U.S. Senate Special Committee on Aging
Aging in South Carolina: Biomedical Research in the Palmetto State
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Clemson University Translational Aging Research and Engineering: Interdisciplinary Research and Innovation Programs in Bioengineering, Regenerative Medicine, and Population Health

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Senator Scott, Senator Collins, and distinguished guests, it is a privilege and honor to speak before you this morning. My name is Martine LaBerge, and I am a faculty member at Clemson University with an adjunct appointment in orthopaedic surgery at the Medical University of South Carolina. I also serve as Chair of the Department of Bioengineering at Clemson and as Executive Director of the Clemson University Biomedical Engineering Innovation Campus, known as CUBEInC. I sincerely thank you for the opportunity to provide testimony this morning about the impact of the exciting biomedical technology and health research led by Clemson University to ensure that older Americans can fulfill a longer, healthier and independent life.

As South Carolina's land-grant institution, Clemson University has tackled the socioeconomic burden of aging through an integrated, interdisciplinary approach. The result is significant, with impactful biomedical technology and health research, economic development, and education programs. We have taken as an opportunity that South Carolina is an ultimate retirement destination. In the Upstate, more than 21% of Oconee County residents are older than 65 years while 23% of residents of both Beaufort and Georgetown counties on our coast are considered elderly. As such, South Carolina is an ideal location to conduct research focused on the ability to age in place through use of innovative-care models and technology for managing chronic conditions and/or age-related disabilities as well as caregiver education and support. Our state is also an ideal platform for gerontology and geriatrics research and engineering; we are fully aware that the outcome of our work will impact our fellow citizens and our economy.

Clemson presents an extensive portfolio of research programs, initiatives, and partnerships developed to foster aging-related health research and innovations and workforce development. Our **Clemson University School of Health Research (CUSHR),** led by Dr. Windsor Sherrill, is a multidisciplinary unit of Clemson that facilitates medical research and scholarship in partnership with health care systems in the state. In partnerships with the Medical University of South Carolina (MUSC), the Greenville Health System (GHS), and the Greenwood Genetic Center, Clemson brings a wealth of research expertise, and the health care systems offer the clinical opportunities students and researchers need to put their ideas into action. Healthcare

practitioners and Clemson researchers work together to improve outcomes and to keep the patient as a focus. The result is breakthroughs in health care delivery, access, and affordability that make a difference in the doctor's office, the operating room, and beyond. For example, a true breakthrough at the forefront of our research agenda is regenerative medicine and precision medicine. With aging, diseased and failed organs and tissues must be replaced. Who would not dream of replacing an aging and diseased liver, heart, pancreas, or brain tissue with a new one? Considered utopian not too long ago, fabrication of organs is no longer a dream, it is a reality that Clemson helped pioneer with its bioprinting technology. Others may claim the concept, but 3D printing for producing a cellular construct was introduced by Clemson University researchers in 2003 and patented by Clemson in 2006. This technology has been licensed to Organovo. Through our Hansjörg Wyss Endowed Chair in Regenerative Medicine, our tissue engineering and regeneration research programs, our internationally renowned researchers, and our clinical partnerships, we can address the technological, clinical and ethical challenges associated with regenerative medicine and precision medicine to meet individual patient needs. The **Clemson-MUSC Bioengineering Program** was formally established in 2003 and is pivotal for regenerative medicine. The Program's mission is to bridge engineering and physical sciences with the life sciences disciplines to better understand fundamental biological and disease processes. The program is located on the MUSC campus in Charleston, where Clemson Bioengineering faculty and their research personnel maintain full-time laboratories and office space. This joint program provides a clinical setting that offers tremendous opportunities for both faculty and students to innovate and develop new technologies for precision medicine. Research must be accelerated and rapidly translated so that our nation's aging citizenry can be assured that their diseased and aging tissues can be replaced.

And in parallel, our quest for longer lasting and improved medical devices remains a priority. The affordability and availability of these medical devices and technology are known to be of great interest to the **Senate Special Committee on Aging**. Clemson is also at the forefront of medical device and technology research. In fact, our **Department of Bioengineering** is recognized worldwide as the birthplace of the field of biomaterials, the building blocks of medical devices. For more than 50 years, our bioengineering researchers have developed numerous technologies that have improved artificial joints, bone-implant fixation, bone-fracture fixation, and heart valve replacements, among others. We continue to develop patient-focused and outcome-driven bioengineering research projects to meet clinical needs. Our teams include students and healthcare practitioners and, where possible, patients.

For example, more than 600,000 knee replacements are performed annually in the United States. With an aging population staying in the workforce longer and obesity on the rise, demand for total knee replacement surgery is expected to exceed 3 million by the year 2030 according to a study published in the August 2013 issue of *Journal of Bone and Joint Surgery*. The Engage Knee System, a knee replacement that can be selectively locked in extension by patients with weakened knees and instability developed by Dr. John Desjardins and former PhD Bioengineering student Dr. Eric Lucas, is an example of innovation developed to meet special needs of the aging population. This research is part of a future in which patients adjust prostheses to fit activities at work and play. The pioneering work on elastin degradation in

tissues as a phenomenon of aging by Dr. Naren Vyavahare and his team has led to licensed technology aimed at preventing elastin degeneration to reduce signs of aging. Every year, more than 300,000 patients undergo replacement surgery after structural failure of their heart valves. When an aging patient suffers from severe heart-valve disease, the structure must be replaced by an implant. Dr. Vyavahare and his research group develop new technology aimed at increasing the functional lifetime of the device.

Approximately 25% of Americans over age 60 have diabetes; it affects functional status and risk of institutionalization for older patients. According to the American Diabetes Association, the total estimated cost of diagnosed diabetes in 2012 was $245 billion, including $176 billion in direct medical costs. Direct cost is largely attributed to glucose monitoring. Clemson bioengineering students, Kayla Gainey, Tyler Ovington, and Alex Devon developed a new, inexpensive type of test strip made of commonly available materials using bioprinting as a platform to develop the technology. Diabetics can be provided with low-cost testing equipment they need to manage their blood sugar. This technology was licensed to Accessible Diagnostics, with doctoral student Kayla Gainey serving as its chief technology officer.

The examples cited above are a few among many bioengineering success stories where university, state, and federal funding led to discoveries that have been translated to patient care. Clemson University in collaboration with the Medical University of South Carolina and the University of South Carolina have established the **South Carolina Medical Translational Technology program (SCMedTransTech).** The three universities have partnered with six hospitals in South Carolina, AnMed Health System, Bon Secours St. Francis Health System, Greenville Health System, MUSC Health, Oconee Medical Center, and Palmetto Health System, to support research aimed at developing clinically relevant technology and its rapid translation. SC MedTransTech focuses on the clinical potential of translational research and comprises a critical mass of researchers and innovators throughout the State of South Carolina who use a team approach where engineers, scientists, students, and clinicians work together to develop technology to address clinical needs. Through this unique partnership between universities, hospitals and Stryker, a leading medical device manufacturer, technology licensing and commercialization are optimized. Our goal is to continue developing in-state start-up companies based on our technologies by stimulating an entrepreneurial culture within the state's biomedical engineering inventors. This culture is practiced and exemplified at CUBEInC.

The Clemson University Biomedical Engineering Innovation Campus (CUBEInC), located on the Patewood campus of Greenville Health System in Greenville, SC, is aimed at educating and nurturing investigators and leaders who can develop, implement, and market innovative scientific and technological knowledge related to aging and related disabilities. CUBEInC integrates education, research and economic development in medical technology and attracts clinical and industrial participation with multi-investigator research laboratories. It provides the environment essential to faculty and students to conduct research to improve patient care delivery and disease diagnosis in collaboration with healthcare practitioners. Research conducted through this strategic initiative enhances patient-oriented outcomes while stimulating economic growth in the Upstate. Targeted research areas include orthopaedic

engineering, cardiovascular science and engineering, tissue engineering, bioimaging, advanced surgical technologies, and regenerative medicine, among others. CUBEInC is supported by a robust clinical trial program at Greenville Hospital System (GHS) and its Institutional Review Board resources for the use of humans in research. With the financial support of the South Carolina Life Sciences Act, industry partners, and Greenville Health System, CUBEInC plays a key role in the growth of South Carolina's biotech industry, finding new ways of diagnosing and treating illness associated with aging. At CUBEInC, we also educate a graduate engineering workforce at the forefront of medical device recycling and reprocessing through a unique certificate integrated in the GreenMD program led by Dr. Melinda Harman. Reprocessing of medical devices helps healthcare providers enhance patient care by controlling supply costs and maintaining safety and quality control. Studies have shown that up to 50% of healthcare cost related to medical devices, including their disposal as biohazardous waste, can be saved through well-executed reprocessing programs. The pioneering research in regenerative medicine in the laboratory of Dr. Dan Simionescu at CUBEInC in collaboration with scientists at Clemson, the National Cardiovascular Center in Osaka, Japan, and the Cardiovascular Surgery Center in Cape Town, South Africa, has led to the development of tissue-engineered scaffolds from decellularized blood vessels. Scaffolds are treated with agents to control their *in vivo* biodegradability and enriched with specific growth factors to promote host cell infiltration, remodeling and revascularization. This technology offers a unique potential to create functional and viable tissue constructs for patients requiring organ replacement.

Through the School of Health Research, Clemson uses an integrated approach to tackle health research where bioengineers, public health scientists, construction scientists, architects, psychologists, sociologists, and industrial engineers, to name a few, work in teams to address aging and health disparities. The **Clemson University Institute for Engaged Aging (IEA),** led by Dr. Cheryl Dye, provides the nexus for Clemson faculty conducting research to promote quality of life for older adults. Faculty Associates from all Clemson colleges collaborate on research teams to explore aging, from the cellular level to the built environment. Institute faculty are brought together with researchers at the Greenville Health System, University of South Carolina (USC), Palmetto Health System, and the Medical University of South Carolina (MUSC) through the South Carolina Aging Research Network (SCARN) and its annual Aging Research Day as well as through SeniorSMART™, the Smart State Center of Economic Excellence focused on promoting independent living of older adults. SeniorSMART™, a partnership between Clemson University, USC and MUSC, has objectives to **S**upport **M**obility, **A**ctivity, **R**ehabilitation, and **T**echnology for older adults.

Clemson University researchers have developed and implemented projects using community volunteer **Health Coaches** (HCs) to mentor peers in self-management of chronic conditions and to have trained healthcare clinical staff in health coaching skills. These efforts have yielded improvements in the health of HC clients and in the knowledge and skills of healthcare providers. The projects respond to the challenge of health reform legislation mandated by section 3026 of the Affordable Care Act and also address the Triple Aim framework of access, population health, patient experience of care, quality, and cost efficiency.

Recently, Clemson University partnered with Self Regional Healthcare to develop the **Center for Human Genetics**, a core campus adjacent to the Greenwood Genetic Center in Greenwood, SC. Clemson researchers and companies are engaged in human diagnostics, cognitive development, central nervous system, autism, birth defects, cancer, and inflammatory diseases. The collaborative seeks discoveries in genetic diagnostics and epigenetic therapeutics. In collaboration with the Greenwood Genetic Center, Clemson scientists develop diagnostics and therapeutics that have the potential to provide immediate diagnosis of a variety of diseases.

Clemson University and GHS Roger C. Peace Rehabilitation Hospital have partnered to address the needs of South Carolina's population of aging drivers by developing objective training and assessment programs in addition to developing and evaluating new products and services. This unique collaboration, led by Dr. Johnell Brooks of the **Department of Automotive Engineering**, houses university laboratories within a major healthcare system for cutting-edge multidisciplinary research with strong industry relationships. The partnership strives to be the recognized national leader, enabling the aging population to drive as long as safely possible through research and innovation.

At Clemson University today, more than 150 researchers and scientists are conducting biomedical research that relates to aging. The examples above don't begin to reveal the wealth of knowledge they are making. But all have something in common: the quest for funding, which is especially difficult for translational research. Federal support for biomedical technology and aging research must keep up with inflation, and federal support for translational research and accelerated innovation must be given priority. NIH funding today is 25 percent less than the purchasing power of 10 years ago. As a result, the US government is spending $25 on care for every dollar spent on finding a cure. And, this cost of care does not even take into consideration lost earning potential or the significant burden placed on families and care givers of elders.

In closing, I sincerely thank you for the opportunity to represent my colleagues and Clemson University and to share with you our success with a model based on collaboration and partnership, as well as our engagement in biomedical and health research to improve the quality of life of our seniors. Through our research, we are dedicated to transform economic development and the wealth of our state. South Carolina's assets, talent and leadership undoubtedly make it the ultimate aging-in-place destination. We look forward to working with you to fulfill the mission of the Special Committee on Aging.