittany Knight
Sarah Palmer
Jeonga Gu
Maura Brumbaugh
Nathanael Taylor
Elizabeth Christensen
Emily Cluff
Jonny Skidmore
Jamie Howell
Catherine Wendel

MLS PROGRAM HEADS BYU COVID RESPONSE

As the pandemic swept across the world, MLS faculty and students were at the forefront of the fight to keep BYU healthy and safe.

In early November of 2020, Governor Herbert released an order that all college students would need to be tested for COVID-19 on a weekly basis. For Dr. Mary Davis of the Medical Laboratory Science program at BYU, this was a shock. “How are we going to do that?” she recalled thinking. The order was soon rescinded, but the wheels were already turning for Dr. Davis.

A CALL TO ACTION

The Medical Laboratory Science (MLS) program in the MMBio Department prepares students to work in a clinical laboratory, processing medical samples and assays to deliver information doctors use to diagnose patients. The program includes plenty of lab classes, but besides a 16-week internship requirement to graduate, there is nothing within the major to expose students to a real-life clinical lab setting.

Dr. Davis saw the need for an increased COVID-19 response on BYU campus and the need for more hands-on learning to prepare her students for their future careers, so she created a plan. She would set up a Clinical Laboratory Improvement Amendments (CLIA)-certified laboratory in the Student Health Center (SHC), and MLS students would analyze samples from their peers’ COVID-19 tests as a replacement for their molecular diagnostics course. Dr. Davis brought this plan to President Worthen and the President’s Council. Seeing the value in providing this service to the campus, the council immediately agreed and provided resources to purchase state of the art equipment and FDA-approved reagents, which would ensure testing was as efficient and accurate as possible. “The university contributed the funds both to help with the pandemic response and to help with experiential

learning," Dr. Davis said.

Then began the hard part. Most CLIA-certified hospital labs take six months to set up. The MLS faculty and students were trained, equipment was set up, and the hospital lab was ready to run in the SHC in fewer than six weeks. From the start of January 2021 to the end of April, MLS students worked in the SHC lab to process and test samples, sometimes testing up to 200 in one night. For the first few weeks, this testing was happening concurrently to training, in which students were learning how to navigate a hospital lab and memorize the standard operating procedures. This was all while being quizzed and tested for class credit on detailed aspects of the molecular diagnostic techniques they were using. At first, the new processes and procedures were overwhelming, and there were too many moving parts for the students with no clinical lab experience outside of the SHC lab, but they soon found their groove.

THE WORK

The workload was divided into two shifts, three hours each, and each MLS student was slated for one shift a week. Because it was a CLIA-certified laboratory, a full medical laboratory scientist was required to be at each shift, so MLS faculty members and two recent alumni switched off every day. Starting at 4pm, after all COVID-19 samples were collected that day, the first shift was responsible for mixing reagents, preparing plates that have 96 small wells to hold liquids, and pipetting patient samples into the wells (all while keeping meticulous note of which sample was where). One of the reagents used in this process was a small tube of an FDA-approved mixture manufactured by ThermoFisher for use in COVID-19 tests that cost $15,000 on its own. This price tag made some students nervous to use the reagent, so they implored Dr. Davis to portion it out into many smaller tubes. Luckily, nobody dropped the expensive vial during testing.

The second shift ran the RNA extraction in a state-of-the-art machine that uses magnets to move magnetic beads bound to RNA from solution to solution to extract the genetic material automatically, rather than having to do every step by hand. Then, the RNA samples were moved to the qPCR (quantitative polymerase chain reaction) machine, a machine that amplifies targeted genes if they are present in a sample and monitors the real-time amplification. In this case, three genes identified in COVID-19 virus strains were amplified and monitored. If two or more of the genes were amplified successfully in a sample, then the patient is positive for SARS-CoV-2 or the UK variant. If none of the genes were amplified, then the test is negative. MLS students were able to get test results back to doctors by the next morning so they could call patients and inform them of the results.

Most MLS students lacked experience with the aspect of quality assurance in a hospital lab setting, but after a few weeks, it became just another part of the process. The lab had a "clean room" in which students donned sterile lab coats and gloves to ensure no extra genetic material was introduced to the testing area. Each qPCR run included a positive control, so MLS students could see if the tests were done properly. Every step of the procedure was accompanied by verbal or written confirmation between lab workers, including instances where a student went to pipette a sample into the wrong tube but stopped themselves—in fact, these "near-misses" required paperwork to be filled out. "It's a lot of checks and balances just to make sure you get the correct thing happening," Mark Wilson, a senior in the MLS program who worked in the SHC lab, explained, "and if you don't, a lot of times the answer is to just start over."

"Our students are very conscious that if they do this wrong, someone will have to quarantine that won't need to, or someone won't quarantine, and then they might have to be hospitalized, or they'll give it to their grandma who might die," Dr. Davis said. "It changed the dynamic of their experience in really wanting to be motivated to do it correctly. You can't really mimic that in a lab."

There was a case in which the second shift workers realized a part of the process had been messed up in the first shift that day, and they spent until 11:30pm on a Friday night trying to fix the mistake. They returned the next morning at 6:00am to finish the process so that doctors could inform their patients of the test results by 8:00am.

Dr. Davis continued, "They spent all of their Friday night and all of their Saturday morning fixing someone else's problem without complaint. They were just happy to be there and make sure that their results were there."

The molecular diagnostics course that the COVID-19 lab work replaced for MLS students during Winter Semester 2021 usually covers RNA and DNA extraction, lab procedures like pipetting and aseptic technique, and how to run a PCR, but could not mimic the stringent policies and the gravity of what students will be doing in their future clinical lab careers. "In the Student Health Center, working with COVID-19 samples, it felt like, 'Okay, these are real people, we are making a difference, we are actually getting to be able to participate in this world we are about to enter," expressed Danielle Fortin, a senior in the MLS program.

THE IMPACT

By the end of April, MLS students had analyzed over 4,000 COVID-19 tests, providing essential information to doctors to inform patients of how best to maintain their health. These test results were vital to helping students continue their education at the university, even in the midst of a pandemic.

Performing COVID-19 testing in the SHC also combatted the supply shortage, as the qPCR method of testing required common reagents that were almost always in stock, unlike many of the testing kits on the market. Additionally, the MLS students and faculty involved in the endeavor were compensated. None of this would have happened were it not for the immense good it did for students' learning experiences.

"They spent all of their Friday night and all of their Saturday morning fixing someone else's problem without complaint. They were just happy to be there and make sure that their results were there."

Dr. Davis noticed that during this time, she got more questions from her students on how to answer their friends' and families' questions about COVID-19 and testing. "Once they started working in a COVID lab, their family and friends turn to them as experts for COVID," she said. "It was really neat as a professor to see the students become more engaged in the testing, as well as other aspects of COVID, so they could better educate their family and friends."

Additionally, this opportunity gave students a real hospital lab experience to put on their resumes. While the MLS program already boasts an impressive 100% job placement rate after graduation, the students involved in the COVID-19 testing lab have more confidence in their abilities as medical laboratory scientists. "I got much more comfortable in a functional lab setting. Going into my internship, I'm not as intimidated now as I would have been," Fortin affirmed.

For Wilson, the experience helped solidify his idea of what daily life in his future career will be like. He said, "Having a daily set workflow where you're doing that over and over again, and you really understand standard operating procedures- I feel like that's something really hard to get in a classroom setting."

Dr. Davis believes that the experiences her students had in the SHC COVID-19 testing lab will stay with them forever. "They're going to be telling their grandkids how they contributed to the pandemic at BYU. That's so cool!" she said. The MLS program pushes its students to be the best scientists and problem-solvers they can be, and this opportunity to involve MLS students in the real world of pandemic relief is yet another thread woven into the MMBio Department's fabric of experiential learning.

UNDERGRAD SPOTLIGHTS

Ashley Smith Ward is a Molecular Biology major from Aurora, Illinois. Inspired by her AP Biology teacher who worked at a cancer center, she declared her major freshman year and hasn't looked back. She loves learning how genes work, how they are expressed, and how these fundamental concepts impact human health. As a participant in Phage Hunters and as the current president of the MMBio Academic Association, Ashley is heavily involved in the department. She participated in two internships this summer, with the Center for Genomic Interpretation and the Adult Cardiology Group for Intermountain Health. When she's not busy with work and school, she loves to spend her time bowling. She plans to apply for genetic counseling programs. Ashley advises, "Be confident in yourself and your abilities. As long as you keep working hard and doing the best you can, things will work out."

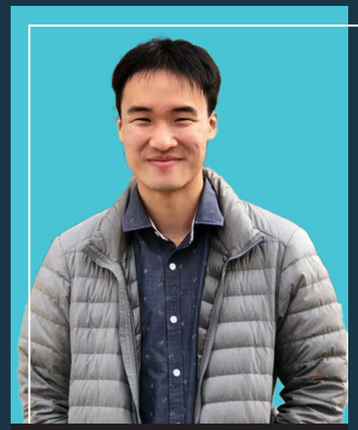
ASHLEY WARD SMITH

HANNAH WINN

Hannah Winn, a senior from Dallas, Texas, has had a winding road through her BYU career. She began in the nursing program but felt she wouldn't cut it, switching to elementary education. However, after shadowing a teacher, it became apparent that teaching was not for her. Then, Hannah took an introductory biology class and fell in love with it. With some help from her academic adviser and Dr. Breakwell, she became a microbiology major and has never looked back. Hannah believes impostor syndrome is what kept her from her passion for science; she felt she could not compare to the competence of other BYU students, even though that was not the case. For those that currently feel the effects of impostor syndrome, Hannah encourages, "You're not alone. Often you feel like you are, but you can talk and be open with everyone around you and realize that you're not the only one." She also advises current undergraduate students to be patient with themselves.

Carter Stancil has been immersed in academia all her life. Now, with her microbiology background, Carter plans to further her education by starting a master's program after graduation, focusing on marine parasite ecology. Carter has a passion for marine invertebrates and hopes to use their parasite-host interactions as bioindicators of ecosystem health. "If you are ever confused about something, especially if it is a fundamental topic or something that will come up again, ask your professor for help," Carter encourages, "I did not ever contact my professors until my Junior year, and I regret waiting for that long. I can think of a few B's that could have been A's if I had just asked for help. They can offer so much help and are a great resource for students."

CARTER STANCIL

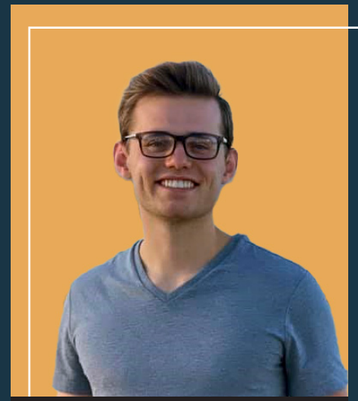


BRIAN KIM

Brian Young-Shiek Kim is a senior in the microbiology major and will graduate in August. He was first drawn to the subject of microbiology because it fulfilled pre-med requirements, but he soon found he had a fascination with the hidden world of microscopic organisms and viruses that we live among. In his four years at BYU, Brian has had the opportunity to work with Dr. Hope as a TA and a research assistant investigating canker sores. Brian cultivated a love for teaching while on his mission and, just like he enjoyed teaching religion then, he enjoys instructing and answering questions from microbiology students now. After graduation, Brian will begin a Master's program in anatomy at Case Western Reserve University in Ohio. He is looking forward to being closer to his family in Wisconsin and preparing to apply to medical school in the future. He hopes to become a dermatologist or plastic surgeon. "I used to have bad acne growing up, and that was a self-esteem killer for me, so I'd love to help people with that and with how they look," Brian said.

Gabby Brown, originally from Kingston, Jamaica, is a molecular biology major in her sophomore year. In high school, Gabby grew enamored with biology, "I loved seeing Heavenly Father's creations through the eyes of science." At BYU, she realized the molecular biology major held everything she enjoyed: DNA, biology, and genetics. Gabby conducts bacteriophage research in the McCleary Lab, is on the College of Life Sciences Student Council, and she is the Y-Serve marketing team director. When Gabby was 12, she wanted to be a pediatrician and a teacher, with her practice and her school next door to one another. "I don't know how realistic that is, but if I can, I'm going to make it happen," Gabby said with a laugh. She plans to go to medical school after BYU.

GABBY BROWN



NOLAN COLE

Growing up in a farming family in Ririe, Idaho, Nolan Cole never planned to go to college. While he enjoyed math and science in high school, his bigger priority was helping out with the sheep. It wasn't until being exposed to higher education through his mission and through his older brother that he decided to attend BYU. While at BYU, Nolan feels like he exhausted his professors with ceaseless questions about everything that interested him. This curiosity led Nolan to the path of the biostatistics major and a molecular biology minor. Recently, Nolan had the opportunity to intern at Harvard in the Department of Biomedical Informatics working on single-stranded RNA sequencing. Currently, Nolan does research with faculty in the Statistics Department analyzing clinical data, and with Dr. Johnson in the MMBio Department studying epigenomics. This summer, he will be interning at UCLA School of Medicine.

MMBio professional TRACKS

Ever wondered what you can do with a degree in microbiology or molecular biology? Let's break down some possible career paths.

PROFESSORIAL TEACHING EMPHASIS

Professors advise, teach, and inspire the next generation of scientists through content and curriculum creation. Some professors may pursue their own research in addition to teaching one or more courses. This track requires a master's degree at the minimum, but a PhD is advised to teach at the university level.

PROFESSORIAL RESEARCH EMPHASIS

Professors at research schools focus on designing and leading research and facilitating learning with graduate students and postdoctoral researchers. Research professors write grants, synthesize scientific literature, and write about their own research. This track requires a PhD.

GENETIC COUNSELING

Genetic counselors bridge the gap between complex genetic concepts and personalized healthcare. Genetic counselors advise physicians and patients on the risk of inherited conditions and birth defects. For those affected by these genetic conditions, counselors aid in informed decision-making and coping. Most positions require graduate school degrees.

LABORATORY SUPERVISOR

Laboratory supervisors combine their benchwork expertise with strong interpersonal skills to oversee the technical and administrative aspects of running a lab day-to-day. In addition to collecting, analyzing, and interpreting data, lab supervisors also manage personnel and finances. A bachelor's degree in a related field of study is required.

MEDICAL/ DENTAL

The medical and dental track is for those who want a personal role in providing quality care and expertise for patients. There is a wide range of opportunities for individuals in medicine and dentistry, most of which require years of specialized postgraduate education and residencies. Those who pursue this path can choose to work in hospitals, outpatient clinics, or open their own private practice.

RESEARCH SCIENTIST

Research scientists help answer the big questions in the study of life from microbiology to clinical studies. They are responsible for planning and conducting experiments, writing reports, managing junior personnel, and keeping up with current research. Graduate school is advised for this career.

FORENSIC SCIENTIST

Forensic scientists use laboratory skills and specialized training to collect and process evidence in criminal cases. From documenting and analyzing an entire crime scene to analyzing a fingerprint, forensic scientists have a wide range of job responsibilities. A bachelor's degree is required.

FORENSIC CRIMINOLOGIST

Forensic criminologists weave social and life sciences together to discover what is at the heart of crime. They assist law enforcement in better understanding what causes crime and how to prevent it. A bachelor's degree is enough for entry-level positions, but a graduate degree may be required for higher positions.

OPERATIONS MANAGER

Operations managers oversee and direct the functions of a public or private organization. For research or medical laboratory operations managers, this includes hiring and managing technicians. In a commercial lab, the operations manager organizes and runs daily tests and assays used to characterize product correctly. A master's degree and management experience are recommended.

HOSPITAL LABORATORY TECHNICIAN

Laboratory technicians in hospitals provide technical expertise to process samples and run tests in order to diagnose, treat, and prevent disease. Lab technicians record and track patient data, use and maintain lab equipment, and work with colleagues to solve problems. A bachelor's degree in Medical Laboratory Science is required for this career track.

GRADUATE DEGREES IN THE LIFE SCIENCES

The Master's (MS) and Doctorate (PhD) tracks are for individuals interested in continuing with their microbiology, molecular biology, or many other life science sub-disciplines beyond an undergraduate degree. Graduate students complete coursework, conduct groundbreaking laboratory research, and defend an original thesis or dissertation. Most MS programs take 2-3 years, while PhD programs take 4-6 years.

OPERATION OUTBREAK

A year after the novel coronavirus (COVID-19) outbreak was declared a pandemic by the World Health Organization (WHO), another SARS-like virus struck hundreds of BYU students. Or, at least, their phones.

Operation Outbreak is a simulation originally invented by Todd Brown, director of community outreach at Sarasota Military Academy, and Pardis Sabeti, a computational geneticist at the Broad Institute and professor at Harvard, who was on the ground in West Africa during the 2015 Ebola outbreak. Inspired by a field day activity at a middle school in Florida, Operation Outbreak has been converted into a smart phone app to model how broad-scale, real-world actions have health consequences for the individual and the community.

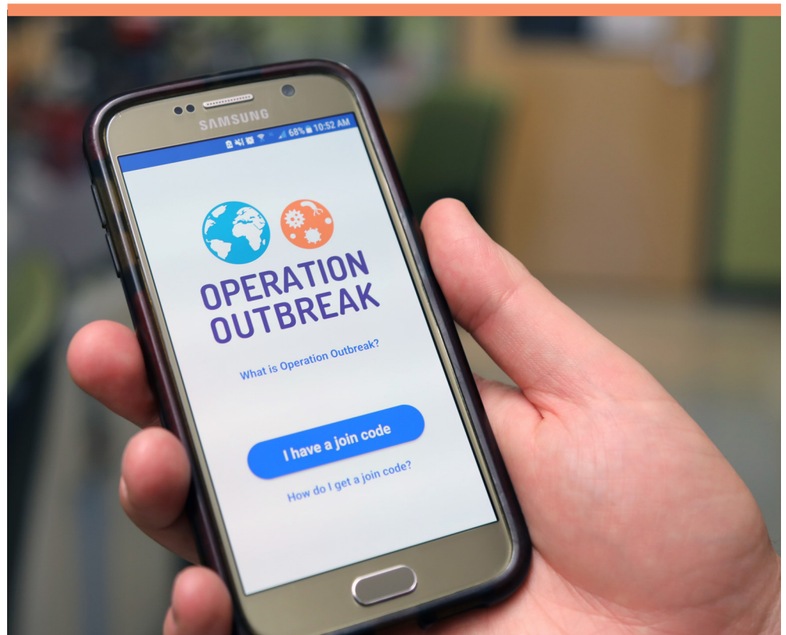
Curtis Hoffman, a student researcher in Dr. Brett Pickett's Lab, brought this program to the MMBio Department's attention. He noted that during the course of the pandemic, people became less accepting of mandates coming from higher levels like the WHO. Curtis wanted to increase empathy between students during future health events. When BYU adopted the program, MMBio faculty members decided to use SARS-CoV-2 as their simulated virus and employed virtual mask policies to see how the virtual disease would spread.

HOW IT WORKS

The Operation Outbreak mobile app tracks anonymized social interactions between student participants on BYU campus by using the Bluetooth function in their smart phones. As "infected" students come into close proximity with "uninfected" students, the disease spreads and the newly infected student is notified. Students can keep track of their virtual health status, virtual symptoms, and the number of contacts they have made with other participants on the app.

Every day students have the option to "wear a mask" virtually that reduces the statistical likelihood of passing on the virus. Over the course of the simulation, a limited number of vaccines were available per day at vaccination booths in the Life Sciences Building. Getting "vaccinated" reduced the chance of being exposed to the virus.

A survey was given before and after the simulation that asked about which college students attend, what their housing situation is like, and their beliefs and attitudes toward the pandemic and the public health initiatives currently in place.



HOW IT WENT

Operation Outbreak at BYU was the largest and longest iteration of the simulation to date, with 460 unique participants and a runtime from February 19th to March 1st, 2021. Dr. Pickett, a faculty member in the MMBio Department who helped spearhead the endeavor, was surprised at how little the virus spread. By the end of the week-and-a-half long experiment, the reproduction number (the statistical term that shows how infectious a pathogen is) was less than one, meaning less than one person was infected with COVID-19 by every one person who had it. The virus died out.

Another surprise was that vaccination rates were lower than expected. Prior to Operation Outbreak, faculty from the MMBio Department and the Public Health Department collaborated to make predictions on how many vaccinations they should expect. In the simulation, only about 15% of students got vaccinated. Though the survey results show low levels of vaccine hesitancy from students, Dr. Pickett hypothesizes that the low vaccination rates are due to vaccine complacency, which is the attitude of making vaccination a lesser priority—something that happens in real life as well as in the simulation

WHAT WE LEARNED

We learned that pandemic-related policies are effective. Operation Outbreak participants still followed BYU guidance to attend online classes or classes that maintained physical distancing. This effect was compounded by the small scale of the simulation in relation to the size of BYU campus. Though rates of mask usage and vaccination were lower than expected, the physical distancing measures still proved effective, as the virus eventually died out.

We also learned that one person's actions influence the health of another. There was an instance in which one person went on campus for a single class, sat by an infected participant for 15 seconds, and became infected themselves. The original goal of Operation Outbreak at BYU was to create empathy among students, and Dr. Pickett believes this was achieved. "Based on the survey, I think everyone realized that we are ultimately all in this together. Everyone can impact the community around them," he said.

Dr. Pickett hopes to run Operation Outbreak again in the future, with more participants university-wide and with a different scenario that "isn't quite so close to home." This simulation will add to the portfolio of experiential learning opportunities the MMBio Department has available to students.

At BYU, we believe "the world is your campus". Thanks to the collaboration between the Broad Institute and BYU, our campus became a model of the world.

Alumni Spotlight

JOSHUA FIELDS

Doctor of Internal Medicine for the Air Force

Like many students in college, California-native Joshua Fields (MD, 2015) thought he knew exactly what he was going to do and where he would end up in the future. He would complete his undergraduate degree, take the DAT, and attend dental school as soon as he graduated college. However, when Josh stayed in the lecture hall to listen to a class for pre-medical students and found himself enthralled, he knew it was time to make the first of many changes in his life plan.

After scoring well on the MCAT and maintaining an impressive GPA, Josh applied and interviewed with many medical schools. He thought they all went well, so it was a surprise when all he got back was rejection letter after rejection letter. "I felt crushed and I couldn't understand why I had been so strongly pulled to this field only to be rejected by it." However, there was one more important factor in his life; "I started dating a young lady in my singles ward who was slightly less critical of my application to marry her and ultimately accepted."

That next year and next round of applications, Josh's only acceptance letter was from a military school he had applied to solely because there was no fee. After deliberation, he and his wife Chelsea decided not to delay medical school one more year and to attend Uniformed Services University of the Health Sciences in Maryland.

"Getting accepted to the military medical school the second year forced me into an intimidating decision, but it has turned out to be an incredible experience that has blessed our family beyond measure." These blessings include the ability to afford IVF treatments that gifted them with 3 boys (the youngest of which was born in March of 2021), ample travel, a medical degree, financial security, and the opportunity to serve the country in a higher calling.

Currently, Josh and his family are stationed at the Lakenheath Air Force Base in the United Kingdom, where Josh is practicing as an Internal Medicine Specialist. Recently, he earned his pilot's license and bought his own Cessna 172 aircraft, which has been a gratifying pursuit for Josh.

For current students, Josh recommends investing time to figure out what truly fulfils them. "It takes time to research these fields and may take a few stumbles along the way. They shouldn't all feel pressured to go into a medical career path either. I now realize how much of the medicine I use is based on evidence from rigorous molecular developmental studies, and in many ways the lab researchers are the true unsung heroes of science."

PHIL BENNALLACK

Siemens Healthineer

Phil Bennallack (PhD, 2016), from Adelaide, Australia, began his love for science in high school. He said, "I liked that there were rules that you could understand to the natural world, and if you can understand those things, you can manipulate them to create things."

While working on his undergraduate degree at Macquarie University in Molecular Biology, he got engaged to his now-wife Kaylee and made a deal: if she would move to Australia, so he could finish his degree, he would look for a graduate program in Utah, so she could finish hers. They were married and followed through on their plan. Phil graduated, found a PhD program at BYU, applied for a green card, and by the fall of 2011, they had moved across the Pacific to Utah.

While at BYU, Phil worked with Dr. Griffitts and Dr. Robison to study a compound produced by some bacteria that kills pathogenic microbes. Phil was able to mentor undergraduate students in the lab he worked in and teach as an instructor for microbiology and molecular biology courses. For Phil, these experiences solidified that wherever he was headed in the future, he wanted to also be able to teach.

Phil was then hired as a postdoc at Boston Children's Hospital, where he researched endometriosis and was immersed in the Harvard research system. Despite the valuable skills he was learning, he found that research in an aggressive environment like this was not for him. He missed the opportunities to mentor undergraduate students and teach labs that he had at BYU.

That experience brought him to Siemens, a manufacturing plant that designs and produces assays for various diagnosable conditions. As an industry scientist, Phil has the opportunity to do project-based work to design better assays and manufacturing procedures. He is also able to teach new recruits in the informal "Phil Training Program," as his coworkers call it.

Working for a private company to create a product as a scientist is sometimes stigmatized in academia, but Phil urges any students to consider industry as a worthwhile option. Phil is open to whatever Heavenly Father has in store for him next; he knows that he is well-equipped for any changes that may come.

ANDREA REDISKE

Professor of Microbiology and Anatomy at Valencia College

Andrea Rediske (PhD, 2017) was born into science. Her parents were chemists, and she grew up in Tri-Cities, Washington, which at the time had the highest concentration of PhDs in the country. Surrounded by professionals in the STEM field—especially women—up to whom Andrea could look, her own love for science was cultivated. She cites a particular instance in 8th grade where her science teacher brought in pond water to look at under a microscope. This triggered a lightbulb moment in her mind: here was an invisible world that she lived among that she could now see and study. From then on, microbiology became Andrea's passion.

Andrea found a second home in the MMBio Department at BYU as she completed a bachelor's and master's degrees in microbiology. "I'm convinced microbiologists just know how to have a good time," she said as she reminisced about an Oktoberfest celebration in the Widtsoe Building, which involved so many grills plugged into the hallway outlets that a fuse in one of the labs blew. During this time, she also met her now-husband, Chris, as a guest cellist for his Provo-based garage band

While teaching a microbiology lab at BYU, Andrea was able to facilitate that same lightbulb moment with her students that she had in 8th grade. After graduating and working in a few industry positions as a microbiologist, she knew that while she loved the science behind what she did, teaching was her passion. Andrea then began an 11-year career as an adjunct professor at Valencia College in Orlando, Florida. In the latter part of that time, she felt a PhD was next for her, and she wanted to be a better educator while still maintaining a balanced life between work and her busy sons. She pursued and completed a PhD in Science Education from UCF. Andrea returned to Valencia College as a full-time faculty member and has been there ever since.

Currently, Andrea researches how to measure and improve learning outcomes for undergraduate students in microbiology, anatomy and physiology, and biology. Most recently, she published a paper in the April edition of the Journal of Microbiology & Biology Education assessing how learning gains have been affected by COVID-19.

In her own classroom, Andrea provides a place where her students can revise their thinking, learn how to learn new things, and be prepared for futures in the healthcare field and beyond. Many of Andrea's students are nursing students, which is a field Andrea has extensive experience with while caring for a medically fragile loved one. Everything Andrea has experienced affects how she teaches these future nurses. "I've been in the hospitals, I've had nurses in my home, so I really do know what they need to know… I have a passion because I've lived it," she said.

-enter to learn
go forth to serve-

A Virologist's View of the PANDEMIC


Dr. Brian Poole

Dr. Brian Poole is an associate professor at BYU in the MMBio Department and an immunovirologist, meaning he studies the complex interactions between viruses and the immune system. Currently, he is researching the genes that impact the development of lupus, an autoimmune disease, as well as looking into how Epstein-Barr viruses and Herpes Simplex viruses affect the genetic expression of infected cells.

When the World Health Organization first brought this novel coronavirus to global attention, Dr. Poole assumed the disease would act like SARS, an acute respiratory illness caused by a coronavirus that was declared an outbreak in 2003 and contained that same year. Dr. Poole figured each country's control protocol would be enough to contain the disease and it would be confined to airports, as was largely the case with SARS. "I was surprised that that was not what happened," he said. Unlike SARS, COVID-19 apparently spread via asymptomatic and presymptomatic people, which meant that temperature and symptom checks were not as highly effective as in the case of SARS.

PANDEMIC RESPONSE

In the beginning of the pandemic, Dr. Poole was impressed with the sense of camaraderie he experienced; "I felt a real sense of community. I felt like people were listening to the scientists well." He felt like people were heeding the actions put in place by the CDC in the beginning, like mask usage and staying home when possible.

However, this public attitude did not last. Dr. Poole noticed that for every piece of evidence explaining how masks or viruses work, there were many more articles, blog entries, and social media posts that misled readers. Much of this misinformation preys upon fear and uses poor science to support its claim. In the case of mask usage, there have been claims that the pores in masks are simultaneously too small to allow oxygen in and carbon dioxide out, while being too large to effectively trap SARS-CoV-2 even though a single coronavirus is many times larger than a molecule of oxygen. Contradictory statements like this picked up more steam as the pandemic wore on.

Dr. Poole attributes this shift in public reception of science to pandemic fatigue. "I think a lot of people choose to believe what makes their life easier, especially if they haven't seen firsthand what the effects are." According to the CDC, in the United States, fewer than 10% of people have been infected with COVID-19 and among those, there is a 1.8% mortality rate. This means most people in America have not been directly affected by the disease and following guidance that feels disruptive to daily life is easier said than done.

DISPELLING THE DARKNESS

Dr. Poole has also noticed that while communication has been key throughout the pandemic, important conversations have been happening in two different languages: the language of science and the language of everyday life. "Most people do not think scientifically. That includes everyone, even scientists. People tend to believe what feels right to them and call that common sense," he said, "Most science is fighting against common sense." Scientists are trained to present evidence and a confidence interval for how often the observed conclusion actually applies, but that can often leave the average reader—who is used to 100% certainty—with doubts. Dr. Poole noticed that, in the case of wearing masks, the more

convincing evidence for his non-scientist friends and family is an explanation that masks work and why, rather than specific values for how masks reduce transmission along with their confidence intervals.

One of the tools Dr. Poole wielded against misinformation was making public appearances in writing and in videos. Over the course of the past year, he has been on the news twice to talk about vaccine hesitancy. He has also been involved in multiple Deseret News articles about vaccines and the economic impacts of the pandemic. Additionally, he has been featured in videos the MMBio Department has released explaining aspects of COVID-19.

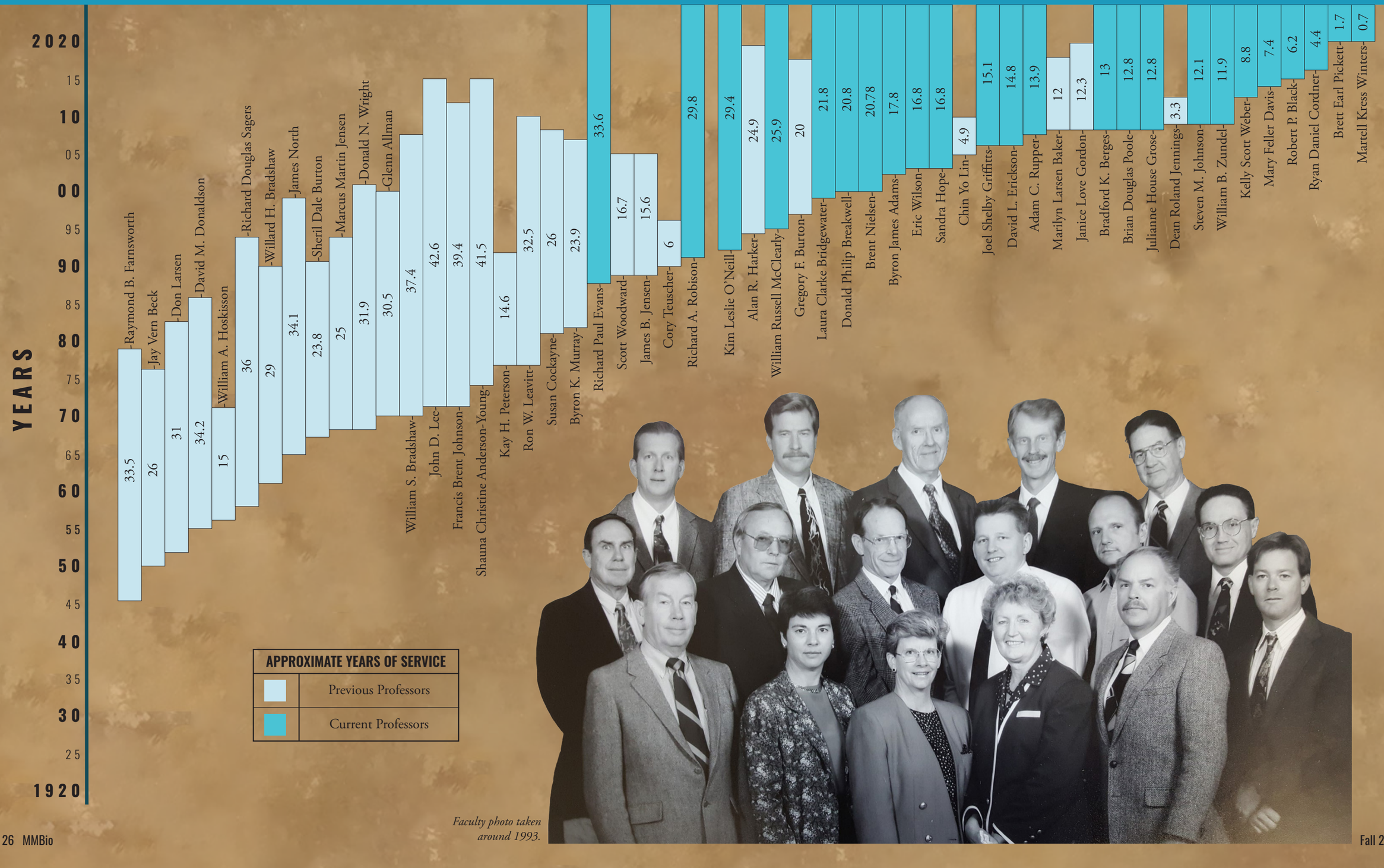
Perhaps most importantly, Dr. Poole fields questions for his friends and family on social media about the virus and the pandemic. "I've been happy that people are interested and happy that I'm getting a way to tell people what's going on," he said. It is important to him that people turn to credible, accurate sources and he sees his position as a virologist as an opportunity to point people in the direction of critical thinking regarding the conflicting information they see.

For all of the negative aspects of the COVID-19 pandemic, Dr. Poole highlights some of the amazing things which have come from it: vaccines being invented, manufactured, and distributed as quickly as they have. He also believes that the pandemic has made communities closer and has furthered our knowledge of viruses and how they work.

For the next pandemic, Dr. Poole urges scientists and non-scientists alike to keep open minds in how they share and consume information. He encourages people to remember that science isn't necessarily wrong if it changes—it's evolving as scientists learn new things.

Through surveys given during the pandemic, Dr. Poole found that a message people are more receptive to is making the community stronger. "Fostering a sense of community and responsibility for each other is really the main thing because there are a lot of problems you can deal with individually, but a pandemic is not one of them," he said. Amid the uncertainty, fear, and confusion the COVID-19 pandemic has ushered, scientists, like Dr. Brian Poole, are fielding questions, revising their own understanding, and educating the public to dispel the darkness.

MMBio Professor Timeline



Faculty photo taken around 1993.

Laboratory Breakdown

Berges Lab

The Berges Lab studies how viruses infect the blood of "humanized" mice—mice with human blood cells. Their interests are in herpes viruses and HIV. The Berges Lab also studies antibiotic resistance in the bacteria responsible for staph infections and other illnesses.

Breakwell Lab

In an age of increased antibiotic resistance in many common bacterial pathogens, the Breakwell Lab seeks to understand bacteriophages (viruses that infect and destroy bacteria) that could be used to treat animal and plant infections. Specifically, the lab determines how effective phages are against bacteria and how to create a phage cocktail for medical use.

Davis Lab

Researchers in the Davis Lab use electronic medical records and statistics to extrapolate the genetic causes and risk factors of multiple sclerosis (MS), an autoimmune disease. Patients with MS experience a wide variety of symptoms, so understanding what determines that will help improve patient outcomes in clinics.

Erickson Lab

The Erickson lab studies bacteria that infect both animals and humans, including *Escherichia coli* and *Yersinia*. They are interested in learning how some strains of these bacteria have evolved to colonize and cause disease in multiple hosts or tissues, whereas others are more specific.

Evans Lab

The Evans Lab studies fish and mummies to uncover the evolutionary history and life stories contained in their biomolecules.

Griffitts Lab

Bacteria are fascinating members of the natural world, and people put them to work for diverse purposes. The Griffitts Lab works to understand fundamental rules about bacterial gene expression, and how bacteria adapt to new environments by moving about and resisting toxic compounds, such as heavy metals and antibiotics.

Grose Lab

Another force in the fight against antibiotic resistance, the Grose Lab researches new bacteriophages and how they can be used in human health. Researchers in the Grose Lab are also looking at how PAS Kinase, a protein that helps cells get energy to function, contributes to cell metabolism.

Hope Lab

The Hope Lab has a diverse portfolio of past projects, such as creating a phage-based treatment for beehive infections, working on canker sore treatment, and creating a nanoinjector to inject DNA into cells. Currently, the Hope Lab is studying research lab management and aspects of intellectual properties in science.

Johnson Lab

Eukaryotic cells have vast amounts of DNA that must fit in a tiny package. Researchers in the Johnson Lab study how DNA is packaged in the form of chromatin (the mix of DNA and proteins that make up chromosomes) and how this packaging affects gene expression.

McCleary Lab

Phosphate is an essential material to life, providing DNA with its backbone and providing cells with energy to function in the form of ATP. The McCleary Lab's interest is in how the highly adaptive bacteria *E. coli* senses and responds to changes in the amount of phosphate available from the environment.

Nielsen Lab

The Nielsen Lab studies halophytes ("salt-loving plants") native to Utah and how their microbiome gives these plants an edge in high-salinity environments. These bacteria are being used to inoculate crops to stimulate their growth in harsh environments, and the mechanisms for this stimulation are being examined.

O'Neill Lab

Researchers in the O'Neill Lab study cancer, specifically how to detect it and enhance the human immune system's defenses against it. They have successfully found biomarkers that can be used in T cell therapy and are continuing to explore other forms of immunotherapy in cancer treatment.

Pickett Lab

The Pickett Lab uses public transcriptomics data to look at how human cells react during various diseases and conditions, including infections and cancer. They analyze this data to find genes, signaling pathways, and therapeutic drugs that can counteract the symptoms of infection, while the genes and pathways from cancer samples help them to better understand the mechanism(s) of the condition. They also study genomes of viruses and bacteria to determine how, where, and why they mutate.

Poole Lab

The Poole lab has two major areas of focus: autoimmune disease and vaccination. They study how genetic risk factors work to cause the body to attack itself, especially in terms of how they may cause misguided immunity against virus infection. They also study how education about microbes, diseases, and vaccines can affect vaccine attitudes.

Robison Lab

Members of the Robison Lab study a wide variety of BSL-2 and BSL-3 pathogens. They are interested in pathogen evolution and drug resistance. They have developed several real-time PCR assays which can be used to detect and characterize these pathogens. The lab also studies disinfection, sterilization, and infection control.

Weber Lab

Our immune system alters how we fight infections and cancer, the development or prevention of diseases, and how we respond to environmental antigens. The Weber Lab studies T cell activation and its critical role in improving our immune response to pathogens. This information is helping us develop targeted immunotherapies for cancer and better understand how the immune system influences Alzheimer's disease and asthma.

Wilson Lab

Chemokines are proteins that help direct immune system traffic to the appropriate tissues. The Wilson Lab studies how they direct immune cells to home in on specific areas, which is important in the development of vaccines that can be administered through mucosal regions in humans.

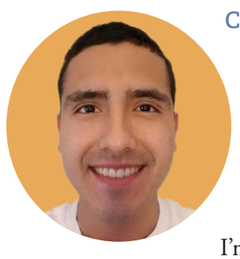
GRADUATE STUDENTS

Jessica Lewis (PhD)
McCleary Lab

I am interested in studying how PhoE-dependent phages interact with their hosts. Little, however, is known regarding which PhoE sites are necessary for phage attachment and which phage genes encode for the receptor binding protein. We also want to analyze the impact phage receptor binding proteins have had on their evolution.

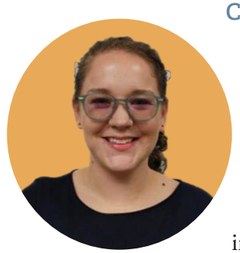
Melinda Moss (PhD)
Griffitts (MMBio) & Taylor (NDFS) Labs

The goal of my project is to optimize the conversion of dairy lactose to rare sugars by cloning and expressing the enzymes required to hydrolyze the lactose and subsequently convert the resulting glucose and galactose into the rare sugars allulose and tagatose respectively.



Carlos Moreno (PhD)
Weber Lab

Understanding how CD5 regulates T cell metabolism and function can provide important insight into immunotherapies. I'm also working on a project in which we are investigating whether CD5 is a good target to reduce inflammation in periodontal disease, a disease that affects 20-50% of people worldwide. Understanding how CD5 affects inflammation in periodontal disease may very well help with the treatment of this shockingly prevalent disease.



Colleen Newey (MS)
Grose Lab

My research is investigating the role of the protein PAS Kinase in the development of stress granules, which are involved in a variety of diseases including ALS and cancer. I hope to better understand this pathway so it could be used as a target against these diseases.

Elizabeth Porter (MS)
Robison Lab

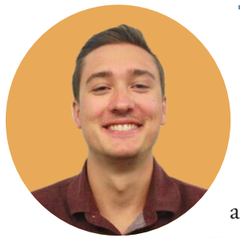
I am interested in how *Yersinia pestis* has evolved over time and space. I study the DNA sequence variances of *Y. pestis* in specific regions within a period of time looking at how these changes vary in different regions of the world. I have employed deep sequencing as well as bioinformatic tools to parse through and evaluate the genetic evolution of the bacterial genomes.

Weston Hutchison (PhD)
Erickson Lab

Bovine mastitis is the infection of a cow's udder with bacteria or other infectious materials. Most of these are caused by *E. coli*. In order to cause mastitis, bacteria must evade the immune system and adhere to the cells in the udder. I study the way that certain strains of *E. coli*, isolated from severe cases of mastitis, adhere to and invade epithelial cells.

David Redd (MS)
Poole Lab

Vaccine hesitancy is an issue of great concern for public health officials and medical professionals. In order to better understand what factors affect vaccine hesitancy, I am crafting and distributing a series of surveys assessing history, attitudes, and knowledge of vaccination. Understanding what factors affect vaccine hesitancy will improve educational efforts and allow clinicians to better address concerns. Currently I am researching parental attitudes and other factors that influence adolescent HPV vaccine uptake.



Timothy Call (MS)
Berges Lab

My research involves the study of *Staphylococcus aureus* and its accompanying virulence factors. Currently, I am researching *S. aureus* biofilm mechanisms and characteristics by investigating the genes and proteins involved in biofilm synthesis. I hope to find novel disruptors that could be used to treat infections.

Daniel Arens (PhD)
Grose Lab

I study two proteins, PAS-Kinase and USF1, and their roles in metabolic diseases. As we learn more about their mechanisms, interacting partners, and how to manipulate them, we will be able to develop treatments and therapies for diabetes, obesity, and hyperlipidemia.

John Carter (PhD)
Johnson Lab

I study chromatin architecture by looking at nucleosome positioning and its relation to the underlying DNA sequence in the genome.

Jacob Herring (PhD)
Tessem Lab

Diabetes is characterized by a decrease in functional β-cell mass. Nuclear hormone receptor 4a1 plays a role in the regulation of functional β-cell mass. My research focuses on the mechanism of Nr4a1 in the β-cell.

David Bates (PhD)
Johnson Lab

I study chromatin architecture by looking at nucleosome positioning and its relation to the underlying DNA sequence in the genome.

Edwin Velazquez (PhD)
O'Neill Lab

I'm working to develop new cell adoptive therapies for cancer immunotherapy and performing tumor target discovery. My work consists of genetically engineering human immune system cells with tumor targeting receptors to selectively eliminate tumor cells.

Kyson Jensen (PhD)
Griffitts Lab

The overall objective of my project is to understand the mechanism by which microorganisms adapt to environmental stressors, specifically towards toxic heavy metals, such as nickel. Understanding of mechanisms of heavy metal tolerance may provide clues about evolutionary pathways giving rise to this trait.

Taalin Hoj (PhD)
Robison Lab

It has been estimated that 70% of bacterial infections are resistant to at least one commonly prescribed antibiotic, prompting the CDC to announce that humanity has entered the "post-antibiotic era." Among the most serious of these infections are caused by carbapenem-resistant Enterobactericeae (CRE), bacteria resistant to even last-line antibiotics. I study mechanisms of resistance in CREs, the stability and evolution of carbapenem resistance, and methods of treating septicemia caused by CREs.

Khin Zar Win Pyae (MS)
Griffitts Lab

For my MS project, I am interested in learning the mechanisms of stress adaptation in soil bacteria, and specifically how specialized genes can result in higher tolerance to heavy metal stress. To answer this question, I imposed heavy metal (nickel) stress to bacteria, and then I employed next generation sequencing to hunt for Single Nucleotide Polymorphisms (SNPs) and other genetic variations in the stress-tolerant mutants.

Daniel Thompson (PhD)
Grose Lab

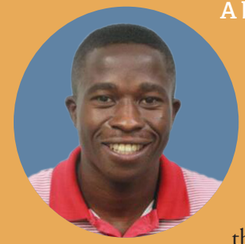
I am a third-year PhD student currently researching bacteriophage biology. I received my undergraduate degree in Molecular Biology. I am interested in antibiotic resistance and spore forming bacteria, phage therapy, and microbiome replacement research. I am currently working on novel treatments to improve honey bee health.

Ashley Miller (MS)
Nielsen Lab

I study an incredible interaction between alfalfa plants and salt-loving bacteria called halophiles. Alfalfa (like most crop plants) is salt-sensitive. However, when salty soil with alfalfa seedlings is inoculated with special halophiles like *H. Elongata 1H9*, the alfalfa grows an average of 8X more plant mass than plants grown in salty soil without bacterial inoculation. In our lab, we seek to find out how this interaction leads to increased growth.

Alexander Benedict (PhD)
Griffitts Lab

Sinorhizobium meliloti is a species of bacteria that is best known for its ability to engage in a symbiotic relationship with legume plant hosts. It also has a remarkable metabolic capacity that enables it to thrive in nutrient-limited soils. My research is focused generally on learning which genes contribute most to the fitness of this organism and, more specifically, on a subset of bacterial genes called peptidases that have the potential to modulate symbiotic outcome.



Abraham Quaye (PhD)
Poole Lab

Due to the immunosuppressive traits of VAS, vaccinated turkeys are more susceptible to secondary bacterial infections than unvaccinated cohorts, leading to substantial economic losses. My research focuses on identifying the VAS genes mediating its immunosuppressive traits and studying the mechanism of action of such genes. Ultimately, we hope to engineer a novel THEV strain with no immunosuppressive characteristics to be used as an improved vaccine.

Diana Calvopina (PhD)
Griffitts Lab

I am studying a molecular machine that makes the antimicrobial peptide Micrococcin. This molecular machine is made of 3 proteins, and we call it the IJN machine. We want to understand more about the IJN complex, so we can use it to make alternative peptides with biological properties, and potential medical applications such as antibiotics.

Andrea Kokkonen (MS)
Evans Lab

I am looking at the evolutionary history of 9 subspecies of cutthroat trout. These fish are a popular native fish of western North America and their relationships to each other are still unresolved, despite years of studies. I am looking to delineate these subspecies, specifically those in the Great Basin interior, by using RNA-seq to both examine expressed gene sequences and create a phylogenetic tree that finally resolves a centuries-long debate.

Jacob Fairholm (MS)
Berges Lab

I study how different mutations in a protein produced by HIV affect the virus's ability to cause AIDS. This is done by measuring how T cells die both in cell culture and in vivo. To test in vivo, we inject mice with human immune stem-cells in order to create "humanized" mice.

Tyler Brown (PhD)
Wilson Lab

My research is centered on *Staphylococcus aureus'* ability to survive in a host that employs various nutritional immunity factors. We are especially interested in iron utilization and how Staph accesses sequestered host iron sources.

Jonatan Fierro Nieves (MS)
Berges Lab

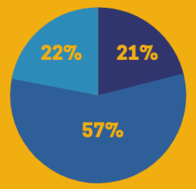
I study how different mutations in a protein produced by HIV affect the virus's ability to cause AIDS. This is done by measuring how T cells die both in cell culture and in vivo. To test in vivo, we inject mice with human immune stem-cells in order to create "humanized" mice.

Kiara Whitley (PhD)
Weber Lab

My research focuses on studying T cells. One project focuses on studying how altered peptides affect helper T cell activation in response to *Listeria monocytogenes*, a common food-borne pathogen. My other project focuses on the role of CD5, an inhibitory T cell co-receptor, in regulating T cell metabolism.

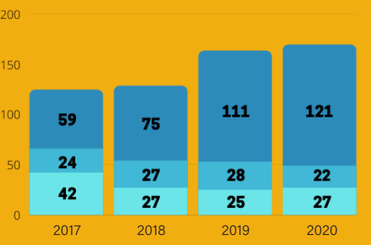
MMBIO STATISTICS

STUDENTS IN MMBIO MAJORS



- 21% Molecular Biology
- 22% Medical Laboratory Science
- 57% Microbiology

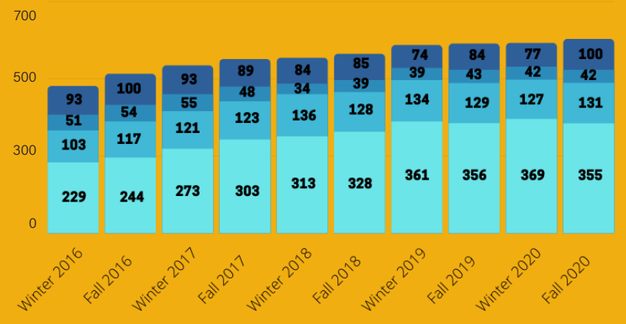
MMBIO BS GRADUATES



- Microbiology
- Molecular Biology
- Medical Laboratory Science

UNDERGRADUATE ENROLLMENT

- Medical Laboratory Science Premajor
- Medical Laboratory Science
- Molecular Biology
- Microbiology



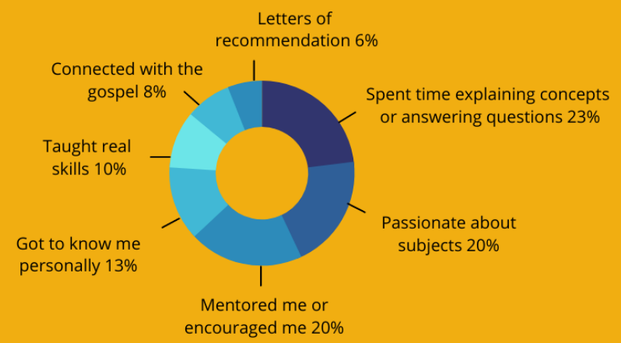
MOST BENEFICIAL COURSES

(NOTED BY STUDENTS IN EXIT SURVEY)

- **MMBIO 261** Infection & Immunity
- **MMBIO 240** Molecular Biology
- **MMBIO 465** Virology

WHAT WERE THE MOST SIGNIFICANT CONTRIBUTIONS THAT MMBIO FACULTY MADE IN YOUR EXPERIENCE AT BYU?

(NOTED BY STUDENTS IN EXIT SURVEY)



Connect with MMBio

Like, follow, and subscribe for more awesome content!

@BYUMMBio

@BYUMMBio

@BYUMMBio

BYU MMBio

@BYUMMBio

@BYU_MMBio

BYU MMBIO

Your donations to BYU's MMBio Department makes possible:

- New Discoveries
- Mentored Research
- Improved Education

We appreciate all of your support!

To donate to the Department of Microbiology and Molecular Biology
please contact Philanthropies at 800-525-8074 or Philanthropies@ChurchofJesusChrist.org