The Mayo Model of Research is a set of principles that applies the core value of Mayo Clinic — the needs of the patient come first — to the role of research. As an academic medical center focused on innovation, Mayo Clinic advances research to transform the practice of medicine. Today, as throughout Mayo Clinic history, research fuels the engine of innovation by providing the opportunity for clinicians and scientists to work together to solve patients’ most serious, complex and rare conditions.

Team science and collaboration are essential to how we operate within the Mayo Model of Research. This unique model has three priorities: discovery, translation and application:

**DISCOVERY**

*Accelerating discoveries through team science collaborations for unmet patient needs across the nation*

Bringing together experts from diverse settings, we are broadening the scope and diversity of biomedical collaborations.

**TRANSLATION**

*Bridging basic science discoveries into clinical trials and improvements in the treatment and healing of complex conditions*

Physicians and scientists work together to discover new ways to improve health; translate those discoveries into evidence-based treatments, processes and procedures; and apply this knowledge to advance the boundaries of medical care.

**APPLICATION**

*Scaling medical advances into innovations and commercial opportunities that strengthen the care of patients at Mayo and beyond*

Mayo Clinic is committed to ensuring that the research we do and the care we provide are constantly infused with new knowledge to solve the most serious and complex medical challenges for humanity — one patient at a time. Investment in biomedical research at Mayo Clinic yields answers to rare, complex medical conditions. It attracts and cultivates a diverse workforce. And, it transforms health care and improves the lives of patients across the world.
OVERVIEW

RESEARCH AT MAYO CLINIC

Mayo Clinic’s research accelerates the discovery, translation and application of life-changing therapies, surgical procedures and technologies so our patients can receive exactly the care they need when it’s needed most.

With research facilities on Mayo’s Arizona, Florida and Minnesota campuses, we have the ability to investigate the full scope of research, from cell mechanisms to patient treatments offered in the clinic, despite geographic barriers. We have nearly 400,000 square feet of research laboratory space. Plans include investment for growth in size and capability of research over the next two decades.

We are dedicated to strengthening our research workforce and committed to recruiting and engaging individuals with diverse thoughts, ideas and backgrounds to solve complex problems and adapt to change.

Other highlights of our research enterprise include:

- Over 3,800 full-time personnel including 1,000 research investigators, 234 full-time scientific faculty and 740 physicians who are actively involved in research.
- Investments in research each year that result in hundreds of new clinical trials. In 2017, our research budget was $750.5 million, with $446.4 million from external funding and $304.1 million from Mayo-based funding including practice operations, philanthropic gifts and diversified activities.
- More than 2,800 new research protocols in 2017, and more than 12,000 active studies involving human participants in progress.
- More than 4,980 research grants and contracts.
- Total of $306 million in National Institutes of Health (NIH) funding in 2017. In recent years, Mayo Clinic has ranked in the top 25 academic medical centers in terms of the amount of NIH funding received.
- Core facilities that include several robotic freezers capable of storing 3.5 million DNA samples.

THE GLORY OF MEDICINE IS THAT IT IS CONSTANTLY MOVING FORWARD, THAT THERE IS ALWAYS MORE TO LEARN.

—William J. Mayo, M.D.
As you can see in the 2017 Research Funding chart (Figure 1), funding sources are Mayo Clinic (including grateful benefactors), external sources, the U.S. government, industry and other extramural sources. Research dollars transform the practice of medicine, especially when focused in areas of unmet need — cardiovascular, neuroscience, oncology and transplant, among others.

Mayo has significantly increased its research funding as traditional sources, such as the National Institutes of Health, have remained flat or increased only slightly over the same period (Figure 2). This investment has accelerated our ability to leverage the Mayo Model of Research through increased collaborations with government, academia and industry.

In 2017, Mayo’s total budget for education and research programs exceeded $1 billion, and Mayo Clinic and benefactors contributed more than $556 million of that total. Mayo received $306 million in NIH funding in 2017.

*Mayo Funding is a combination of practice operations, philanthropic gifts and diversified activities

NIH budget comparison 2005-2017: $28.6B–$34.3B
SEVERAL ENGINES ADVANCE THE WORK OF OUR RESEARCH ENTERPRISE

The Center for Biomedical Discovery investigates the origin of disease and how cellular mistakes can lead to illness. By focusing on biological processes like aging, metabolism and immunity, researchers in the center learn about complex diseases such as cancer, fibrosis and diabetes. This knowledge fuels development of breakthrough therapies and critical advances in patient care.

Bringing together research teams made up of molecular and cell biologists, physiologists, physicians, engineers and geneticists, the center’s collaborative approach helps Mayo Clinic solve the most complex and serious medical challenges.

The center is organized into three platforms that, together, address the molecular aspects of diseases that strike virtually every organ in the body:

- Immunity and Fibrosis: Examines the immune system’s role in disease and the cellular mechanisms driving organ fibrosis.
- Cancer and Cell Aging: Explores the molecular basis for diseases of aging and cancer.
- Metabolism and Molecular Nutrition: Investigates metabolic disturbance and diseases such as obesity.
The **Center for Regenerative Medicine** focuses on accelerating regenerative science and translational research into patient care.

Through scientific discovery and clinical research, we are learning how to trigger the natural healing response and amplify the body’s internal signals to regenerate.

Regenerative medicine therapies address the health care challenges and quality-of-life issues many patients face. Heart disease, stroke, diabetes and osteoarthritis are examples of chronic conditions that are long-lasting and do not resolve on their own.

Regenerative medicine goes beyond disease management in search of therapies that will support the body to repair, regenerate and restore itself back to a steady state of well-being. Our focus continues to be driven by unmet patient needs.

- Mayo Clinic is conducting, participating in, or monitoring more than 100 regenerative medicine clinical projects and trials.
- A new manufacturing platform will accelerate production of large quantities of stem cells, enough to scale up regenerative clinical trials.
- The FDA allowance of this latest technology establishes Mayo Clinic among the first automated stem cell manufacturing sites nationwide. The platform is an enterprise-wide resource for Arizona, Florida and Minnesota and will help expedite rapid translation of novel regenerative products for unmet patient needs.

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The **Center for Individualized Medicine** uses sophisticated genomic technologies to define relationships between an individual’s disease and their unique genome. In this way, we end diagnostic uncertainty, develop new ways to identify and treat genomic alterations, and pioneer how we use biobanks in this new era of medical research. Here are some examples of how we bring the power of genomics to everyone.

- The application of pharmacogenomics, called PGx, is one way we individualize health care. We now routinely sequence the genes that control how medications are broken down and absorbed into your body. What we find is embedded in Mayo Clinic’s electronic health record where providers are alerted to possible drug-gene issues. This is a proactive way to identify genetic variants that negatively affect the medications you take.
- Biobanks are important because they provide researchers ready-access to patient data and push the discovery of new biomarkers. Mayo Clinic was awarded
the honor of leading the national biobank, called the All of Us Research Program. Through this landmark effort, we will store blood and tissue samples from 1 million or more participants. The program will also represent the nation’s diversity by collecting data from people who historically have been underrepresented in research.

- If you have an inherited cancer, there’s a 50 percent chance someone in your immediate family has the same genetic mutation that could also develop into cancer. We aim to identify inherited cancers and better detect cancer in people whose disease would otherwise go undetected. If your genomic screening shows a risk for cancer, we find proactive clinical strategies that are right for you, such as earlier and more frequent skin exams, colonoscopies, breast imaging, circulating DNA biomarkers or preventive surgeries.

The Mayo Clinic Cancer Center is the only National Cancer Institute-designated comprehensive cancer center with three locations — in Phoenix, Arizona; Jacksonville, Florida; and Rochester, Minnesota. Mayo Clinic has received funding as an NCI-designated Cancer Center since 1973.

The Mayo Clinic Cancer Center’s NCI designation means the clinic’s nearly 400 renowned physician researchers and scientists carry out team-based, patient-centered research to develop the latest technologies and treatments to address unmet patient needs. As a result, the 120,000 people with cancer who come to the clinic each year have access to hundreds of clinical trials in all phases, including an Early Cancer Therapeutics Clinic that offers patients whose cancers haven’t responded to standard treatments the opportunity to join early-phase clinical trials of potential new treatments.

The Mayo Clinic Cancer Center has 10 major cancer research programs focused on providing medical solutions for cancer patients. These research programs include six highly competitive NCI Specialized Program of Research Excellence (SPORE) grants supporting research in breast cancer, lymphoma, multiple myeloma, ovarian cancer, pancreatic cancer, and liver and biliary tract cancer.

Mayo Clinic Cancer Center also plays a leadership role in the nation’s clinical trial study groups. It is a lead academic participating site in the National Clinic Trials Network (NCTN), a cooperative group program of the NCI. The Cancer Center also receives NCI funding to fulfill two key roles for the Alliance for Clinical Trials in Oncology, serving as the Alliance statistics and data center and as the Alliance research base for the NCI Community Oncology Research Program (NCORP).
Experts engage in research across Mayo Clinic campuses in Rochester, Minnesota; Phoenix/Scottsdale, Arizona; and Jacksonville, Florida.
The **Mayo Clinic Robert and Arlene Kogod Center on Aging** is focused on discovering and developing interventions to increase health span — the healthy, productive time in life — and improve the quality of life for older adults. The center has seven research programs designed to change how the health care system examines the growing population of aging patients:

- Aging Bone and Muscle
- Cardiovascular Function and Aging
- Cellular Senescence
- Translation and Pharmacology
- Healthy Aging and Independent Living
- Metabolism, Nutrition and Aging
- Regenerative Medicine and Aging

One of the center’s greatest strengths is its ability to conduct translational research — from initial discovery in basic science laboratories through clinical trials with patients, conducting every phase of this research in-house, at Mayo Clinic.

- James Kirkland, M.D., Ph.D., and collaborators in the Kogod Center and several other institutions published preclinical findings in *Nature Medicine* that showed senolytic drugs improve function and life span in old age in mice. The findings were reported in more than 50 news outlets around the world, including *Time*, *U.S. News & World Report* and *Newsweek*.

- The senolytic agents discovered in mouse models at Mayo and reported in 2015 have now been shown to increase life span and health span and delay onset of or treat multiple chronic diseases, including cancers, cardiovascular diseases, dementias, osteoporosis, dementia, diabetes, arthritis, lung fibrosis, several liver diseases, complications of chemotherapy or radiation, complications of organ transplantation, frailty and muscle weakness.

- Ten additional senolytic drugs have been discovered at Mayo and with collaborators since 2015.
The Center for Clinical and Translational Science (CCaTS) serves as a central hub for institutional advancement of research and education at Mayo Clinic. It takes an average of 17 years for a new discovery or innovation to make its way to the patient. The goal of CCaTS is to shorten that timeline, accelerating the transformation of scientific discoveries into solutions for unmet patient needs. The center does this by providing the infrastructure needed to support the full spectrum of medical research — connecting researchers to the communities, resources and information they need to keep science moving forward.

**Highlights:**

- The center currently supports 317 grants and nearly 200 unique principal investigators, facilitating studies reflecting more than $75 million in extramural funding.
- CCaTS works with diverse communities as key stakeholders and collaborators in the research process. The Community Engagement in Research Program has catalogued 34 community-based participatory research partnerships and has relationships with more than 300 community groups.
- Education: To educate the next generation of clinical researchers and biomedical entrepreneurs, CCaTS offers a variety of specialized educational programs and services. To date, 46 scholars (half of them women) have completed the intensive KL2 Mentored Career Development Program and have gone on to receive more than 187 extramural grants valued at more than $209 million.
The Mayo Clinic Robert D. and Patricia E. Kern Center for the Science of Health Care Delivery uses data-driven science, human-centered design and knowledge management to solve the most pressing challenges facing patients today. As a result, the center transforms the experience of health care for both patients and providers.

- The center is addressing the nation’s opioid epidemic by leading research across Mayo Clinic to develop evidence-based prescribing guidelines. This research has led to custom guidelines for different surgical areas at Mayo and a reduction in prescriptions while considering the ideal dose for individual patients. The research is also informing state and national efforts to curb opioid overprescribing.

- Recognizing the vast potential of augmented human intelligence, Mayo Clinic is establishing a central office in the center to support initiatives in data analytics, informatics and knowledge management. This expertise will allow researchers and physicians in all fields to make transformational discoveries that could not happen without the power of big data, artificial intelligence and machine learning.

- With AskMayoExpert, the center links health care providers with a point-of-care tool, including disease management protocols, care guidelines, treatment recommendations and condition-specific reference materials.

Through an international network of member practices, providers serving 12 million patients have access to Mayo expertise through AskMayoExpert.
At Mayo Clinic, the needs of the patient come first. Part of this commitment involves conducting medical research to find solutions to unmet patient needs. Through clinical research, including clinical trials, researchers can better understand how to diagnose, treat and prevent health problems.

Mayo Clinic is a leader in clinical trials. Since 2012, Mayo has consistently ranked in the top five among academic medical centers for number of registered clinical trials. In addition, Mayo Clinic has implemented clinical research administration covering all locations, which streamlines the ability to conduct trials across geographic barriers. Inpatient and outpatient staff includes specially trained nurses, laboratory technicians and others who stand ready to carry out clinical research protocols with an emphasis on patient safety and research quality.

**Mayo Clinic research collaborates to:**

- Attract high-impact trials to Mayo Clinic.
- Recruit and retain the right participants.
- Control expenses through efficient administration and execution.
- Expedite study activation while maintaining the highest level of accuracy.
- Speed the translation of new science into practice.

12,000+ Active human research studies

2,800 New human research studies in 2017
The Mayo Clinic research journey has no end. Mayo researchers relentlessly pursue discoveries that will deliver hope and better health to people today and for generations to come.

**Research highlights from 2017 include:**

- The National Institutes of Health renewed one of Mayo Clinic’s largest government grants through 2022. The $48.8 million award from the NIH’s National Center for Advancing Translational Sciences supports researchers in translating discoveries to address unmet patient needs and supports efforts ranging from educational programs for researchers to community engagement efforts for research participants.

- Neurologic research progressed in using electrical stimulation of the brain and spinal cord to address paralysis, memory, epilepsy and stroke.

- A new transatlantic partnership was announced with Mayo Clinic, the University of Oxford and Oxford University Hospitals NHS Foundation Trust to underpin collaboration in patient care and medical research.

- Stem cell research included a rocket launch from NASA’s Kennedy Space Center of several samples of donated adult stem cells from a research laboratory at Mayo Clinic’s Florida campus.

- A new manufacturing platform will accelerate production of large quantities of stem cells, enough to scale up regenerative clinical trials. The FDA allowance of this latest technology establishes Mayo Clinic among the first automated stem cell manufacturing sites nationwide.

- The NIH opened national enrollment for the All of Us Research Program in May, aimed to advance individualized prevention, treatment and care for people of all backgrounds. In 2016, Mayo Clinic was awarded $142 million in funding over five years by the NIH to house the nation’s biobank, a repository where the biospecimens are stored. The goal is to speed up health research breakthroughs by collecting sample biospecimens from volunteers across the U.S. The program seeks to enroll 1 million or more volunteers from communities that have been underrepresented in research, thereby making the program the largest, most diverse resource of its kind.
Mayo Clinic researchers have discovered that a molecular communication pathway — thought to be defective in cancer — is a key player in determining the effectiveness of measles virus oncolytic cancer treatment in ovarian and aggressive brain cancers. This discovery enabled researchers to develop an algorithm to predict treatment effectiveness in individual patients.

Researchers discovered six genes that contain mutations that may be passed down in families, substantially increasing a person’s risk for pancreatic cancer. Because researchers found these genetic mutations in patients with no family history of pancreatic cancer, they are now recommending genetic testing for all pancreatic cancer patients as the new standard of care.

Mayo Clinic researchers broke new ground by using senolytic drugs in mice to remove senescent or dysfunctional cells. The research seeks to uncover whether this procedure can remove or limit age-related conditions and extend life. The findings from Mayo Clinic researchers and collaborators provide a foundation on which to move forward in this area of aging research.

Research is expanding on Mayo Clinic’s Florida campus. The Dorothy J. and Harry T. Mangurian, Jr., Building is a medical and research destination for cancer and neurological care. Additionally, the Discovery and Innovation Building, opening in 2019, will provide stem cell production capabilities so researchers can accelerate stem cell manufacturing. The building will also include space for lung restoration, making more donated lungs viable for transplantation, and a bioincubator designed to pair Mayo Clinic expertise with start-up ventures for more innovations in health care.

One Discovery Square, now under construction as part of the Destination Medical Center public-private partnership in Rochester, Minnesota, will offer an innovative research hub. The space will be a catalyst to help establish more collaborative partnerships and businesses that incorporate Mayo Clinic intellectual property.
For information on supporting the Mayo Model of Research, please contact:

DEPARTMENT OF DEVELOPMENT

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