

ANNUAL REPORT ON
RESEARCH
FY 2016
FINANCIAL SUMMARY



OFFICE OF
RESEARCH
UNIVERSITY OF MICHIGAN



**Investments in university
research are investments in
the future of our students, our
communities, our nation, and
our global society.**



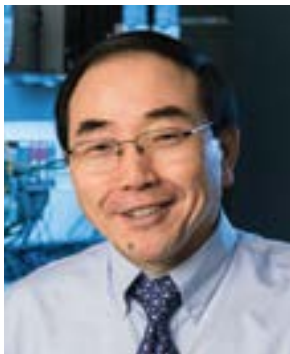
Cover: Leslie E. Decker, Ph.D. student in ecology, studies the disease dynamics of the monarch butterfly and its protozoan parasite in the context of global change.

Photo: Austin Thomason/Michigan Photography

This Page: Santiago Schnell, professor of molecular and integrative physiology, works in the Brehm Center for Diabetes Research.

Photo: Scott R. Galvin/Michigan Photography

OVERVIEW



In fiscal year 2016, which ended on June 30, 2016, research expenditures at the University of Michigan grew by 7.2 percent to a record high of \$1.39 billion. The growing investment in U-M research is a measure of the confidence

of our sponsors in the value that our faculty and students bring to society. This funding enables us to continue to anticipate—and to accelerate—continuing advances that underlie progress and prosperity. And the involvement of our undergraduate and graduate students in the process of research helps us prepare them for the challenges they will face in whatever careers they choose to pursue.

The federal government has long been the major sponsor of research at our nation's universities, and last year, sponsorship at U-M from the various agencies of the federal government grew by 7.4 percent to a total of \$792 million, reversing a downward trend in recent years. This funding is important not only for its size, but also for its breadth, encompassing such disparate fields as public policy, economics, the arts, and social science, as well as the physical sciences, engineering, and medicine. Moreover, it funds much of the basic science that has laid the groundwork for many of the most important innovations of our times in the full spectrum of areas ranging from computers to medicine.

Research expenditures funded by industry grew to \$85 million, an 8.6 percent increase over the previous year, and a new record high. Although this number is small in comparison to the federal investment, it brings important benefits to our research and educational mission. By working with industry, our

faculty and students can not only stay abreast of the emerging needs, interests, and perspectives of industry, but also help translate the ideas and insights that arise from our research into practice.

Industry engagement is also a key component of U-M's commitment to examine some of the most pressing challenges our society faces, and to explore the emerging opportunities at the frontiers of research for addressing them. With the guidance and support of the U-M Office of Research (UMOR), the university is making progress in building ambitious partnerships with such goals as improving the safety and sustainability of vehicles, better targeting health care to the needs of individuals, improving the techniques of social sciences, and optimizing the educational process to individual needs.

This year's results show that the pipeline for new research at U-M remains strong. The total number of research contracts awarded to U-M in FY 2016 rose by 3.6 percent, while the total dollar value of those awards rose by about 14.8 percent. Looking further ahead, the number of proposals submitted for new research awards dropped by 3.5 percent, but the dollar value increased by .42 percent.

Investments in university research are investments in the future of our students, our communities, our nation, and our global society. With a strong performance in FY 2016 and a reputation as one of the world's leading research universities, U-M is well positioned to continue to provide the research and education that drive innovation and change.

A handwritten signature in black ink, appearing to read 'S. Jack Hu'.

S. Jack Hu
Vice President for Research
J. Reid and Polly Anderson Professor
of Manufacturing

FACULTY AWARDS + SCHOLARSHIPS

A selection of honors received by U-M faculty from July 1, 2015 to June 30, 2016.

GUGGENHEIM FELLOWSHIPS

- **Victor Caston**, professor of philosophy; professor of classical studies
- **Charles R. Doering**, Nicholas D. Kazarinoff Collegiate Professor of Complex Systems, Mathematics and Physics; director of the Center for the Study of Complex Systems
- **Mark Newman**, Anatol Rapoport Distinguished University Professor of Physics; professor of complex systems
- **Derek R. Peterson**, professor of history; professor of Afroamerican and African studies
- **Valerie Traub**, Frederick G. L. Huetwell Professor of English and Women's Studies; Adrienne Rich Distinguished University Professor of English and Women's Studies

ALFRED P. SLOAN RESEARCH FELLOWS

- **Michael Cafarella**, Morris Wellman Faculty Development Professor of Computer Science and Engineering; associate professor of electrical engineering and computer science; faculty associate at the Survey Research Center
- **Honglak Lee**, Morris Wellman Faculty Development Professor of Computer Science and Engineering; associate professor of electrical engineering and computer science
- **Paul Zimmerman**, assistant professor of chemistry

ANDREW W. MELLON FOUNDATION NEW DIRECTIONS FELLOWSHIP

- **Jason De León**, assistant professor of anthropology

AMERICAN ACADEMY OF ARTS AND SCIENCES (AAAS)

- **John Carethers**, John G. Searle Professor of Internal Medicine; professor of human genetics; chair of the Department of Internal Medicine
- **Magdalene Lampert**, professor emerita of education
- **Melanie Sanford**, Moses Gomberg Distinguished University Professor of Chemistry; Arthur F. Thurnau Professor of Chemistry
- **George Tsebelis**, Anatol Rapoport Collegiate Professor of Political Science

NATIONAL ACADEMY OF MEDICINE

- **Kathleen Cho**, Peter A. Ward Professor of Pathology; professor of internal medicine
- **Laurie McCauley**, dean of the School of Dentistry; William K. and Mary Anne Najjar Professor of Periodontics; professor of dentistry; professor of pathology
- **Robert Neumar**, chair of the Department of Emergency Medicine; professor of emergency medicine
- **Marita Titler**, associate dean for practice and clinical scholarship development at the School of Nursing; Rhetaugh Graves Dumas Professor of Nursing

NATIONAL ACADEMY OF SCIENCES

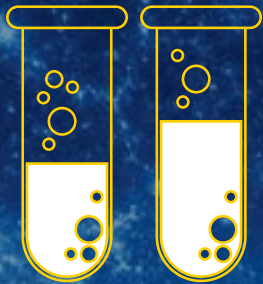
- **Stephen Forrest**, Peter A. Franken Distinguished University Professor of Engineering; Paul G. Goebel Professor of Engineering; professor of electrical engineering and computer science; professor of materials science and engineering; professor of physics
- **Judith Irvine**, Edward Sapir Collegiate Professor of Linguistic Anthropology
- **Susan Murphy**, Herbert E. Robbins Distinguished University Professor of Statistics; research professor at the Survey Research Center; professor of psychiatry
- **Melanie Sanford**, Moses Gomberg Distinguished University Professor of Chemistry; Arthur F. Thurnau Professor of Chemistry

FELLOWS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

- **John Carethers**, John G. Searle Professor of Internal Medicine; professor of human genetics; chair of the Department of Internal Medicine
- **James Dalton**, dean of the College of Pharmacy; professor of pharmaceutical sciences
- **William Giannobile**, William K. and Mary Anne Najjar Professor of Dentistry; professor of biomedical engineering
- **Peter Green**, Vincent T. and Gloria M. Gorguze Professor of Engineering; professor of materials science and engineering; professor of macromolecular science and engineering; professor of chemical engineering
- **Timothy McKay**, Arthur F. Thurnau Professor of Physics; professor of astronomy; professor of education
- **Edward Stuenkel**, director of the doctoral program in neurosciences; professor of molecular and integrative physiology

6,547

RESEARCH
LABS + ROOMS



2,070

RESEARCH
AWARDS
VALUED AT
MORE THAN

\$1B



2.8M

SQUARE FEET
OF LAB SPACE
FOR RESEARCH
AND TEACHING

MICHIGAN RESEARCH

AT A GLANCE

43,651

STUDENTS



1,400

UNDERGRADS PARTICIPATED
IN RESEARCH LAST YEAR
THROUGH UROP

\$1.39B

RESEARCH EXPENDITURES

TECH TRANSFER



12

NEW BUSINESS
STARTUPS

428

NEW INVENTION
REPORTS

103

GRAD PROGRAMS
RANKED IN

TOP 10

BY U.S. NEWS &
WORLD REPORT



\$85M

INDUSTRY-SPONSORED RESEARCH

Cancer decoy

A small, implantable device that researchers are calling a cancer “super-attractor” could eventually give doctors an early warning of relapse in breast cancer patients and even slow the disease’s spread to other organs in the body.

The sponge-like device developed at U-M is designed to attract the cancer cells that emerge in the bloodstream during the early stages of cancer’s recurrence—before tumors form elsewhere in the body. A new study in mice shows that the device attracts detectable numbers of cancer cells before they’re visible elsewhere in the body. It also shows that the cancer cells spread to the lungs 88 percent more slowly in the mice that received the implants.

“We set out to create a sort of decoy—a device that’s more attractive to cancer cells than other parts of the patient’s body,” said Lonnie Shea, the William and Valerie Hall Department Chair of Biomedical Engineering at U-M. “It acts as a canary in the coal mine. And by attracting cancer cells, it steers those cells away from vital organs.”

Surgery safety

Brain tumor tissue can be hard to distinguish from normal brain tissue during surgery. Neurosurgeons use their best judgment in the operating room, but often must guess exactly where the edges of the tumor are while removing it.

Even the state-of-the-art imaging equipment in today’s operating rooms doesn’t make the process much easier. But a new laser-based microscopic technology may help surgeons see the difference between tumor tissue and normal brain tissue in real-time.

Called a stimulated Raman scattering (SRS) microscope, it’s now being tested at the U-M Health System. Researchers have used the SRS microscope to image several patient samples — the first clinical test of the technology.

“It allows the surgical decision-making process to become data driven instead of relying on the surgeon’s best guess,” said Daniel Orringer, the U-M neurosurgeon piloting the technology.



Photo: UMHS Department of Communications

RESEARCH HIGHLIGHTS

U-M research spans nearly every field from medicine and engineering to public policy and the arts. Here is a selection of key research achievements from across campus during FY 2016.

Gravitational waves

For the first time, scientists observed ripples in the fabric of spacetime called gravitational waves, arriving at Earth from a cataclysmic event in the distant universe.

The discovery confirmed a major prediction of Albert Einstein’s 1915 general theory of relativity and opened an unexpected new window onto the cosmos.

“This first observation of gravitational waves opens up a new field of astronomy, one in which we ‘listen’ to the vibrations of space itself, using instruments of unprecedented sensitivity,” said Keith Riles, U-M professor of physics.

Gravitational waves carry information about their dramatic origins and about the nature of gravity that cannot otherwise be obtained.

A collaboration that includes more than 1,000 scientists from universities around the world worked on this project. U-M researchers joined the hunt for gravitational waves in 1997 as charter members of the collaboration.

Credits: R. Hurt/Caltech-JPL

Kidney on a chip

U-M researchers used a “kidney on a chip” device to mimic the flow of medication through human kidneys and measure its effect on kidney cells.

The new technique could lead to more precise dosing of drugs, including some potentially toxic medicines often delivered in intensive care units.

Precise dosing in intensive care units is critical, as up to two-thirds of patients in the ICU experience serious kidney injury. Medications contribute to this injury in more than 20 percent of cases, largely because many intensive care drugs are potentially dangerous to the kidneys.

“When you administer a drug, its concentration goes up quickly and it’s gradually filtered out as it flows through the kidneys,” said Shuichi Takayama, U-M professor of biomedical engineering. “A kidney on a chip enables us to simulate that filtering process, providing a much more accurate way to study how medications behave in the body.”



Makeup of methane

Like the poet, microbes that make methane are taking chemists on a road less traveled: Of two competing ideas for how microbes make the main component of natural gas, the winning chemical reaction involves a molecule less favored by previous research, something called a methyl radical.

The work is important for both producing methane as a fuel source and tempering its role as a powerful greenhouse gas. Understanding how microbes generate methane might help scientists find ways to control pollution or make fuels.

“Methane is a greenhouse gas and, at the same time, one of the major sources of energy used worldwide,” said lead author Stephen Ragsdale, U-M professor of biological chemistry. “Detailed knowledge of the microbial mechanism may lead to major breakthroughs for designing efficient catalytic processes for converting methane into other chemicals.”

Prescription pain

High-school students who legitimately use an opioid prescription are one-third more likely to abuse the drug by age 23 than those with no history of the prescription, according to a U-M study.

These teens abuse OxyContin, Vicodin, and other prescription pain relievers to get high, relax, or feel good after leaving high school despite their strong disapproval of marijuana use, U-M researchers say.

Their findings are timely in light of the U.S. Food and Drug Administration’s decision to approve use of OxyContin for children ages 11 to 16, they say.

“Most likely, the initial experience of pain relief is pleasurable and this safe experience may reduce perceived danger,” said the study’s lead author Richard Miech, U-M research professor at the Institute for Social Research. “A pleasurable and safe initial experience with a drug is a central factor in theories of who goes on to misuse drugs.”

INTERDISCIPLINARY INITIATIVES

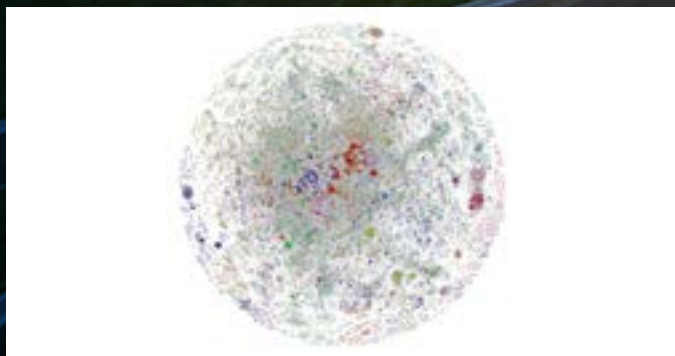
The hallmark of the University of Michigan's research enterprise is excellence across the breadth of its 19 schools and colleges, coupled with a strong culture of cooperation among academic disciplines. Building on these core strengths, the university has launched several major initiatives that bring together the perspectives of diverse disciplines, as well as of industry partners to address the complex challenges that underlie progress in areas of broad potential impact.

Data Sciences Initiative

Progress in fields ranging from medicine to transportation relies critically on the ability to gather, store, search, and analyze "big data"—collections of information so vast and complex that they challenge traditional approaches to data processing. In FY 2016, U-M announced an investment of \$100 million to hire as many as 40 new faculty, as well as to engage existing faculty to explore the potential of big data. The funds will also expand U-M's research computing capacity; strengthen data management, storage, analytics, and training resources; foster new methodological approaches to big data; and provide educational opportunities for students pursuing careers in data science. The initiative supports interdisciplinary data-related research in four key areas: connected and automated vehicles, learning analytics, personalized healthcare, and online survey research. Industry engagement is central to progress, with a particular focus on the automotive, chemical, finance, health care, and pharmaceutical sectors.

midas.umich.edu/dsi

Graphic: Jason Owen-Smith



Mcity

U-M launched the Mobility Transformation Center (MTC) in 2014 with the goal of laying the foundations for commercially viable systems of connected and automated—including driverless—vehicles. Integrating the most promising approaches to mobility into a coordinated system could dramatically reduce motor vehicle fatalities, as well as energy consumption and carbon emissions. In addition to working with local, state, and federal government, MTC has engaged the support of more than 60 companies from a wide range of industries around the world interested in shaping the future of mobility. In FY 2016, the MTC made a major step forward with the opening of Mcity, a full-scale "mini-city" designed to rigorously and efficiently test emerging technologies in a safe, controlled environment. Located on a 32-acre site on campus, the facility includes a variety of types of roads with intersections, traffic signs and signals, sidewalks, benches, simulated buildings, streetlights, and other obstacles.

mtc.umich.edu/test-facility



Photo: Joseph Xu, Michigan Engineering Communications & Marketing

Battery Lab

With the support of the Michigan Economic Development Corporation and the Ford Motor Company, U-M opened its Battery Fabrication and Characterization User Facility that allows industry and academia to collaborate on developing cheaper and longer lasting energy storage devices for a wide range of potential applications, from lap tops to electric vehicles. Operating under the auspices of the U-M Energy Institute, a unit of the U-M Office of Research, the Battery Lab brings together materials scientists, engineers, and chemists, as well as suppliers and manufacturers in a world-class facility designed for fabricating, testing, and analyzing batteries and the materials that go into them. Its state-of-the-art equipment is available to students, faculty, and industry.

energy.umich.edu/project/battlab

Exercise & Sport Science Initiative

With developments in areas ranging from improved helmet designs to the analysis of sports data, science and technology are opening up a host of new opportunities to transform sports and exercise. UMOR laid the groundwork in FY 2016 for a new research program that brings together several of U-M's schools and colleges, Michigan Athletics, and industry partners to optimize physical performance and health for athletes and exercisers of all ages and abilities. The Exercise & Sport Science Initiative (ESSI) builds on the work of more than 100 faculty and student researchers from such diverse disciplines as kinesiology, medicine, bioengineering, psychology, nutrition, social sciences, and data science. Research will initially focus on performance optimization in exercise and sport for individuals and teams, applications of data science and analytics in sport and exercise, and new technologies for sensors and other devices, apparel, and equipment.

essi.umich.edu



Photo: Michigan Photography

Photo: Joseph Xu, Michigan Engineering Communications & Marketing

ANNUAL RESEARCH PERFORMANCE

Total research expenditures at the University of Michigan for Fiscal Year 2016, including the Ann Arbor, Dearborn, and Flint campuses, reached a total of \$1,393,105,207, up 7.2 percent from the previous year. This number includes externally and internally funded direct and indirect expenses and disbursements, including research initiative and startup expenses, research related facilities and administrative expenses, and research equipment purchases.

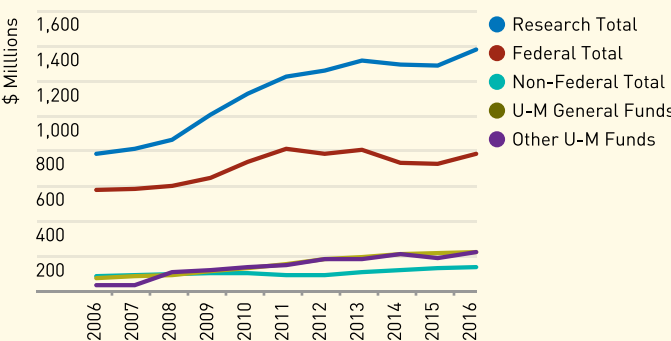
TABLE 1 highlights the relative contributions of the major sponsors of U-M research. Research conducted under contract with various federal agencies—about 57 percent of the total—rose 7.4 percent to \$792 million. Research supported by non-federal external sources was up 4.5 percent, including a significant 10.3 percent increase from industry. Internal support was up 7.9 percent, led by an increase from designated or expendable restricted endowment funds.

TABLE 1. MAJOR RESEARCH SPONSORS

Sponsor Group	FY 15	FY 16	% Change
Total Federal Government	\$737,623,556	\$792,052,275	7.38%
Total Non-Federal Sponsors	\$138,847,873	\$145,030,671	4.45%
Industry (direct)	\$62,076,227	\$68,463,085	10.29%
Foundations	\$29,312,404	\$26,784,688	-8.62%
Other	\$47,459,243	\$49,782,898	4.90%
Total U-M Funds	\$422,773,541	\$456,022,261	7.86%
Total Expenditures	\$1,299,244,971	\$1,393,105,207	7.22%

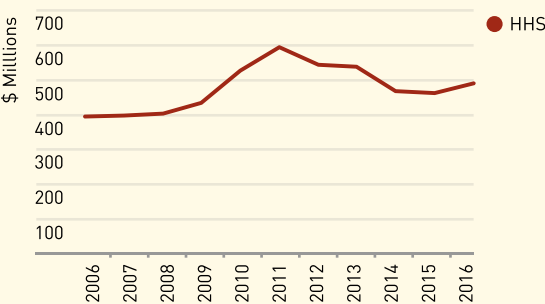
FIGURE 1 illustrates the overall trends over the decade from FY 2006 through FY 2016. Expenditures funded from the federal government are consistently the largest component of research expenditures. Federal expenditures showed a more rapid rate of growth in FY 2016 after having slowed considerably since 2011.

FIGURE 1. U-M RESEARCH EXPENDITURES



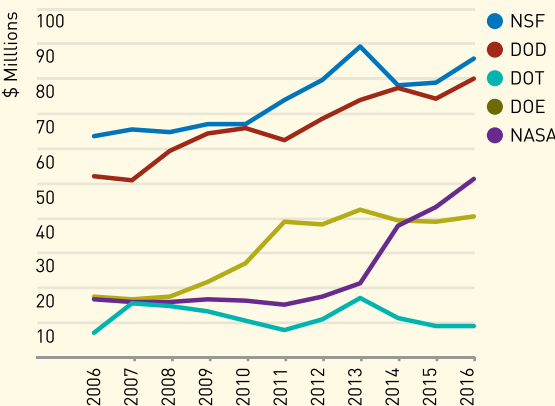
Health and Human Services, which includes the National Institutes of Health, is by far the largest component of the federal total, as shown in FIGURE 2. The sharp increase in funding that peaked in 2011 and eased off in recent years arose primarily from the short-term infusion of funds under the American Recovery and Reinvestment Act of 2009 (ARRA), as well as from a major collaborative oncology research program that was temporarily housed at U-M. In FY 2016, HHS expenditures increased 6.4 percent to \$457 million.

FIGURE 2. U-M FEDERAL FUNDING BY HHS



Federal agencies other than HHS also showed an upward trend, as highlighted in FIGURE 3. Funding from the National Science Foundation increased 8.6 percent to \$86 million, accelerating a trend from the previous year. Support from the Department of Defense was up 7.8 percent to \$80.5 million. At the same time, expenditures under contracts with the National Aeronautics and Space Administration rose 19.5 percent, to \$52 million, and funds from the Department of Energy were up 4.3 percent to \$40 million. Although expenditures from the Department of Transportation were flat in FY 2016, ongoing investments by industry in mobility research will help position the university for further growth from both government and industry.

FIGURE 3. U-M FEDERAL FUNDING BY AGENCY



Further details on the level of funding from these sources and others is included in Appendix I.

FIGURE 4 shows the longer-term trend in federal research funding, adjusted for inflation. At the end of FY 2016, the American Association for the Advancement of Science estimated total funding to be \$69 billion, a 5 percent increase over what it was 10 years previously. There was a short-term boost in the middle of the decade under the American Recovery and Reinvestment Act of 2009. Over the same ten-year period, U-M showed a 14.7 percent net overall gain in federal funds, adjusted for inflation, showing the university's relative strength in competing for research funding.

FIGURE 4. TRENDS IN FEDERAL RESEARCH FUNDING

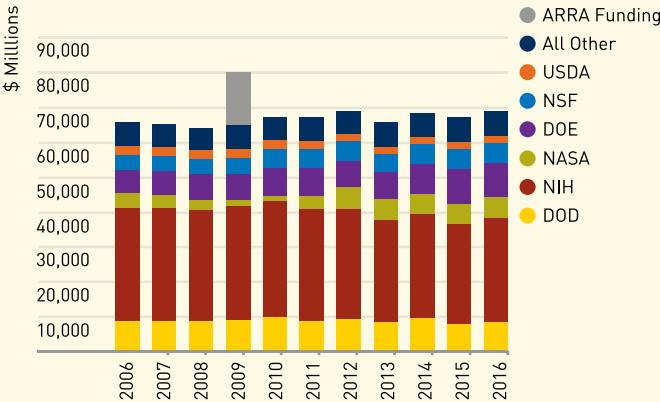
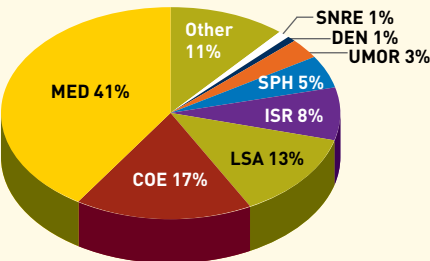


FIGURE 5 shows the expenditures for FY 2016 across U-M's 19 schools and colleges. As usual, the Medical School's portfolio is the largest on campus, at 41 percent of the university total, followed by the College of Engineering; the College of Literature, Science, and the Arts; the Institute for Social Research, and the School of Public Health. APPENDIX II provides further detail, documenting the level of funding at each unit and the percentage change from FY 2015 to FY 2016.

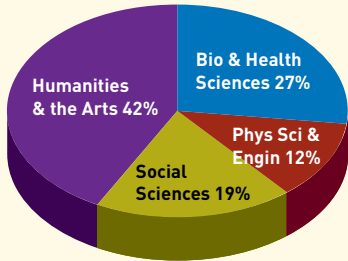
FIGURE 5. RESEARCH EXPENDITURES BY UNIT



The sector labeled UMOR represents the sum of expenditures by research units that report directly to the U-M Office of Research rather than a school or college. These units include the U-M Transportation Research Institute, the U-M Energy Institute, the Mobility Transformation Center, the Center for Human Growth and Development, Advanced Research Computing, Functional Magnetic Resonance Imaging, Consulting for Statistics, Computing and Analytics Research, the Institute for Research on Women and Gender, and the Institute for Research on Labor, Employment, and the Economy.

UMOR also helps spur research and scholarship across the university through its Faculty Grants and Awards Program. FIGURE 6 shows the breakdown of these awards for FY 2016 by broad disciplinary area. The program provides bridging funds for projects, seed funding for young faculty, as well as for senior faculty who are changing research direction, and support in areas where sponsored funding is unusually constrained. About 42 percent of the total funding from this program supports the arts and humanities, which receive much less external funding than the other areas.

FIGURE 6. UMOR GRANTS & AWARDS

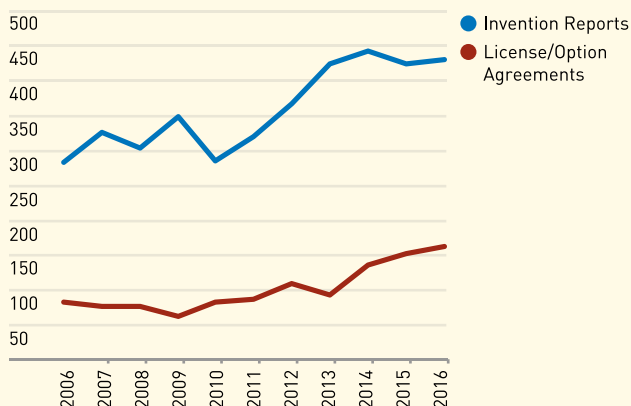


Federal expenditures showed a more rapid rate of growth in FY 2016 after having slowed considerably since 2011.

TECHNOLOGY TRANSFER

The Office of Technology Transfer (OTT) is a unit of the Office of Research that plays a central role in helping to ensure that society realizes the benefits of the research conducted on campus. In FY 2016, U-M researchers submitted 428 new inventions—the fourth straight year of more than 400 inventions—and 135 patents were issued. **FIGURE 7** shows the steady rise of invention disclosures over the last 10 years, reaching a total of 3,963 for the decade. In addition, the office negotiated a record 173 license/option agreements last year with both new and existing companies, up 16.9 percent from the previous year's record of 148.

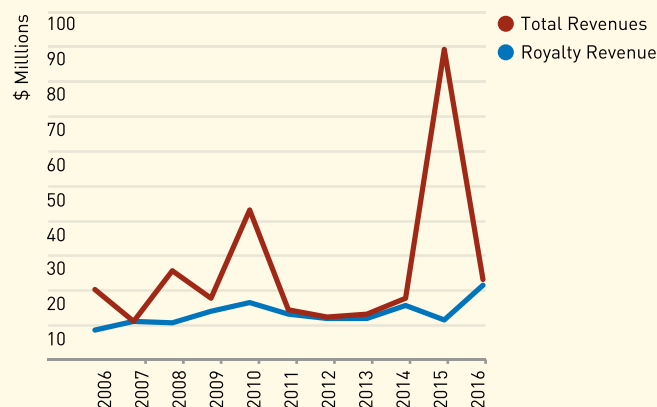
FIGURE 7. TECH TRANSFER RESULTS



OTT operates a Venture Center that brings together talent, funding, and other resources to help launch startup companies based on intellectual property developed at U-M. The Center launched 12 new startups in FY2016, continuing the average of one new company every four weeks over the last 10 years.

FIGURE 8 tracks revenue from Tech Transfer operations over the last decade. The baseline of royalty revenue has remained stable, but total revenue, which includes revenue from liquidated equity from startups and up-front royalty payments, fluctuates considerably depending on specific deals occurring from year to year. In FY 2015, for example, total revenues reached \$78 million, largely from the monetization of royalties on a license for a drug developed to treat Gaucher disease, an inherited disorder that affects many of the body's organs and tissues. The spike in revenues in 2010 came from the monetization of royalties on FluMist, an influenza virus vaccine delivered as a nasal mist. Total revenue for FY 2016 was \$23 million, with \$21.7 million coming from royalties.

FIGURE 8. TECH TRANSFER REVENUES



BUSINESS ENGAGEMENT

Reporting jointly to U-M Office of Research and the U-M Office of Development, the Business Engagement Center plays a central role in helping industry to find opportunities to invest in U-M research and to provide philanthropic support to the university. As a gateway for companies to access the expertise and resources in the U-M community, including educational programs and student talent, the BEC and its affiliated corporate relationship managers across campus participated in a total of 1,255 visits with industry representatives in FY 2016. It now maintains ongoing relationships with more than 1,200 companies.

TABLE 2 provides a close look at the total research funding from industry, which rose 8.6 percent in FY 2016 to \$85.2 million. This sum includes direct contracts, as well as subcontracts from federal contracts awarded to industry, and support from corporate foundations. Industry funding is now more than 9 percent of total externally sponsored research expenditures.

Philanthropic contributions from industry rose 43.6 percent to \$54.4 million. All together, U-M received a total of \$139.6 million in industry support in FY 2016, a 19 percent increase over the previous year.

TABLE 2. INDUSTRY RESEARCH EXPENDITURES

Industry Research (total)	FY15	FY16	% Change
Direct Contract	\$62,076,227	\$68,463,085	10.29%
Subcontract (on Federal Prime)	\$12,128,400	\$12,027,550	-0.83%
Corporate Foundations (est.)	\$2,430,527	\$2,726,514	12.18%
Other Industry Research	\$1,875,647	\$2,084,469	11.13%
Total Research Expenditures	\$78,510,801	\$85,301,618	8.65%

PLANNING FOR THE FUTURE

Although research expenditures rose in FY 2016, competition for funds remains strong. U-M is pursuing a variety of strategies to diversify its funding sources and improve productivity in order to sustain the vitality of its research enterprise:

- **Build the pipeline of new projects**—TABLE 3 shows the total number of external research contracts awarded to U-M in FY 2016 rose 3.6 percent, with an increase of total dollar value of 14.8 percent. These awards will contribute to expenditures in coming years. Looking further ahead, TABLE 4 shows U-M faculty submitted 3.5 percent fewer research proposals for new awards, but with a .42 percent increase in dollar value.

TABLE 3. NUMBER AND VALUE OF AWARDS

	Number of Awards	Value of Awards
FY 2016	2,070	\$ 1,024,680,298
FY 2015	1,998	\$ 892,777,046
Difference	72	\$131,903,252
% Change	3.60%	14.77%

TABLE 4. NUMBER AND VALUE OF SUBMISSIONS

	Number of Submissions	Value of Submissions
FY 2016	5,255	\$ 4,343,049,484
FY 2015	5,447	\$ 4,324,779,006
Difference	-192	\$ 18,270,478
% Change	-3.52%	0.42%

- **Create larger projects that draw on the university's interdisciplinary strengths and innovative partnerships**—An ongoing strategy is to develop major long-term interdisciplinary research efforts in collaboration with government and industry that draw on the university's core strengths. As outlined elsewhere in this report, significant progress was made in the areas of connected and automated vehicles, data science, innovative battery development, and exercise and sport science.
- **Encourage new innovative research ideas**—This past year, Mcubed, a unique program established in 2012 to provide seed funding to kick-start novel interdisciplinary research projects, launched a second round of internal funding to support new project ideas. The program was also opened up to industry sponsors. Through two rounds, the program has sponsored 459 projects involving 1,300 faculty members, leading to more than \$60 million in further grants from other sources.

- **Strengthen industry outreach**—Building on its continuing success in FY 2016, U-M's Business Engagement Center is working with faculty to engage industry in projects across the university. One key focus of the Center has been to connect partners from a wide range of industries in the university's major new interdisciplinary initiatives summarized in this report.
- **Expand clinical trials**— In FY 2016, the number of awards for clinical trials rose to \$74.5 million, a 20 percent increase over the previous year.
- **Seek more funding from foundations**—Working with the U-M Office of Research, U-M's Office of Foundation Relations coordinated \$59 million in awards from professional foundations in FY 2016.
- **Pursue philanthropic gifts for research**—The U-M Office of Research and the U-M Office of University Development are increasing efforts to seek research funding from philanthropic sources. In the corporate arena, the Business Engagement Center helped bring in \$54.4 million in gifts to support research and education in FY 2016, up 44 percent from the previous year.
- **Develop more international partnerships**—U-M faculty have strong relationships with the international research community, which enhance research and education by bringing together the complementary strengths and perspectives of other cultures to address common societal challenges. In FY 2016, U-M laid the groundwork for a significant expansion of these relationships, particularly in China.
- **Streamline research administration**—UMOR's Office of Research and Sponsored Projects launched a program to integrate and streamline the entire research award process from proposal to closeout.
- **Reduce faculty administrative burden**—As part of this effort, UMOR's Research Ethics & Compliance Office began developing a plan to consolidate and rationalize processes and IT systems to improve adherence, while reducing the substantial amount of time faculty have needed to meet regulatory requirements.
- **Communicate the value and impact of university research**—*Michigan Research*, a monthly e-newsletter highlighting significant research results, expanded its circulation to more than 80,000, including decision makers in government, industry, and academia, as well as the public. A number of other efforts are underway across campus to communicate the results of research and to promote faculty perspectives on current issues in the news.

APPENDIX I:

Volume of Research Expenditures By Sponsor

	FOR THE YEAR ENDED JUNE 30,		FISCAL YEAR CHANGE	
	2016	2015	DOLLAR (\$)	PERCENTAGE (%)
INTERNALLY FUNDED RESEARCH				
Designated Fund	\$68,544,007	\$42,797,579	\$25,746,428	60.2%
Expendable Restricted Fund	69,460,454	59,199,318	10,261,136	17.3%
General Fund	228,034,929	225,580,703	2,454,226	1.1%
Auxiliary Fund (Medical School)	89,982,871	95,195,940	(5,213,070)	-5.5%
Subtotal University Funds	456,022,261	422,773,541	33,248,720	7.9%
EXTERNALLY FUNDED (SPONSORED) RESEARCH				
Federal:				
Agriculture, Department of	2,665,631	2,505,739	159,891	6.4%
Commerce, Department of	6,787,705	6,119,852	667,853	10.9%
Corporation for National and Community Service	253,024	-	253,024	
Defense, Department of				
Air Force, Department of the	13,148,318	12,661,566	486,752	3.8%
Army, Department of the	35,624,225	31,108,493	4,515,732	14.5%
Navy, Department of the	13,203,117	14,418,934	(1,215,817)	-8.4%
Other	18,535,785	16,523,054	2,012,731	12.2%
Director of National Intelligence, Office of the	40,350	113,793	(73,443)	-64.5%
Education, Department of				
Office of Student Financial Assistance Programs	1,178,864	1,068,712	110,152	10.3%
Other	4,663,915	5,146,566	(482,651)	-9.4%
Energy, Department of	40,797,779	39,098,970	1,698,809	4.3%
Environmental Protection Agency	3,025,047	2,780,258	244,790	8.8%
Federal Reserve System	31,697	188,776	(157,079)	-83.2%
Health and Human Services, Department of				
Centers for Disease Control and Prevention	13,931,714	14,616,202	(684,488)	-4.7%
Centers for Medicare and Medicaid Services	10,656,030	9,245,861	1,410,169	15.3%
Food and Drug Administration	1,956,218	1,206,265	749,953	62.2%
Health Resources and Services Administration	641,283	240,093	401,189	167.1%
National Institutes of Health	457,334,701	430,002,068	27,332,633	6.4%
Substance Abuse and Mental Health Services Administration	285,132	1,295,594	(1,010,462)	-78.0%
Other	9,685,596	10,006,751	(321,155)	-3.2%
Homeland Security, Department of	1,517,456	859,940	657,517	76.5%
Housing and Urban Development, Department of	5,057	-	5,057	
Institute of Museum and Library Services	105,553	98,071	7,481	7.6%
Interior, Department of the	976,787	237,265	739,522	311.7%
Justice, Department of	2,523,520	2,323,765	199,755	8.6%
Labor, Department of	-	6,351	(6,351)	-100.0%
Library of Congress	16,614	-	16,614	
National Aeronautics and Space Administration	51,592,596	43,173,240	8,419,356	19.5%
National Endowment for the Humanities	(10,413)	119,105	(129,518)	-108.7%
National Science Foundation	86,016,859	79,236,809	6,780,050	8.6%
Nuclear Regulatory Commission	827,634	638,495	189,139	29.6%
Smithsonian Institution	426,154	541,611	(115,457)	-21.3%
Social Security Administration	1,802,460	1,734,990	67,469	3.9%
State, Department of	999,658	472,947	526,711	111.4%
Transportation, Department of				
Federal Highway Administration	3,539,699	4,137,571	(597,872)	-14.4%
National Highway Traffic Safety Administration	1,731,166	2,230,845	(499,679)	-22.4%
Other	3,708,261	2,527,642	1,180,618	46.7%
United States Agency for International Development	1,067,698	735,555	332,143	45.2%
Veterans Affairs, Department of	759,385	201,807	557,578	276.3%
Subtotal Federal	792,052,275	737,623,556	54,428,719	7.4%
Non-Federal:				
Foreign Corporations	16,301,095	14,456,316	1,844,779	12.8%
Foreign Foundations	499,208	386,821	112,387	29.1%
Foreign National Governments	2,186,010	1,089,086	1,096,925	100.7%
Foreign Other (Universities/Gifts)	3,001,070	3,414,752	(413,681)	-12.1%
Foreign Public Charities	4,625	-	4,625	
Foreign Trade/Professional Association	5,667	687	4,979	724.4%
International Organizations	696,525	364,936	331,589	90.9%
Local Authorities in Michigan	14,069	34,300	(20,231)	-59.0%
U.S. Corporations	52,161,990	47,619,911	4,542,079	9.5%
U.S. Foundations	26,285,480	28,925,583	(2,640,103)	-9.1%
U.S. Other (Including Universities + Gifts)	11,382,967	8,705,523	2,677,444	30.8%
U.S. Public Charities (+ Hospitals)	18,317,022	19,843,530	(1,526,507)	-7.7%
U.S. State of Michigan	3,104,053	1,613,607	1,490,446	92.4%
U.S. Trade/Professional Assns	11,070,891	12,392,823	(1,321,932)	-10.7%
Subtotal Non-Federal	145,030,671	138,847,873	6,182,798	4.5%
Subtotal Sponsored Research	937,082,946	876,471,429	60,611,516	6.9%
Total Volume of Research Expenditures	\$1,393,105,207	\$1,299,244,971	\$93,860,237	7.2%

APPENDIX II:

Volume of Research Expenditures by Major University Units

UNIT	FY 2016	FY 2015	2015-2016 \$ CHANGE	2015-2016 % CHANGE
Architecture and Urban Planning, Taubman College of	1,838,475	1,382,735	455,740	33.0%
Art & Design, Stamps School of	147,467	213,167	-65,701	-30.8%
Business, Stephen M. Ross School of	12,624,063	11,165,973	1,458,090	13.1%
Dentistry	16,399,567	17,708,485	-1,308,917	-7.4%
Education	8,382,909	9,778,673	-1,395,764	-14.3%
Engineering	253,345,302	225,830,559	27,514,742	12.2%
Graduate School, Rackham	509,246	577,218	-67,973	-11.8%
Information	4,788,712	5,806,592	-1,017,880	-17.5%
Kinesiology	8,790,278	6,371,699	2,418,579	38.0%
Law	4,353,280	5,837,909	-1,484,629	-25.4%
Literature, Science, and the Arts	179,890,323	175,293,102	4,597,220	2.6%
Medical School	566,634,767	535,444,490	31,190,277	5.8%
Music, Theatre & Dance	656,201	593,211	62,991	10.6%
Natural Resources and the Environment	16,065,464	14,055,461	2,010,003	14.3%
Nursing	8,118,687	5,979,368	2,139,319	35.8%
Pharmacy	13,819,512	10,066,176	3,753,336	37.3%
Public Health	65,574,565	67,345,171	-1,770,607	-2.6%
Public Policy, Gerald R. Ford School of	4,589,938	3,628,047	961,891	26.5%
Social Work	5,207,071	4,593,626	613,445	13.4%
Institute of Social Research	118,572,427	110,204,136	8,368,291	7.6%
Other Units	44,012,381	42,235,691	1,776,690	4.2%
UM-Dearborn	7,940,930	6,494,750	1,446,180	22.3%
UM-Flint	920,964	855,101	65,862	7.7%
UMOR Units	38,116,677	35,607,702	2,508,975	7.0%
Unassignable Services	11,806,000	2,175,924	9,630,076	442.6%
Grand Total	1,393,105,207	1,299,244,971	93,860,237	7.2%

NOTES TO APPENDIX I AND II:

The university receives sponsored research funds directly and indirectly from industry, which totaled approximately \$85 million in 2016 and \$78 million in 2015, a 9% increase.

- Federal sponsored research includes federal projects received by the university via corporations, which totaled approximately \$12 million in 2016 and 2015.
- Non-federal sponsored research funded by U.S. and Foreign Foundations includes amounts received by the university via corporate foundations, which totaled approximately \$3 million in 2016 and \$2 million in 2015.
- Non-federal sponsored research funded by U.S. Trade/Professional Associations and the State of Michigan includes projects received by the university via corporations, which totaled approximately \$2 million in 2016 and 2015.

A team of University of Michigan paleontologists worked with an excavator to unearth an ancient mammoth in a farmer's field near Chelsea, Mich.
Photo: Michigan Photography



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