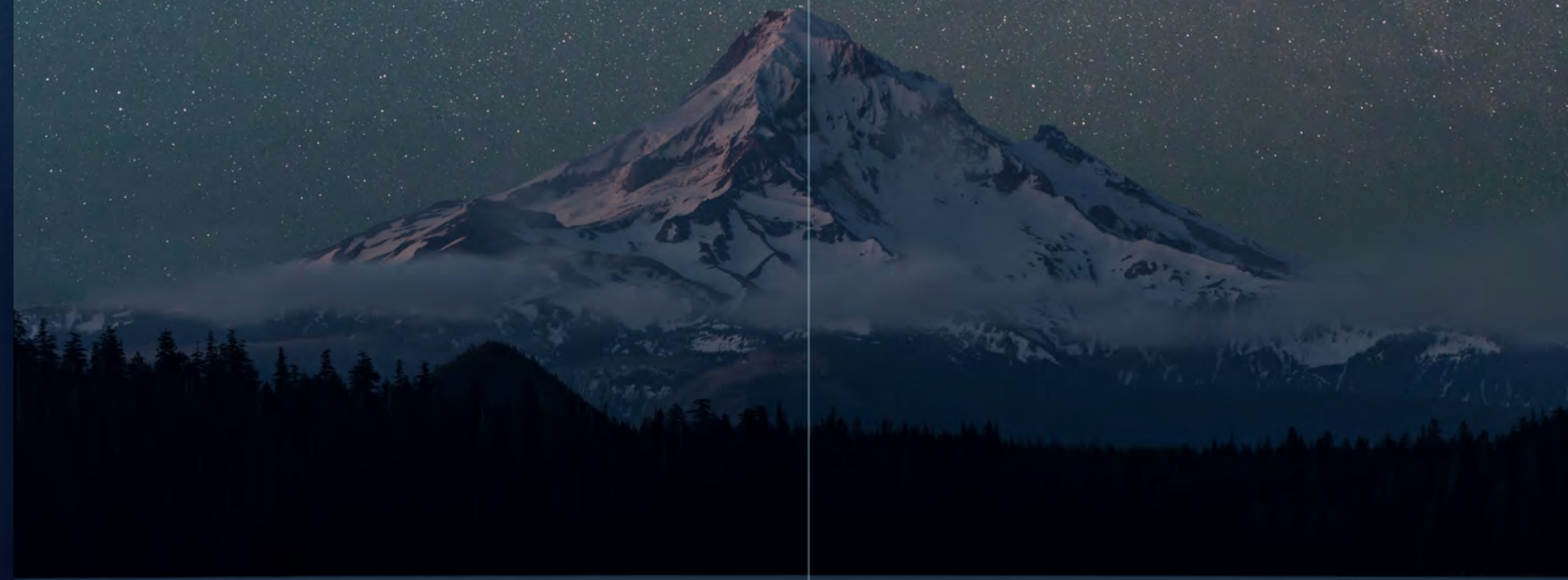


science.oregonstate.edu

COLLEGE OF SCIENCE

Annual Report

2019-2021



Advancing the endless frontier of science



These 2,000-year-old remains of a Sitka spruce forest were little more than local legend for hundreds of years before they were exposed in the late 1990s by a series of storms. As the tide ebbs and flows, the Neskowin Ghost Forest serves as home to myriad sea creatures, and its unique geological features are a source of fascination to tourists and scientists.

Coastal ecosystems are particularly vulnerable to the effects of climate change: rising sea levels, changing storm patterns, erosion and ocean acidification. Our scientists confront the multifaceted issues facing coasts today, seeking to discover effective ways we can reduce the impacts of climate change on fragile ecosystems and preserve natural wonders such as this for future generations.

Photo by Nicholas Morris (@intricateexplorer)



Contents

1	ON THE CUTTING EDGE OF DISCOVERY
3	From Dean Roy Haggerty
5	OUR RESEARCH
7	Tuning in to the cosmic chorus
9	Sparking discovery, innovation and impact
11	Moving materials science into action
13	Catalyzing research to save lives
15	Hopeful solutions for a healthy ocean
17	Discovery at the intersection of science and healthcare
19	Unlocking discoveries in genetics
21	Enhancing the way the world uses data
23	Leadership on the world stage
25	OUR STUDENTS
27	Our competitive edge: Undergraduate research
29	Science pivots to a virtual landscape
31	Our undergraduates reach higher
33	Graduate students who go beyond
35	Confronting systemic inequality in science

37	OUR OUTREACH
39	Outreach and service during a pandemic
41	Enlightening ideas: Distinguished lectures
43	Taking science where it matters
45	OUR HONORS
47	Faculty and student awards
49	OUR COLLEGE
51	Facts and figures
53	Facilities that foster exploration
55	Science champions: Board of Advisors
57	OUR FACULTY
59	Renowned leaders: Faculty highlights
61	OUR ALUMNI
63	Breaking the mold



1.



2.



3.



On the cutting edge of discovery

We stand at the frontier of what is possible.

The College of Science is a trailblazer in pursuing research and innovations that create real-world impact. As an essential hub at a profoundly public-spirited university, we see the world's great challenges as a call to action. Our nation and the world are counting on institutions such as ours to renew scientific talent and support critical U.S. investment in collaborative, interdisciplinary science and radical innovation — a vision promoted in "Science: The Endless Frontier," Vannevar Bush's groundbreaking 1945 work that inspires us still.

Collaboration is built into our DNA. Oregon State scientists and students reach across disciplines to combine their areas of expertise and take a more comprehensive approach to solving urgent concerns, such as the global pandemic, ocean conservation and management, accessible disease-fighting drugs, green materials and processes, and computational tools to help mitigate calamities.

As an incubator for innovation, the College is strengthening opportunities for scientists and partners to develop their ideas into solutions that address practical problems and make their way into the economy. College of Science Research and Innovation Seed (SciRIS) awards empower initiatives that lead to significant pathways.

Our momentum is growing. In fiscal year 2021, College of Science faculty were awarded \$24.4M in external research funding — a 55% increase over the average of the previous three years and our second highest award level in more than 10 years.

As we look to the horizon, we see a future of opportunities. The world is changing rapidly and we are entering a period marked by a growing need for breakthrough solutions. Building on our strong foundation, the College of Science at Oregon State is setting a promising course.

Left 1: Renowned scientist Jane Lubchenco recently accepted a position with the White House as deputy director of climate and environment. **Left 2:** Led by Distinguished Professor Douglas Keszler, OSU's new Continuous Flow Facility aims to enhance a culture of innovation, drive discovery and leverage

regional expertise in CF-based discovery and production. **Left 3:** OSU has been awarded funding to lead a \$17 million NSF center under the direction of Xavier Siemens. **Above:** New hire Marilyn Mackiewicz has hit the ground running with new grants to research early detection of aggressive cancers.



I am pleased to present you with the 2019–2021 College of Science report that highlights achievements from July 2019 through June 2021.

I have never been more honored to serve as dean of Oregon State’s College of Science than I have been in these last two years. Amid extraordinary challenges, this dedicated community fulfilled our mission and values in full-force — shifting engaging learning experiences to online platforms, advancing world-class research, addressing and reducing racial disparities in the classroom and the College, and mobilizing the capacities of our land grant university to help the communities we serve.

COVID-19 took a toll. At the same time, it spotlighted what is best in the College of Science — our scientists’ incredible dedication to teaching and inspiring students and exploring the frontiers of scientific research, discovery and innovation.

In this report, you will read how OSU Science leadership has literally reached across the world. Our scientists achieved award-winning success even in the midst of pandemic challenges. They produced knowledge, generated innovations and inspired national policy to promote economic, social, health, cultural and environmental progress for the people of Oregon and beyond.

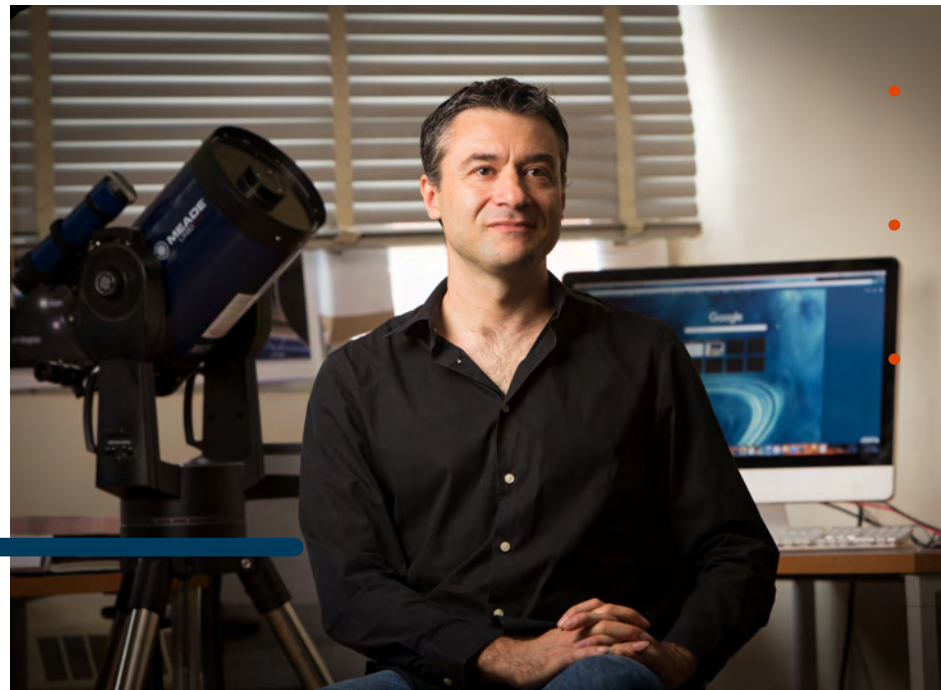
We continue efforts to uphold our values of diversity, racial justice and equity — striving to provide equitable pathways to success and improve

outcomes for underrepresented students, faculty and staff. In June 2021, we launched the Diversity Action Plan for 2021–2024: *Embedding Equity, Access and Inclusion*. I encourage you to view the report and watch for measurable progress at science.oregonstate.edu/diversity-plan.

Looking forward, I see the College of Science progressing further as an inclusive hub for discovery and innovation and an incubator for tomorrow’s global leaders. Building a strong learning and research enterprise requires teamwork, and I am so grateful for the investments faculty and staff made in these past two years. I also want to thank our generous alumni and friends whose gifts to the College funded undergraduate research opportunities, helped students facing financial hardship due to the pandemic, and bolstered our teaching and research mission.

OSU Science is making its mark on the world. Inspired still today by the vision of Vannevar Bush in his seminal work, *Science, the Endless Frontier* that led to the creation of the National Science Foundation, we will continue advancing knowledge and discovery at the endless frontier of science.

Roy Haggerty
Dean, College of Science



1.



3.



2.



Our Research

Harnessing the power and potential of science

Our scientists unlock knowledge and turn it into real-world impact.

In the spirit of advancing science that benefits the people of our state and the world, College of Science researchers aim for the farthest frontiers of research. In these last two years, our scientists have set forth new paradigms for basic research in response to urgent national and global challenges.

The pandemic drove our scientists to combine research, leadership and collaboration to create a transformative public health project with far-reaching societal effects. From biological systems to astrophysics, our scientists pursued new directions of fundamental research to explore the world around us. Propelled by rigorous investigation and the unyielding determination of our scientists, long-term research projects have culminated in critical discoveries and applications. These are profoundly influencing solutions to energy security and sustainability, the crisis of global warming, biomedical challenges, mathematical models of complex phenomena and other pioneering research.

Research and education in the College are pushing the bounds of fundamental knowledge, accelerating the pace of innovation and facilitating vital partnerships with industry. In 2019-21, federal research awards in the College rose to \$50M in the fields of biological sciences, physical sciences and mathematics. This was boosted by the College's own substantial investments in research to help innovation and discovery flourish. These competitive internal and external grants have spawned highly productive research endeavors that benefit health and medicine, industry and economy, environment and biodiversity. Many of these projects are redefining the goals of basic research, leveraging scientific discoveries for enterprise creation and technological innovation.

Underpinning it all is the College's enduring nurturing of scientific talent and the next generation of scientists, ensuring broad opportunity and success for our students.

Left 1: Astrophysicist Davide Lazzati has provided significant insight into the relationship between binary neutron star mergers, gravitational waves and gamma-ray bursts. **Left 2:** Chemist Chong Fang's breakthroughs in femtosecond stimulated Raman spectroscopy further a vision of molecular

"machines" with targeted, functional designs. **Left 3:** Biophysicist Afua Nyarko presents "Selectivity and Specificity in Cancer Regulatory Proteins" at the 2019 CGRB Conference. **Above:** Rebecca Vega Thurber and doctoral candidate Emily Schmeltzer collect coral samples for time-series analysis.

Tuning in to the cosmic chorus

Oregon State scientists are at the forefront of exciting new research in astrophysics.

The first-ever detection of gravitational waves by the Laser Interferometer Gravitational-Wave Observatory (LIGO) in 2015 threw open new frontiers of our universe and expanded the limits of human understanding. Now, thanks to the leadership of physicist **Xavier Siemens**, a \$17M National Science Foundation (NSF) Physics Frontiers Center opened in April at Oregon State University to forge a new era of gravitational wave astronomy. The center, called NANOGrav — the North American Nanohertz Observatory for Gravitational Waves — will enable scientists to learn how black holes, galaxies and other matter form and evolve.

Siemens and Maura McLaughlin, an astronomer at West Virginia University, will co-direct this Physics Frontier Center. The center's scientists will study the universe through low-frequency gravitational waves, ripples in the fabric of space-time caused by movements of massive astronomical objects such as colliding black holes and exploding stars. NANOGrav scientists make use of some of the world's best telescopes and most advanced technology, drawing on physics, computer science, signal processing and electrical engineering to successfully detect very low frequency gravitational waves.

Detecting gravitational waves with extraterrestrial clocks

The NANOGrav center will help fund a collaboration of 200 astrophysicists at 18 universities, including OSU physicist **Davide Lazzati**, and approximately 20 graduate and undergraduate students.

LIGO's first-ever detection of gravitational waves is billed as one of the most significant physics discoveries since Albert Einstein predicted the existence of gravitational waves in his 1915 General Theory of Relativity. NANOGrav will carry forward the quest for gravitational wave signals with the help of celestial clocks spread across our

region of the Milky Way Galaxy called pulsars — rapidly spinning remains of exploded neutron stars that send out regular radio wave pulses. The tiniest deviations in the measurements of these remarkably stable clocks can alert astronomers to the presence of gravitational waves.

Groups of pulsars allow detection of complex gravitational wave combinations caused by the most explosive cosmic phenomena possible: supermassive black hole mergers. Black holes are millions to billions of times the mass of the sun and exist in the centers of galaxies. If each gravitational wave signal is a note, then NANOGrav researchers aim to grasp the musical piece that is black hole collision: "We want to hear the collective chorus of all of the supermassive black hole binaries that are merging in the universe," said Siemens.

Clues to the formation of the universe

Recently, the NANOGrav project unveiled hints of new knowledge when it announced detection of a strong signal potentially attributable to gravitational waves. The findings, which appeared in *The Astrophysical Journal Letters*, reveal the detection of unexplained fluctuations, consistent with the effects of gravitational waves, in the timing of 45 pulsars spread across the sky and measured over a span of 12.5 years. "If we are able to confirm that the signal we are seeing is produced by gravitational waves from supermassive black holes, we will learn how structure in the universe forms and grows over cosmic time," said Siemens.

Siemens joined the Oregon State faculty in 2019. Previously, he directed the NANOGrav Physics Frontier Center at the University of Wisconsin-Milwaukee, where it launched in 2015 with a \$14.5M award from the NSF. Oregon State is one of only 11 institutions to host an NSF Physics Frontiers Center and one of three from the Pacific 12 Conference; the other two Pac-12 schools are the University of California, Berkeley, and the University of Colorado.

This rendition of the PSR B1257+12 pulsar system illustrates the lighthouse-like emission of radiation from a pulsar's poles. Just as these planets were discovered by measuring anomalies in the pulsar's 'pulse', NANOGrav uses pulse anomalies to measure gravitational waves and learn about black holes and other phenomena. Image by NASA/JPL-Caltech.



Sparking discovery, innovation and impact

Robust investment through the College's Research and Innovation Seed (SciRIS) Program has led to fundamental discovery and bold applications of science. Between 2019 and 2021, the College invested \$763K in innovative research, setting the stage for scientists to net competitive, high-powered federal grants to develop game-changing new technologies in areas from healthcare to materials science.

A plum deal for new cancer treatments

The College's SciRIS program has paved the way for new breakthroughs in cancer and rare disease treatment by one team. Chemist **Chris Beaudry** and biochemist **Victor Hsu** won successive stages of SciRIS funding totaling \$200K to advance pharmaceutical research to treat leukemia and other hematologic malignancies and tumors. The research, which focuses on chemically synthesizing scarce and expensive medicinal compounds found in nature, also garnered them a four-year \$981K National Institutes of Health grant in 2020. Homoharringtonine (HHT) is a plant alkaloid used to treat multiple forms of cancer including chronic myeloid leukemia. HHT is currently derived from plum yew trees (*Cephalotaxus harringtonii*) grown in China — a prohibitively expensive process. The innovative technology of cascade reactions used to construct the new molecular architectures of HHT not only increases its yield, but does so with greater efficiency in fewer steps than previous chemical processes. Beaudry and Hsu's research expands the field of synthetic chemistry and its application to develop natural products as medicines that include HHT and other disease-fighting molecules as well as modern drug delivery systems.

Ushering in a new era of sustainable energy

Chemist **David Ji**'s lab has been working toward a more sustainable alternative to the traditional lithium-ion batteries which pose intractable problems with respect to large-scale energy

storage and safety. The Ji Lab uses aqueous redox chemistry to create battery reactions for low-cost energy storage and safe electrified transportation. The research has resulted in the invention of a group of new electrolytes in which zinc metal electrodes can be plated and stripped with extremely high efficiency. This makes it possible to transform zinc batteries from primary batteries to rechargeable ones. The path-breaking invention has led to an OSU spinoff company GROTHUSS Inc., which was awarded highly competitive federal seed funding by Small Business Innovation Research (SBIR) to develop the technology for commercialization. Ji and his team are working toward developing lighter zinc metal electrodes to improve the battery's energy density. "Energy storage is growing into a trillion-dollar market. It will take a symbiotic integration of science, engineering, entrepreneurship and investment to address this grand challenge of our time," said Ji.

Designing next-generation quantum materials

An emerging class of 2D materials present outstanding opportunities for science and industry because of their unique physical and electrical properties. Two-dimensional materials are a class of nanomaterials defined by their property of being low in dimension — or one or two atoms thick — making them suitable for a wide range of innovative nanoelectronic applications. Yet many of their properties remain unknown to scientists, and thus their capabilities as functional materials are not fully realized. Physicist **Oksana Ostroverkhova** received a SciRIS individual investigator award to advance research on fundamental physics properties in newly discovered 2D materials, using unique magneto-optic measurements being developed at the ultra-fast laser facility at OSU. Her research will guide technological advances and better design of spintronic and valleytronic devices for quantum computing, sensing, information storage and optical modulation.

Compounds from the plum yew, *Cephalotaxus harringtonii*, are effective in treating certain cancers. But deriving its benefits is costly, so researchers are taking what they've learned from this powerhouse plant to create a synthetic version with all the same benefits and even greater yield.



Moving materials science into action

From synthesizing research and manufacturing to the discovery of nanomaterials for scrubbing carbon emissions, OSU researchers are shattering the ceiling on materials applications.

Designing materials from the atoms up

A grant from the M.J. Murdock Charitable Trust helped launch the Oregon State Continuous Flow Facility that will transform the discovery and synthesis of new molecules and materials by continuous flow (CF) methods. As the name suggests, the facility integrates multiple-step reactions and processes in a single continuous flow, allowing for state-of-the-art control and automation for enhanced capabilities, optimization and specialized chemical production.

Doug Keszler, University Distinguished Professor of Chemistry, is at the helm of the comprehensive effort to accelerate the synthesis and manufacturing of chemical products that will spur digital chemistry discovery, processes and sustainable manufacturing by industry partners. Keszler and other researchers from the Department of Chemistry will collaborate with industry partners to design, build and integrate specialty reactors and in-line analytical instrumentation. “There is a dearth of relevant chemistry experience in CF synthesis, so very few universities are producing the graduates needed to exploit its potential. The project will prepare students for a burgeoning industry that is eager to hire qualified candidates,” Keszler said.

Preventive and predictive medical technologies

Oregon State University has emerged as a pioneering center of Femtosecond stimulated Raman spectroscopy (FSRS) — the only technology of this kind in the Pacific Northwest — that reveals the mechanism of molecular processes in chemical, physical and biological sciences. Chemist **Chong Fang** is one of the core developers and a leading global expert on FSRS. His lab utilizes state-of-the-art vibrational spectroscopies to capture data on chemical reactions in light-absorbing proteins at exceedingly fast timescales that are of

Using an LED reactor, members of the Stylianou Lab can test the photocatalytic activity of porous materials toward water splitting and hydrogen generation. These porous metal-organic frameworks have exciting potential for energy, environmental and sensing applications.

immense technological and biological importance. With the support of a SciRIS individual investigator grant, Fang is applying cutting-edge spectroscopic techniques to reveal the working mechanisms and unique properties of fluorescent yellow proteins within the jellyfish species *Phialidium* sp. The goal of the research is to achieve a breakthrough in rational design and molecular engineering of next-generation fluorescent-protein-based biosensors, which can advance bioimaging applications to improve human health.

Powerful nano-scrubbers for a cleaner planet

Climate experts and scientists agree that any solution to address global climate change must include the transformation of infrastructure, transportation and other high-carbon-footprint products. Chemist **Kyriakos Stylianou**'s research has led to important discoveries about the role nanomaterials known as metal-organic frameworks (MOFs) play in decarbonizing smokestack emissions and manufacturing biofuels. Most MOFs do not perform well because the water in flue gases competes with the CO₂ for the same adsorption, which means those MOFs are not selectively scrubbing CO₂. Kyriakos, who holds the Terence Bradshaw Chemistry Professorship, identified different types of CO₂ binding sites in MOFs that would capture both CO₂ and water optimally as flue gases make their way out of smokestacks. The findings published in the premier science journal *Nature* show that the selected MOFs outperform some of the CO₂ removal materials currently on the market.

Marking an important milestone on the road toward reducing reliance on fossil fuels, Stylianou has also developed a new MOF for the efficient separation of biobutanol from the fermented broth of biomass, with the potential to serve as a renewable and sustainable fuel alternative in gasoline-powered engines. With the help of a College of Science SciRIS individual investigator award, Stylianou is developing MOFs to filter out chemical contaminants.

Catalyzing research to save lives



Scientists confronted the devastation of COVID-19 with a statewide public health project and an arsenal of research findings on a key protein in the viral genome.

At the forefront of prevalence testing

A first-of-its-kind coronavirus testing project called TRACE-COVID-19, or TRACE, launched in April 2020 under the leadership of College of Science researchers and public health experts. TRACE, which stands for Team-Based Rapid Assessment of Community-Level Coronavirus Epidemics, has been widely hailed as a game changer for adopting a novel approach early on in the pandemic that was different from other coronavirus testing strategies; Instead of capturing data on past infections, TRACE detects the current prevalence and spread of the SARS-CoV-2 virus in a community in real time, capturing valuable data on asymptomatic individuals. Jointly led by population biologist **Benjamin Dalziel** and College of Public Health epidemiologist **Jeffrey Bethel**, the project harnessed the research and technological strengths of OSU by combining community surveillance sampling, wastewater analysis, viral sequence data and mathematical models of SARS-CoV-2 prevalence developed by the team.

With a leadership team that includes College of Science Dean **Roy Haggerty**, Distinguished University Professor of Integrative Biology **Jane Lubchenco** and **Katherine McLaughlin**, assistant professor of statistics, the TRACE project has proven invaluable to communities across Oregon. Its community-level virus surveillance produced actionable knowledge about the prevalence of the virus and identified hotspots in the state as the pandemic was beginning to spread dangerously across the country. Since its launch, TRACE has carried out nearly 80,000 individual tests to check for the prevalence of the coronavirus within cities throughout the state and the OSU community.

The substantial achievements and impressive potential of the TRACE project were recognized with a \$2 million grant from the David and Lucile

Packard Foundation to create a national TRACE Center to expand the public health project to other states. TRACE programs are starting at two other major universities across the country, and project leaders hope to grow the network to include more university partners, focusing on minority-serving institutions. TRACE also received support of \$800K from PacificSource Health Plans for community testing. “While we are producing generalizable scientific knowledge in terms of epidemic modeling and refining field testing, TRACE’s primary goal is to mobilize the capacities of the land grant university to help the communities we serve,” said Dalziel.

Clearing pathways to new drugs

Biochemists at Oregon State have taken a key step toward the development of new drugs and vaccines for combating COVID-19 with a deep dive into one protein’s interactions with SARS-CoV-2 genetic material. Biochemist **Elisar Barbar** runs one of the few labs in the world that work on disordered proteins in viruses using Nuclear Magnetic Resonance Spectroscopy (NMR). Barbar’s team studies how one of the essential proteins encoded in the viral genome, the nucleocapsid N-protein, performs its essential functions in SARS-CoV-2 viral infection, transmission and control.

The team’s cutting-edge biophysical NMR studies of the N-protein helped them measure changes in its size and shape when bound to a fragment of the viral RNA genome. The bound protein/RNA complex creates a template for high levels of virus replication. The team advanced important discoveries of conditions under which the protein binds more strongly to a RNA segment and identified regions of the protein that are essential for RNA binding. This opens up avenues for anti-SARS-CoV-2 drugs that thwart the N-protein’s flexibility and disrupt any of those protein/RNA complexes that prove to be of special significance. “Our study helps us quantify how many copies of N are needed and how close they are to each other when they stick to the RNA,” said Barbar. An NSF EARly-concept Grant for Exploratory Research (EAGER Grant) supported this research.

Our community mobilized through TRACE, a massive group data collection project driven by science and our responsibility to keep our universities, neighborhoods and surrounding counties safe.

Hopeful solutions for a healthy ocean

Facing rapidly warming oceans, Oregon State marine science is making swift progress toward vital solutions that broaden our understanding of climate-driven changes and propose ways to conserve species health.

Capturing and storing atmospheric CO₂

An interdisciplinary investigation into the Earth's ocean ecosystem-aerosol-cloud system has revealed significant information about the variable effects of phytoplankton on excess carbon dioxide in the atmosphere. The spring phytoplankton bloom in the North Atlantic is probably the largest biological carbon sequestration mechanism on the planet each year, and the size of cells determines how fast that carbon sinks. A critical determinant of the planet's ecological health, these tiny plants float in the upper part of the ocean sucking up CO₂, the most abundant greenhouse gas in the atmosphere.

Conducting research for NASA's North Atlantic Aerosols and Marine Ecosystems Study, University Distinguished Professor **Steve Giovannoni** focuses on characterizing plankton ecosystem properties and their relationship with climate disturbances — particularly the reasons for an annual plankton bloom and the effects of the plankton ecosystem on marine aerosols and clouds that interact with water and carbon cycles. In a study of the winter phytoplankton bloom in the western North Atlantic, he found the area was dominated by nano or small cell phytoplankton, and that regional influences play a large role during the seasonal progression of blooms. His findings show a lower carbon export efficiency than the larger North Atlantic models allow for, and expose concerning limitations in popular carbon sequestration models.

The quest to save the sea star

The iconic sunflower sea star has been listed as critically endangered by the International Union for Conservation of Nature following a groundbreaking population study led by Oregon State University and The Nature Conservancy. Biology postdoctoral

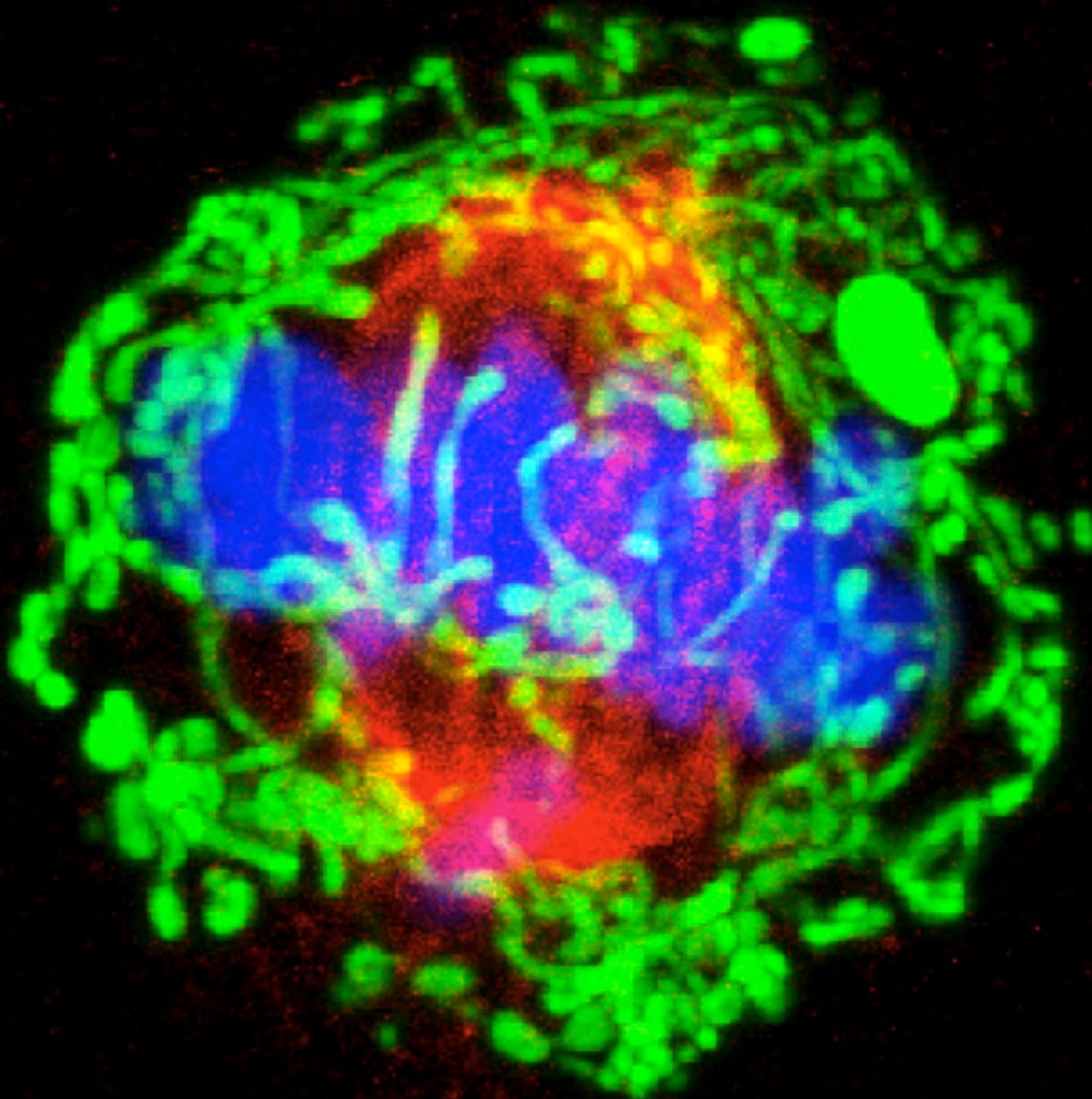
scholar **Sarah Gravem** was lead author on the study. Populations of the sunflower sea star suffered dramatic crashes because of a marine wildlife epidemic, referred to as sea star wasting syndrome, that began in 2013. "This listing is one step above extinction — and I don't think they're coming back without help like captive rearing and reintroduction and reducing direct harvest and accidental harvest," said Gravem. More than 60 institutions joined the population study on the sunflower sea star, known scientifically as *Pycnopodia helianthoides*, which plays an important role in maintaining kelp forests, and thus sustaining marine life, along the West Coast from Alaska to Baja, California.

Manifesting a 'Big Idea' to save species from climate change

Responding to a paucity of research on the influence of ecological disturbances on the microbiome, an interdisciplinary team of microbiologists, biochemists and computer scientists is studying how microbes influence their wildlife host's sensitivity and resilience to human-induced environmental changes. Led by microbiologist **Rebecca Vega Thurber**, the team will investigate microbiome transformations in three aquatic organisms: seagrass, corals and zebrafish. The organisms are affected by antibiotic exposure, warming waters and pathogen infection. The goal is to discover how microbiomes function in healthy and stressed hosts, potentially transforming microbiome research and innovation, particularly as it applies to health and natural resource management. "Because our work focuses on diverse host systems and disturbances that represent major categories of anthropogenic stress, we expect to develop foundational insights into how human activity impacts wildlife through their microbiomes," said the project scientists. The research project received a \$3M award in the NSF category of Understanding the Rules of Life, one of NSF's 10 Big Ideas, to advance pioneering research that serves the nation's future.

The sunflower sea star, *Pycnopodia helianthoides*, is as big as a trash bin lid with 20 arms. By preying on sea urchins, this giant invertebrate plays a key role in maintaining kelp forest ecosystems, hubs of marine life that support coastal economies and absorb millions of tons of carbon dioxide annually.

Discovery at the intersection of science and healthcare



New research approaches to disease and the complex integrated functions of the body are contributing profoundly to our knowledge of diagnosis, treatment and the underlying mechanisms of illness and health.

Insights into early cancer detection

OSU biomedical chemists are applying nanotechnologies to develop novel diagnostic methods to detect and treat diseases, including the highly aggressive triple-negative breast cancer. Chemist **Marilyn Mackiewicz**, whose research is supported by the College's Disease Mechanism and Prevention Fund, aims to improve current imaging technologies to detect breast cancer that will enable effective delivery of site-directed drugs to reduce the loss of life. Without more sensitive imaging with higher contrast to detect cancer early — particularly triple-negative breast cancer — the consequences can include delayed diagnosis and reduced rates of survival. Moreover, the traditional iodine-based contrast agents used in imaging are toxic, affect patients with compromised kidney function and are poorly responsive to variations in tissue density among women. To address the critical need for enhanced and nontoxic contrast agents (materials to improve pictures of the inside of the body) in medical imaging, Mackiewicz is working on developing biocompatible silver nanomaterials with a higher X-ray contrast to identify triple-negative breast cancer cells in very early stages of the disease.

Fast-tracking gene therapy to cure deafness

Biochemists have found a key new piece of the puzzle in the quest to use gene therapy to enable people born deaf to hear. Supported by the National Institutes of Health, scientists in **Colin Johnson's** lab have been working for years with the otoferlin protein, which encodes sound in the sensory hair cells in the inner ear. Mutations in otoferlin are linked to severe congenital hearing loss. In 2017, Johnson's team identified a truncated form of the otoferlin gene that can function in the encoding of sound for the deaf. The team recently discovered

that the shortened form also must include a part of the gene, called the transmembrane domain, to ensure the optimal functions of otoferlin in hearing impaired people. Without the transmembrane domain, the sensory hair cells in the inner ear were slow to mature and less neurotransmitter was released, affecting the encoding of sound. Their findings could lead to effective gene therapy treatments in the future for people who are deaf.

Detangling protein interactions for disease therapy

Protein molecules lie at the heart of many functions and processes crucial to life and health. Biophysicist **Afua Nyarko's** research is uncovering how specific proteins involved in regulating cell growth, memory and kidney function interact with one another to control the growth of tissues and influence the body's regulatory capabilities. Nyarko's lab is particularly interested in the hippo signalling pathway — so named because gene mutations can cause "hippopotamus-like" tissue overgrowth leading to cancerous tumors.

The protein complexes Nyarko studies play a crucial role in balancing cell growth and cell death, and are typically arranged in a complex, spaghetti-like structure. This class of proteins is known as intrinsically disordered proteins (IDPs) and comprises more than 30% of all proteins in the body. With a new \$820K four-year NSF grant, Nyarko hopes to discover how these IDPs choose between their many potential binding partners — an important component in regulating their many biological functions. When the interactions between biological protein molecules go awry, it can lead to various disease conditions, including cancer, chronic kidney disease and Alzheimer's. Nyarko's research integrates an array of highly specialized molecular biophysics and computational techniques to build a more complete understanding of the IDP interaction network. She hopes her work will guide the design of therapeutic agents to alter improper protein-protein interactions that give rise to diseases.

Triple-negative breast cancer makes up 10–15% of all cases, with higher prevalence among Black and Latinx people. Mackiewicz's research could improve the prognosis of patients with this difficult-to-treat subtype through earlier detection.

Unlocking discoveries in genetics



Rapid advances in genetics and genomic research are leading to vital solutions and new knowledge in the areas of biotechnology, human DNA genetics and evolutionary change driven by global warming.

New proteins to improve imaging technology

As the world's leading center for genetic code expansion (GCE) — a way to engineer new proteins for novel functions — the **Ryan Mehl** Lab is swiftly streamlining GCE technology for a wider range of applications in the field of protein labeling methods inside living cells. Having pioneered a methodology to attach a labeling reaction to proteins for therapeutic applications and sensors, the lab is using multiple federal grants totaling \$3M to take this genetic tool even further. Combining new imaging technology with high-speed and highly specific protein labeling rates, Mehl's research is making it possible to create modified proteins inside and outside of the living system. Mehl and his collaborators are developing a series of fluorogenic protein labeling tools that will “turn on” when they bind to DNA, thus enabling the study of protein function and interactions in its native environment with unprecedented levels of detail. The research will vastly improve imaging technology and shed new light on protein functions that have remained obscure.

Illuminating human physiology through fungal genetics

Research of fungal genetics and genomics at OSU is leading to insights that address fundamental questions in human biology and health. Supported by both NIH and NSF, biochemist **Michael Freitag** leads a research program on chromatin-mediated gene silencing using fungi as convenient model systems. Chromatin is the building block of DNA, compactly storing DNA and protein in the nucleus of our cells. Normal development relies on regulated gene expression, which in many organisms is achieved by protein complexes that alter the structure of chromatin to silence or activate genes. Freitag's research focuses on mechanisms of chromatin-based gene silencing

by the Polycomb repressive complex, which is responsible for establishing and maintaining the repressive states of thousands of developmental genes. However, its role in the development of an organism is not well understood. Studies undertaken by the Freitag Lab on the influence of chromatin and chromosome dynamics on gene activity, expression and regulation will substantially contribute to public health and societal benefits by generating key knowledge on fungal infection factors and cancer cells, as well as fungi-based industrial biotechnology products such as biofuels and enzymes.

Genetic fitness in an era of global warming

Biologist **Felipe Barreto** combines cutting-edge, high-throughput DNA sequencing technologies, genomic and bioinformatic analysis, and organism-scale experiments to provide insights into fundamental evolutionary questions and hypotheses. Focusing on how genomes in marine invertebrates respond to thermal stress and hypoxia — two effects of global climate change — the Barreto Lab has made pioneering discoveries about the coevolution and coadaptation of mitochondrial and nuclear genes. By studying the model organism, the intertidal copepod *Tigriopus californicus*, Barreto and his graduate students have investigated the effects of interbreeding between divergent gene pools upon interacting nuclear and mitochondrial genomes in marine species. They found that high levels of adaptive fitness to changing environmental conditions are achieved when nuclear and mitochondrial genes are inherited from the same parental populations because these genes coevolved to function in harmony. Their research has led to a greater understanding of the genomic basis of adaptation to a changing environment and produced new insights on key evolutionary processes of reproductive isolation and hybrid breakdown or reproductive failure. Barreto, an OSU Inclusive Excellence Fellow, created a plan in 2020 to improve representation of underrepresented scholars in evolution and marine biology.

Copepod species *Tigriopus californicus* inhabits the intertidal zone, where it must quickly adapt to changes in temperature, salinity and oxygen levels that vary widely between tides. Photo by Waldo Nell.

Enhancing the way the world uses data

From deeply understanding relationships among mathematical forms to modeling global crop epidemics and HIV prevalence, OSU mathematicians and statisticians are opening up new research avenues.

'Rich and intricate discoveries' in mathematics

Oregon State mathematician **Holly Swisher** is investigating some of the field's most fundamental questions pertaining to modular and automorphic forms, which play a crucial role in various branches of mathematics and physics. Swisher, who specializes in number theory, is investigating combinatorial functions as a testing ground for the theory of modular forms. Determining a general theory for the modularity of combinatorial generating functions would provide a significant missing piece of the puzzle. She notes, "One of the beautiful things about number theory is that seemingly simple questions, when deeply investigated, can blossom into rich and intricate discoveries."

Swisher is a member of one of the most ambitious mathematical collaborations in recent times. She was chosen to join a team of more than 70 mathematicians from 12 countries to create a massive mathematical database called the L-functions and Modular Forms Database, which catalogs objects of central importance in number theory and maps out the intricate connections between them.

Clean seeds to help feed our planet

In recent years, Oregon State has gone from strength to strength as a center of excellence for research and education in applied mathematics and mathematical biology. Mathematician **Vrushali Bokil** is extending the applications of mathematical modeling to plant diseases that are having devastating effects on agricultural production worldwide, resulting in drastic yield reductions in cotton, soybean, tomato and cassava crops. Bokil focuses on diseases like maize lethal necrosis, an emerging disease in Kenya and other parts of Africa that is caused by co-infecting

viruses and spread by insects called thrips. Her team uses stochastic models and optimal control theory to understand the mechanisms that drive patterns of co-infection in plant populations and effective techniques for controlling the spread of disease in crops and native grasslands. An aspect of Bokil's research considers the optimal usage of pathogen-free seeds ("clean seeds") as a method to control plant diseases in developing countries. Utilizing mathematical principles, she analyzes epidemiological and economic impacts of using clean seeds with respect to the control of maize lethal necrosis in East Africa. A transatlantic research project in the U.S. and France, this was supported by the FACE Foundation through the Thomas Jefferson Fund and the College's ScIRIS individual investigator award.

Putting data to use in the cause of urban communities

Teaming up with the Centers for Disease Control and Prevention (CDC), statistician **Katherine McLaughlin** investigates new statistical methodologies to estimate the number of people who inject drugs in metropolitan areas. Her work, which received the College's Disease Mechanism and Prevention Fund award in 2019, refines and improves current methods to improve population-level demographic, behavioral, disease prevalence and population size estimations. This will aid the CDC in its efforts to contain or slow the rate of HIV in metropolitan areas across the U.S. In her statistical research, McLaughlin has developed new data sampling designs and computational models to estimate characteristics of at-risk "hidden" populations around the world. These populations comprise female sex workers, men who have sex with men, victims of sexual violence, people who inject drugs, victims of trafficking and migrants — some of the groups most vulnerable to infectious diseases, substance misuse and behavioral health issues. She has worked with data from at-risk populations across the globe, including Morocco, the Democratic Republic of the Congo, Italy, Armenia and the United States in collaboration with the CDC.

Plant diseases pose a serious threat to global food security. Mathematical models developed by Vrushali Bokil map out crop disease management strategies for farmers in Kenya.

Leadership on the world stage

As national leadership moves to restore science to its rightful place, OSU scientists are engaged in efforts to rebuild bridges between science and policy. They serve in key roles to influence solutions for our rapidly changing planet and to open more pathways for research and education in ocean science.

A strong voice in the White House

Renowned marine ecologist **Jane Lubchenco** is tackling some of the world's most urgent problems as deputy director for Climate and the Environment in the White House Office of Science and Technology Policy.

Previously the director of National Oceanic and Atmospheric Administration (NOAA) during the Obama administration, in February 2021 she began a collaboration with the Biden administration to “craft evidence-based solutions to environmental challenges that will produce durable outcomes for people, the nation and the world.”

Lubchenco, OSU's Wayne and Gladys Valley Professor of Marine Biology, has a long and decorated history as not only a high-caliber researcher, but as an influential advocate for science. Named one of the “most highly cited” ecologists in the world, she won the 2018 Vannevar Bush Award for her exceptional contributions to science, technology and public policy. Serving from 2014 to 2016 as the first-ever U.S. envoy for the ocean, she worked with countries around the world to develop new ocean practices to improve sustainability and bolster long-term economic growth. In her new position, she hopes to reinforce a new narrative that sees the ocean not as a victim, but as a solution.

Taking swift action for sustainable ocean management

In an inspiring example of science-guided policy and action, leaders of 14 major maritime nations have committed to achieve 100% sustainable ocean management of their national waters by

2025, acting on recommendations of a group of global experts co-chaired by Jane Lubchenco. The High Level Panel for a Sustainable Ocean Economy, or Ocean Panel, represents 40% of coastlines and 20% of fisheries worldwide. Lubchenco served as Expert Group co-chair, coordinating experts from 48 countries, including OSU scientists **Kirsten Grorud-Colvert** and **Jenna Sullivan**, in a collaboration that resulted in 19 peer-reviewed papers and an Ocean Solutions Report to the panel.

Sustainable ocean management, they found, would allow production of up to six times more food from the ocean, generating up to 40 times more renewable energy and lifting millions of people from poverty. “It is exciting and gratifying to see presidents and prime ministers ask for, listen to and follow scientific guidance,” said Lubchenco.

Leading OSU's NOAA Center for a new era of ocean science

After a competitive evaluation, NOAA chose Oregon State to host its new Cooperative Institute for Marine Ecosystem and Resource Studies (CIMERS). Directed by Integrative Biology Professor **Francis Chan**, the \$37M institute will focus on four key themes: conservation, protection and restoration of marine resources; marine ecosystems; ocean acoustics; and ocean coastal and seafloor processes.

CIMERS replaces a previous OSU institute known as the Cooperative Institute for Marine Resource Studies. In its new form, Chan believes the institute will “better reflect the breadth of the ocean science we need to sustain a productive ocean ecosystem in the face of climate change.” The institute will support marine research around the world, with an emphasis on the Northwestern Pacific Ocean, and will serve as a training pipeline for future NOAA scientists. It will also center efforts to increase diversity, equity and inclusion in marine science. “We have too many challenges and opportunities ahead in ocean science to be leaving people behind,” Chan said.

Three billion people rely on the ocean for their livelihoods, the vast majority in developing countries. Sustainable management could produce up to six times more food from our oceans, turning the tide on global hunger and poverty.



1.



2.



3.



Our resilient, determined students forge ahead.

Boosting scientific research and discovery to solve real-world problems hinges on training and mentoring future scientists. For more than 150 years, the College of Science has been doing just that — providing a hands-on, interactive science education taught by faculty who inspire curiosity, creativity and the confidence to create change.

For half of our undergraduate students, that science training includes working on research projects guided by faculty mentors. During 2019–2021, programs like the Summer Undergraduate Research Experience, or SURE Science, among other student experiences, provided \$405K in scholarships to 80 students to participate in substantive lab and field-based research experiences. Additionally, College of Science academic and need-based scholarships enabled many students to focus on academics and participate in immersive research opportunities that advance their growth and development.

Our mission did not change when the COVID-19 pandemic shifted the university to a remote-learning environment. Science faculty, staff and students found ways to adapt and innovate to ensure ongoing enriching educational experiences. Some labs figured out how to maintain in-person instruction, installing barriers between stations, Zooming in lab partners and increasing the level of personal protective equipment. Others used the online learning environment to explore new, out-of-the-box ways of learning.

Despite the challenges presented over the past two years, our students achieved remarkable successes. They secured prestigious internships, received nationally competitive awards and landed exciting jobs. We celebrate their determination to persevere under difficult circumstances. They truly demonstrate the tenacity, perseverance and grit to become science leaders of the future.

Our Students

Planting the seeds for future success

Left 1: Ph.D. candidate Ian Colliard’s research under May Nyman seeks to improve actinide applications like radiotherapy and nuclear waste management. **Left 2:** Luis Garcia-Lamas served as OSU’s SACNAS vice president to increase diversity in his field while also participating in statistics research.

Left 3: Devonte Casey’s dedication to conservation stems from his Siletz roots and has been strengthened by both a tribal internship and his classes at OSU. **Above:** Maja Engler discovered a passion for biomedical research at OSU that she will take abroad to Germany as a Fulbright scholar.

Our competitive edge: undergraduate research

In the College of Science, students learn to think like scientists by integrating theory and practice. The College offers students a number of resources and opportunities to broaden their scientific learning and to apply what they learn in the classroom early in their undergraduate careers. With the Summer Undergraduate Research Experience (SURE) Program, students take charge — developing, pursuing and implementing research projects alongside faculty mentors.

SURE Science awards, made possible by generous donations from alumni and friends of the College, allow students to complete 11 weeks of paid full-time research in the summer for a maximum scholarship amount of \$5,060. Fifty percent of College of Science undergraduates participate in research projects addressing real-world problems that range from medical research to astrophysics computational modeling. This markedly high level of engagement contributes to our solid retention rates and produces graduates who shine in graduate and professional school as well as industry.

Conducting research helps students learn to make science their own and develop into creative, tenacious problem-solvers. Honors chemistry and molecular biology major **Grace Scuderi** said her SURE scholarship added momentum to her path: “It’s given me the confidence to continue on with research, in addition to empowering me to work hard.”

The SURE program enables undergraduates to interact with scientists beyond the classroom. Biochemistry major **Gretchen Fujimura** said that OSU’s many astounding STEM role models, especially female scientists, inspire her. Fujimura is pursuing research on respiratory viruses and is looking forward to working alongside Elisar Barbar, head of the Department of Biochemistry and Biophysics. “She is inspiring because she is not only a successful woman in STEM, but she is also in a leadership position.”

The program also helps students gain the experience they need for their next steps after

college. “The SURE scholarship is a stepping stone to my future,” said mathematics major **Luis Garcia-Lamas**, whose research project was “fundamental to my graduate school applications.”

Since its inception in 2016, SURE Science has helped motivated students access research opportunities and overcome significant barriers. “This scholarship means the world to me,” said integrative biology major **Samantha Gregory**. “I have several chronic illnesses and accessing scholarship programs where I can control my physical activity has been a challenge. I am finally able to start doing the kind of research I want to do for the rest of my life!”

Ambitious high school students are also drawn to OSU’s numerous opportunities to participate in meaningful research experiences. That was the reason chemistry major **Alice Lulich** chose Oregon State. She now conducts cutting-edge research in inorganic chemistry. “The structures I make in the lab have never been made before. It’s exciting to know that I am at the forefront of science!” said Lulich.

In 2020, SURE scholars persevered in their research despite limited access to laboratory space during the COVID-19 pandemic. Some completed their work in-person under Oregon Health Authority safety guidelines, while others found creative ways to complete their projects remotely. The research timeframe was also extended to the following May.

For **Rohal Kakepoto** (Physics ’21), the SURE scholarship allowed him to complete his senior thesis project during the pandemic while juggling family responsibilities and a full-time job. When facilities were closed, he quickly recalibrated and found a way to pivot his research question away from lab work and toward physics theory with the support of his advisor, Janet Tate, Distinguished Professor of Physics. Kakepoto’s undergraduate research and learning experiences influenced his career path, helping him land a job as an engineer at Hewlett Packard.

SURE scholar Luis Garcias-Lamas applies mathematics and statistics to investigate how aspects of corn genotype, such as mutations, affect its phenotype, or physical attributes.

Science pivots to a virtual landscape



While the last year was marked by unprecedented challenges, it also brought examples of adaptation and innovation, engagement and outreach – all guided by our mission to provide educational experiences that transform lives. While it is difficult to virtually replicate all aspects of in-person classrooms and hands-on learning, we are so proud of the ways College of Science leaders and faculty delivered high-quality science instruction and enabled our students to persist and succeed in a virtual-learning environment.

Best-in-class online science courses

When science classes transitioned to remote-learning formats in spring 2020, Oregon State University's top-ranked Ecampus provided our students with additional flexibility. For years, more than 100 College of Science courses and labs have been available to students online — all developed and taught by the same outstanding professors who teach our on-campus courses, including Oregon State's most admired professors (say, for example, Chemistry Senior Instructor **Daniel Myles**). Having online technologies for remote and blended educational models already in place created greater flexibility with online courses that met a range of student needs.

Teaching labs 2.0

Lab training is a core component of science education, which is why our science labs adapted quickly last year when classes moved online. Biochemistry Molecular Techniques and Experimental Chemistry were among the very few labs still offered in-person during the transition to remote learning, with instructors taking extraordinary measures to ensure the safety of their students. For instance, Biochemistry and Biophysics Senior Instructor **Kari Van Zee** personally constructed and installed individual, customized Plexiglass barriers between workstations. Her setup allowed students to alternate performing in-person labwork and following along with their lab partner over Zoom, while still maintaining a safe distance from other students.

Students and faculty brought a resilient, creative spirit and a can-do attitude to the challenges of pandemic-era learning, proving once again that nothing can stop a group of determined scientists.

Other departments chose a different approach — rather than bringing the students to the lab, some instructors developed creative ways to bring labs to students. Microbiology Instructor Allison Evans employed strategies including having students make their own Winogradsky columns, cook their own media using gelatin and record videos demonstrating proper aseptic technique with paper Bunsen burners and plates.

Peer-to-peer learning: coaches, advocates and role models

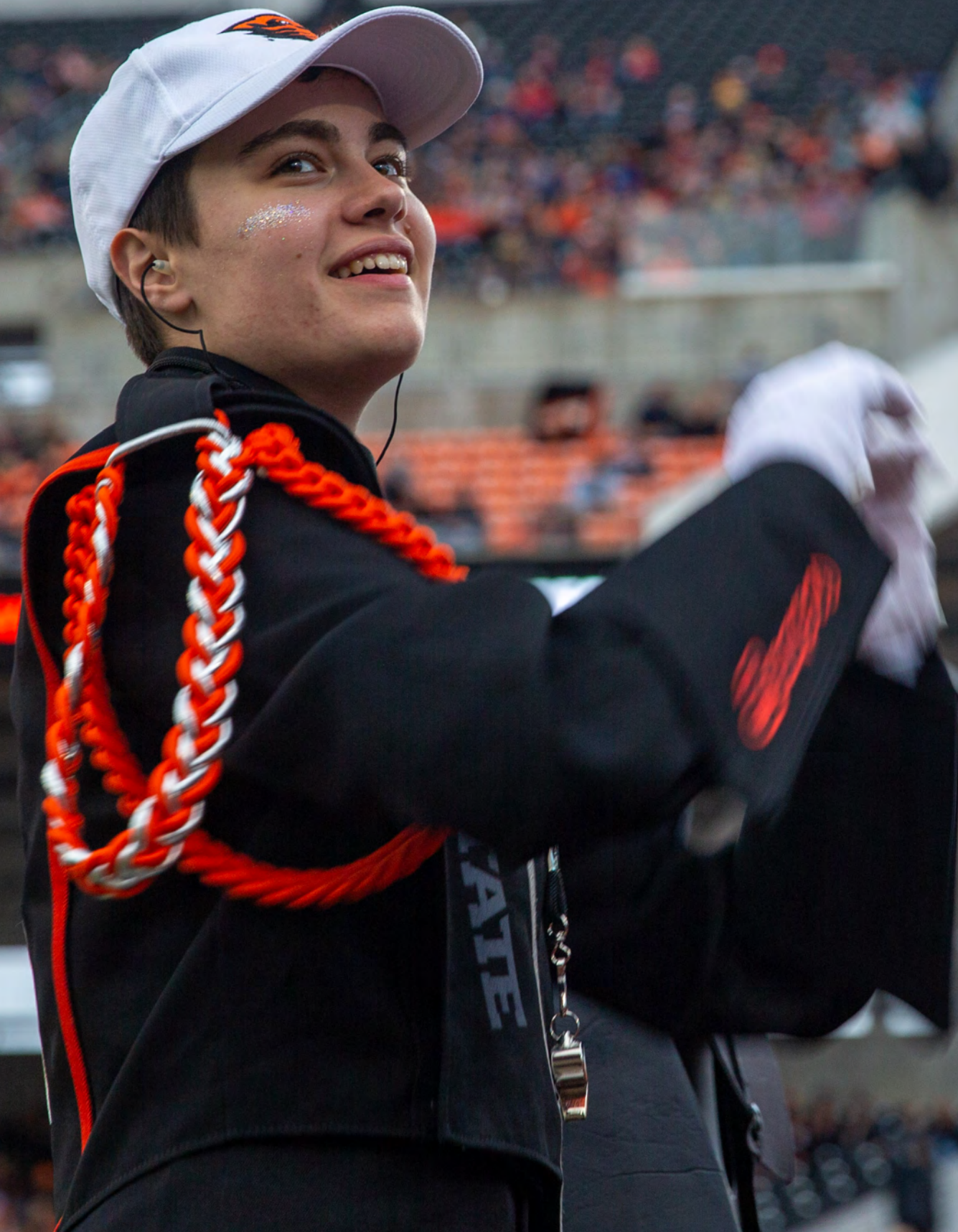
We are a college that continually works to foster success and clear barriers for every student. While it is difficult for a professor to connect individually with every student in an in-person lecture hall, Zoom lectures added a new dimension of challenges. In the process of adapting to a remote environment, learning assistants (LAs) proved invaluable. “In physics, the LAs are probably the most important members of the instructional staff,” said Instructor **KC Walsh**.

In fall 2020, 147 LAs supported nearly 7,000 students, helping answer questions during lectures, assist with homework, and develop and test new curriculum. Outside of the classroom, tutoring centers provided virtual help desks and transitioned their learning communities to an online setting. Within two weeks of formation, the virtual physics tutoring center received nearly 1,600 queries.

As we move closer to a post-pandemic world, we eagerly await the return to in-person classes while recognizing the uncertainty that lies ahead. While the shutdown may have forced some compromises, it resulted in a rapidly gained proficiency in new technology and teaching methods that could open up learning opportunities for a broader range of learners.

Over the past year, flexibility and compassion have been very important. We are proud that our students and faculty have consistently shown the spirit and perseverance to keep going.

Our undergraduates reach higher



Michael Kupperman (Honors Biochemistry and Molecular Biology and Honors Mathematics, '20) completed a prestigious Science Undergraduate Laboratory Internship at the Los Alamos National Laboratory in Los Alamos, New Mexico, one of the largest science and technology institutions in the world. Kupperman was also an Accelerated Master's Platform student, a member of the University Honors College, and an OSU presidential scholar. His research interests lie at the interface of mathematics and biology, focusing on probability theory and dynamics.

Isabella Karabinas (Honors Biochemistry and Molecular Biology, Psychology '20) received a 2020 Fulbright Award to study neuroscience at the Universidad Complutense de Madrid in Madrid, Spain. She is also a recipient of the prestigious Goldwater Scholarship and Merrill Family Foundation scholarship at OSU. Karabinas said her research experiences have influenced her decision to pursue M.D. and Ph.D. degrees to become a practicing neurologist or psychiatrist.

Mahtab Singh Brar (Honors Biology '20) started medical school at OHSU, the next step in his family's longstanding commitment to doing good. "We believe in the concept of seva or selfless service," he explained of his Sikh heritage. Alongside his sister, Brar has organized free medical screenings for low-income, uninsured people and Sikhs. He also served as a Hindi translator during an Honors College community service trip to Nepal. While at Oregon State, Brar received awards including the Finley Academic Excellence Scholarship, a Vernier Mentoring and Diversity scholarship and a Merrill Family Foundation Scholarship.

Devonte Casey (Zoology '21) was inspired by the synergy between his academic pursuits and his identity as a Native American. While at Oregon State, his biological research internship with the Confederated Tribes of Siletz Indians Department of Natural Resources and his coursework in marine biology and ecology combined to ignite his interest in ecological restoration. Casey, a Vernier Mentoring and Diversity scholarship recipient, was

also co-president of his tribe's youth council. "I can say with 100 percent certainty that the reason I am studying zoology, specifically marine science, is because of my coastal traditions and my coastal tribe," he remarked.

Biochemistry and molecular biology Honors student **Maja Engler** and biology alumna **Emily Newton** ('12) received 2021 Fulbright Awards. The grant will take Engler to Ulm University in Germany, where she will research medical applications of the biochemistry of hibernation in dwarf hamsters. Hibernation processes provide insight on how to prolong the storage time of human organs for transplantation. Engler's goal is to work for a space agency to carry out research on how to put astronauts into a hibernation-like state for safer and more efficient space travel. She also won the Cripps Undergraduate Research Experience Fellowship, the Oregon Space Grant Consortium Undergraduate Scholarship and the OSU Retirement Association Scholarship.

Newton's Fulbright award will enable her to research how climate change causes translocation of invasive marine invertebrates in Antarctic waters. She will collaborate with scientists from the University of Otago in New Zealand.

Linus Unitan (Honors Chemistry '21) said his experiences at Oregon State will make him a strong candidate when he applies for medical school. Conducting OSU's marching band as a drum major enhanced his leadership skills, while presenting a paper he co-authored on analytical and bioanalytical chemistry at multiple conferences boosted his confidence. He credits his lab mentor, Chemistry Professor Vince Remcho, with helping him apply his love for chemistry to projects that will positively impact human lives through medicine. Unitan's patent-pending project in the lab focused on using microfluidic blood separators to isolate plasma from as little as a pinprick volume of blood to be studied separately. While at OSU, Unitan received the George and Marthel Porter Premedical Scholarship, Keith McKennon Chemistry Scholarship, and Carroll and Gerry DeKock Scholarship.

"There's an expression in marching band that we often use: 'Do your beaver best.' It means to try your hardest and do whatever you can, whatever the circumstances." —Linus Unitan

Graduate students who go beyond



Microbiology Ph.D. student **Corbin Schuster** works with Professor of Microbiology Michael Kent to uncover the effects of common diseases in zebrafish and develop methods to prevent or control them. His research is supported by the National Institutes of Health program Research Supplements to Promote Diversity in Health-Related Research. As a member of the Yakama Nation, Schuster is interested in the study of human diseases that have a higher incidence among Native peoples, as well as diseases of salmon, which are central to the food, culture and religion of the Yakama people.

Heather Masson-Forsythe, a Ph.D. candidate in the Department of Biochemistry and Biophysics, won the 13th annual Dance Your Ph.D. contest organized by *Science Magazine* in 2021. Masson-Forsythe used multiple styles of dance in her video to mimic biochemical structure and communicate her research thesis, which is centered around the nucleocapsid protein of coronavirus SARS-CoV-2. Masson-Forsythe is part of Elisar Barbar's lab group, and her COVID-19 research is funded by the National Science Foundation through its Division of Molecular and Cellular Biosciences.

Kristofer Bauer and **Cheyenne Jarman**, both first-year doctoral students in the Department of Integrative Biology, received NSF Graduate Research Fellowships to support their research in the fields of marine science, evolution and ecosystem management. Bauer is investigating how marine invertebrates adapt to climate change. He graduated with a degree in integrative biology after gaining research experience in the marine ecology centered Menge-Lubchenco Lab. As an undergrad, Bauer received the Alexei Lubchenco Menge Fellowship to support his ecological field research on invertebrate population dynamics in rocky intertidal habitats.

First-generation college graduate **Cheyenne Jarman's** research in marine biologist Mark Novak's lab examines predator-prey behavioral interactions

Heather Masson-Forsythe (left, with wife Margeaux) has excelled as a leader and science communicator, serving as cohost of 88.7 KBVR-FM's radio show and the podcast Inspiration Dissemination. She also helped organize the Biochemistry & Biophysics Diversity, Equity & Inclusion work group, leading events designed to create a more inclusive environment. Photo by Sienna Plus Josh Photography.

to strengthen conservation and the management of ecosystems. Jarman graduated with high honors in marine biology and computer science from University of California-Santa Cruz where she was a STEM Diversity Fellow and conducted research in a coastal ecosystems lab.

Chemistry Ph.D. candidate **Ian Colliard** was selected for the U.S. Department of Energy's Office of Science Graduate Student Research program, which prepares graduate students for STEM careers deemed critically important to the department's Office of Science mission. As a member of Professor May Nyman's lab, Colliard used the DOE research opportunity to study nuclear chemistry and radiochemical separations at the Lawrence Livermore National Laboratory.

Mathematics graduate student **Ruby (Ali) Chick** (M.S. '20) was on a team with other graduate students from Environmental Sciences and Fisheries and Wildlife Sciences that collaboratively analyzed the environmental impact of microplastics. The multidisciplinary team is a part of the NSF Research Traineeship program, which has established a new paradigm of cross-disciplinary STEM graduate student education on campus. The program encourages the development of transformative models for STEM graduate education training in high-priority interdisciplinary research areas.

Isabel Rodríguez (M.S. Physics '21) received the 2021 Harriet "Hattie" Redmond Award. This award celebrates a member of the OSU community who works as an agent of change in service of racial justice and gender equity. This Breaking Barriers award is sponsored by the President's Commission on the Status of Women, the Office of Institutional Diversity, the Office of the Provost and OSU Athletics. As a Black woman in astrophysics, Isabel is a brilliant example of a scientist who works tirelessly and effectively for change in service of racial justice and gender equity.



Confronting systemic inequality in science

The year 2020 will be remembered for its outsized impact on history. The rise of the Black Lives Matter movement engendered much-needed political and social transformations, not least on U.S. university campuses. As the College of Science, we have made advances over the years to improve the climate for diversity, equity and inclusive excellence in our academic programs, yet far more remains to be done.

The BLM movement has made it possible to push forward for change and deeper reforms at a more accelerated clip in all institutions of society. We welcome this historic moment and opportunity to do our part to root out the problem of systemic inequality in research and education in our College and in the larger scientific community.

Town hall paves the way for action

Change begins with listening, self-education and dialogue. A virtual town hall listening session in October 2020 centered the experiences of Black science students in the College.

Moderated by Black faculty, administrators and students across Oregon State, the session was attended by more than 300 people. Panelists and participants advocated for the adoption and enforcement of cultural and structural changes in the College that create equity, not just equality. Panelists and Black students who responded to a survey overwhelmingly urged the College to “hire more professors and staff that look like us.”

Black students in the College have lower retention and graduation rates than students who are not historically underrepresented. “I’d like to acknowledge the failings that we’ve had in the College and pledge to do better,” said Roy Haggerty, dean of the College of Science.

The town hall event laid the groundwork for the development of a diversity action plan to ensure the College becomes a more inclusive and equitable learning environment for all students.

The impact of George Floyd’s murder and the subsequent growth of Black Lives Matter has catalyzed justice movements internationally. (Photograph by TrevorWK in London, UK).

A more equitable and inclusive future

The College’s Diversity Action Plan, “2021-2024: Embedding Equity, Access and Inclusion,” aims to improve outcomes for underrepresented students, faculty and staff. The plan, which will evolve based on evidence, results and ongoing input, will be our guide to increasing progress in the coming years. Encompassing equitable hiring, an inclusive climate and innovative access to learning and research, the plan outlines key strategic goals aligned with specific actions and accountability structures to achieve greater diversity and equity in all units of the College. The first and most important action will be to hire a Program Director for Equity, Access and Inclusion (EAI), which will help embed values and actions supportive of EAI in our classrooms and institutions. Shaped by listening sessions, surveys and dialogues with faculty, staff and students, the plan capitalizes on the core strengths of the College: An equity-minded community of students and scholars, a passion for scientific progress and a collective determination to defeat the barriers of inequality in science.

The five strategic goals include:

Goal 1: Embed, integrate and advance inclusive excellence within all aspects of the College.

Goal 2: Establish holistic, inclusive and equitable hiring, recruitment and retention practices.

Goal 3: Create a welcoming college climate to support a sense of belonging and equitable learning and training experiences.

Goal 4: Provide innovative, inclusive, accessible and equitable access to learning and research experiences that incorporate global experiences.

Goal 5: Communicate accomplishments reflecting our commitments to inclusion and mutual respect of all members while enhancing visibility of minoritized communities.

Read the report and watch for measurable progress at science.oregonstate.edu/diversity-plan.



1.



2.



3.



Our impact reaches across Oregon and beyond.

Outreach ensures the work we do, the new ideas we inspire and the expertise we foster impact people in Oregon and beyond. In many ways, our outreach looked different in the midst of the pandemic. After March 2020, we adapted to a revised way of connecting with our communities. Instead of large, in-person gatherings, we gathered for Zoom lectures and online conferences, allowing more people to attend than before. In a certain sense, the pandemic flattened the world, broadening access to the impacts of our powerful scientific community.

One of our greatest connections with the community over the past two years was through the Team-based Rapid Assessment of Community-level Coronavirus Epidemics, or TRACE, project, a first-of-its-kind effort to test the prevalence of the COVID-19 virus in an entire community

through door-to-door sampling in representative sets of neighborhoods. What started in Corvallis quickly spread to other communities across the state, then received funding to go national — a testament to the College’s vital role in making our community healthier.

Outreach over the past two years has also included looking inward, examining areas for growth and improvement. As the Black Lives Matter movement gained momentum after the murder of George Floyd, the College held a virtual town hall to amplify the experience of Black students at OSU. This led to our Diversity Action Plan, “Embedding Equity, Access and Inclusion,” that launched in June 2021. The plan aims to provide equitable pathways to success and improve outcomes for underrepresented minority students.

Our Outreach

Science worth spreading

Left 1: Alumna Briony Horgan returned to campus to present an inspirational seminar that detailed her part in the Perseverance Rover mission. **Left 2:** Gilfillan Lecturer Michael Blouin’s timely talk “What Darwin couldn’t imagine” brought our community together to learn how evolutionary genetics

connects with other fields like human health. **Left 3:** A College-wide effort helped provide much-needed supplies to the OSU community and healthcare workers. **Above:** Globally renowned in the field of fungal biology, molecular geneticist Michael Freitag will present the next Gilfillan Lecture in 2022.

Outreach and service during a pandemic



Providing care to communities in need

In April 2020, a dangerous shortage of accurate testing was addressed by the large-scale Team-based Rapid Assessment of Community-level Coronavirus Epidemics project, or **TRACE-COVID-19**. (See p. 14 to learn more about this project). By implementing new testing strategies and providing timely information that enabled public health officials, individuals and the university to curb the spread of the coronavirus, Oregon State scientists were leaders in outreach and community service at a crucial time.

TRACE Community field workers went door-to-door in 30 neighborhoods in Corvallis collecting around 700 samples on each of several weekends, as well as analyzing community wastewater.

As fall and winter holidays arrived, TRACE broadened its scope to provide free rapid-result testing for all OSU students and employees. Since public testing was difficult to access at that time without symptoms of infection, this service brought a measure of comfort and security to the Corvallis community.

TRACE later extended its collection services to Bend, Newport, Hermiston, Eugene and Redmond, and met with widespread gratitude on all fronts. “We are excited to participate in Oregon State University’s TRACE Community project,” said Redmond Mayor George Endicott. “As an OSU alumna, I am proud to see the innovative work being done here in my hometown.”

In Eugene, TRACE collaborated with University of Oregon, reflecting “our joint commitment to serving Oregonians,” said Dean Roy Haggerty, adding that “the fact that we are going door-to-door together symbolizes that we are teaming up to serve the community of Eugene.”

TRACE’s dedicated team made an impression across the region, with the Oregon Health

Instead of feeling powerless at home, brave volunteers took proactive steps to fight back against fear, uncertainty and the spread of COVID-19. Even in the midst of a global crisis, they went door-to-door conducting tests, building a safer community from the ground up.

Authority calling it a “key partner” in the state’s COVID-19 response and contributing \$1.1M. PacificSource Health Plans contributed \$800K to community testing.

Indeed, the project was so effective in uniting public health with community service that it also inspired a \$2.8M grant from the David and Lucile Packard Foundation. Chad English, science program officer for the Packard Foundation, commented that TRACE has “proven invaluable to communities in Oregon.”

Going all in to assist frontline workers

The **OSU Chemistry Store** became a vital player in providing essential supplies to the university community and beyond when consumer panic led to a national shortage of hand and surface sanitizers. Store manager **Rusty Root** and storekeeper **Sierra Hansen** became heroes to the community as they rushed to find creative solutions to meet the growing need, which included producing sanitizer in-house. According to Hansen, by October of 2020, they had produced nearly 2,000 gallons of surface sanitizer and 733 gallons of hand sanitizer — the equivalent to filling 64 standard-size bathtubs. “It is rewarding to see first-hand how much of an impact the ChemStores has had for OSU,” said Hansen. “It is humbling to be a part of what has held this campus together through these stressful times.”

In response to a university-wide **PPE drive** initiated by OSU Provost Ed Feser, College of Science faculty dug into their own laboratory stockpiles to contribute to the university’s donation of nearly 200,000 pairs of gloves and more than 8,000 face masks for Oregon healthcare workers. “We are happy to give all we can to the folks on the front lines of this crisis,” said Devon Quick, senior instructor of integrative biology. “They make incredible sacrifices to keep our community safe and deserve whatever they need to do their job with confidence.”



Enlightening ideas: Distinguished lectures

illuminating a life less seen

Michael Blouin presented the 2020 F.A. Gilfillan Memorial Lecture in April 2021. The virtual talk explored Blouin's recent work in health, disease and conservation across species. An evolutionary and population geneticist, Blouin applies genetics research to answer questions in conservation biology and human health. He has generated considerable press attention for his work on salmon conservation in the Pacific Northwest and on parasitic flatworms that cause schistosomiasis, a disease that affects 250 million people worldwide.

Professor of biochemistry and biophysics

Michael Freitag received the 2021 F.A. Gilfillan Award for Distinguished Scholarship in Science. A renowned molecular geneticist worldwide, Freitag researches how genes are regulated by DNA or protein modifications, and as part of that work has found a way to unlock the ability of fungi to produce new molecules that could be medically important. His research has led to groundbreaking discoveries on fungal epigenetics and chromosome structure. He will present the Gilfillan Memorial Lecture on his research in 2022.

Searching for life beyond earth

The physics department hosted alumna **Briony Horgan** ('05 Physics) as part of its Colloquium virtual speaker series April 5, 2021, for a lecture titled "The Perseverance Rover: First Results from Mars and Next Steps in the Search for Life Beyond Earth." Horgan is an associate professor in the Department of Earth, Atmospheric and Planetary Sciences at Purdue University. She is also a member of the NASA Mars Perseverance rover team that helped identify the Jezero Crater as the ideal landing and exploration site for the mission. The rover is searching for signs of ancient microbial life and selecting samples for eventual return to Earth.

Ibram X. Kendi is a #1 New York Times bestselling author and the youngest ever winner of the National Book Award for Nonfiction. He holds an endowed professorship at Boston University, a distinction shared only by Nobel Peace Prize laureate Elie Wiesel. In 2020, *Time* magazine named him one of the 100 most influential people in the world. A foremost scholar on antiracism, Kendi empowers leaders in higher education to think deeply and transform social systems. Photo by Stephen Voss.

Enlightening insight into hyenas

The Department of Integrative Biology and the College of Science presented the 2021 Robert M. Storm Distinguished Lecture in May 2021. **Kay Holekamp**, University Distinguished Professor of integrative biology at Michigan State University gave the lecture, "Selective Forces Shaping the Evolution of Intelligence." Holekamp is recognized as one of the world's leading behavioral ecologists. Her long-running study of spotted hyenas in Africa has acquired more than 30 years of data, covering 10 generations of hyenas.

Centering diverse voices in science

The College hosted a virtual town hall listening session in October 2020 to center the experiences of Black science students in the College community. Oregon State's Chief Diversity Officer, **Charlene Alexander**, and Assistant Director of Black Student Access and Success **Dorian Smith** moderated the event. Panelists, including Biochemistry and Biophysics Professor **Afua Nyarko**, shared the history of ongoing protests and struggles at OSU, stressing the challenges Black students face in science. They advocated for adoption and enforcement of cultural and structural changes in the College that create equity, not just equality. The town hall laid groundwork for the development of a Diversity Action Plan released in June 2021.

Inviting action to create racial equity

The College co-hosted **Ibram X. Kendi** in April 2021 for a virtual lecture as part of Oregon State University's Provost's Lecture series. Kendi is a National Book Award winner, historian and a leading antiracism voice in America. Kendi discussed the intersecting implications of race and racism, culture, class and more, challenging participants to take direct action to fight racism in all its forms.

Taking science where it matters



Science works best when shared, and our need to foster a global community that values science is greater than ever. Through outreach programs, we're instilling scientific confidence across diverse age groups and demographics, promoting scientific literacy and fostering civic engagement.

Discovering the Scientist Within (DSW) 2021 was a huge success in its online format. Eighty students from five states participated in this free, interactive science workshop designed to encourage young women to pursue science, technology, engineering and mathematics (STEM) careers.

Through hands-on activities, small group discussion and testimonies from current scientists, middle-school girls explored what it's like to work in STEM's many interdisciplinary fields. Female OSU undergraduates majoring in STEM participated in the program as role models, challenging perceptions of science as a male-dominated discipline.

The keynote speaker at DSW 2021 was Paige Hoffert, mechanical engineer at Nike. The event was sponsored by Precollege Programs and the MidValley STEM-CTE Hub.

A team lead by microbiology graduate student **Quinn Washburn** in the Giovannoni Lab created a board game to teach children about the microbial ecology of the oceans. The game, **Oligotrophic**, was published in *The Science Teacher* journal of the National Science Teaching Association.

Oligotrophic teaches students about the essential role that marine microbes play in sustaining life in the ocean and in mitigating climate change, and how human actions are connected to ocean health. For students in rural or underserved areas, many of whom do not live near or interact with the ocean, the easy-to-learn game allows them to make these connections in a fresh and enjoyable way. "It was my goal to create a fun, engaging and

Oligotrophic simulates the real-life microbial interactions of the marine carbon pump, by which phytoplankton absorb carbon dioxide from the atmosphere. In this easy-to-learn, strategic tile-placement game, players compete to accumulate biomass, achieve bonuses and take biomass from others, using cards based on actual microorganisms found in the ocean.

interactive game that would transport students into the microbial world so they could learn about this incredible ecosystem, where the action is invisible to the naked eye," said Washburn.

Washburn's team developed Oligotrophic in conjunction with OSU's **Science Math Investigative Learning Experience (SMILE) Program**. SMILE works with schools serving minority, low-income and historically underrepresented populations to increase success in higher education and participation in STEM careers.

Instructor **Kate Shay** of the biochemistry and biophysics department created an interactive science experience called **Biochemistry Blast for High School Students: Molecular Biology of Viral Disease**. This entirely online course allows students interested in biomedical science to get a head start on college prep, while examining how viruses work and how the human body responds to infection.

"My goal for students in my classroom is to cultivate a deep, personal interest in lifelong learning in the molecular biosciences for the good of self, community and the world," said Shay. The two-week program ran twice during summers 2020 and 2021.

Alumni, students, faculty, staff and friends of the university all came together in support of the second annual **Dam Proud Day** on April 28, 2021. In this online campus-wide day of giving, our community raised nearly \$27.5K for the College of Science student emergency fund, which supports Equity Promise Scholarships to help students facing financial distress.

Dam Proud Day, led by the Oregon State University Foundation, yielded over 4,000 gifts totaling more than \$1.1 million university-wide. Donors from 48 states and 10 countries outside the U.S. contributed to programs and projects they believe in, 80% of which directly impact OSU students.

1.



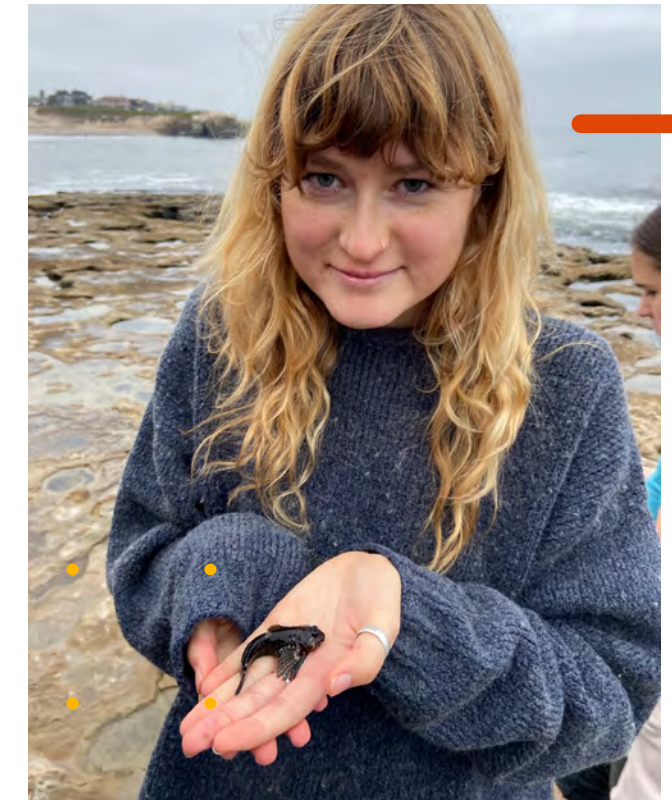
2.



4.



3.



Scientists extend the mission of our global research university.

Year after year, College of Science faculty and students receive national and global honors for their outstanding achievements. Our world-class faculty were recognized for their impact on their disciplines and the lasting significance of their research contributions. The well-deserved awards and recognition they earn affirm the value of their scholarly achievements, leadership and outstanding ability as teachers and mentors.

We are also incredibly proud of our students. They play an essential role in many research labs, internships, clubs and community service programs. We celebrate the way they connect their passion with purpose and seek ways to contribute to Oregon State and the national and global scientific communities. The awards they earn point to their potential to make revolutionary breakthroughs and target complex societal challenges.

Our Honors

Recognizing scientific achievement

Left 1: Elizanette Lopez's ORISE Fellowship took her to the Centers for Disease and Control (CDC) Biorepository in Georgia to process SARS-CoV-2 samples and organize biorepository collections. **Left 2:** Physicist Bo Sun won the Richard T. Jones New Investigator Award, which honors an early-career investigator for showing exceptional promise in biomedical research. **Left 3:** Former Oregon Climate Fellow John Stepanek will use an NSF Graduate Research Fellowship

to measure the carbon sequestration capacity of coastal sand dunes. **Left 4:** Chemist May Nyman was honored with a Humboldt Research Award, sponsoring her sabbatical journey to work collaboratively with materials chemists at prestigious research institutions in Germany. **Above:** NSF Fellow Cheyenne Jarman tidepools for sculpins at the Oregon Coast. Her research examines predator-prey interactions to strengthen conservation and ecosystem management.

Faculty awards 2019–2020 Integrative Biology

Jane Lubchenco was the first recipient of the Mary Sears Medal awarded by The Oceanography Society for her exceptional leadership, research and solutions to restore ocean health and sustainable fisheries.

Lubchenco also received an honorary Doctor of Science degree from Oxford University.

Robert Mason became a Fellow of the American Association for the Advancement of Science for distinguished contributions to the fields of behavioral endocrinology and chemical ecology.

Bruce Menge was elected as a member of the American Academy of Arts and Sciences for his work to advance evolutionary and ecological sciences.

Mathematics

Malgo Peszynska was selected to serve as program director within the Division of Mathematical Sciences at the National Science Foundation in Washington, D.C. where she will review national research proposals and make crucial funding recommendations.

Physics

Bo Sun received the Medical Research Foundation of Oregon 2019 Richard T. Jones New Investigator Award for his work on the biophysics of collective behavior in cells.

Faculty awards 2020–2021 Biochemistry and Biophysics

Maria Franco was elected to the Council for the Society for Redox Biology and Medicine.

Chemistry

David Ji was identified as one of the most influential researchers in the world by Clarivate Web of Science due to his multiple highly-cited papers that rank in the top 1% by citations.

May Nyman received a Humboldt Research Award, which will take her to study at three leading institutions in Germany in 2021–22. The award recognizes leading researchers from outside Germany, and provides a paid stipend and invitation to conduct research at a German research institution for up to one year.

Integrative Biology

Jane Lubchenco was appointed the deputy director of climate and environment in the White House Office of Science and Technology Policy. In the newly created role, Lubchenco will collaborate with Biden-Harris administration science and climate advisors to tackle one of the world's most pressing problems.

Mathematics

Malgo Peszynska became a Fellow of the American Association for the Advancement of Science for outstanding contributions to multidisciplinary mathematical and computational modeling of flow and transport in porous media.

Peszynska also received the Society for Industrial and Applied Mathematics Geosciences Career Prize, which is awarded every two years to an outstanding senior researcher for broad and distinguished contributions to the solution of mathematical and computational problems in the geosciences.

Student Awards 2019-20 Biochemistry and Biophysics

Isabella Karabinas ('20) received a 2020 Fulbright Award, which took her to the Universidad Complutense de Madrid to study neuroscience. She also won the Undergraduate Young Investigator Award at the 2019 Society for Redox Biology and Medicine Conference in Las Vegas.

Diego Rodriguez ('20) was awarded the American Society of Biochemistry and Molecular Biology 2019 Marion B. Sewer Distinguished Scholarship.

Chemistry

Ph.D. student **Ana Arteaga** was one of three graduate students to receive a GEM Fellowship in 2019, which enabled her to do research at the Pacific Northwest National Lab. She is also a David T. Wong Chemistry Research Internship Fund recipient.

Ph.D. student **Ian Colliard** was awarded a GEM Fellowship, which took him to the Lawrence Livermore National Laboratory to conduct research.

Colliard also was selected for the U.S. Department of Energy's Office of Science Graduate Student Research Program.

Two 2018 chemistry alumni, **Joseph Kincaid**, an organic chemistry Ph.D. student at University of California Santa Barbara, and **Alena Vasquez**, a Ph.D. student in chemistry at Scripps Research, received National Science Foundation Graduate Research Fellowship Program (NSF GRFP) awards.

Integrative Biology

Ph.D. candidate **Claire Couch**, an ARCS Foundation Scholar, was one of 12 graduate students across the U.S. to win the Ecological Society of America's Katherine S. McCarter Graduate Student Policy Award.

Ph.D. students **Leah Segui**, **Vanessa Constant** and **Katie Dziejczak** were among 69 John A. Knauss Marine Policy Fellows, which took them to Washington, D.C. for one year to gain experience working on national policy affecting ocean, coastal and freshwater resources.

Ph.D. candidate **John Stepanek** was one of three OSU students to receive an NSF GRFP award. His research focuses on ocean ecosystems and the effects of climate change. **Alyssa Adler** (Marine Biology '12), a recipient of a National Geographic Early Career Grant and a videographer with Lindbald Expeditions, also won an NSF GRFP award.

Alumnus **Jeremy Chu** (B.S. '18) was chosen as an alternate for a Fulbright English Teaching Assistantship in Macau.

Mathematics

Alumni **Patrick Flynn** ('18), a Ph.D. student of applied mathematics at Brown University, and **Gregory Mirek Brandt** ('18), a Ph.D. student of astrophysics at the University of California Santa Barbara, won NSF GRFP awards.

Microbiology

Ph.D. candidate **Grace Deitzler** also received an NSF GRFP award. Her research focuses on the honey bee gut microbiome and its

role in health and immunity as a way to conserve bee populations.

Physics

Katelyn Chase (Physics '18), a doctoral student in quantitative and computational biology at Princeton University, won an NSF GRFP award.

Student Awards 2020-21 Biochemistry and Biophysics

Maja Engler ('20) was selected as a 2021–22 Fulbright Scholar, which will take her to Ulm University in Germany to conduct research.

Emily Gemmill, a junior, and sophomore **Alyssa Pratt** received Barry Goldwater Scholarships, the top undergraduate award in the country for sophomores and juniors in the fields of science, technology, engineering and mathematics (STEM).

Postdoc **Isabelle Logan** received the Children's Tumor Foundation Young Investigator's Award grant of \$89K.

Ph.D. candidate **Heather Masson-Forsythe** was a winner in the 13th annual Dance Your Ph.D. contest organized by *Science Magazine*.

Integrative Biology

Ph.D. students **Kristofer Bauer** and **Cheyenne Jarman** won 2021 NSF Graduate Research Fellowships. Bauer studies how marine invertebrates may be adapting to climate change. Jarman's research examines predator-prey behavioral (non-consumptive) interactions to strengthen conservation and the management of ecosystems.

Alumna **Lorraine Waianuhea** ('18), currently a research assistant at the San Diego Zoo Global, also received a 2021 NSF GRFP award.

Ph.D. students **Sara Hamilton** and **Zechariah Meunier** received Katherine S. McCarter Graduate Student Policy Awards, presented by the Ecological Society of America. The award provides graduate students with the opportunity to receive policy and communication training valuable for working with lawmakers.

Hamilton studies the applied ecology of kelp forests in the Pacific Northwest, and Meunier investigates community assembly processes in rocky intertidal ecosystems of Oregon, California and Nova Scotia.

Julia Zavala ('21) was one of seven undergraduate students at OSU awarded the Benjamin A. Gilman International Scholarship to undertake a pre-medical internship in Cordoba, Argentina. Zavala also received a Merrill Family Foundation scholarship.

Microbiology

Master's student **Elizanette Lopez** was selected to participate in the Oak Ridge Institute for Science and Education Fellowship program, which took her to the Centers for Disease Control Biorepository in Lawrenceville, Georgia.

Ph.D. student **Lu Wang** was one of 74 graduate students nationwide selected as a John A. Knauss Marine Policy Fellow. Wang worked in the NOAA Office of Ocean Exploration and Research for her fellowship.



1.



2.



3.



In the College of Science, we take our mission seriously.

We are driven to advance science and build global leaders for a healthy people, living on a healthy planet, in a healthy economy.

For over a century, the College of Science has invested in and multiplied the curiosity of thousands of scientists and innovators who have undertaken forward-thinking initiatives to improve our world. Our responsibility to serve the people of our state and the globe stems in part from the exceptional distinction of Oregon State as one of only two universities in the U.S. to have land, sea, space and sun grant designations. The breadth of our College's interdisciplinary research — across seven programs in the mathematical, physical and biological sciences — positions us well to steward

these grants, applying them to research, teaching, public engagement and extension programs.

Fundamental science is the engine of our research and teaching endeavors, leading to path-breaking discoveries that serve as the platform for new applications, making tomorrow's technologies possible. The College continues to broaden access and advance equity and inclusion in partnership with students, faculty and minority-serving institutions on campus, with a particular focus on supporting and sustaining diverse and equitable classrooms and research communities. Working together at every level, we are committed to fostering the different facets of learning and research that are crucial for modern science.

Our College

Building a better world through scientific discovery

Left 1: The John L. Fryer Aquatic Animal Health Laboratory's wet-lab facility houses hundreds of fish in continuous flow-through tanks. **Left 2:** The OSU Herpetological Collection consists of more than 50,000 ethanol-preserved amphibians and reptiles, and approximately 20,000 frozen tissue samples.

Left 3: Mahtab Singh Brar found Oregon State University a solid fit to prepare him for medical school. He started at OHSU in Fall 2020. **Above:** At OSU, Goldwater scholar Alyssa Pratt discovered she could pursue her dual interests in programming and science through bioinformatics.

Facts and figures

Majors

Biochemistry and Biophysics
 Biochemistry and Molecular Biology
 Biology
 BioHealth Sciences
 Chemistry
 Mathematics
 Microbiology
 Physics
 Zoology

Master's Degrees

Biochemistry and Biophysics
 Chemistry
 Integrative Biology
 Mathematics
 Microbiology
 Physics
 Statistics
 Data Analytics (online)

Doctoral Degrees

Biochemistry and Biophysics
 Chemistry
 Integrative Biology
 Mathematics
 Microbiology
 Physics
 Statistics

Departments

Biochemistry & Biophysics
 Chemistry
 Integrative Biology
 Mathematics
 Microbiology
 Physics
 Statistics

By the numbers

2,585

undergraduates on all campuses

445

graduate students on all campuses

293

Ecampus students

31,000+

alumni

3.57

average GPA of incoming students

31%

of Honors College students are science majors

66%

average medical school admit rate, one of the highest in the country

2/6

Oregon State Goldwater Scholars were science majors, 2020-21

4/6

Oregon State Fulbright Scholars were science majors, 2020-21

23/61

Oregon State Fulbright Scholars were science majors since 1965

2/16

OSU Gilman International Scholars were science majors, 2020-21

11

Student and alumni NSF Graduate Research Fellows, 2020-21

122

tenure/tenure-track faculty

184

total faculty

22

Distinguished Professors, the highest of any college at OSU

2

National Academy of Science members

\$40.5M

in research funding 2020-2021

55%

Increase in funding in 2021 alone

Facilities that foster exploration



The College of Science works in partnership with the Research Office and others to support top-of-the-line facilities that allow researchers and students to make discoveries that contribute to a healthy, sustainable and technologically advanced world. Our instrumentation and synthesis capabilities are world-class and a point of pride — we stay on the cutting edge of technology and make our equipment available both to partners in industry and to OSU faculty and students.

Supporting applications for industry

Our **Materials Synthesis and Characterization Facility**, which has elicited worldwide interest for its blue pigment research, works in collaboration with industry partners and national laboratories to create an engine for economic impact through novel products and job creation. Our **X-Ray Diffraction Lab** supports research on characterization of atomic structures through collection of X-Ray data, and the **Electron Microscopy Facility** houses the most advanced electron microscopes for all basic and applied research programs. With 25 years of experience in survey methodology, our **Survey Research Center** is an essential resource for data collection.

Advancing biomedical discoveries and human health research

The **OSU Mass Spectrometry Center** supports research across many disciplines that depend on cutting-edge mass spectrometry, while the **PNW Center for Translational Environmental Health Research** develops new ways to track contaminants and their effects. Our **Unnatural Protein Facility** facilitates nC_{AA}-protein research, while the **Center for Genome Research and Biocomputing** supports high-level computational biology and bioinformatics research.

Basic research to address complex questions

Sporting the highest field NMR spectrometers in Oregon, the **Nuclear Magnetic Resonance Facility** supports scientific inquiry across structural biology, organic chemistry, natural products analysis and environmental studies. The **Electrophysiology Facility** is the backbone for electrophysiological experiments to advance neuroscience research at OSU.

Conserving biodiversity, planetary health

Two world-renowned collections, the **Oregon State Arthropod Collection** and **OSU Herpetological Collection**, serve as research strongholds and natural history museums. The **John L. Fryer Aquatic Animal Health Laboratory** facilitates research with freshwater fish, amphibians and invertebrates and hosts interactive community outreach.

Oregon State Continuous Flow Facility

Funded by a \$493K grant from the M.J. Murdock Charitable Trust, the **Continuous Flow Facility** is equipped with in-line scientific analytical tools and process units that transform the discovery and synthesis of new molecules and materials by continuous flow methods. This collaborative center for academic and industrial researchers will bring synthetic chemistry into the digital age and prepare OSU graduates to address the grand challenges of sustainable chemical manufacturing. University Distinguished Professor of Chemistry Douglas Keszler leads the project.

Oregon State Microbiome Initiative

This virtual research and education center is part of the \$121M National **Microbiome Initiative**, a federal program to investigate microbial communities in humans, crops and aquatic and terrestrial ecosystems. OMBI develops bioinformatic and data analysis tools to understand what makes a microbiome healthy and how to fix non-functioning systems, with broad applications across diverse topics, from autism to climate change. The center also hosts research training and national and international conferences and symposia.

NANOGrav Center

Oregon State is the lead institution for the \$17M North American **Nanohertz Observatory for Gravitational Waves Center**, funded by the National Science Foundation as a Physics Frontiers Center. OSU is one of just three institutions within the Pacific 12 Conference to host such a research group, which will comprise roughly 200 astrophysics researchers at 18 universities. The center, operating under the direction of Professor of physics Xavier Siemens, will push the boundaries of physics knowledge by studying the universe through low-frequency gravitational waves, ripples in the fabric of space and time.



Science champions: Board of Advisors



Jan Armstrong ('57)
Retired Director of Community Relations
Kansas City Southern Industries



Scott Clark ('08)
General manager of SigOpt
Intel Corporation



Megan Cook ('09)
Director of Education and Outreach
Ocean Exploration Trust



Eileen Hartmann ('74, '76)
Retired
Certified public accountant



Keith E. Krueger ('86)
Oral and maxillofacial surgeon
Krueger and Lenox



Prabu Nambiar ('88)
Founder and Principal
Syner-G Pharma Consulting



Joel Peterson ('69)
Founder, Ravenswood Winery,
Once & Future Wine



Heather Runes ('01)
Director of GMP QA
Myovant Sciences



Ronald Schoenheit ('65)
President
Cascade Coil Drapery

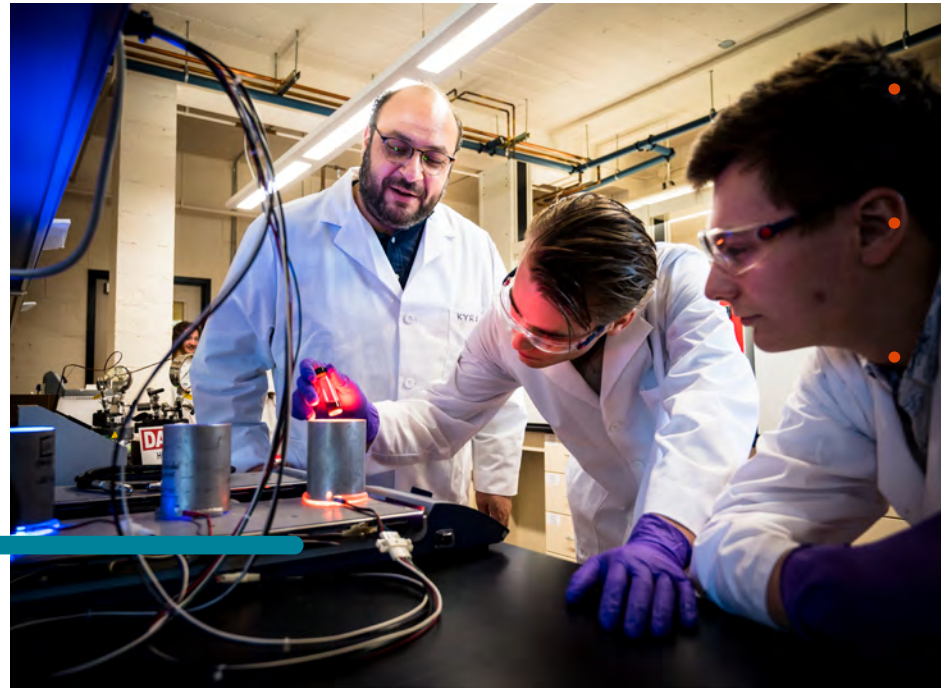


Luisa Snyder ('09)
Dentist
Snyder Family Dentistry



Michael Waterman ('64 and '66)
Emeritus University Professor, University
of Southern California
Distinguished Research Professor,
University of Virginia

A trailblazer in computational biology, Michael Waterman ('64, '66 Mathematics) received the College's Lifetime Achievement in Science Award in 2020 for his work which includes laying the foundation for what became the Human Genome Project. Waterman is an Emeritus University Professor at the University of Southern California and Distinguished Research Professor at the University of Virginia. Photo by Leah Lee.



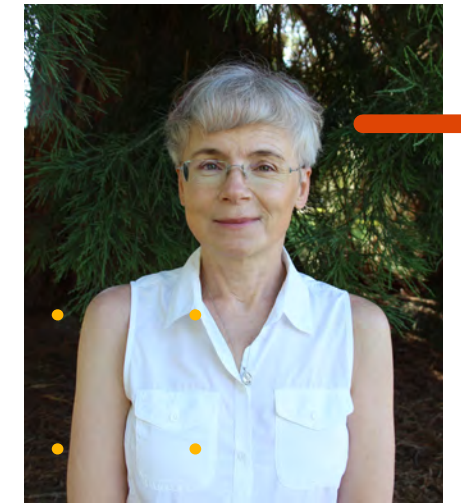
1.



3.



2.



Our Faculty

Transforming ideas into solutions

Our scientists pursue knowledge with passion and purpose.

As scholars and leaders at Oregon's largest research university, our faculty tenaciously cut new pathways in education, research and innovation – cornerstones of our land grant mission. The scientific talent they bring to their work is awe-inspiring, vital and changing the world.

College of Science faculty share a deep commitment to doing fundamental research and making discoveries across a broad range of disciplines to reveal insights to benefit society. Their work runs the gamut across all the different areas of science – from fundamental science where they seek to understand the workings of the universe and the origins of life, to applied science where they work to solve problems such as disease or environmental challenges to improve people's lives and shape a healthier, more sustainable future.

Our faculty also are leaders in the delivery of education. As they pursue new discoveries, they never lose sight of our mission to build future leaders in science. Our faculty are deeply engaged in mentoring graduate and undergraduate students and transforming teaching and learning. They have won numerous awards for their teaching, but the real testament of their dedication are the students who catch their contagious enthusiasm for solving society's challenges and go on to develop fulfilling careers in science.

In the midst of extraordinary challenges over the last two years, our faculty provided engaging, high-quality instruction to our students through difficult circumstances, and persisted in pursuing groundbreaking discoveries that contributed new knowledge to benefit society.

Left 1: Terence Bradshaw Chemistry Professor Kyriakos Stylianou seeks new materials to help capture carbon. **Left 2:** 2020 Dr. Russ and Dolores Gorman Faculty Scholar Virginia Weis studies coral-algal symbiosis, a foundation of coral reef ecosystems. **Left 3:** College of Science Faculty

Scholar KC Walsh has been a strong driver in the strength of OSU's online physics curriculum. **Above:** Mathematician Malgo Peszynska was named a Fellow of the American Association for the Advancement of Science in 2020. She then received the SIAM Activity Group on Geosciences Career Prize in 2021.

Renowned leaders: Faculty highlights



Distinguished Professors

Joseph Beckman, Biochemistry and Biophysics
 Andrew Blaustein, Integrative Biology
 Balz Frei, Biochemistry and Biophysics
 Stephen Giovannoni, Microbiology
 Andrew Karplus, Biochemistry and Biophysics
 Douglas A. Keszler, Chemistry
 Jo-Ann Leong, Microbiology
 Jane Lubchenco, Integrative Biology
 Christopher Mathews, Biochemistry and Biophysics
 Bruce A. Menge, Integrative Biology
 Donald J. Reed, Biochemistry and Biophysics
 Arthur W. Sleight, Chemistry
 Mas Subramanian, Chemistry
 Janet Tate, Physics
 Virginia Weis, Integrative Biology

American Association for the Advancement of Science

Christopher Bayne, Integrative Biology
 Andrew Blaustein, Integrative Biology
 Michael Freitag, Biochemistry and Biophysics
 Sally Hacker, Integrative Biology
 Andrew Karplus, Biochemistry and Biophysics
 Walter Loveland, Chemistry
 Jane Lubchenco, Integrative Biology
 David Maddison, Integrative Biology
 Bob Mason, Integrative Biology
 Christopher Mathews, Biochemistry and Biophysics
 Bruce Menge, Integrative Biology
 Malgo Peszynska, Mathematics
 Vince Remcho, Chemistry
 Bob Smythe, Statistics
 Mas Subramanian, Chemistry

National Academy of Sciences

Jane Lubchenco, Integrative Biology
 Ken van Holde, Biochemistry and Biophysics

American Academy of Arts & Sciences

Jane Lubchenco, Integrative Biology
 Bruce Menge, Integrative Biology

Distinguished Professor of Physics Janet Tate's research is supported by more than \$7M in grants, and her collaboration with materials scientists stimulated the invention of the Retina 5K display now found in Apple products. For her outstanding mentorship of students, Tate has received the Frederick H. Horne Award for Sustained Excellence in Teaching Science and two OSU Mortar Board top professor awards. An advocate for equity in STEM, she has been a part of Discovering the Scientist Within for the last 13 years, nurturing girls' interest in science.

Endowed science faculty

Joe Beckman, Biochemistry and Biophysics
 Margaret W. Terrill Linus Pauling Research
 Innovator Faculty Scholar; Burgess and Elizabeth
 Jamieson Chair in Healthspan Research

Paul Ha-Yeon Cheong, Chemistry
 Bert and Emelyn Christensen Professor

Tory M. Hagen, Biochemistry and Biophysics
 Helen P. Rumbel Professor for Healthy
 Aging Research

Jane Lubchenco, Integrative Biology
Bruce Menge, Integrative Biology
 Wayne and Gladys Valley Chairs in Marine Biology

David Maddison, Integrative Biology
 Harold E. and Leona M. Rice Professorship in
 Systematic Entomology

Devon Quick, Integrative Biology
 Whiteley Faculty Scholar

Vince Remcho, Chemistry
 Patricia Valian Reser Faculty Scholar

Kyriakos Stylianou, Chemistry
 Terence Bradshaw Chemistry Professor

Mas Subramanian, Chemistry
 Milton Harris Chair of Materials Science

Rebecca Vega Thurber, Microbiology
 The Emile F. Pernot Distinguished Professorship
 in Microbiology

KC Walsh, Physics
 College of Science Faculty Scholar

Virginia Weis, Integrative Biology
 Dr. Russ and Dolores Gorman Faculty Scholar



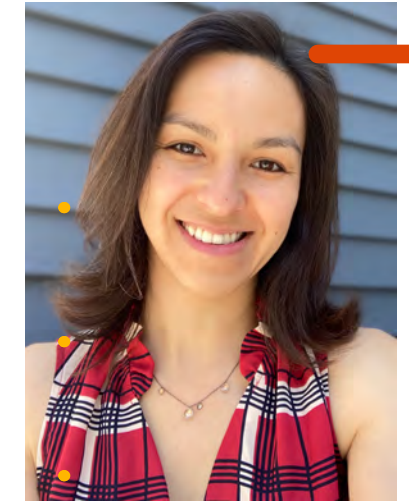
1.



2.



4.



Our alumni multiply our vision of leadership.

We celebrate the creativity, drive and achievements of our 31,000+ alumni. Through the decades, they have united their passion with a great determination to make the world a better, healthier place.

Michael Waterman's ('64, '66 Mathematics) work in computational biology laid the foundation for what would become the Human Genome Project. In 2020 he received the College's Lifetime Achievement in Science Award.

Karen Wooley ('88 Chemistry) is a foremost expert in materials and polymer chemistry and in nanomaterial development. A Distinguished Professor of Chemistry at Texas A&M, she was named 2021 SE Conference Professor of the Year.

Steve Bjornson ('96 Microbiology) is vice president and chief operating officer for Pfizer Vaccine R&D. He oversaw the team that developed the first vaccine approved for COVID-19.

Charity Dean ('00 Microbiology) was the assistant director of the California Department of Public Health during the COVID-19 pandemic, leading its Testing Task Force. She is currently the CEO and co-founder of Public Health Company.

Briony Horgan ('05 Physics) played a key role in identifying Jezero Crater as the ideal landing and exploration site for the NASA Mars rover Perseverance. She is an associate professor of planetary science at Purdue University.

Tari Tan ('08 Biochemistry & Biophysics) is the director of education for Harvard Medical School's Department of Neurobiology where she designs curricula and teaches future neuroscientists.

Colin Huber ('10 General Science), social media manager at the National Football League, won an Emmy in 2020 for his work. He previously won awards for his social media work for OSU.

Our Alumni

Leading the way forward

Left 1: Although Colin Huber originally came to OSU to be a dentist, his experiences while earning his degree led him to discover another exciting path. **Left 2:** Attorney Román Hernández was recently recognized for his deep and abiding commitment to causes of social justice, diversity, equity and

inclusion. **Left 3:** Judy Faucett's tenacity, determination and success have paved the way for more women to join the actuarial profession after her. **Above:** Neuroscientist Tari Tan's experiences with teaching and advising at OSU motivated her to find a fulfilling job as an educator and mentor to others.

Breaking the mold



A vocal healthcare advocate

When the COVID-19 pandemic spread across the country, **Eva Galvez** ('99 Biology), a family physician at the Virginia Garcia Memorial Health Center in Washington County, Oregon, knew it had the potential to disproportionately impact the community she serves: largely migrant and seasonal workers and others with barriers to receiving care. She helped set up one of the first drive-through testing centers in March 2020 and recorded public service announcements that aired on three Spanish-language radio stations and Univision. Yet case counts continued to rise.

Galvez found that migrant and seasonal farmworkers were not receiving support at work. Most operations continued as though the pandemic did not exist, without PPE provisions despite the elbow-to-elbow work. In labor camps, multiple families shared living spaces, exacerbating the challenges of containing the virus.

A vocal advocate, Galvez addressed the Select Subcommittee on the Coronavirus Crisis in the Oregon House of Representatives to petition for temporary rules in the fields to improve sanitation and living conditions and expand farmworker benefits. "There are many things that contribute to poor health that are beyond medicine. Once you get at the root causes, then you realize that you must start pushing for change at a policy level," she said.

In 2020, Galvez received the OSU Alumni Association's College of Science Alumni Fellow Award to honor her advocacy for health equity.

Building bridges in law for Latinos

While serving in the Air Force, **Román Hernández** ('92 General Science) was inspired to pursue a law degree by a Judge Advocate General (JAG officer), the first Latino lawyer he had known. Today, he is a nationally recognized attorney specializing in labor and employment law and commercial litigation.

Alumna Eva Galvez grew up in a community of seasonal farmworkers. Seeing the struggles they faced, she gained a passion for health rights in a cross-cultural context. "If we are going to bring health equity and reduce disparity in health, we must take into account those social determinants which are relative to culture, people's language and people's beliefs," she said. Image courtesy of Virginia García Memorial Health Center.

The youngest of eight children of migrant farm workers from Mexico, Hernández now reaches out to young racial and ethnic minority students in secondary education to encourage them to pursue higher education. This passion to inspire others earned him the 2021 Oregon State University Diversity, Equity and Inclusion Alumni Legacy Award.

Hernández has garnered numerous accolades for his professional achievements and commitment to social justice and civil rights, including the American Bar Association's 2021 Spirit of Excellence Award and the Diversity and Inclusion Champion Award from Oregon State Bar. He was also named to the Lawyers of Color Nation's Best List and recognized in The Best Lawyers in America.

A lifetime of giving back

Judy Faucett ('70 Mathematics) is used to being the only woman in the room, from the classroom to the boardroom. Her love for mathematics and determination to succeed in the face of adversity led to a successful career as an actuary. As a consultant for some of the top firms in the country, she helped pave the way for other women to follow.

A first-generation college student, Faucett was the first woman to be hired by Pacific Mutual Life and the first to complete the company's actuarial training program. She rose to the position of vice president over a 15-year span and retired in 2004 as a Senior Vice President of Equitable Life Assurance.

Faucett is passionate about helping hard-working students achieve their dreams. An active supporter of the College for more than 40 years, she is the founder of the Rise Scholarship, the first scholarship at Oregon State that exclusively serves students with disabilities. "These young people are going to change the world," she said. In 2020, she received the College's Distinguished Alumni Achievement Award for her achievements and a lifetime of philanthropy.



Science is one of the greatest forces for good in human history. Our continual quest for new knowledge has enabled society to tackle disease, produce new materials that enhance lives and catalyze innovation to protect our planet.

Science achieves its impact because it is a nexus of diverse perspectives and experiences. But it is less powerful when some lack access or resources to fully participate in or benefit from life-changing learning

opportunities and research. Science is diminished when its contributions do not equitably benefit all.

Fortunately, science is self-correcting. When we find errors, we seek out new information, analyze the data, amend our positions and get closer to truth by constant improvement. When we become aware of injustices, we move to correct them. Our work to advance the endless frontier of science is inseparable from our aim to advance inclusion and equity in Oregon and beyond.