UMBC

2024 RESEARCH AND CREATIVE ACHIEVEMENT ANNUAL REPORT

Inquiring Minds

R1 DOCTORAL UNIVERSITY

Mercedes Burns, assistant professor of biological sciences and a 2023 NSF CAREER Award recipient, handles a harvestman (also known as a daddy longlegs) in her laboratory.

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ON THE COVER (LEFT TO RIGHT):

Image 1: Kevin Rippy (right), an undergraduate student in computer science, controlling one of the autonomous robots in the Center for Real-time Distributed Sensing and Autonomy.

Image 2: Deepak Koirala (left), assistant professor of chemistry and biochemistry and 2023 NSF CAREER Award recipient, with Ph.D. student Naba Krishna Das.

Image 3: Undergraduate student participant in the Visual Concepts II/Camera Vision course, fall 2023.

Image 4: Student presenters during UMBC's 2023 Undergraduate Research and Creative Achievement Day.

All photography by Marlayna Demond '11 for UMBC unless otherwise noted.

Building a Research Culture

A word from UMBC's Vice President of Research and Creative Achievement

"Public Research for Public Good"—this motto, combined with a campus-wide commitment to inclusive excellence, drives all of our efforts in research and creative achievement here at UMBC.

In this 2024 annual report, *Inquiring Minds*, we are presenting a cross section of some of the key areas of achievement across our UMBC community.

Earlier this year, we shared in the pride of our faculty, staff, and students, when they attended the launch of NASA's Plankton, Aerosol, Cloud, and ocean Ecosystem (PACE) satellite, watching from the Banana Creek Launch Viewing Area at Kennedy Space Center. The spacecraft included HARP2—a key instrument developed at UMBC—to measure aerosol particles and clouds. The HARP2 instrument is the most visible manifestation of the close and mutually beneficial partnership between UMBC and NASA Goddard Space Flight Center, a partnership that dates back well over a quarter century.

Recently, we learned that UMBC has been chosen to develop one of the initial three science instruments—the Lunar Environment Monitoring Station (LEMS)—to accompany astronauts on NASA's Artemis III mission as they prepare to return to the moon for the first time since 1972.

We are immensely proud of the six early-career faculty members who were selected to receive a prestigious NSF CAREER Award in 2023, bringing UMBC's total CAREER Award recipients to 49. We are equally delighted that these six 2023 CAREER Award recipients each represent a different academic department, which shows the breadth of expertise and the focus on excellence across our campus. UMBC is a perfect place to establish and build your career.

Over the past three years, we successfully established three new cooperative centers with the U.S. Army, focusing on key topics such as AI and autonomy; position, navigation, and timing; and digital enterprise for emergent manufacturing.

UMBC faculty and students are also working on a broad range of environmental resilience efforts. This includes bringing together clean-energy generation and nuclear fusion efforts with world-leading aquaculture facilities; long-term ecosystem studies and social-environmental collaborations, and combining their work with expertise in environmental economics and policy, as well as environmental justice and ethics.

UMBC has seen a significant rise in research expenditures—from $84 million in 2021 to more than $144 million in 2023. That growth builds upon UMBC's 2021 classification as a Carnegie R1 university, placing us among the top 146 research universities in the nation and as one of three R1 institutions in Maryland. UMBC's R1 journey was included in *The Chronicle of Higher Education's* "The Research Driven University" report in 2023, which highlighted our institutional approach to creating a true research culture.

We are building that research culture by integrating research into departmental and institutional priorities and providing our undergraduate and graduate students opportunities to explore and address some of today's most pressing societal questions. We are investing in our people, strengthening our partnerships, and showcasing the broader impact of our research and creative achievement endeavors.

We welcome you to learn more about our community of inquiring minds with this annual report.

Karl V. Steiner
Vice President of Research and Creative Achievement

By the Numbers

Who We Are

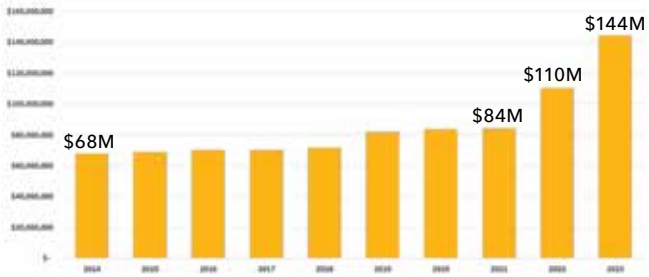
UMBC is home to 560 full-time faculty, plus 403 part-time faculty conducting instructional and research activities.

14,148
Total enrollment*
** As of Fall 2023*

3,658
Graduate students

90+
Countries represented

Annual HERD R&D Expenditures



Since 2021 UMBC's HERD expenditures have grown by more than 70% to $144M in 2023.

UMBC's National Rankings

The National Science Foundation's Higher Education Research and Development (HERD) survey summarizes the federal, state, industry, and other funds a university spends on all its research activities. The HERD survey collected research and development expenditures (R&D) from 900 universities and colleges across the nation. In fiscal year 2022, UMBC was ranked:

#16
nationally in NASA funding

#33
in federal support for geosciences, atmospheric sciences, and ocean sciences

#44
in federal support for social sciences

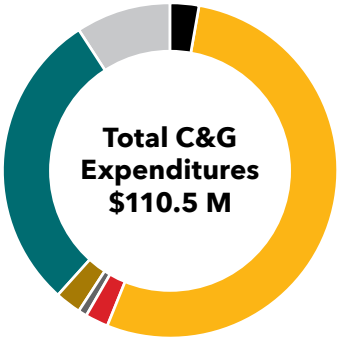
#55
in federal support for computer and information sciences

#58
in federal support for physical sciences

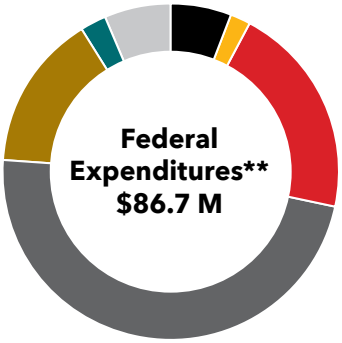
#107
in federal R&D expenditures among public institutions

#122
in overall R&D expenditures among public institutions

Who Funds Research and Creative Achievement at UMBC?



Corporate	$3,200,966
Federal	$59,041,753
Foundation	$2,269,551
Local	$879,088
Private	$2,762,422
State	$32,327,626
University	$9,964,775



DOD	$5,230,418
DOE	$1,873,290
HHS	$18,079,371
NASA	$42,412,442
NSF	$13,235,234
USDA	$2,247,516
Other Federal	$5,593,773

***by original funding source*

Our People

At UMBC, we are connected by a shared sense of mission and vision to make a difference in our community and the world through inclusive excellence in our classrooms and research spaces. We combine a passion for rigorous scholarship and a supportive community to reach excellence across the board, which starts with the faculty, staff, and students who make up our community of inquiring minds.

Early-Career Faculty Excellence

UMBC's six 2023 NSF CAREER Award recipients, the most awarded in a single year in the university's history, with President **Valerie Sheares Ashby** (center). Recipients from left to right: **Deepa Madan**, **Tyler Josephson**, **Chenchen Liu**, **Sanjay Purushotham**, **Deepak Koirala**, and **Mercedes Burns**.

"Just like the first word carved on stone and the first rocket launched into space, AI is another milestone in human history. It marks humankind's exploration of intelligence itself, asking questions about how it is formed and how it might evolve.... I believe an incredible increase in AI complexity will be the next big thing in the world, and I am excited to become a small part of it."

– 2023 NSF CAREER Award recipient Chenchen Liu, assistant professor of computer science and electrical engineering

Experiential Learning in Action

UMBC students are growing their research and broadening their skills beyond the classroom with experience-based learning opportunities. Among them:

Jessica Novak, a fourth-year Ph.D. student in biological sciences, studies how the *bacterium Cellvibrio japonicus* breaks down complex carbohydrates with Jeffrey Gardner, associate professor of biological sciences. Novak was selected to conduct research at the National Renewable Energy Laboratory in Colorado with support from a competitive U.S. Department of Energy Office of Science Graduate Student Research Program Award.

Kevin Chen '23, computer science, **Zachary Amoss** '24, computer science, and **Leela SaiNadh Gade,** M.P.S. '24, cybersecurity, represented UMBC in the 2023 Country-to-Country Capture the Flag event at the Hiyoshi Campus of Keio University in Yokohama, Japan. Kevin Chen's team received the Hitachi award. The competition brought together 80 students from around the world to team up and complete 25 cybersecurity challenges within 10 hours.

Meredith Power '21, history, a public history graduate student, and **Gabe Morrison** '23, anthropology, worked with the Albin O. Kuhn Library and Gallery Special Collections team to digitize and rehouse more than 5,400 images from photographer Lewis Hine's archival collection that documents the harsh conditions of child laborers in early 20th-century America.

Meredith Power '21, history, preserving historical photos with mylar sleeves.

"The fellowship at the National Renewable Energy Laboratory gives me a chance to peek into the industry side of research and advance my research at the same time, which will help me figure out what I want to do moving forward."

– Jessica Novak, Ph.D. student in biological sciences

Learn more about UMBC's graduate programs:
gradschool.umbc.edu

Centering Community-Engaged Research

At UMBC, our researchers are working with communities to unearth untold stories, address and solve complex problems, make decisions, influence policies, and create programs and interventions. Examples of community-engaged research include:

Felipe Filomeno, associate professor of political science and global studies and associate director of UMBC's Center for Social Science Scholarship, who works with Latinx communities in Baltimore to investigate immigration politics and policy, was appointed to Maryland Governor Wes Moore's Commission on Hispanic affairs in 2023.

Fan Yang, associate professor of media and communication studies, mines 21st-century media artifacts to make visible the economic, cultural, political, and ecological entanglements of China and the United States in her new book *Disorienting Politics: Chimerican Media and Transpacific Entanglements* (University of Michigan Press, 2024).

Michelle R. Scott, professor of history *(pictured below)*, was the first to deeply explore the lives of the performers, theater owners, producers, managers, and audiences that were part of Black Vaudeville and the Theater Owners Booking Association (T.O.B.A.) in her book *T.O.B.A. Time: Black Vaudeville and the Theater Owners Booking Association in Jazz Age America* (University of Illinois Press, 2023).

UMBC's Center for Navigation, Timing, and Frequency Research (CENTAUR) team, led by Curtis Menyuk, professor of computer science and electrical engineering, discussing their developing research on alternative timing and navigation technologies. From left to right: Curtis Menyuk, graduate student Logan Courtright, Gary Carter, professor of computer science and electrical engineering, and graduate student Pradyoth Shandilya.

Investing in Our Research Community

UMBC is dedicated to investing in our faculty and student researchers at every level. The university's wide range of internal institutional support assists our research community to advance their research and creative achievement endeavors. UMBC researchers can apply for a number of internal pilot grant opportunities ranging in award sizes.

Our Partnerships

Every day our UMBC research community collaborates with partners across the region, nation, and abroad to build a better tomorrow. We seek to listen deeply to the needs of our community members and to leverage the resources of the university to build and sustain meaningful, mutually beneficial partnerships with community affiliates, academic peers, government agencies, corporations, and foundations.

Research Collaborations with the Department of Defense

UMBC's ongoing collaborations with the Army Research Laboratory and other Department of Defense facilities are strengthening our nation's defense and have expanded in recent years. Faculty and students in several centers are working on key topics through the Center for Navigation, Timing, and Frequency Research (CENTAUR) and the Center for Research in Emergent Manufacturing (CREM). This work builds on our long-term partnerships focused on cyber defense and AI through UMBC's Center for Cybersecurity (UCYBR) and the Center for Real-time Distributed Sensing and Autonomy (CARDS) with its focus on AI and autonomy.

Nilanjan Banerjee, professor of computer science and electrical engineering and director of the Center for Research in Emergent Manufacturing, talks to students in the new operations technology cyber range.

UMBC and the University of Maryland, Baltimore (UMB) have a long-standing partnership that dates back several decades. From left to right: Karl V. Steiner, UMBC's vice president of research and creative achievement; Stephen N. Davis, vice president of clinical and translational science at UMB; and Bruce E. Jarrell, president of UMB. (Photo courtesy of Karl Steiner)

A Shared Purpose: UMBC's Long-Standing Partnership with UMB

- In 2023, UMBC and the University of Maryland School of Medicine (UMSOM) were jointly awarded a four-year, $4 million Research Evaluation and Commercialization Hubs (REACH) grant from the NIH to advance biomedical entrepreneurship and innovation in the Baltimore region under the UM-BILD program.
- In 2022, UMBC and UMSOM received a five-year, $13.7 million grant from NIH's Faculty Institutional Recruitment for Sustainable Transformation (FIRST) program to enhance recruitment and training of junior faculty from groups underrepresented in biomedical science.
- Since joining UMB's Institute for Clinical and Translational Research (ICTR) in 2019, UMBC has contributed the cybersecurity and AI training core for ICTR. UMBC faculty successfully apply for pilot funding under the ICTR's Accelerated Translational Incubator Pilot and Community-Engaged Research grant programs, with 22 UMBC faculty having received funding through ICTR.

Explorations and Community Connections in Art

UMBC is committed to promoting inquiry and experimentation in and across the arts disciplines. Our creative achievement initiatives include partnering with communities to illustrate the expansiveness of artistic expression and scholarship.

- The Center for Art, Design, and Visual Culture (CADVC)—established in 2003 as a university-wide arts research center—is a forum for scholarship, publication, and experimental engagements in the fields of art, design, and visual culture. The center hosts an exploratory research residency program, curates exhibits, oversees the Joseph Beuys Sculpture Park, and runs K-12 programs that serve Baltimore County and Baltimore City schools, among others.
- The Center for Innovation, Research, and Creativity in the Arts (CIRCA) is an interdisciplinary research center dedicated to promoting inquiry and experimentation in and across the arts disciplines. CIRCA is committed to enhancing the local, national, and global reputation of the arts at UMBC as well as fostering innovative research and diverse viewpoints through its guest lectures, panel discussions, workshops, and performances.

Learn more about the CADVC: **cadvc.umbc.edu**

Above: Visitors viewing UMBC's 2022 IMDA MFA Thesis Exhibition: Extimacy.

Right: The CADVC's 2023-24 Artist in Residence Levester Williams (left) discusses his experimental public projection work, "Dreaming of a beyond: Baltimore" at the CADVC gallery with curator Lisa Freiman (center), presented by Rebecca Uchill, director of the CADVC.

Cultivating Inclusive Excellence in STEM Education

UMBC is collaborating with Cold Spring Harbor Laboratory, University of Puerto Rico-Río Piedras, and the Universidad del Sagrado Corazón to establish a new science education center at the Arecibo Observatory site in Puerto Rico. The National Science Foundation will contribute more than $5 million over five years to establish the multidisciplinary center, called the Arecibo Center for Culturally Relevant and Inclusive Science Education, Computational Skills, and Community Engagement (Arecibo C3).

Leaders in Accelerated Real Time Analytics

UMBC is partnering with Rutgers University, the University of Miami, and Arizona State University under the Center for Accelerated Real Time Analytics (CARTA) Phase II, a five-year initiative that explores data analytics research to develop new accelerated and real-time approaches to address advanced technology integration with applications in health care, weather, finance, and security. CARTA initially launched in 2018 with funding provided by the NSF's Industry-University Cooperative Research Centers program to develop next-generation computing hardware to address data-intensive infrastructure challenges.

"My passion has always been to increase the number of Latinas in computing. There are too few of us in the field—creating inclusive programs from Arecibo C3 will help us bridge that gap."

– Patricia Ordóñez, M.S. '10, Ph.D. '12, computer science, associate professor of information systems, serves as UMBC's lead investigator in the Arecibo C3 project

UMBC-CARTA Phase II faculty and student collaborators discussing a project, led by director Karuna Joshi (center, standing), associate professor of information systems.

Our Impact

At UMBC, we believe in the power of "Public Research for Public Good." This phrase exemplifies how UMBC's research and creative achievements impact our lives and unravel the mysteries of our universe while preparing a diverse new generation of scholars. We are excited by the opportunity for our work to have a direct impact on the communities we partner with, by facilitating a deeper intercultural understanding through our arts and humanities scholarship, and by furthering our knowledge across a spectrum of science and engineering fields.

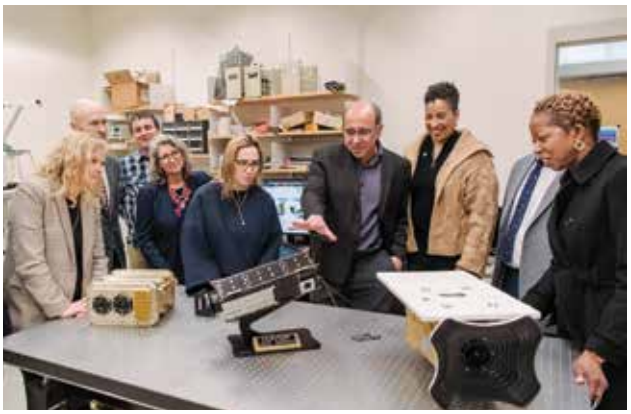
"Communities across the U.S. should be planning for growing threats related to climate disasters. Food security is a basic human need and is highly susceptible to disruption when families and communities experience disasters. I'm excited to work with a multidisciplinary and multi-sector team to develop a new tool for measuring community food security to support communities planning for, responding to, and recovering from hurricanes and other natural disasters."

– Lauren Clay, associate professor and chair, emergency and disaster health systems

Climate, Environmental Resilience, and Sustainability

UMBC researchers are paving the way in scholarship that aims to deepen our understanding of the impacts of climate change while exploring possible solutions to the environmental challenges affecting communities in Maryland and around the world. We're strengthening our expertise and footprint in environmental research across all disciplines with initiatives such as developing disaster resilient food systems, the UMBC-led Institute for Harnessing Data and Model Revolution in the Polar Regions (iHARP), the Interdisciplinary Consortium for Applied Research in the Environment (ICARE), the Center for Urban Environmental Research & Education (CUERE), sustainable aquaculture research happening in downtown Baltimore at the Institute for Marine Environmental Technology, and much more.

Faculty and student researchers of UMBC's Interdisciplinary Consortium for Applied Research in the Environment (ICARE) are evaluating the environmental impacts on Baltimore's Harbor. From left to right: Chris Blume, M.S. '23, Darryl Acker-Carter, M.S. '23, Jessica Diaz, M.S. '23, Tamra Mendelson, professor of biology, and Mercedes Burns, assistant professor of biology. (Photo courtesy of Tamra Mendelson)



Vanderlei Martins (center), professor of physics and director of the Earth Space Institute, during a demonstration of the HARP instrument family with Makenzie Lystrup (left of Martins), director of NASA Goddard Space Flight Center, and her leadership team and UMBC President Valerie Sheares Ashby (far right).

Examining Earth's Atmosphere

UMBC continues its scholarly explorations beyond the laboratory with the launch of the Hyper-Angular Rainbow Polarimeter #2 (HARP2) instrument, a wide-angle imaging polarimeter that will measure aerosol particles and clouds. HARP2 was developed by **Vanderlei Martins**, professor of physics, and his team of scientists and engineers at UMBC's Earth and Space Institute (ESI). This follows the development of the HARP cubesat, which launched to the International Space Station in November 2019 and was released into orbit in February 2020. HARP spent over two years collecting first-of-its-kind data on Earth's atmosphere, and finally deorbited in April 2022. In February, the HARP2 instrument launched into space as a contributed instrument on NASA's Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission. The launch marked the first time NASA deployed a university payload on a large operational Earth science space mission.

Learn more about UMBC's Earth and Space Institute:
esi.umbc.edu

NASA's PACE spacecraft at the Astrotech Space Operations Facility near Kennedy Space Center preparing for its launch on February 8, 2024. (Image by NASA)

Expanding Culturally-Competent Clinical Services in Underserved Communities

UMBC psychology faculty were awarded a two-year, $990,000 grant from the Health Resource and Service Administration (HRSA) to increase the number of clinical psychology and social work behavioral health professionals trained in the provision of integrated, culturally and linguistically competent children, adolescents, and adult behavioral health services. The grant, awarded to **Sandra Barrueco**, **Rebecca Schacht**, and **Pamela Rakhshan Rouhakhtar**, psychology, will assist in expanding training and employment opportunities in underserved and rural communities in Maryland. The project, in collaboration with the University of Maryland School of Social Work, includes extensive community-based interdisciplinary partnerships with more than 20 hospitals, community mental health clinics, community agencies, and government organizations at the state and local levels.

UMBC psychology faculty members (from left to right) Sandra Barruecho, psychology graduate student Samatha Berg, and a social work graduate student Emily Lipsitz-Wardrick discussing their HRSA-funded program to expand access to culturally-competent clinical services in rural communities.

bwtech@UMBC Incubators

bwtech@UMBC Research and Technology Park's North and South campuses house 131 companies and organizations. Over the last three decades, bwtech@UMBC has brought more than 1,800 jobs to Baltimore County, has generated more than 4,500 direct and indirect jobs, and $700 million in labor income and business sales for the state, according to an assessment by the Sage Policy Group in 2019.

bwtech@UMBC is home to Maryland's first cyber incubator and features additional govtech and biotech incubators. The research park facilitates the advancement of companies at all stages of development.

Wendy Martin (center), director of UMBC's Office of Technology Development, assists faculty in all aspects of intellectual property protection and commercialization. Through bwtech@UMBC, Soobum Lee (left), associate professor of mechanical engineering, connected with Pranay Kohli (right), an energy sector executive with experience working with companies and clients around the world. In 2018, Lee and Kohli founded ACTIVEcharge, a startup that develops solutions to autonomously monitor wind turbines. In 2020, Lee and Kohli received a Maryland Innovation Initiative (MII) grant to develop vibration-powered sensor technology for wind turbines. Since launching in 2012, MII has supported 39 UMBC faculty in their commercialization pursuits.

Global Scholarship on Aging Populations

Christine Mair, associate professor of sociology and gerontology and director of UMBC's Center for Health, Equity, and Aging, examines the increasing population of older adults globally who will be both unpartnered and childless, often referred to as "kinless." Her research explores the presence or absence of family and non-family ties and seeks to document how social integration and support (or lack thereof; e.g., "kinlessness") shape mental health, physical health, end-of-life experiences, and other aspects of well-being especially cross-nationally. Mair was a 2023 recipient of the Isaac Manasseh Meyer Fellowship from the National University of Singapore (NUS), serving as a visiting scholar at the Centre for Family and Population Research in the Department of Sociology and Anthropology at NUS.

Supporting Rising STEM Students

At UMBC, we invest in our students through mentorship, research opportunities, and financial support. In 2023, UMBC was awarded $1 million in grants from the Jack Kent Cooke Foundation to support students with financial need who intend to pursue degrees in science, technology, engineering, and mathematics (STEM) fields. The grants provide $500,000 in current-use funding—to support over the next two academic years incoming and current students with financial need who intend to pursue STEM degrees—and $500,000 in endowed scholarship support for STEM undergraduates with financial need.

Graduate students of Professor Erin Green's lab as they work on various projects, which includes Green's research on the role of the enzyme SMYD3 in prostate cancer progression. Left to right: Ph.D. student Luke Mason, Erin Green, associate professor of biological sciences, Ph.D. students Winny Sun, Maki Negesse, and Devonique Brisset. (Photo by Melissa Penley Cormier, M.F.A. '17/UMBC)

GRIT-X

GRIT-X is an annual series of presentations launched in 2016 to celebrate the passion and achievements of UMBC's alumni, faculty, and graduate students, featuring invited speakers to convey compelling aspects of UMBC's impact in the areas of research and creative achievement.

GRIT-X 2023 presenters and moderators from left to right: William LaCourse, Kimberly Moffitt, Zhensen Huang, Michelle R. Scott, Justin Webster, Irina Golubeva, Charles Ichoku, Mercedes Burns, Carlos Romero-Talamás, Cynthia Matuszek, Melanie Harrison Okoro, David Dauwalder, and Karl V. Steiner. (Photo by Erika Nizborski)

Access the full list of all GRIT-X presenters by visiting **research.umbc.edu/grit-x**.

UMBC

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