

VCU Strategic Research Priorities Plan

“Improving the Human Condition”

Mission

To enrich the human experience and advance human health and well-being through exceptionally creative, collaborative and community-engaged research.

Vision

We are a nationally prominent research institution whose efforts at improving the human condition by developing fundamental knowledge and transformative solutions to address society’s grand challenges facing individuals, communities, our environment and the natural world.

One VCU Research

From its inception in the 1800s, Virginia Commonwealth University's mission included improving the human condition, initially through the medical school's healing efforts and then through the community engagement of the Richmond School of Social Work and Public Health. We honor that tradition today across both campuses and a wide range of areas of inquiry and discovery. Our nationally, top-ranked School of the Arts sparks our imagination. From different perspectives, our nationally, top-ranked School of Education and School of Social Work engage our communities to initiate dialogues and confront social inequities. The College of Humanities and Sciences teaches analytical tools for critical thinking and fundamental scientific principles to produce curiosity. Our clinics provide health and dental care to area residents. VCU computer scientists lead our national prominence in cybersecurity.

Faculty from the School of Media and Culture, funded by one of the nearly 20 annual VCU Presidential Research Quest Fund awards, use eye-tracking software to conduct groundbreaking research on visual social media platforms. We study housing stability, inequity and factors behind Richmond's high eviction rates, and how policies enacted into legislation affect Virginians. Our environmental scientists reveal how the James River and its riverine plant and animal life respond to a host of factors brought on by climate change.

In 2005, in the aftermath of 9/11 and the anthrax attacks, VCU started the nation's first homeland security and emergency preparedness program to train students to manage the complexities of disaster planning and response. We prepare students for a rapidly shifting workforce that requires STEM training and equip them as individuals to create, comprehend or challenge technological change. We collaborate with local school systems to improve science education and produce more STEM teachers. We seek ways to reduce the historically high levels of unemployment among historically marginalized people with intellectual and developmental disabilities.

Today, VCU's research community responds to the global COVID-19 pandemic by executing a coordinated, strategic response in this quickly changing, unprecedented new reality. As they have done before, our researchers pivot to address emerging needs and issues in a fast-paced world of discovery and invention. A new COVID-19 rapid research funding opportunity engaged investigators on both campuses to explore ideas across disciplines to ultimately find creative, collaborative support to test discoveries and take their ideas to market. Clinical trials, patent applications and licensing income put VCU at the forefront among Virginia universities.

Now, more than ever, we respond to our nation's pressing health needs. VCU is currently the only academic partner involved in the \$354 million, 4-year contract

between the U.S. Department of Health and Human Services (BARDA) and Phlow Corp., based in Richmond. Phlow will incorporate the advanced manufacturing technologies of Medicines For All in VCU's College of Engineering to produce desperately needed medications for the country's supply chain. Additionally, VCU receives the most NIH funding in addiction/substance abuse treatment of all Virginia institutions and our biomedical informatics facility is fast-tracking life-saving research in opioid addiction and other critical areas. Researchers at the VCU Health Pauley Heart Center and the Massey Cancer Center, a National Cancer Institute-designated center since 1975, develop new treatments for some of our most intractable diseases. We launched the nation's first doctoral program in pharmaceutical engineering to transform the design of production of pharmaceuticals and offer greater access to lifesaving medication. Our C. Kenneth and Dianne Wright Center for Clinical and Translational Research, funded by the NIH National Center for Advancing Translational Sciences (NCATS), turns laboratory discoveries into treatments for patients. VCU's outstanding neuroscience program is part of our collaborative basic, translational, and clinical neuroscience community, which spans departments, schools, colleges and campuses. With our partners at the McGuire VA Medical Center, VCU oversees a national research consortium to study the wave of traumatic brain injury among the country's service members and veterans that mark 21st century combat.

VCU research changes lives locally, regionally and across the nation, one of the reasons the Carnegie Foundation ranks VCU as one of only 53 institutions designated both as one that has "very high research activity" *and* is "community engaged." Our university research family includes Baruj Benacerraf, an alumnus who won the 1980 Nobel Prize in Physiology or Medicine; Jeffrey Lacker, an economist and former chief of the Federal Reserve Bank of Richmond; Richard Lower, who performed the 16th heart transplant in the world and the first in Virginia; and John Fenn, a professor within the College of Humanities and Sciences, who won the 2002 Nobel Prize in Chemistry. Their place in VCU history is joined by faculty whose ongoing research accomplishments span many disciplines. Shermaine Jones of the English Department is a fellow of the Wilson National Fellowship Foundation and artist Guadalupe Maravilla is a fellow of both the Guggenheim Memorial Foundation and Soros Arts. Hong-Sheng Zhou of our College of Engineering holds a Google Faculty Research Award. Kenneth Kendler of the School of Medicine is the world's most cited scientist in the field of psychiatry research and chemist Katherine Tibbetts holds a Presidential Early Career Award for Scientists and Engineers. They and our five faculty members elected to the National Academy of Medicine and five fellows of the National Academy of Inventors show us that the way forward is not to rest.

VCU focuses on achieving social impact through a culture of research collaboration, as set forth in the university's grand plan *Quest 2025: Together We Transform*. To guide VCU Strategic Research Priorities Plan
06/4/2020

the VCU research enterprise in its commitment to research, discovery and innovation, Vice President for Research and Innovation, P. Srirama Rao, Ph.D., in late 2019, convened the Strategic Research Priorities Planning (SRPP) Committee. Co-chairs Dr. Kathleen Rudasill, Associate Dean for Research and Faculty Development in the School of Education and Dr. Michael Donnenberg, Senior Associate Dean for Research and Training in School of Medicine, and a group of key leaders across both VCU campuses were tasked with creating a bold, ambitious and strategic university-wide plan to serve as a framework to streamline investments leading to increased funding and growth, ultimately advancing excellence in research at VCU.

The committee considered current and aspirational areas of research excellence and resources, infrastructure and investment needed to accomplish significant programmatic improvements in the research enterprise. It evaluated VCU's research funding and expenditures and how to assist schools and colleges in realizing strategic goals and full research potential. The committee sought input from the VCU community and garnered hundreds of comments reflecting VCU's diverse and essential perspectives. When the draft plan was finalized, it was shared with university leadership for additional input.

The attached plan outlines and expands on the four initiatives that seek to engage more members of the VCU community through a culture of collaboration and aspires to have greater impact on humanity by:

- **Enriching the human experience**
- **Achieving a just and equitable society**
- **Optimizing health**
- **Supporting sustainable energy and environments**

This is **One VCU Research**, dedicated to improving the human condition through a culture of creativity, responsiveness to sudden societal changes that fundamentally alter our lives, team science, collaborative research and recognition. As we emerge from the COVID-19 pandemic and face a forever changed landscape, this plan will provide the framework to not only further advance our mission, but to position ourselves to answer the call, whatever it may be. We must nurture our ability to pivot and meet the challenges of the day by developing novel ideas and seizing unique opportunities. An integrated approach across both VCU campuses will move us forward toward our goal: by 2025, VCU will be among the top 50 public universities in research and top 25 among our urban peers. We expect to surpass \$400 million in sponsored awards, allowing VCU to accelerate its commitment to addressing society's most vexing problems and its most urgent needs as a premier, urban research university that is nationally known and internationally recognized.

Initiative 1: Enriching the Human Experience

We apply creative expression, critical analysis and advancements in knowledge and technology to enhance individual quality of life and social infrastructure.

Goal 1.1: Develop creative technological and analytical improvements and evidence-based educational approaches to society's problems to serve the needs of individuals and communities.

Objective 1.1.1: Empower people to achieve their aspirations through the use of data science, autonomous systems and smart devices.

Innovations in data science, smart devices and autonomous systems significantly enhance the quality of life of many people and VCU already contributes technologies that make a difference. With strategic resource allocation, VCU has the opportunity to become a global research leader and industry partner in this fast-moving field.

ACTION: We will identify and support impactful technological innovations and strengthen and prioritize targeted research efforts to increase our impact on quality of life.

Objective 1.1.2: Enhance educational outcomes and broaden opportunities for student success by engaging in systematic studies of pedagogy and learning.

VCU faculty, staff and students are engaged in research that identifies best practices in education, seeking to determine for whom, when and under what conditions specific educational practices are most effective. Our deep and long-standing partnerships with local school systems and other community organizations provide opportunities to engage in additional meaningful and impactful research. VCU's research in education provides increased access to and improved opportunities for our neighbors and residents of areas beyond Richmond. We can further our success by eliminating institutional silos and research infrastructure barriers and encouraging interdisciplinary collaboration and education-focused research.

ACTION: We will identify the specific barriers to education research and encourage interdisciplinary communication to facilitate collaboration and increase our impact on local and national educational outcomes.

Objective 1.1.3: Enhance the human experience in a modern digital world by advancing research in and application of artificial intelligence (AI), virtual reality (VR) and machine learning.

AI is expected to enhance the capabilities of humans, machines and systems. It offers the potential to solve many difficult problems and free our time for other pursuits. VCU has the opportunity to lead the field by expanding on its current expertise in VR, machine learning and nascent efforts in AI.

ACTION: We will institute a collaborative effort to educate VCU researchers about this emerging field and we will pair AI and data science technology researchers with application researchers to increase our AI research and innovation output.

ACTION: We will build on our current strengths in VR and machine learning to enrich the human experience. We will leverage our expertise in VR and machine learning and aspire to be national leaders to optimize human health and management in targeted areas.

Objective 1.1.4: Inform policies that improve the capacity of business, governments and educational institutions to better serve society through research advancements.

Humans function not only as individuals but collectively in societies as well. The human condition has improved largely through societal advances. Inquiry at VCU in areas as diverse as political science, business, economics, psychology, education and health administration, centers on assessing and improving the way organizations function. Business, government, education and other institutions best respond to technological, social and cultural changes through research that supports new practices, policies and evolutions.

ACTION: We will substantially increase our impactful research on organizational and institutional performance and increase external support for policy-oriented research.

Goal 1.2: Enrich lives and elevate human understanding and aspirations through cultural contributions and critical analysis.

Objective 1.2.1: Contribute to worldwide intellectual capital by increasing production of research, scholarship and creative works.

Artistic creativity involves imagination and the generation of original ideas and novel ways of interpreting the world. Arts and humanities are essential to the development of critical and creative thinking, innovation and societal advancement. Contributions to literary analysis, art history, history, philosophy and other arts and humanities

fields produce meaningful knowledge and significantly enrich our institution. VCU recognizes the intellectual value of the humanities and the important role that humanities scholarship plays in an informed, respectful and meaningful analysis of cultural challenges of the past and present. By expanding and enhancing the recognition of these disciplines' contributions, VCU can realize the full potential of its strong arts and humanities programs.

ACTION: We will increase our production of nationally recognized contributions to the arts and humanities.

ACTION: In concert with creating a culture that prioritizes and recognizes research effort and innovation (Goal F.1), we will develop explicit criteria to evaluate the impact of these efforts in the form of books, journal articles and digital humanities and to ensure that they are rewarded.

Objective 1.2.2: Improve the awareness and understanding of contributions made by the arts and humanities to community, society, culture and the world economy.

VCU believes that the arts and humanities are vital to human progress and fulfillment. The creative economy is a network of industries whose activity produces creative assets, potentially generating economic growth and development. The terms "creativity, arts and intellectual property" can be ambiguous. A lack of reliable and universally understood data hampers an understanding of the qualitative value that the arts and humanities contribute to communities, societies and cultures. There is a dearth of research into the contributions of the arts and humanities to societies, nations and the world economy.

ACTION: We will research and develop tools to analyze creativity as a measurable process that contributes to society and the world economy, focusing on return on investment, job creation and overall development of countries.

Objective 1.2.3: Contribute to worldwide intellectual capital with fundamental scientific discovery.

Increased understanding and contributions to fundamental sciences such as mathematics, physics, chemistry and biology is the cornerstone for understanding the basis of life and nature. Strong research programs in these areas will not only continue to increase our basic understanding of life, nature and the universe, but also our overall quest for knowledge and curiosity, which in itself enriches the human

experience. Furthermore, fundamental science research always has the potential to lead to novel discoveries and practical technologies, although it may not be easily or readily translated to products or services. VCU will recognize the important role and promote the value of fundamental science research.

ACTION: We will increase our production of new knowledge and nationally recognized contributions to fundamental scientific disciplines.

ACTION: We will develop explicit criteria to evaluate the impact of these efforts in the form of books, journal articles, digital contributions and the next generation of field shapers.

Initiative 2: Achieving a Just and Equitable Society

We commit to identifying injustices and finding solutions to the most difficult social problems to build a better world, recognizing that change begins with us.

Goal 2.1: Reduce the impact of inequality, discrimination and disparities by developing knowledge and solutions at the levels of practice, services and policy.

Objective 2.1.1: Identify solutions for inequality and its associated impacts by stimulating interdisciplinary scholarship focused on causes, consequences and remedies.

Inequality impacts society in many ways, including illness, poverty and social exclusion. Given the VCU community's diversity and urban setting, VCU is ideally positioned to be a national leader in research that addresses disparities and inequities. By sufficiently prioritizing, valuing and encouraging scholarship focused in this area, VCU can create solutions with a comprehensive, holistic, interdisciplinary approach to these problems.

ACTION: We will increase investment in communities of practice, pilot funding for scholarship focused on disparities and inequities and support for research that focuses on these topics.

Objective 2.1.2: Produce diverse, inclusive and relevant scientific knowledge by increasing the number of faculty, staff and students from underrepresented groups participating in interdisciplinary research and collaborations across VCU.

As an urban, community-engaged research university, VCU attracts faculty and students from diverse backgrounds, who participate in varying degrees in our research mission. We must maximize the ability of underrepresented faculty, staff and students to contribute to research. Specifically, VCU needs to engage these members of our community in research that generates knowledge, practices and policies that address disparities and inequalities by removing institutional systemic barriers to these contributions.

ACTION: We will foster the growth, retention and success of faculty from underrepresented groups by increasing the number of underrepresented faculty, including women, who serve as principal investigators and in director roles of

research-related institutes and centers, as well as through recognition of research focused on diversity and equity in the promotion and tenure process and through university awards.

ACTION: We will achieve equity with regard to race, ethnicity, gender and sexual orientation in the allocation of research-related resources. We will increase institutional training grants and minority supplements on grants for trainees from underrepresented backgrounds and redouble our efforts to recruit underrepresented graduate and doctoral students.

Objective 2.1.3: Inform effective programs, policies and practices that lead to systems change through effective translation, communication and application of research results.

The community surrounding VCU faces societal challenges and needs that guide much of VCU's research. Effective communication of our findings can lead to transformative improvements or solutions to these challenges. Feedback and novel approaches from community members can also make our efforts more relevant. Engaging and collaborating with community members is an essential component of successful research. VCU endeavors to become a national model for transforming research into outcomes by enhancing mechanisms for knowledge dissemination and community engagement and impact. By conducting scholarship in collaboration with community stakeholders and translating research in a relevant manner, we increase our potential to improve and inform effective policies and programs and create societally relevant outcomes.

ACTION: We will reward humanities, social science and scientific research that engages with the community and provide sustained support to implement practices that lead to systems change.

Objective 2.1.4: Discover effective methods of educating learners from diverse backgrounds and experiences and those with varied abilities.

Educational opportunities are not evenly distributed across society. Individuals of different income backgrounds, those with disabilities, those who are English language learners or are persons of color often have very different educational experiences. These disparities stem, in part, from our incomplete knowledge about how to teach every student effectively, as well as imperfect methods for retaining high quality teachers, managing student behavior and implementing practices that distribute resources equitably.

ACTION: We will prioritize the study of educational methods that meet the needs of diverse learners, attracting and retaining high quality teachers and informing district and state policy to support students and teachers.

Goal 2.2: Create knowledge that is translational and has real-world impact by prioritizing community-engaged research that reflects the perspectives and needs of diverse communities.

Objective 2.2.1: Enhance community collaborations through deliberate development of VCU infrastructure to engage the community with our research mission, training for faculty and staff, community research advisory boards and increased partnerships with local historically black colleges and universities (HBCUs) and minority-serving institutions (MSIs).

VCU is one of only 54 colleges and universities to have very high research activity and receive the Carnegie Community Engagement Classification. We endeavor to build on this strength and to serve as a model for other institutions with community engagement as a central mission. VCU has a unique opportunity to partner with community organizations and to ensure that our findings are translated back to the community to maximize societal improvement. By creating centralized infrastructure to facilitate these interactions, we will ensure that research focuses on the needs of our community partners, ensure that findings are effectively communicated to community members and facilitate understanding of and engagement with research outcomes.

ACTION:

We will develop infrastructure that will empower and motivate community agencies and organizations to engage in the research process and identify research priorities that best meet their needs.

ACTION: We will provide training and support for researchers to develop and maintain community partnerships.

Objective 2.2.2: Integrate stakeholder input at all stages of the research process by promoting community participation and inclusive research methods and strategies.

Traditional research often excluded collaborating organizations and community members from the process of designing research questions and research

frameworks, relegating our partners to a non-reciprocal role. Greater inclusivity in the research process engenders trust and reciprocity.

ACTION: We will reward and incentivize research approaches that involve stakeholders at all stages of the process and will train investigators in cultural responsiveness and respect.

Initiative 3: Optimizing Health

We use trans-, multi-and interdisciplinary approaches at scales from molecules to populations in search of new ways to preserve and restore human health.

Goal 3.1: Reduce the burden of disease and improve wellness through transformative basic, translational, clinical and population research.

Objective 3.1.1: Create personalized treatments and interventions through a better understanding of biology, behaviors and environment.

Disease treatments and supportive interventions are most effective when they account for the patient's individual variations in biology (e.g., age, sex, genetics, epigenetics and microbiome), behavior (e.g., lifestyle choices) and internal/external environment (e.g., societal factors, environmental stressors, exposure to pollutants). VCU is well positioned to make great strides in personalized interventions due to our excellent basic and clinical researchers and our ongoing service to a diverse community. Improved coordination among the various disciplines that explore these factors can accelerate the translation to clinical practice.

ACTION: We will promote collaborations and facilitate interactions among researchers with diverse expertise and backgrounds.

ACTION: We will increase our translation of individualized interventions.

ACTION: We will increase intellectual property assets in precision health.

ACTION: We will develop nationally-accepted treatment guidelines.

Objective 3.1.2: Reduce the burden of the leading causes of morbidity and mortality by achieving breakthroughs in cancer, neuroscience/addiction and cardiovascular and metabolic disorders.

VCU has basic, fundamental, translational and clinical research strengths in neuroscience/addiction, cancer, cardiovascular and metabolic disorders. These areas of research align with the clinical needs of the community that VCU serves. Research in these fields would benefit from targeted investment and increased collaborations among internal and external investigators. The linkage between clinical research in these areas and measurable outcomes in the health of the

community must be strengthened.

ACTION: We will invest in research space and provide metric-driven resources and support for research institutes and centers focused on these areas.

ACTION: We will support enhanced collaboration with the McGuire Veterans Medical Center Hospital as well as other regional partners.

ACTION: We will increase collaboration and support for population health research linked to the study of outcomes in these areas.

Objective 3.1.3: Advance health care from bench to bedside to community and back by improving the efficiency and efficacy of translational research through informed partnerships between researchers and clinicians.

The depth of biological and behavioral research at VCU, coupled with outstanding clinical scholarship and care delivery at VCU Health System, provide the opportunity for robust translation of new discoveries into highly impactful clinical trials and population interventions. Creating a structure that promotes easy and productive interaction between researchers and clinicians would improve our potential to improve patient health through innovative translational research.

ACTION: We will enhance the professional benefits for clinical providers to collaborate and participate in team science critical to meeting our goals.

ACTION: We will enhance collaborations between clinicians and basic scientists working in biomedical-related areas.

ACTION: We will develop forums and provide expert guidance to optimize interactions among basic, clinical and population scholars.

Objective 3.1.4: Advance new treatments and interventions by facilitating and increasing access to clinical trials, with a particular focus on trials that may assist diverse populations.

The safety and efficacy of new treatments, interventions and preventive strategies to enhance health are evaluated in carefully designed and efficiently performed clinical trials. The talented faculty and staff, advanced facilities and diverse patient population in the VCU Health System provide a particularly fertile field for cutting-edge and highly impactful clinical research. Although many landmark studies have

emanated from this environment, we have not achieved our full potential due to deficiencies and inefficiencies in the clinical research infrastructure.

ACTION: We will support, strengthen and prioritize our **One VCU Research** initiative to identify and eliminate barriers to clinical research.

ACTION: We will improve patient access to safe and high-quality clinical trials and, when appropriate, offer opportunities to participate in research to all patients, creating a sustained benefit for patient outcomes in Richmond and beyond.

Goal 3.2: Improve health outcomes by leveraging emerging technologies, data science, machine learning and mathematical modeling.

Objective 3.2.1: Discover relationships and patterns that benefit health by coordinating efforts in data sciences and artificial intelligence.

Data acquisition and analysis require coordination among biologists, clinicians, computational scientists, mathematicians and biostatisticians, among others, to discover patterns in disease and treatment response. Large data sets offer transformative potential. Improved infrastructure and research computing capabilities will amplify our ability to realize it.

ACTION: We will establish a university-wide bioinformatics core facility advised by a data science consortium that represents a broad and diverse spectrum of relevant VCU faculty and staff.

ACTION: We will continue to build and expand ultrahigh speed networks within VCU and support robust connections with external networks.

Objective 3.2.2: Accelerate scientific progress by engaging stakeholders including community partners, ethicists, data managers and members of the data science consortium.

Those who collect, manage, distribute, model and analyze data play a critical role in its use. The FAIR (Findable, Accessible, Interoperable and Reusable) principles guide data management and stewardship practices to promote the re-use and re-analysis of data and to increase transparency and reproducibility. The emerging field of data science presents new privacy and security concerns and additional responsibilities, such as preventing bias and discrimination in algorithmic decision making.

ACTION: We will promote FAIR data principles.

ACTION: We will create a culture of inclusion around data science at VCU that promotes innovation and the ethical use of data.

Goal 3.3: Generate new medications, biologic treatments, interventions, devices and vaccines by actualizing discoveries made at VCU.

Objective 3.3.1: Develop, formulate and deliver novel drugs, vaccines and biologic treatments by enhancing our expertise in structural biology, medicinal chemistry, pharmaceutical sciences, pharmacology and pharmaceutical engineering to decrease morbidity and mortality.

VCU scientists and clinicians possess the skills to develop new drugs with selectivity and efficacy. These therapeutics can be advanced through the formation of new biotech companies by VCU scientists or partnerships with biotech and pharmaceutical companies. Growing collaboration and expertise in translation and balancing target identification and subsequent steps in the process will magnify the impact of basic discoveries.

ACTION: We will invest in structural biology, medicinal chemistry, nanomedicine and pharmaceutical development.

ACTION: We will integrate our expertise in diverse and complementary research areas and establish regular communications, leading to an increase in the number of compounds developed at VCU that enter phase 1 and 2 clinical trials and ultimately reach patients.

Objective 3.3.2: Address unmet clinical needs and health challenges by developing innovative biological technologies and medical devices, combining clinical insights with advanced engineering, physical sciences and biological sciences.

VCU biomedical engineers, scientists and clinicians play a key role in advancing research leading to new technologies and devices for treatment and cures for various disorders including orthopedic (bone and cartilage healing), cancer, cardiovascular and neurological diseases. To maintain our leadership and innovation, VCU must promote multidisciplinary collaboration and integration of developments in advanced manufacturing, bioengineering, robotics, computational analysis, VR, AI, 3D printing and imaging with new discoveries in

biological and clinical sciences.

ACTION: We will invest in key infrastructure, leading to new knowledge and expertise as well as advanced training for a new generation of researchers to solve puzzling health challenges through a team science-based approach.

ACTION: We will create a vibrant, multidisciplinary and collaborative environment for converging ideas from engineering, biological and medical disciplines to go to market. Streamlining efforts by researchers working with industry and clinics will increase the number of novel biological technologies and medical devices. This will create clinical solutions and ultimately improved health and well-being of patients.

Objective 3.3.3: Ensure community engagement with and support of VCU health research and align VCU research with the most pressing community needs by fostering collaborations and sharing best practices with the community.

VCU must build on its strengths in community engagement to bolster our research and honor our commitment to the communities we serve. While the university is dedicated to engaging our community, we must improve understanding of and knowledge about clinical and health-related research for members of the community. We will optimize coordination between VCU and VCU Health System units to support research. Community-engaged health-related research conducted in many units across the university will benefit from this collaboration to maximize efforts and efficiency.

ACTION: In concert with Objective F.2.2, we will establish a health subcommittee of the Community Research Advisory Board to encourage community engagement in health research across the university. This board will provide feedback on how well VCU health research addresses community needs and improve understanding of health-related research in the community. This will inspire increased community confidence as well as enrollment in research.

Initiative 4: Supporting Sustainable Energy and Environments

We create evidence-based solutions that contribute to a better future in a rapidly changing natural world.

Goal 4.1: Advance renewable energy sources, energy saving, clean air and water resources, resilient natural systems and biodiversity through the research, development and application of novel, evidence-based solutions.

Objective 4.1.1: Create a cross-disciplinary research collaborative to develop innovative products, tools, policies and processes that promote renewable energy, clean water and air resources and healthy ecosystems.

Access to renewable energy and conservation of clean air and water resources are pressing issues of our time and require an improved ability to collect and use renewable energy. The most effective solutions to these issues will transcend traditional disciplinary and organizational boundaries. VCU can leverage its internationally recognized research expertise and assets in hydrogen production and storage, as well as catalysis and electrochemical storage. Eliminating barriers between disciplines will improve our ability to identify and support new collaborations and enhance our competitiveness for external funding.

ACTION: We will establish a cross-disciplinary collaborative to identify, support and coordinate complementary research teams from within and beyond VCU. This will increase nationally relevant research and technology innovation focused on the dynamic energy-air-water interface.

ACTION: We will strengthen VCU excellence in the area of nanomaterials for clean energy by adding expertise and promoting cross-disciplinary interactions.

Objective 4.1.2: Expand the impact of VCU's environmental and energy assets to build new partnerships and expand existing environmental research relationships across disciplines.

VCU's unique university resources provide access to state-of-the-art facilities, research infrastructure and diverse natural habitats. This supports scholarship and training in ecology, earth systems science and the application of new environmental and energy technologies. These resources serve the basis for relationships with a relatively small number of federal science agencies and VCU academic units.

Leveraging these resources could provide opportunities to aggressively build new and valuable research programs within and beyond VCU.

ACTION: We will leverage VCU's unique environmental and energy assets and geography to diversify VCU's research partnerships and expand our impact in the emerging disciplines of conservation medicine, restoration ecology, eco-informatics, eco-genomics, environmental technology and climate disruption.

Goal 4.2: Educate our communities and inform positive changes in environmental policy and practice at local, state and national scales by effectively translating and communicating our data and published scholarship.

Objective 4.2.1: Create objective, data-driven and evidence-based pathways for improved environmental literacy, understanding, knowledge and practice by engaging with our communities.

The best public policies on the environment will be informed by relevant and objective academic research that is effectively communicated to policymakers at all levels of government. Researchers at VCU currently conduct extensive research on STEM (science, technology, engineering and math) education to improve STEM literacy. By reducing systemic institutional barriers to effective and productive collaboration among students and faculty in STEM, education and public policy fields, VCU will expand its influence on environmental science literacy and its ability to inform public policies that contribute to a better quality of life.

ACTION: We will identify and address internal barriers to collaboration and build resources and capacity to effectively cross-train faculty and students in STEM, policy and education fields.

ACTION: We will expand VCU's ability to effectively communicate about science and expand environmental awareness by creating and staffing a translational science- and education-based public policy laboratory.

Goal 4.3: Create environmentally and economically sustainable materials, products, processes and infrastructure.

Objective 4.3.1: Accelerate the development of sustainable manufacturing materials and practices through collaborations among VCU experts and other academic, governmental and industry partners.

VCU has ongoing collaborations with industry, non-profit foundations and government within the emerging, important field of advanced manufacturing. The next generation of manufacturing will fully incorporate environmental and economic sustainability. VCU must magnify its impact in new areas of advanced materials and manufacturing, including nanomaterials, manufacturing at the point of use, additive manufacturing and 3D manufacturing.

ACTION: We will increase collaboration between VCU researchers and key partners in the field to identify materials and manufacturing-related problems that will affect industry and society in the next century and offer solutions.

ACTION: We will ensure that innovative technologies developed at VCU will support the convergence of technological innovation and sustainability.

ONE VCU Research

Foundation: Societal Impact through a Culture of Collaboration

We are committed to improving the human condition through a culture of creativity, team science, collaborative research and recognition at VCU. These efforts transcend all four themes of our strategic priorities plan.

Goal F.1: Create a culture that prioritizes and rewards research effort and innovation.

Objective F.1.1: Provide incentives for research effort and output.

Outstanding advances in research are essential to achieving our *Quest 2025* strategic theme of national prominence. Faculty who make important research contributions deserve timely and tangible rewards. However, the research and creative activity of VCU faculty takes many forms.

ACTION: Each academic unit must develop its own plan to incentivize research and creative activity.

Objective F.1.2: Review promotion and tenure guidelines to ensure that research and creative output is clearly rewarded.

While quality research and creative activity are highly valued and given strong consideration during promotion and tenure deliberations, procedures must accommodate the changing landscape of research. Advances in certain fields have become ever more dependent on collaboration and team science. In these efforts, it can be difficult to identify the contributions of essential individuals by conventional criteria, such as authorship order in publications or principal role in funding.

ACTION: We will develop explicit criteria to reward these efforts. Additionally, criteria for evaluating forms of research and creative activity that are not measured by funding dollars, citations, invention disclosures, patents and licensed technologies must be better defined.

Objective F.1.3: Recruit and retain productive, eminent research faculty and staff.

Many efforts to advance research by training, developing and supporting current members of the faculty and staff are detailed elsewhere in this document, but perhaps the most direct method to boost institutional research is to recruit successful investigators and field shapers to join our research team.

ACTION: We must make an uncompromising commitment to fill faculty and leadership positions with eminent researchers.

ACTION: We must actively identify our most successful faculty and staff and continually strive to provide the environment and rewards to retain them at VCU.

Objective F.1.4: Increase opportunities for interactions between researchers and members of the VCU community who contribute primarily to the educational and clinical missions.

Cultural change must be pervasive. Not all members of the faculty can contribute actively to the research effort but they are highly valued for their contributions to our educational or clinical missions. However, all our faculty, staff and students must appreciate the value of the discoveries made at VCU. When all members of the VCU community have a better understanding of the value of research, increased referral into clinical trials and increased student involvement in research is possible.

ACTION: We will increase opportunities for interaction between investigators and non-research members of our community.

ACTION: We will improve communication and dissemination of our research accomplishments.

ACTION: We will develop novel ideas for informal events to share experiences.

Goal F.2: Facilitate research collaborations to enhance innovation and impact.

Objective F.2.1: Accelerate innovation through collaboration between VCU experts and industry partners.

Innovation and the creation of new technologies and products requires a continuum of expertise, from ideas to discoveries to actualization. At VCU, experts in a wide range of fields support the advancement of concepts into research that leads to an enhanced human experience. However, additional partnerships are necessary to bring the products of our research to market. Industry partners and investors may help catalyze innovative research, but only if our faculty are aware, motivated and enabled to develop these key relationships.

ACTION: We will accelerate the production and market reach of technologies and products developed at VCU by building relationships with strategic investors or industry partners to identify and engage in opportunities for collaboration. We will work actively to attract industry partners to build a robust commercialization advisory

network. We will raise awareness among our faculty members of these opportunities.

Objective F.2.2: Establish a streamlined pathway for partnership with community organizations to meet their needs.

With its emphasis on community engagement and urban location, VCU has a broad network of community organizations with which to partner. While the Center for Community Engagement and Impact has a goal to be a central unit for maintaining these relationships, many separate partnerships have formed across the university to serve each unit's needs. This has resulted in disparate and inconsistent approaches to engaging the community with research. VCU has not invested in infrastructure that streamlines interactions with community organizations so that researchers have one entry point to engage with local and regional community members.

ACTION: We will work with the Center for Community Engagement and Impact to establish a streamlined system for engaging with community partners in research and a central VCU Community Research Advisory Board of representatives from a variety of community organizations who can identify appropriate stakeholders to provide feedback and guidance for VCU research.

ACTION: We will work with the Office of Vice President for Research and Innovation (OVPRI) to identify a formula for indirect cost recovery for units that engage in community-focused research, which is typically linked to funding with low indirect cost rates.

Objective F.2.3: Address barriers to collaboration across VCU units and incentivize transdisciplinary research collaboration.

In VCU's current budget model, indirect costs are recovered only by the home unit of the principal investigator. While faculty from other units may participate in the research project, there is no financial recompense for the indirect costs associated with their time. Additionally, administrative burden is often only increased by having a multidisciplinary team of investigators, with multiple administrators required to handle duplicative work to support the project. Instead of providing simple approaches to team science, our current infrastructure and processes favor investigators working in silos.

ACTION: We will work to detail the barriers to collaborative research and provide solutions to VCU leadership to encourage research collaboration across units.

Objective F.2.4: Ensure that institutes, centers and core resources have value across the university.

VCU institutes and centers are hubs of collaboration and multidisciplinary teamwork. Our core facilities offer important services and facilities that enable researchers to conduct essential work for their projects. While VCU has strength across these areas, many of our institutes, centers and core resources are under-used or under-supported.:

ACTION: Using the focused efforts of review committees led by the OVPRI, we will continue to invest and ensure that VCU institutes, centers and core resources meet the needs of the research enterprise.

ACTION: We will communicate the benefits and assets of these resources to the VCU community and promote efficient operations to enable collaboration.

Objective F.2.5: Increase research partnerships with other universities in Virginia, especially HBCUs.

Virginia is rich with universities that offer complementary expertise and programs to those at VCU. Locally, there are several HBCUs that are ideal partners for conducting research that reflects, represents and responds to the needs of diverse communities. While we collaborate with these institutions in some capacities, we have not fully realized the potential for more meaningful research partnerships.

ACTION: We will identify opportunities and methods to collaborate with faculty, students and constituents at other universities in Virginia, with a focus on HBCUs. We will enhance the diversity of our research teams and participants and identify new approaches to and ways of understanding the needs of the communities we serve.

Goal F.3: Accelerate discoveries by promoting a robust pipeline of diverse trainees through excellence in training programs.

Objective F.3.1: Increase opportunities for undergraduate students to engage in high quality research experiences.

VCU is committed to the REAL (Relevant, Experiential and Applied Learning) initiative, an academic experience involving hands-on learning activities directly relevant to the student's personal and professional goals. In many fields, involvement of undergraduate students in research is essential. Unfortunately, institutional funding for undergraduate student research does not come close to

meeting existing needs. Furthermore, the administrative support required to match students with mentors is inadequate.

ACTION: We will increase investment in these areas to benefit both students and researchers.

Objective F.3.2: Implement strong research training programs for diverse trainees and students.

Traditionally, the opportunities and resources necessary to build successful research programs have been preferentially provided to men and people from a limited range of backgrounds. These disparities have resulted in a research landscape that is not reflective of our national diversity. VCU, with its majority “minority” student population and impressive portfolio of externally funded programs for training new researchers from diverse backgrounds, is poised to assume a leadership role in correcting this imbalance. This effort can be part of a broader initiative to increase the number of externally funded training programs, which already strive for diversity, at VCU.

ACTION: Faculty who attract training grants should be rewarded for these efforts, especially as many of these opportunities do not include faculty salary support.

Goal F.4: Translate and communicate research to the community and engage in dialogue to promote and develop relevant and effective programs, policies and practices that advance society and lead to systems change.

Objective F.4.1: Promote the dissemination of research results to research participants and the broader community.

Publication of research results within one’s field is often a hallmark of successful research. Historically, communication to the public comes when a discovery is commercialized or when an internal communications team is made aware of its importance. This approach to the dissemination of research results can neglect to inform and educate participants in research and fail to spark change in the broader community. Understanding the breadth of research performed at VCU and how this research may improve society can increase the number of people interested in participating in research, promote an improved understanding of the many benefits of research and enhance the design of research studies by providing an opportunity for community feedback.

ACTION: We will develop university-wide guidelines to promote VCU research to

the broader community, including support for culturally and socially sensitive mechanisms of communication.

Objective F.4.2: Collaborate with community partners to design effective strategies to translate research into transformative outcomes.

VCU's strength in community engagement provides opportunities to develop strategic partnerships focused on identifying gaps between research and actionable outcomes for society. Conducting research does not end with publication and requires additional work to provide understanding of how research can most effectively benefit society. Collaborations with partners who work daily in the communities and might most directly benefit from research outcomes will allow VCU to effectively promote change and address societal challenges.

ACTION: By developing targeted pilot programs for translating research into societal change, we will develop programmatic templates that can be used across disciplines.

Objective F.4.3: Create systems of cyclical and continuous communication to ensure community needs inform research, which drives systems change, which impacts community needs.

A one-time snapshot of a community's needs cannot be used indefinitely. Research teams must continuously seek feedback from affected individuals and groups to ensure that adaptations are made to accommodate changes in society. A community-engaged approach to both process and quality improvement will lead to research outcomes that are more readily translated into solutions and improvements for the community.

ACTION: Community advisory boards and other infrastructure established for numerous improvements to VCU's research enterprise will assist in developing effective communication tools and protocols to ensure a continuous feedback cycle.