Chapter 9  Research & Technology Transfer

Goals
Excellence in research and scholarly activity is a central tenet of the University of Michigan’s mission. The broad scope and overall size of the U-M’s research program, along with its emphasis on interdisciplinary approaches, contributes to Michigan’s standing as one of the world’s leading research universities. As such, the faculty attracts generous financial support from the public and private sectors.

The University envisions that the faculty will make contributions to society not only through research and scholarship reported in the ordinary academic channels, but also through the application of discoveries as innovative products and processes. The U-M places a high priority on supporting this activity through the Office of Technology Transfer and the Business Engagement Center.

Overview
Most of this chapter examines data about sponsored projects. Total research expenditures by the University exceed $1.3 billion per year, with 70 percent of the University's research spending in any given year provided by outside sources. The biggest share of that research funding comes from the federal government. When research funding from all sources is counted, U-M ranks No. 2 in the nation among all universities and No. 1 among public universities.

The University’s largest fraction of grant-supported work occurs in the biomedical and clinical sciences. The U-M Medical School alone regularly attracts close to $300 million each year to support research by its faculty.

Some research outcomes are of interest to the private sector. The Office of Technology Transfer works with faculty inventors to file patents and negotiate licensing agreements that benefit the University's industry partners and fund additional research and development work on campus. In certain instances, U-M faculty members establish companies to develop their inventions, thanks in part to an emerging campus culture of innovation and entrepreneurship.

U-M wishes to promote partnerships that involve academia, government and industry. Toward this goal, the University has and will continue to fund interdisciplinary teams that address issues with broad societal impact.

At the same time, the U-M, as well as all of higher education, faces serious challenges to maintaining the quality and productivity of research and scholarly activity. Budget pressures from flat or declining federal funding of research will make it more difficult than ever to maintain the quality of the faculty and the facilities needed to conduct world-class research.

For More Information
U-M Office of Research (research.umich.edu/)
Office of Technology Transfer (techtransfer.umich.edu/)
Business Engagement Center (bec.umich.edu/)

Charts in Chapter 9
9.1.2 Research Expenditures by Major Funding Source, Adjusted for Inflation, FY2006-16.
9.1.3 Direct Research Expenditures by Discipline, Adjusted for Inflation, FY2006-16.
9.1.4 Sponsored Research Expenditures by Type, FY2016.
9.1.5 Sponsored Research Indirect Cost Recovery by Source, Adjusted for Inflation, FY2006-16.
9.2 Research Workforce by Full-Time Equivalents, Fall 2016.
9.4.2 Revenues from Royalties and Equity Sales, FY2006-16.
9.4.3 Formation of Start-up Companies that Utilize U-M Technology, FY2006-16.
9.5 Technology Transfer Indicators for the U-M and Research-Intensive Universities, FY2015.
During the last three decades, total research expenditures from all sources (including U-M funds) have quadrupled, even after adjusting for inflation.

### 9.1.1 Total Research Expenditures, Adjusted for Inflation¹, 1980-2016.

![Graph showing total research expenditures]

**Federal Non-defense R&D Expenditures (inflation-adjusted)**

**U-M Research Expenditures (inflation-adjusted)**

**Fiscal Year**


**$0 $200 $400 $600 $800 $1,000 $1,200 $1,400 $1,600 $1,800 $80 $70 $60 $50 $40 $30 $20 $10 $0**

**Millions of Dollars (Scale for UM line)**

**Billions of Dollars (Scale for Federal Line)**

**SOURCE:** U-M Financial Operations.

The trend in University of Michigan research expenditures (adjusted for inflation, black line) largely mirrors the total federal non-defense R&D spending (red line) through FY2006. The increase in FY2007 – indicated as (A) – is an artifact of a change how U-M calculates research spending². The further increase at (B) is due to a surge of grant support provided under the American Recovery and Reinvestment Act of 2009 (ARRA).

Likewise, the lack of growth from FY2011 in both total federal non-defense R&D and U-M research expenditures largely reflects the depletion of ARRA funds combined with overall decline in growth of federal funding of research.

The total Federal Non-defense R&D Expenditures is estimated for 2016; a final figure is not available yet.

¹ Based on 2016 U.S. Consumer Price Index.

² Starting in FY2007, research support originating from the U-M faculty medical group practice was included as research expenditures. Previously this was reported with clinical activity.
Federal grants and contracts now cover less than 60% of U-M research expenditures.

9.1.2 Research Expenditures by Major Funding Source, Adjusted for Inflation\(^3\), FY2006-16.

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Non-Sponsored (U-M Funds)</th>
<th>Non-federal Grants/Contracts</th>
<th>Federal Grants/Contracts</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>$74M (11%)</td>
<td>$508M (11%)</td>
<td>$289M (11%)</td>
</tr>
<tr>
<td>2007</td>
<td>$68M (11%)</td>
<td>$523M (11%)</td>
<td>$270M (11%)</td>
</tr>
<tr>
<td>2008</td>
<td>$66M (11%)</td>
<td>$530M (11%)</td>
<td>$264M (11%)</td>
</tr>
<tr>
<td>2009</td>
<td>$64M (11%)</td>
<td>$537M (11%)</td>
<td>$259M (11%)</td>
</tr>
<tr>
<td>2010</td>
<td>$66M (11%)</td>
<td>$545M (11%)</td>
<td>$253M (11%)</td>
</tr>
<tr>
<td>2011</td>
<td>$67M (11%)</td>
<td>$553M (11%)</td>
<td>$249M (11%)</td>
</tr>
<tr>
<td>2012</td>
<td>$62M (11%)</td>
<td>$560M (11%)</td>
<td>$246M (11%)</td>
</tr>
<tr>
<td>2013</td>
<td>$62M (11%)</td>
<td>$567M (11%)</td>
<td>$243M (11%)</td>
</tr>
<tr>
<td>2014</td>
<td>$57M (11%)</td>
<td>$574M (11%)</td>
<td>$240M (11%)</td>
</tr>
<tr>
<td>2015</td>
<td>$57M (11%)</td>
<td>$581M (11%)</td>
<td>$237M (11%)</td>
</tr>
<tr>
<td>2016</td>
<td>$57M (11%)</td>
<td>$588M (11%)</td>
<td>$234M (11%)</td>
</tr>
</tbody>
</table>


The dotted line indicates that in FY2007 the U-M began to include research support from the medical group practice revenues as part of Non-sponsored research expenditures (see “A” in chart 9.1.1).

\(^3\) Based on 2016 U.S. Consumer Price Index.
Direct research expenditures increased in FY2016 for the first time in several years.

9.1.3 Direct Research Expenditures by Discipline, Adjusted for Inflation\(^4\), FY2006-16.


Direct expenditures cover salaries and benefits of researchers, whether faculty, staff or students, as well as equipment and supplies, research-related travel and other expenses tied to specific projects. Chart 9.1.5 displays overhead spending – known as “indirect” costs – that supports the entire research enterprise.

\(^4\) Based on 2016 U.S. Consumer Price Index.
About 45 percent of the total annual sponsored research expenditures on the Ann Arbor campus goes to salaries and benefits for faculty, staff and graduate students.

9.1.4 Sponsored Research Expenditures by Type, FY2016.

**FY2016 Total: $932,493,735**

- **Indirect Costs** $242M (26%)
- **Salaries** $324M (35%)
- **Equipment** $16M (2%)
- **Subcontracts** $115M (12%)
- **Supplies & Services** $139M (15%)
- **Benefits** $76M (8%)
- **Financial Aid** $21M (2%)

**SOURCE: U-M Financial Operations.**

The FY2016 total externally sponsored research expenditures for the Ann Arbor campus was $932.5 million, an increase of $60.3 million from the previous year. As the chart indicates, the conduct of research and scholarship is labor-intensive with a large fraction of expenditures attributable to salaries and benefits.

Indirect costs (IDC) are the costs of University operations that are not readily assignable to a particular project. Indirect costs can be thought of as overhead, and include costs for general research administration, utilities use in research space, and other services that contribute broadly to the operation of the University’s research enterprise.

For FY2016, 26 percent of the total research expenditures went to pay for indirect costs; however, the actual indirect cost recovery rate varies for each project based on the type of research activity and the sponsor. The indirect cost rate for research funded by the Federal government or industry is 55.5 percent for on-campus research and 26 percent for off-campus research. Clinical trials conducted on campus supported by the Federal government or industry have an indirect cost rate of 30 percent.

The indirect cost rates charged to foundations and public charities vary from zero to 20 percent, according to the published policies of such non-profit sponsors. Research sponsored by State of Michigan agencies also varies depending on the specifics of the funded project.
Federal sponsored projects provide about 90 percent of indirect cost recovery funds.

9.1.5 Sponsored Research Indirect Cost Recovery by Source, Adjusted for Inflation\(^5\), FY2006-16.

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**SOURCE:** U-M Financial Data.

The peak in indirect cost recovery for FY2011 is largely due to the bump provided by federal “stimulus” funds that had supported research. The inflation-adjusted total indirect cost recovery is still down by 5 percent since the 2011 peak year.

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\(^5\) Based on 2016 U.S. Consumer Price Index.
A fall 2016 snapshot of personnel paid under sponsored projects shows that grants and contracts fund the full-time equivalent of 4,134 faculty members, post-docs, staff and students.

9.2 Research Workforce by Full-Time Equivalents (FTEs), Fall 2016.

- **Students** 694 (17%)
- **Faculty** 452 (11%)
- **Research Faculty** 458 (11%)
- **Post-doctoral Fellows** 730 (18%)
- **Admin. & Research Staff** 1800 (43%)


Many tenured and tenure-track faculty members play key roles in sponsored research activity. Research faculty members, post-doctoral fellows, graduate (and some undergraduate) students and a subset of the staff also contribute in major ways to the research enterprise.

The Fall 2016 total represents an decrease of 24 FTEs (0.6 percent) supported on sponsored projects compared to Fall 2015.
U-M spends more on research than any other U.S. public university.


<table>
<thead>
<tr>
<th>Institution</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012</td>
</tr>
<tr>
<td></td>
<td>2013</td>
</tr>
<tr>
<td></td>
<td>2014</td>
</tr>
<tr>
<td></td>
<td>2015</td>
</tr>
<tr>
<td>Johns Hopkins</td>
<td>$2,145M</td>
</tr>
<tr>
<td>MICHIGAN</td>
<td>$1,279M</td>
</tr>
<tr>
<td>Washington</td>
<td>$1,149M</td>
</tr>
<tr>
<td>UC San Francisco</td>
<td>$995M</td>
</tr>
<tr>
<td>UC San Diego</td>
<td>$1,009M</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>$1,112M</td>
</tr>
<tr>
<td>Duke</td>
<td>$1,022M</td>
</tr>
<tr>
<td>Stanford</td>
<td>$908M</td>
</tr>
<tr>
<td>UCLA</td>
<td>$982M</td>
</tr>
<tr>
<td>Harvard</td>
<td>$650M</td>
</tr>
</tbody>
</table>


The U-M has been the nation’s leading public university in total research spending for the past five years. Total expenditures include research spending from government sources, non-government sources, and the institution’s own budget.

The list above is ordered by total research expenditures for FY2015. Data for public universities are shaded in yellow; private university data are shaded in blue.

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6 Starting in FY2010, the NSF ranked institutions by geographically separate campuses, each headed by a campus-level president or chancellor. Prior to that, some institutions were ranked by the aggregate R&D expenditures for all campuses in a multi-campus university or state system.

7 Johns Hopkins University expenditures include those by the Applied Physics Laboratory. In FY2015, APL R&D expenditures totaled $1.161M, 50% of JHU’s total for the year.
Since 2006, U-M faculty, staff and students have reported more than 3,900 inventions, leading to 1,270 agreements, and 1,145 patents.


![Graph showing invention reports, license or option agreements, and U.S. patents issued over fiscal years 2006 to 2016.]

**Source:** U-M Office of Technology Transfer.

Invention reports are descriptions of discoveries made by U-M faculty, staff and students with the potential to be further developed into new products or processes. Patents protect intellectual property that shows some promise for future development and application. License and option agreements are legal arrangements with companies (some of which have U-M faculty involvement) that allow the firms to use University-owned technology in products or processes being developed for the market.
Over the last decade, U-M discoveries have generated $280 million in revenues. The inventors and University share these revenues, with the U-M's portion devoted to ongoing research and development.

9.4.2 Revenues from Royalties and Equity Sales, FY2006-16.

![Bar chart showing revenues from royalties and equity sales from 2006 to 2016.](chart.png)

SOURCE: U-M Office of Technology Transfer.

Revenues from licensing agreements support technology transfer operations as well as provide valuable resources for investment in research, education, and innovation.

Royalties are periodic payments by a licensee to the University of Michigan in order to have continued access to U-M-owned intellectual property. Equity sales include transfers of stock or cash payments by a licensee to the U-M.

Royalty revenues reached an all-time high in FY2015. Nearly $75 million of that total comes from a new royalty agreement connected to a drug to help patients with Gaucher disease that was developed at U-M, according to the Medical School.
Since 2006, 123 new companies employing U-M discoveries have been launched.

9.4.3 Formation of Start-up Companies that Utilize U-M Technology, FY2006-16.

While much of the new technology developed at the U-M is licensed to existing companies for use in new products and processes, some inventions become the basis of new enterprises. Often this occurs when the U-M inventors wish to have hands-on involvement in the further development of the technology.

Several U-M start-ups have reached a level of success such that larger firms have acquired them. For example, two medical device start-ups – HandyLab and Accuri Cytometers – were acquired by Becton Dickinson in 2009 and 2011, respectively. Arbor Networks, which provides internet protection tools, was purchased in 2010 by Tektronix Communications, and Health Media, developer of health support programs, was acquired in 2008 by Johnson & Johnson. And in October 2012, Compendia Bioscience, which has developed an oncology database that drug companies utilize in drug discovery work, was acquired by Life Technologies Corp.

In 2011, the U-M opened the Venture Accelerator at the North Campus Research Complex. The Venture Accelerator provides laboratory and office space, as well as business services, to startup companies emerging from the pipeline of new ventures at U-M Tech Transfer.

Of the 12 start-ups U-M helped launch during FY2016, eleven have headquarters in the state of Michigan.

Portfolio of U-M start-ups:
techtransfer.umich.edu/about/startups.php
By several indicators of technology transfer activity, the U-M ranks highly compared to leading U.S. universities according to research expenditures.\(^7\)

### 9.5 Technology Transfer Indicators for the U-M and Research-Intensive Universities, FY2015.

<table>
<thead>
<tr>
<th>Institution (FY2015 R&amp;D Expenditures)</th>
<th>Invention Reports</th>
<th>Issued Patents</th>
<th>New Agreements</th>
<th>Startups</th>
<th>License Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johns Hopkins ($2,306M)</td>
<td>517</td>
<td>122</td>
<td>149</td>
<td>16</td>
<td>$17.9M</td>
</tr>
<tr>
<td>MICHIGAN ($1,369M) 2(^{nd})</td>
<td>422 (5(^{th}))</td>
<td>159 (4(^{th}))</td>
<td>164 (3(^{rd}))</td>
<td>12 (6(^{th}))</td>
<td>$78.8M (2(^{nd}))</td>
</tr>
<tr>
<td>Washington ($1,181M)</td>
<td>373</td>
<td>81</td>
<td>337</td>
<td>15</td>
<td>$42.8M</td>
</tr>
<tr>
<td>Wisconsin ($1,069M)</td>
<td>387</td>
<td>161</td>
<td>70</td>
<td>6</td>
<td>$40.0M</td>
</tr>
<tr>
<td>Duke ($1,037M)</td>
<td>229</td>
<td>79</td>
<td>162</td>
<td>7</td>
<td>$36.8M</td>
</tr>
<tr>
<td>Stanford ($1,023M)</td>
<td>483</td>
<td>232</td>
<td>112</td>
<td>28</td>
<td>$95.1M</td>
</tr>
<tr>
<td>Harvard ($1,014M)</td>
<td>354</td>
<td>50</td>
<td>268</td>
<td>16</td>
<td>$18.5M</td>
</tr>
<tr>
<td>North Carolina ($967M)</td>
<td>399</td>
<td>103</td>
<td>157</td>
<td>16</td>
<td>$42.0M</td>
</tr>
<tr>
<td>Cornell ($954M)</td>
<td>318</td>
<td>40</td>
<td>99</td>
<td>11</td>
<td>$2.5M</td>
</tr>
<tr>
<td>MIT ($931M)</td>
<td>795</td>
<td>314</td>
<td>124</td>
<td>28</td>
<td>$34.8</td>
</tr>
</tbody>
</table>

SOURCE: Association of University Technology Managers.

The University of Michigan rank for every indicator is listed next to each indicator’s number value. These universities are ordered according to the size of their research expenditures, as reported to the National Science Foundation Higher Education Research & Development Survey for FY2015.

The indicator value in each category is highlighted in green. Data for public universities are shaded in yellow; private university data are shaded in blue.

\(^7\) The University of California System and University of Texas System report their indicators in the aggregate, not by individual university, so comparisons to schools such as UC-San Diego, UCLA or UT-Austin are not possible.