

SMALL TALK

Collaborations across scientific disciplines lead to outsized impact

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SMALL TALK

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Connecting our vibrant community

On the cover — Dense cyanobacterial bloom in the Deschutes Arm of Lake Billy Chinook, central Oregon, being tracked by microbiologist Theo Dreher (see p. 8).

FROM THE HEAD

Jerri Bartholomew
Department Head



Welcome to Small Talk!

As microbiologists we investigate life's smallest organisms, exploring microbial communities in environments as diverse as coral reefs and the human gut. Our research is often highly collaborative, and this issue spotlights some intriguing collaborations that have sprung up within the department.

Our undergraduate program is thriving. This fall we welcomed a record number of students: 753 BioHealth Sciences and 148 Microbiology majors. Staying connected presents challenges, but our advising team makes everyone feel part of the department. Meet several of our incredible undergraduates in the following pages.

Last spring we graduated 10 M.S. and Ph.D. students, and this fall welcomed eight new graduate students. A few of their new careers and research interests are featured in this newsletter.

Our new accelerated master's program gives high-performing OSU undergraduates a jump on a graduate degree, and a new non-thesis master's degree serves students pursuing data skills and BioHealth sciences.

Our faculty have had a successful year. Microbiology faculty were either PIs or co-PIs on over \$13M in new research funding this year. Special congratulations to Thomas Sharpton, who was promoted to associate professor with tenure. Other transitions in the department include Theo Dreher and Walt Ream, who will be following Peter Bottomley and Bruce Geller in retirement. We are initiating a search for a new instructor to join the teaching and advising team and for two assistant professors in virology. We were saddened by the loss of Distinguished Emeritus Professor Bill Sandine at the end of 2018. Bill will be remembered for his research legacy, for the incredible support that he provided

the department through his dairy patents, and for being a true gentleman with a kind sense of humor.

We could not accomplish all we do without the generous support of you, our alumni and friends. This year we started a new scholarship thanks to faculty gifts, and we celebrated the dedication of the Nash Hall Courtyard sculpture with the help of our dear friend Mary Fryer. This is my last newsletter as department head as I plan to join the faculty in June. This year will be a busy one, however, as I take over as head of the School of Life Sciences. I've learned a lot this past five years and enjoyed working with an amazing group of people. I've also enjoyed the opportunity to share department news with you. But my lab is doing exciting things, and I want to be part of that again!

Jerri Bartholomew
Department Head



Jessica Lopez at Dyess Air Force Base, Texas

BRIGHT MINDS, BOLD MOVES

Students excelling beyond the classroom

OUR UNDERGRADUATES

Jordyn Hamilton (BioHealth Sciences), a Presidential Scholar and honors sophomore who was inspired to become a doctor by the stories of her ER physician grandfather, is off to a flying start as an OSU Wellness Agent doing campus-wide outreach. Fluent in Spanish, Hamilton hopes to study abroad in a clinical setting in a Spanish-speaking country before graduating. Grateful for OSU's Ecampus, she takes several courses online so she can tend to her ailing grandfather in Eugene. As someone who has beaten the odds – raised by a single parent and in a family that survived incarceration, addiction and unemployment – Hamilton is thrilled to have received an OSU Presidential Scholarship, which covers four years of tuition.

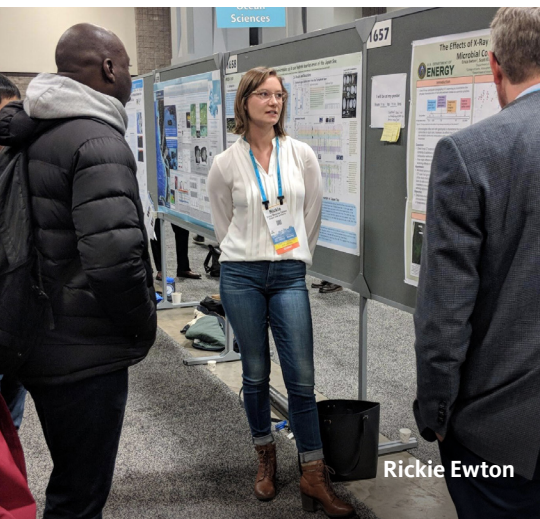
Mikayla Pivec, an honors BioHealth Sciences senior, might be best known for leading the Beavers women's

basketball team to victory against La Salle University last year, but she also works with Kelly Chandler in the College of Public Health and Human Sciences on the challenges homeless people face. Pivec donated \$1,000 of her \$5,000 SURE Science Award to homeless shelters in Corvallis. "It's my way of giving back for what was given to me," says Mikayla, who suffered from eczema as a child and wants to be a dermatologist.

Jessica Lopez, a dual BioHealth Sciences and Spanish major junior with a double minor in military science and chemistry, is active on many fronts. In the ROTC, she has marched in the Albany Veteran's Day parade, competed in California's annual drill and ceremony competition, served on the color guard for baseball games, and more. She also works as a certified nursing assistant in Corvallis. Thanks to the OSU STEM Leaders Program, Lopez conducted undergraduate research with graduate student

Brandy Nagamine and Brian Dolan in the Carlson College of Veterinary Medicine. She is also a mentee in the College of Science's Faculty-Student Mentor Program. To advocate for those sharing her Hispanic-Latino heritage, Lopez created the Instagram page #primerosoy. She plans to pursue a career in trauma or emergency medicine.

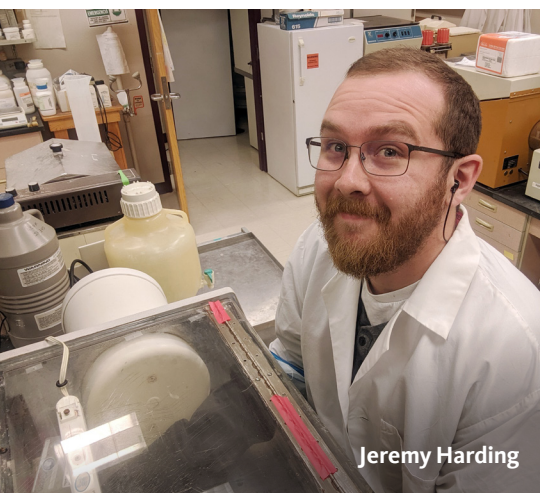
Erica (Rickie) Ewton, an honors microbiology senior, traveled to Washington, D.C., for the 2018 American Geophysical Union Fall Meeting, the world's largest gathering of Earth and space systems scientists. There, she was excited to learn from a variety of talks and posters and present her own research poster, "The effects of X-ray computed tomography on microbial communities in sediment cores." Ewton returned with a new appreciation for the breadth of research in the field and valuable feedback for writing her honors thesis. She is grateful



Rickie Ewton

to the U.S. Department of Energy, the American Geophysical Union, the Honors College, and the department for supporting her participation.

Jeremy Harding, a microbiology senior, is researching the effects of elevated temperatures on *Agrobacterium tumefaciens* with Walter Ream and Jennifer Parke (Department of Botany and Plant Pathology). Parke hopes to publish Harding's data to ascertain what soil solarization temperature rids soil of pathogenic agrobacteria. Last spring Harding designed and tested new PCR (polymerase chain reaction) primers to detect pathogenic agrobacteria in agricultural soils; he and Ream are writing a short paper describing this work. Finally, Harding, Ream and Parke are writing a paper about the effects of soil solarization on tree seedlings. Harding is grateful for the Microbiology Faculty Scholarship that allowed him to quit one of his



Jeremy Harding

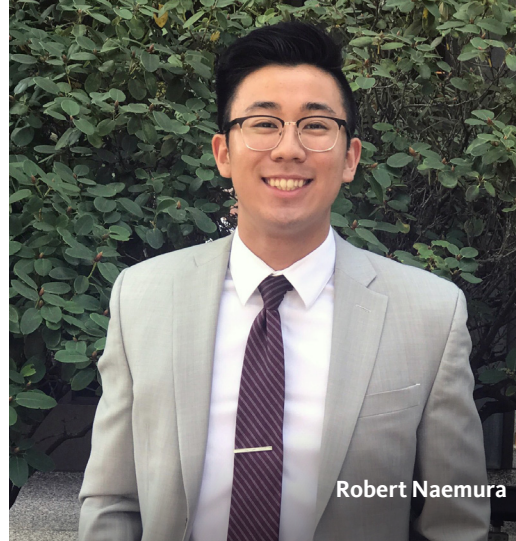
two jobs to participate in research and devote more time to studies.

Robert Naemura, a BioHealth Sciences senior with a pre-dental option and a minor in business and entrepreneurship, was an academic learning assistant for Tebeau Hall his sophomore year, helping over 300 students. A member of Sigma Phi Epsilon, Naemura leads a Young Life group and volunteers for Medical Teams International, which provides free dental procedures for underprivileged communities and veterans. In 2018, he led summer camp activities for elementary-school children from difficult circumstances on a U.S. Army base for 10 weeks in Wiesbaden, Germany. The two summers prior, Naemura interned at Kaiser Permanente and won a competition to develop marketing materials for Kaiser's integrated medical and dental healthcare. His intern team presented their ideas, which were implemented in a national marketing campaign, to CEO Bernard Tyson. After graduation, Naemura will apply to dental school.

Francine Mendoza and **Sydney Phu** (BioHealth Sciences) helped the OSU Bioethics Society host last April's inaugural NW Collegiate Biomedical Ethics Conference, which drew ethicists and physicians from across Oregon. Oncologist Michael Huntington gave an enlightening keynote on universal healthcare and the effects of healthcare disparities. Student-led panels discussed pediatric cancer, healthcare rationing, the pharmaceutical industry and stem cell therapies.

Student Clubs and Events

The **Microbiology Student Association** (MSA) helps students to network, learn about careers and promote microbiology literacy. Last



Robert Naemura

year, MSA hosted a graduate school information night in collaboration with the BioHealth Sciences Club and the OSU Graduate School and a bake sale supporting OSU's February Food Drive. Their grand event in April 2019, the MSA Symposium, featured speakers from across Oregon and student research posters.

In October 2018, four microbiology instructors and 16 undergraduates traveled to OHSU in Portland to attend the American Society for Microbiology Northwest chapter conference. Students networked and enjoyed all-day talks and poster sessions. Their attendance was made possible by travel grants from alumnus Joel Peterson (see p. 16).



MSA Undergrads and Faculty

The **BioHealth Sciences Club** provides volunteer opportunities, guest speakers and graduate program tours for students in health-related majors. Last year they hosted a tour of Western Washington University's College of

Osteopathic Medicine of the Pacific Northwest; organized guest lectures by an internal disease specialist, an optometrist, and a medical laboratory scientist; and held a spring pizza and bowling social. This year the club will host more guest speakers, complete a CPR certification course and tour Oregon Health and Sciences University.

GRADUATE STUDENTS

Gamification, microbe style

Quinn Washburn, a doctoral candidate in the Giovannoni Lab, designed the ocean ecology board game *Oligotrophic* to educate players about the marine microbes that form the basis of life in the ocean and perform 50% of Earth's photosynthesis. The easy-to-learn game, where players strategically place tiles to build biomass, is free and available online at Board Game Geek. Washburn developed the game through the Giovannoni Lab's partnership with OSU's Science Math Investigative Learning Experience (SMILE) Program to enhance K-12 science education.

Accelerated Master's program graduates its first student

Our new Accelerated Master's Platform (AMP) enables highly motivated students to enroll in a master's program while finishing their undergraduate degree. Last May our first AMP



L to R: Stephanie Nervino, Sofiya Yusova, Susie Cummings, M.K. English, Sebastian Singleton, Alex Vompe, Austin Hammer, Savannah Leidholt



Da Vinci Days

The Microbiology Graduate Student Association showed up in force at Da Vinci Days 2019, Corvallis' annual STEAM celebration. Kids made take-home Winogradsky columns of the microbes inhabiting our local riverbanks and peeked through microscopes at dog hair, *Staphylococcus* bacteria, red blood cells and more.

student, **Ian Humphreys** in the Sharpton Lab, successfully defended his thesis on how study parameters impact the accuracy of 16S rRNA phylogenies. He is now a Ph.D. student at the University of Washington. Our second AMP student, **Sofiya Yusova**, graduated with a B.S. in spring 2019 and is currently studying the ecology of a Deschutes River myxozoan fish parasite in the Bartholomew Lab. This fall we welcomed two new AMP undergraduates, **Jack Williams** in the Giovannoni Lab and Erica (Rickie) Ewton in the Thurber Lab.

In their words: Incoming graduate students

Austin Hammer: I am rotating through labs performing microbiome and microbial ecology research. I will use integrated "omic" and bioinformatic

techniques to examine microbial diversity and link microbial community function to ecological processes.

Mary Kay English: I'm developing a probiotic blend that improves oyster spat survival. I will use 16S community analyses to examine how probiotics affect the oyster microbiome.

Alex Vompe: I am investigating the effects of anthropogenic stressors on Earth's threatened coral reefs.

Susie Cummings: I will explore ocean microbial ecology while rotating through the Thurber, Sharpton and Giovannoni labs.

Sofiya Yusova: I am studying climate change effects such as river temperature on genetic variants of *Ceratonova shasta*, a myxozoan parasite

that infects Pacific Coast salmonids, and how phenologies may adapt to future climate changes.

Savanah Leidholt: My research interests lie in marine microbial diversity, genetics and bioinformatics. I will identify marine fish diseases in the Vega-Thurber Lab.

Sebastian Singleton: I will examine how microbes co-metabolize the decomposition of highly complex carcinogenic and plastic compounds with the hopes of processing plastic waste on an industrial scale.

Stephanie Ann Nervino: I am studying the correlation between prespawning Chinook salmon mortality rates and their parasite load, particularly *Certanova shasta* and a potentially new microsporidian species.

Already published

Nicole Kirchoff (Sharpton Lab) demonstrated a clear link between aggressive behavior and the canine gut microbiome in a groundbreaking study of more than two dozen rescued dogs. Her findings were published in PeerJ.

Grace Klinges (Vega-Thurber Lab) discovered a new genus of bacteria that flourishes when coral reefs become polluted, siphoning energy and making the corals more susceptible to disease. The National Science Foundation-funded study, published in The ISME Journal, adds fresh insight to the fight to save our embattled reefs.

Rebecca Maher (Vega-Thurber Lab) led the OSU tranche of a National Science Foundation-funded study of coral reef stressors that suggests that localized attempts to curb pollution on reefs will fail without a worldwide effort to reduce global warming.

Courtney Armour (Sharpton Lab) performed a metagenomic meta-analysis of the roles that gut bacteria play in human health, an analysis that went beyond correlation studies to examine the specific mechanisms by which gut microbes affect health.

Momentum for diversity

A National Institutes of Health (NIH) program enables the Kent Lab to further support diversity in health-related research. Three students in the lab have received NIH grants providing stipend, tuition and full overhead as needed.

Lauren Norris, an African-American student from Portland, completed her master's degree on survival of zebrafish pathogens under different freezing conditions in 2017 and currently works as a researcher at OSU's College of Veterinary Medicine. **Elizanette Lopez**, who is of Mexican-American heritage and from Grapevine, Texas, is studying the effects of *Mycobacterium chelonae* in zebrafish, an emerging model for human disease. **Corbin Schuster**, a Yakama Tribe member from Toppenish, Washington, will complete his M.S. and begin a Ph.D. working on *Pseudoloma neurophilia*, the most common pathogen of laboratory zebrafish.



CONGRATULATIONS

Congratulations to all who received 2019-20 Graduate Scholarship and Fellowship awards at our celebration on June 5, 2019! Left to right, below.

Winni Wang: Mark H. Middlekauf Outstanding Graduate Achievement in Microbiology Scholarship

Hanna Delgado: John L. Fryer Fellowship

Jayanthi Joseph: Excellence in Microbiology Scholarship

Quinn Washburn: Nicholas L. Tartar Graduate Student Fellowship

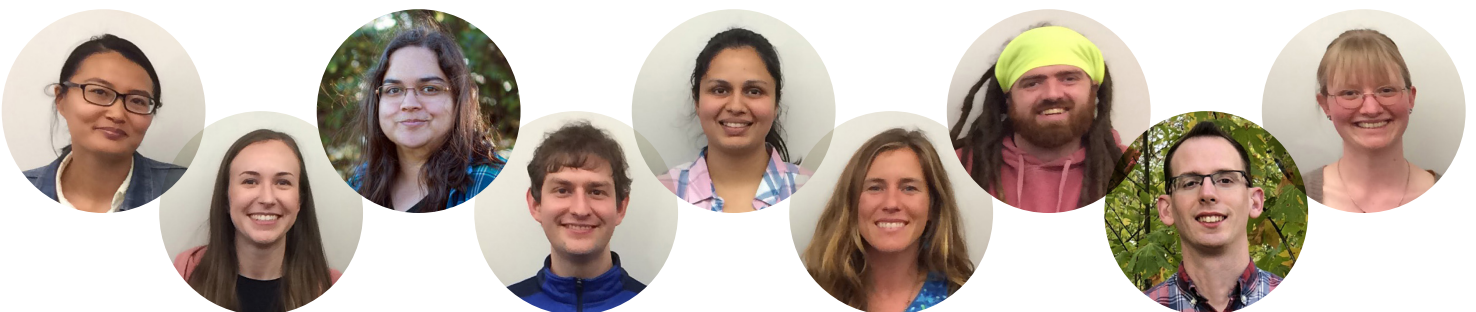
Priyanka Singla: Joan Countryman Suit Summer Fellowship; Nicholas L. Tartar Graduate Student Fellowship

Kaitlin McConnell: Dick & Toshi Morita Scholarship

Parker Smith: Nicholas L. Tartar Graduate Student Fellowship

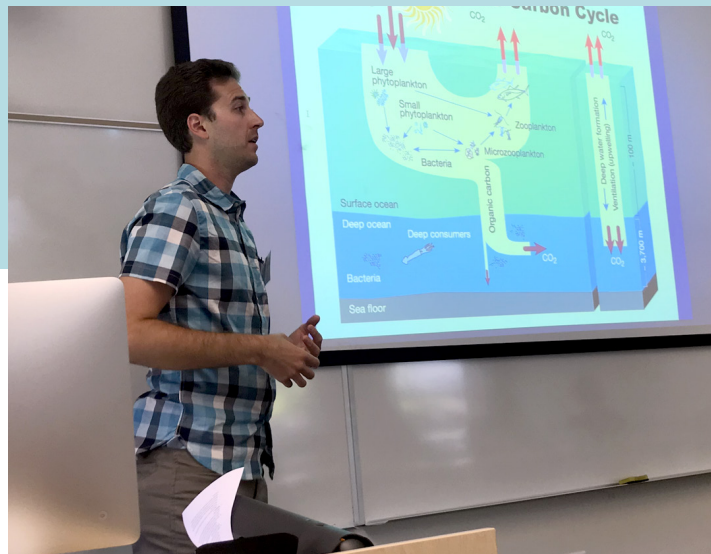
Damien Barrett: Harriet M Winton Scholarship for Graduate Student in the Study of Diseases of Fish

Jessica Buser: Mark H Middlekauf Outstanding Graduate Teaching and Service in Microbiology Scholarship



MAKING WAVES

Microbiologists making a difference



Awards well-deserved

Thomas Sharpton was promoted to associate professor with tenure in September 2019. He was also awarded the Phi Kappa Phi Emerging Scholar Award, which recognizes early career faculty for outstanding research or creative activity in his or her field of study.

Jerri Bartholomew was selected as a 2019 Fellow of the American Fisheries Society (AFS), the world's oldest and largest organization dedicated to advancing fisheries science and conserving fisheries resources. Bartholomew was recognized for her outstanding contributions to the field, particularly in deepening our understanding of how infectious organisms drive disease in salmonids and in developing risk assessments and predictive models to inform

management of salmonid fisheries. She received her award at the annual AFS conference in Reno, Nevada, on September 30.

Kate Field received the OSU Outreach and Engagement Vice Provost Award for Excellence in recognition of the Puerto Rico Engaged Service Learning Course that was highlighted in the last issue of Small Talk. She also received a Writing Intensive Curriculum Mentoring Award for improving student learning through writing.

All aboard for aquatic microbiology

Students interested in aquatic microbiology, an up-and-coming, interdisciplinary field which looks at ocean ecosystems through the lens of microbes and the outsized role

they play in both sustainable resource management and climate change, can now pursue it as a microbiology option. A required aquatic lab taught by Assistant Professor **Andrew Thurber** – on a ship no less! – is at the heart of the new option and immerses students in the contemporary methods of experimentation that are integral to a field that “has revolutionized the pursuit of saving our oceans,” according to Thurber.

LEFT: Jerri Bartholomew, fourth from right, receives award along with other new Fellows of the AFS.

RIGHT: Chris Suffridge, a Giovannoni Lab postdoc, teaches high school teachers about the global carbon cycle and climate change during the August 2019 SMILE workshop.

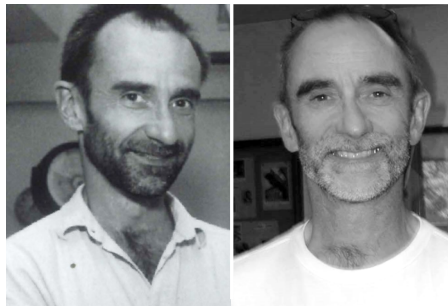
SMILE for STEM

The Giovannoni Lab works with OSU's Science and Math Investigative Learning Experiences (SMILE) Program, which uses experience-based learning to enhance K-12 science education for minority, low-income and educationally underserved students. Funded by a National Science Foundation (NSF) grant, the lab hosts biannual training workshops for educators and developed a SMILE instructional unit, Carbon Cycling by Marine Microorganisms, on the role of ocean biology in climate change. The module is designed to spark curiosity about the natural world and engage students in the scientific method. In the laboratory activity "Bloom in a Bottle," for example, students form and test hypotheses about the impacts of nutrient limitation by stimulating phytoplankton to reproduce. Another activity is the instructional board game Oligotrophic developed by graduate student Quinn Washburn (see p. 4).

In the wake of a pantheon

Four faculty who have served a combined 136 years in the department are retiring. While we celebrate their collective achievement, their loss truly changes the face of the department. Bruce Geller and Peter Bottomley retired over a year ago and are maintaining a partial appointment to finish up some projects. Theo Dreher will retire at the end of this year, and Walt Ream will follow at the end of winter term after teaching Microbial Genetics and Biotechnology for the last time.

Peter Bottomley has been with the department since 1979. After earning



Peter Bottomley, 1979-2016 (37 years)

a Ph.D. from the University of Dundee, Scotland, Bottomley spent four years at the University of Texas at Austin Marine Science Institute. Throughout a long career, Bottomley sought to understand how soil ecosystems efficiently utilize nitrogen and sequester carbon, which is crucial for improving the sustainability of agriculture. He led his research team in answering these questions in forest and agroecosystems throughout Oregon.

Bottomley also leaves an impressive legacy as a teacher and mentor, with 44 graduate students and numerous undergraduates and post-doctoral researchers passing through his lab, including **Anne Taylor**, who continues his research as a post-doc. Bottomley's unique mentoring style, which combined pragmatism with honesty and humor, helped his students succeed and earned him the

“His passion and depth of knowledge for science gets passed on to his students daily”

- STUDENT OF BOTTOMLEY

Excellence in Graduate Mentoring Award in 2006.

As one student remarked, “His passion and depth of knowledge for science gets passed on to his students daily, usually in the form of free-flowing (ok, never-ending) discussions in front of his office. I am truly fortunate to have had him as a mentor.”

Bottomley served as interim department head from 2003-04. He taught General Microbiology for many years, co-taught Biology of the Prokaryotes and developed the course Microbial Ecology.



Bruce Geller, 1987-2017 (30+ years)

Bruce Geller joined the department in 1987 with a Ph.D. from the University of Utah and postdoctoral positions at the University of Texas, San Antonio Health Science Center and the University of California, Los Angeles School of Medicine. His research in bacterial physiology led to an early collaboration with Bill Sandine on *Lactococcus lactis* that resulted in virus-resistant bacterial strains for the dairy industry. Combining his roots in medicine with his experience with *L. lactis*, Geller genetically engineered the bacterium to form oral vaccines against strep throat and avian influenza infections. In the latter phase of his career, he teamed with local biotechnology company AVI BioPharma (now Sarepta Therapeutics) to develop genetically-

based antibiotics against some of the world's worst antibiotic-resistant superbugs, including *Acinetobacter baumannii*, *Klebsiella pneumoniae*, *Escherichia coli* and *Pseudomonas aeruginosa*. These antibiotics are currently moving forward into testing to enable human clinical trials.

Geller taught the undergraduate courses Bacterial Physiology and Metabolism, Bacterial Molecular Genetics and Molecular Microbiology Lab and developed several graduate courses. He mentored eight graduate students, 32 undergraduates and two postdocs.



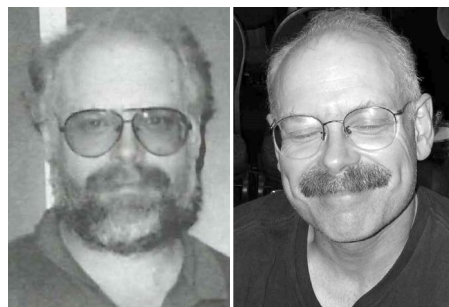
Theo Dreher, 1987-2019 (32 years)

Theo Dreher earned a Ph.D. at the University of Melbourne, Australia, followed by postdoctoral research at Washington State University, University of Wisconsin-Madison and Texas A&M University. He joined the department in 1998 after serving in the OSU Department of Agricultural Chemistry since 1987. Dreher enjoyed training students and postdocs in molecular virology and graduated 11 students. He spent more than two decades in active research in the replication and gene expression of positive strand RNA viruses, including turnip yellow mosaic virus, bacteriophage Q-beta, West Nile virus and dengue virus. During his 10-year tenure as department head, he began working on cyanobacteria, characterizing Pacific Northwest blooms using

genomics and investigating the broader influences that affect these blooms. Most recently, he has become a state consultant on CyanoHAB and influenced legislative action in support of HAB resiliency in Oregon.

Dreher taught the course Virology and co-taught Molecular Virology. Recently, he began teaching an online virology course for BioHealth majors. As department head, he actively promoted others' careers and was instrumental in keeping the department on solid ground.

Walt Ream also migrated to microbiology in 1998 after serving in the Department of Agricultural Chemistry for 10 years. He graduated from the University of California, Berkeley as a Regents Fellow, was an American Cancer Society Postdoctoral Fellow at the University of Washington and a biology professor at Indiana University. Ream was director of the OSU Genetics Program from 1992-2008. During his career, Walt strove to achieve a balance between his passions for research, mentoring and teaching. In research, *Agrobacterium* biology held his attention for 40 years. His many contributions include a genetic map of the T-DNA (the genes transferred to plants), discovery of the "overdrive" sequence (at the origin of T-DNA transfer) and discovery of the "GALLS" DNA transferase



Walt Ream, 1983-2020 (37 years)

(from *Agrobacterium rhizogenes*). Ream used gene silencing to develop transgenic apple trees that are resistant to crown gall. Genome sequences generated in an MB311 lab revealed a new species of *Agrobacterium*.

Ream also collaborated with archaeologist Rob Bonnicksen to study ancient DNA. They analyzed 9,900-year-old DNA from a single hair shaft and recovered DNA from subsurface blood residues trapped in microcracks in ancient stone tools.

Ream worked with 19 graduate students, five postdocs and many talented colleagues, including **Larry Hodges**, who worked with him for over 25 years. While Ream won the Richard M. Bressler Senior Faculty Teaching Award, he enjoyed unsolicited letters of appreciation from students the most.

Tribal college microbiology pipeline

Tribal colleges open doors to Native American student success with educational opportunities. For the past five years, **Andrew Thurber** has collaborated with colleagues at the Northwest Indian College (NWIC) in Ferndale, Washington, to contribute to their research portfolio and to create a bridge to OSU for up-and-coming scholars of Native American ancestry. Thanks to U.S. Department of Agriculture funding, Thurber and co-PI **Jerri Bartholomew** have expanded upon this work, in collaboration with Western Washington University and NWIC, to create a recruitment pipeline for Native students who are interested in pursuing graduate work at OSU, especially in microbiology.

IN MEMORIAM:

Bill Sandine

William E. Sandine (Bill),

Distinguished Emeritus Professor and internationally recognized scientist, passed away on November 28, 2018, in Allen, Texas, at age 90 with his wife, Susan, by his side. Born on June 6, 1928, in Des Moines, Iowa, Bill's interest in the microbial world began in sixth grade when his mother died of pneumonia (penicillin was discovered in 1928, but it was not readily available). In high school, Bill boarded a train to Priest River, Idaho, to work on Blister Rust Control crews combating the microbial fungus spores that were killing millions of white pine trees in the Northwest. In 1951, he earned a bachelor's degree in Dairy Industry at Iowa State University (ISU), where he was a member of the Phi Gamma Delta fraternity, worked at ISU's Creamery and served on the ISU Dairy Products Judging Team. In 1955, he earned an M.S. in Dairy Science from North Carolina State University, and in 1958 a Ph.D. in Food Microbiology from OSU, followed by a postdoc at the University of Illinois Champaign-Urbana. Between 1951-53, Bill honorably served our country in the



U.S. Air Force, stationed with the 32nd Air Division as a sanitation engineer.

Bill served the department for 35 years, rising to the rank of Distinguished Professor, serving as the president for the American Dairy Society and receiving many awards, including the Institute of Food Technologies Industrial Achievement Award, 2007 OSU Alumni Fellow, USDA Award of Honor, and Guest of Honor Award from the National Dairy Shrine.

An expert in lactic acid bacteria physiology and dairy fermentation, Bill created new starter cultures for the dairy industry that improved the flavor and quality of fermented dairy products, increased the shelf life of food and beverage products by impeding growth of spoilage bacteria, and improved methods to ripen cheese. Based on his OSU research, he co-authored 22 scientific patents, co-authored four books (including the textbook *Microbiology of Foods*) and

Bill Sandine, Distinguished Professor Emeritus, working in his dairy microbiology laboratory.

published over 200 peer-reviewed scientific publications. Bill's patents earned OSU and the state of Oregon millions of dollars through technology transfer to the private sector as many of his discoveries became part of dairy industry best practices in fermentation and culturing.

A beloved mentor, Bill served as the major professor for 40 master's and 38 Ph.D. students. During retirement, Sandine played a lot of golf, enjoyed his family, was active in church, drove his Model A, hunted for antiques, traveled and was an active member in Rotary serving humanitarian efforts. Sandine was a true gentleman and we will all remember his wicked sense of humor and generosity of spirit.

INNOVATION IN OUR LABS

Dynamic duos: Collaborations with outsized impact



Collaborative research in STEM fields has grown almost exponentially since the 1970s, and for good reason. Multidimensional, complex global problems like climate change, infectious disease and pollution benefit from team-based approaches that involve not only interdisciplinary and international scientists but other stakeholders as well, from business to policymakers to community members. Collaborative research continues to prove effective, too. The internationalization of research teams has been shown to be correlated with enhanced scientific productivity and increased citation in peer-reviewed journals.

In this issue of Small Talk, we are honing in on four ongoing, small-scale collaborations between pairs of scientists in the department that continue to have an outsize impact, including two husband-wife microbiologist teams. All four illustrate several common characteristics of successful collaborations — they often begin slowly, perhaps over a cup of coffee in Ava's Cafe, last for a long time and are dynamic in nature — evolving as new questions or new funding opportunities emerge. The strength of the core collaboration — built on trust, creativity, strong communication and efficient division of tasks — allows for other researchers, students and postdocs to smoothly join forces when needed in order to move forward the main lines of research. Maintaining a productive collaboration is not always easy, and we're proud of both the endurance and the productivity of these teams. Most of all, though, we're proud of the science they do — and its potential for good on a global scale.

Hidden carbon cycle revealed

Microbiologists **Kim Halsey** and **Stephen Giovannoni**, a wife and husband team, have been working together for a decade studying the cycling of volatile organic compounds (VOCs) by microbes. A wide variety of VOCs, including methanol, acetaldehyde, isoprene and formaldehyde, are produced by plants and algae. Halsey and Giovannoni, working with postdocs **Cleo Davie-Martin** and **Jing Sun** and doctoral students **Eric Moore** and **Lindsay Collart**, have found that many VOCs are consumed by bacteria nearly as fast as they are produced. The project was sparked by a genomics study, which unexpectedly revealed that genes for volatile organic carbon metabolism are common in planktonic bacteria. SAR11, the most abundant plankton in the oceans, was found to convert a variety of VOCs to CO₂. Because common methods for measuring the carbon cycle don't work on volatile compounds, Halsey and Giovannoni call VOCs the “the hidden carbon cycle.”

The 10-year project started with a small National Science Foundation grant and gathered momentum when the team acquired a proton transfer reaction mass spectrometer (PTR/MS), an instrument capable of measuring VOCs. Halsey and Collart are now using the PTR/MS to monitor toxic algal blooms in Oregon lakes, and Eric Moore is measuring the magnitude of the hidden carbon cycle in co-cultures of phytoplankton cells and bacteria.

As VOCs that escape the ocean are involved in chemical reactions that influence the formation of planet-cooling clouds, Halsey and Giovannoni's research is relevant for understanding climate change. One

famous idea, the CLAW hypothesis, predicts that algae producing the VOC compound dimethylsulfide will moderate Earth's climate as it gets warmer. Halsey and Giovannoni's discovery of many new VOCs produced by algae makes the picture much more complicated. Working with atmospheric chemists, they hope to assemble a more accurate picture of how algae alter climate.

Mental health and the gut microbiome

Researchers have struggled to explain the origin of behavioral and cognitive impairment, which often manifests in our children as anxiety, hyperactivity and depression. An increasing body of research points to early-life exposure to environmental pollutants as a contributing factor, but it remains unclear how these pollutants may elicit these effects. Due in part to recent evidence that indicates that the gut microbiome plays an important role in neurological and behavioral development, **Thomas Sharpton** and **Stephen Giovannoni**, along with collaborators Robert Tanguay in the College of Agricultural Sciences and Fred Stevens in the College of Pharmacy, hypothesize that exposure to pollutants impairs how microorganisms colonize the gut early in life and consequently impacts how these microbes contribute to normal behavioral development.

Thanks to a recent NIH grant, Sharpton and Giovannoni are working to test this transformative hypothesis. But to do so, they have to innovate new experimental tools, such as microbiome-free animal model organisms, efficient cell-culturing techniques, and metabolomic methods, that will allow them to prove the microbiome's role in early life behavior development. These new tools will allow them to



Stephen Giovannoni and Kim Halsey

identify specific gut microbes and their metabolites that drive behavior development and that are sensitive to environmental pollutants, and provide the microbiome research community with critically needed methods to discern the cause and effect of gut microbiomes on vertebrate health and behavior. Ultimately, the duo hope to discover how pollutants act on the gut microbiome to impact behavior and develop novel therapies that restore the microbiome to a state that yields neurotypical behavioral outcomes.

Protecting corals from stress

Rebecca Vega-Thurber and her partner **Andrew Thurber** have been collaborating on marine microbiology research for many years, including work on deep-sea viral discovery. Currently, they are combining their unique expertise in oceanography and coral reef ecology to better understand how the coral reef microbiome and virome respond to stress, and how such changes impact the health of threatened coral reefs. Vega-Thurber,

a coral microbiologist/virologist, and Thurber, a microbial ecosystem ecologist, have been working on the island of Mo'orea, French Polynesia since 2014, using an island scale observational approach coupled with experimental manipulations in the lab and field to advance understanding of coral reef ecosystems. They are co-PIs on a National Science Foundation grant that funded the research as well as facilitated the training of 10 OSU undergraduate and nine graduate students across three departments and three colleges.

A race for new anti-parasitic drugs

Roughly one quarter of the world's population are infected by intestinal parasitic worms. Those afflicted are disproportionately from impoverished nations and often suffer life-long health and cognitive impacts. Unfortunately, the prevalent use of anti-parasitic drugs, especially in agriculture, has yielded a sudden and terrifying rise in drug-resistant intestinal parasitic worms. Our ability

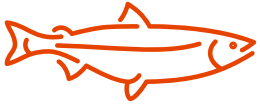
to treat and manage some of the most common infections on the planet increasingly depends upon our ability to discover novel anti-parasitic drugs.

Michael Kent and **Thomas Sharpton** believe that the gut microbiome, or community of bacteria that reside in the gastrointestinal tract, can serve as a wellspring for such new drug discovery. Today's most widely used anti-parasitic drugs were isolated from bacteria that co-habit and compete with worms in soil. Kent and Sharpton hypothesize that the gut microbiome, a competitive ecosystem, might produce chemicals that kill invading worms and thereby be a source of novel anti-parasitic drugs, especially as the bacteria that reside in the gut are evolutionarily distant from those that reside in soil.

Using zebrafish, Kent and Sharpton have advanced a high-throughput animal model to study how gut bacteria influence intestinal infection outcomes by parasitic worms. Housed on the fifth floor of Nash Hall, their labs have developed an extensive collaboration that uniquely combines Kent's expertise on zebrafish and parasitology with Sharpton's expertise in microbiome science. Together, they have received three National Institute of Health (NIH) grants to study how the microbiome impacts intestinal parasitic infection.

Their collaboration is already paying off. Kent and Sharpton have published seven studies since Sharpton joined OSU in 2013, including a recent landmark paper in the top-flight journal *Microbiome* that characterizes how the biodiversity of the zebrafish gut microbiome predicts the outcome of intestinal nematode infection. They are now expanding upon this work and integrating machine learning techniques to identify specific gut microbial anti-

parasitological chemicals, novel drug leads that could hinder the rise of drug-resistant parasites and help human populations the world over.



LARGER COLLABORATIONS

Oregon Department of Fish and Wildlife: A long-time partnership

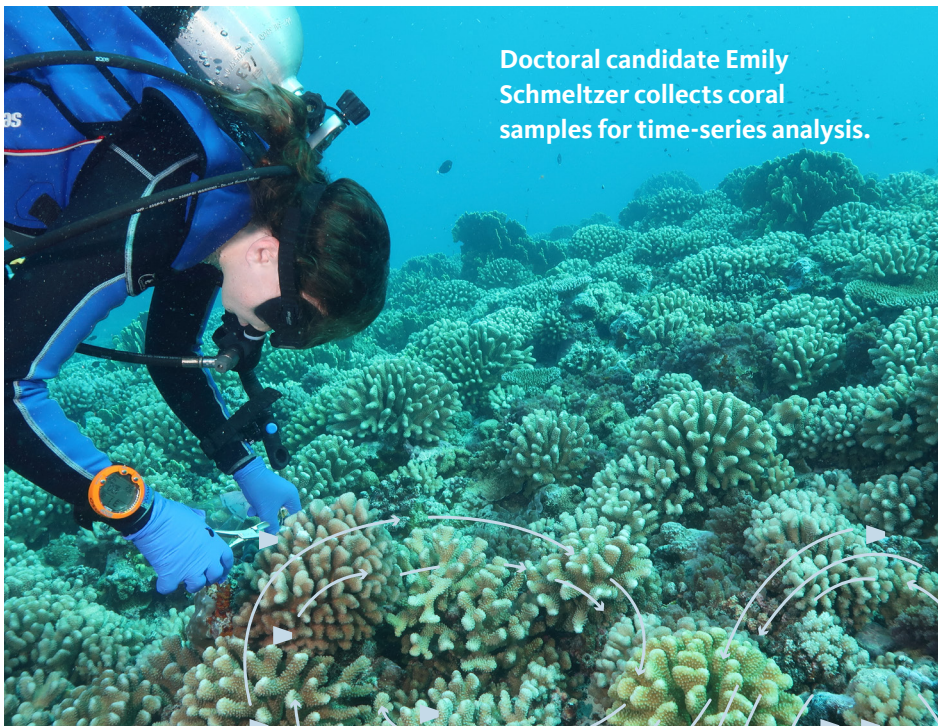
Unknown to many, the Fish Health Services laboratory for the Oregon Department of Fish and Wildlife (ODFW) is located on the 5th floor of Nash Hall on campus. In addition to providing health management services for the state's 34 fish hatcheries, this unit has been a longtime partner of OSU's microbiology department. The relationship began in 1963 with **John Fryer**, then an assistant professor in the department, who received funding from the two

state agencies that managed fish and wildlife in Oregon — the Oregon Fish Commission and the Wildlife Commission. The Wildlife Commission eventually hired a pathologist to be based at OSU — their first hire was an OSU graduate student. A few years later, the Fish Commission hired a virologist to be based at OSU, and thus the second graduate student found a position. In 1975, these two agencies merged to create ODFW, and OSU became home to the Fish Health unit.

For the past 50 years, these collaborations have resulted in major advances in the field of fish health, while also enhancing the department in numerous ways. At the forefront of this relationship is graduate training. Since 1972, the laboratories of microbiologists **Karl Pilcher, John Fryer, Jo-Ann Leong, Stephan Kaattari, John Rohovec, Paul Reno, Jerri Bartholomew** and **Mike Kent** have trained over 150 graduate students in aspects of fish health that range from characterization

of pathogenic bacteria, viruses and parasites to host-pathogen interactions and vaccine development. As part of their training, many of these students gained real-world experience by accompanying ODFW pathologists to hatcheries and learning diagnostic techniques such as immunoassays and tissue culture in ODFW labs. ODFW has also provided direct support in the form of graduate student grants and fellowships. For some students, this eventually led to a career in fish health, with at least 10 microbiology graduates going on to work for the ODFW Fish Health Unit and many more going to work as microbiologists, pathologists and research scientists in other state, federal and tribal agencies and in academia.

In addition to their contributions to the fish health research program in the department, ODFW plays a crucial role in our teaching program. Because it is impractical to work with bacteria that are potentially pathogenic to humans in our laboratory courses, ODFW provides bacterial and viral isolates from hatchery fish to give students experience in isolating and identifying pathogens. They also prepare salmonid cell lines for use in labs so that students have healthy cell monolayers that allow experiments to be successful. ODFW pathologists present guest lectures that discuss real disease outbreak scenarios and give students insight into a career path they may not have considered. They have always been willing partners in providing research opportunities for students in their labs, taking undergraduate and graduate students as volunteers as well as interns. Similarly, they have provided research support to OSU faculty across departments by sharing cell lines, expertise and advice on fish health and disease management.



Doctoral candidate Emily Schmelzer collects coral samples for time-series analysis.



Giovanoni Lab members past and present on the 2019 BIOS-SCOPE Cruise. (L to R) former postdoc Ben Temperton, postdoc Chris Suffridge, Steve Giovanoni, Michelle Michelsen (B.S. Microbiology '18).



BIOS-SCOPE: Cruising for Vitamin B1

Postdoctoral researcher **Chris Suffridge** voyaged aboard the research vessel Atlantic Explorer as a member of the Giovanoni Lab's annual BIOS-SCOPE cruise. BIOS-SCOPE, based out of the Bermuda Institute of Ocean Sciences (BIOS) is a five-year, multi-institutional research program funded by the Simons Foundation International for the study of microbial oceanography in the North Atlantic Ocean. Established in 2015, BIOS-SCOPE leverages ocean measurements and ongoing research at the Bermuda Atlantic Time-series Study (BATS) site, bringing new collaborations and technologies to study the ocean's smallest life forms. The Giovanoni Lab's work with BIOS-SCOPE is focused on understanding the microbial group SAR202, which is the dominant cell type at mesopelagic depths, and has the ability to metabolize recalcitrant forms of dissolved organic matter.

Suffridge's research is focused on understanding oceanic thiamin (vitamin B1) cycling, a project in collaboration with BIOS-SCOPE that is funded by the National Science Foundation. Many marine microbes require vitamin B1, but as they lack the metabolic pathways to synthesize it, they must acquire it from the environment. Suffridge developed a mass spectrometry-based method to measure the concentration of vitamin B1 in the ocean, and has discovered that the concentrations of vitamin B1 dissolved in seawater are so low that they may not be sufficient to meet the needs of the microbial community.

On the cruise, Suffridge studied how the concentrations of vitamin B1 change over the course of the day, and how quickly vitamin B1 is taken up by the microbial community. He hopes to use the data he collected to better understand how the availability of vitamin B1 may influence the marine microbial community structure. The implications of his research are

significant. The ocean is a major carbon sink on Earth, and its ability to sequester carbon is becoming only more important due to climate change. If we want to fully understand the microbial processes that are key to sequestering atmospheric carbon in the ocean, we must understand how vitamin B1 influences microbial growth and community structure.



Research funding on upward roll

Microbiology faculty were either PIs or co-PIs on over \$13 million in new research funding this year. Congratulations to all!

Maude David is part of a new \$1.94 million Small Business Innovation grant to identify connections between the human microbiome and autism spectrum disorder. The goal is to use data from the gut microbiome to search for new treatments for

this developmental disorder. David will collaborate with researchers at the Stanford University School of Medicine and Second Genome, a company based in San Francisco.

Thomas Sharpton is PI on several large grants with faculty both in the department and across OSU.

Sharpton and **Stephen Giovannoni** received a \$2.1M National Institutes of Health (NIH) award to study the impacts of a carcinogen, benzo[a]pyrene on microbiome development and the behavioral consequences; **Sharpton** and **Michael Kent** received a \$404K NIH award to examine the interactions between the gut microbiome and intestinal helminths; **Sharpton** and Anna Jolles (IB) received an National Science Foundation (NSF) Ecology and Evolution of Infectious Diseases g-rant for \$2.5M to study the eco-evolutionary dynamics of infectious diseases in host population networks.

Stephen Giovannoni and mathematical modeler Ferdi Hellweger of Berlin Technical University received

a \$424K NSF grant to study how planktonic cells regulate genes for assimilating carbon compounds from the environment. Doctoral student **Stephen Noell**, who recently traveled to Berlin to meet with Hellweger, is studying the costs and benefits of microbial gene regulation in fluctuating environments.

Andrew Thurber received a \$200K award from the NSF to study the ecosystem impact of the 2019 massive coral bleaching event off the Island of Mo'orea and how this bleaching event shifted the island-wide microbiome and the flow of elements and energy throughout this tropical marine ecosystem.

Andrew Thurber was also awarded a \$630K grant from the National Oceanic and Atmospheric Association (NOAA) to study the blue economy of the Pacific Northwest and the potentially beneficial role of methane seeps in the deep-sea off Oregon and Washington. In collaboration with Kerry McPhail (College of Pharmacy), Thurber will search for medically useful

compounds that the microbes at seeps may make. The planned deep-sea cruise in summer 2020 on the Exploration Vessel Nautilus will live stream explorations straight from the deep sea floor for all to see and ask questions of the scientists on board.

Rebecca Vega-Thurber won a \$627K NSF grant to study the evolution of and symbiosis between a new bacteria that the lab discovered, *Candidatus aquarickettsia*, and corals. A coral parasite, the bacterium may make corals more susceptible to disease. The project is in collaboration with Dr. Erinn Muller, Director of Mote Marine Lab and recent winner of the U.S. President's Award for scientific excellence.

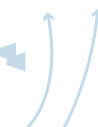
Jerri Bartholomew and research associate **Sascha Hallett** received \$3.1M from the U.S. Bureau of Reclamation to continue fish health studies in the Klamath River. The team will monitor the abundance of the myxozoan parasite *Ceratonova shasta* in river water and in salmon and worm hosts to better understand the environmental variables affecting fish mortality and to develop models to inform adaptive management.

Sascha Hallett is also co-PI on a \$847K grant with researchers from the University of California, Santa Cruz; UC Davis; and NOAA to better understand which infectious diseases and interacting stressors affect the health and survival of Central Valley Chinook salmon as they outmigrate to the Delta. Another research associate in the lab, **Julie Alexander**, received a \$140K grant from Alberta Environment and Parks to examine factors driving whirling disease risk in Canadian wild trout.

Ryan Mueller and Carla Schubiger (Vet Med) received a \$338K grant from NOAA to investigate probiotic solutions to improve Pacific oyster larval growth and spat settlement.



Thomas Sharpton





ALUMNI AND FRIENDS

Finding his true North

Before he founded world-famous Ravenswood Winery, **Joel Peterson** (Microbiology '69) was a pre-med student, ambulance driver, backpack traveler and research immunologist in a cardiovascular lab. Given these twists and turns, he well understands the vital role that exposure to a diverse range of professional experiences can play for undergraduates searching for their true passion.

To help undergraduates find their calling, Peterson funds discipline-related travel grants for microbiology and biochemistry majors to participate in professional conferences, present their research or pursue a distant internship.

“Science is as much about the people as anything,” says Peterson, who only understood the breadth of career options after traveling to professional

microbiology conferences. “I wanted students to have access to the same insights I had so that they could make more strategic decisions about their own future.”

Serving on the College of Science Board of Advisors since 2015, Peterson has enjoyed bringing an entrepreneurial background to help the College monetize more of its activity in a belt-tightening era. He is a strong proponent of diversity and ensuring that all science students have an equal chance at success.

Peterson says seeing students’ enthusiasm and idealism “makes me feel like I’m doing something worthwhile.” He advises students to “work you’re a## off, learn as much as you can and understand that you’re in a world that doesn’t necessarily believe in science, but you’re one of the few people who can make a huge difference.”

Next gen microbiologists

Last year, 162 Microbiology and BioHealth Science students graduated with a bachelor’s degree. About half of them apply to professional or graduate school, largely in medical, dental, and pharmacy programs. The other half apply for research jobs in clinical, food microbiology and environmental labs. We are proud that 90% of our students are accepted to professional programs or find a job in the field within one year of graduating.

Jessica Scotten (Microbiology, '19) “Fell in love with pathogens and how microbes interact with humans” in her first microbiology class and worked for three years in Kim Anderson’s environmental forensic chemistry lab in the College of Agriculture. A summer internship at NASA’s Kennedy Space Center in Florida sparked a passion for a career in space research. Scotten, who is grateful to all her “amazing” OSU advisors and professors, began a Ph.D. at the University of Florida this year.

Carrie Sanders (BioHealth Sciences '19) was featured in local TV station KBVR’s Senior Spotlight series. As a volunteer for Global Brigades, she worked in medical clinics in Honduras. This fall Sanders is back on campus pursuing a PharmD degree at OSU’s College of Pharmacy.

Arisa Larmay (Microbiology '19) launched We Care and Can, a nonprofit that collects bottles and cans to raise money for students with high medical bills. Struggling financially despite working seven jobs over five years at OSU, Larmay was featured in a Corvallis Gazette-Times article about financially strapped students who found cash assistance and a free food pantry at OSU’s Human Services Resource Center. Now a health navigator at Kaiser Permanente, she plans to apply to medical school.



Jessica Scotten

Emman Khan (Microbiology '17), co-president of the Microbiology Student Association, worked in Dan Rockey's lab for several years at OSU. After graduation she worked for ScribeAmerica and is currently in a physician assistant program at Wake Forest University in North Carolina.

Tanner Robinson (M.S. '18) is developing diagnostic tools for infectious diseases at Biofire Diagnostics, Salt Lake City, Utah.

Bailey Keefe (M.S. '19) continues to work as a research assistant in the Bermudez Lab in OSU's College of Veterinary Medicine.

Laura Taggart-Murphy (M.S. '19) is a researcher at Gnotobiotic Zebrafish Research Facility, University of Oregon.

Kalyn Hubbard (M.S. '19) is a zebrafish research technician at NemaMetrix in Eugene, Oregon, testing gene therapies for epilepsy.

Ian Humphreys (M.S. '19) is a Ph.D. candidate in molecular and cellular biology at the University of Washington.

Michelle Pombrol (M.S. '19) works at Novogene, a company providing genome sequencing services.

Wei Wei (Ph.D. '18) is a postdoc at a U.S. Department of Agriculture lab in Fresno, California.



Emman Khan

Scott Klasek (Ph.D. '19) is a postdoc at Woods Hole Marine Biological Laboratory in Massachusetts.

Ryan McMinds (Ph.D. '18) is a postdoc in France where he is analyzing data collected during the TARA Oceans Expedition.

Brandan Kieft (Ph.D. '19) is a postdoc at the University of British Columbia.

In a brother's honor

The Mark H. Middlekauf Memorial Scholarship was established by **Ruth M. Tyson** in 1982 to honor the memory of her brother, 1st Lt. **Mark Humbert Middlekauf**, U.S. Air Force. Middlekauf graduated from Oregon State in 1916. After earning a graduate degree at Iowa State University, he returned to teach at the Department of Bacteriology (now the Department of Microbiology).

A true patriot, Middlekauf enlisted in the Aviation Service during World War I. Tragically, in October 1918, he died as a result of an accident to his plane at Chatillon-sur Seine. His colleagues wrote, "With fine scholarship and sterling character, he was at the beginning of a brilliant scientific career, and his loss is genuinely lamented by the College community." Through her endowment, Ruth M. Tyson ensures that her brother's legacy of service and love of science will persist through future generations.

Honor Roll

The Honor Roll recognizes the Department's annual supporters who have made outright gifts or pledge payments totaling \$1,000 or more between July 1, 2018, and June 30, 2019.

Anonymous (1)

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Bermuda Institute of Ocean Sciences

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Thank you!

Every attempt has been made to ensure the accuracy of these lists. However, if you notice an error, please contact Pam Powell, Associate Director of Stewardship, OSU Foundation, Pam.Powell@osufoundation.org or 541-737-5820.



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