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, overall size, and emphasis on interdisciplinary approaches of the U-M’s research program contributes to university’s standing as one of the world’s leading research institutions. As such, the faculty attracts generous financial support from the public and private sectors.

The University expects that research discoveries by many of faculty will contribute to the development of innovative products and processes. The U-M places a high priority on supporting this kind of activity through the Office of Technology Transfer and the Business Engagement Center.

Overview
Total research expenditures by the University from all sources (external and University funds) exceeded $1.5 billion is Fiscal year 2018, second-highest in the nation among all universities and highest among public universities. Sixty-six percent of U-M's research spending is provided by outside sources, with the largest share of research funding from the federal government.

The University’s largest fraction of grant-supported work occurs in the biomedical and clinical sciences. The U-M Medical School alone regularly attracts more than $400 million each year in research funding.

Some research is of special 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 designates funds to interdisciplinary teams whose work has potential for broad societal impact.

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

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9.1.2  Research Expenditures by Major Funding Source, Adjusted for Inflation, FY2008-18.
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9.2  Sponsored Research Workforce by Full-Time Equivalents, Fall 2018.
9.3  University R&D Expenditures, U-M and Other Leading Institutions, FY2013-17.
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Since 1980, total research expenditures (adjusted for inflation) for all three U-M campuses from all sources (including U-M funds) have increased by nearly 350 percent. U-M spends more on research each year than any other public university in the United States.


\[ \text{Federal Non-defense R&D Expenditures (inflation-adjusted)} \]

\[ \text{U-M Research Expenditures (inflation-adjusted)} \]

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 spending\(^2\).

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 2018; a final figure is not available yet.

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\(^1\) Based on 2018 U.S. Consumer Price Index as estimated by the U-M Research Seminar on Quantitative Economics (RSQE).

\(^2\) 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.
As the federal budget allocated to non-defense R&D spending stalled in the first half of this decade, the U-M has made an effort to grow research support from internal and non-federal sources.

9.1.2 Research Expenditures by Major Funding Source, Adjusted for Inflation\(^3\), FY2008-18.

Source: U-M Financial Operations

In FY2007 the U-M changed its definition of total research expenditures by beginning 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 2018 U.S. Consumer Price Index.
Direct research expenditures on the U-M campus have increased over 10 years.

9.1.3 Direct Research Expenditures by Discipline from federal and non-federal sources, Adjusted for Inflation\(^4\), FY2008-18.

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Multidisciplinary</th>
<th>Humanities &amp; the Arts</th>
<th>Biological &amp; Other Health Sciences</th>
<th>Social Sciences</th>
<th>Physical Sciences &amp; Engineering</th>
<th>Medical Sciences</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>$138</td>
<td>15%</td>
<td>$189</td>
<td>22%</td>
<td>$117</td>
<td>14%</td>
<td>$518</td>
</tr>
<tr>
<td>2009</td>
<td>$518</td>
<td>46%</td>
<td>$518</td>
<td>40%</td>
<td>$518</td>
<td>40%</td>
<td>$117</td>
</tr>
<tr>
<td>2010</td>
<td>$204</td>
<td>16%</td>
<td>$300</td>
<td>24%</td>
<td>$182</td>
<td>14%</td>
<td>$518</td>
</tr>
</tbody>
</table>

SOURCE: U-M Financial Data

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 for items such as utilities, administration, and general maintenance of research facilities – known as “indirect” costs – that supports the entire research enterprise.

\(^4\) Based on 2018 U.S. Consumer Price Index.
Nearly half 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, FY2018.

**FY2018 Total: $1,019,183,720**

- **Indirect Costs** $272M (27%)
- **Salaries** $364M (36%)
- **Equipment** $14M (1%)
- **Subcontracts** $106M (10%)
- **Supplies & Services** $154M (15%)
- **Benefits** $87M (9%)
- **Financial Aid** $24M (2%)

**SOURCE: U-M Financial Operations**

The FY2018 total externally funded research expenditures for the Ann Arbor campus was $1.02 billion, which is an increase of $26 million from the previous year. Salaries and benefits is largest cost component.

Indirect costs (IDC) are the costs of University operations that are not assigned to a particular project, such as the 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 FY2018, 27 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 recovery rate for research funded by the Federal government or industry is 56 percent for on-campus research and 26 percent for off-campus research.

The indirect cost recovery rates charged to non-federal sponsors, such as foundations, State of Michigan agencies, and private companies, vary according to the sponsor's policies or through negotiations with the sponsor. In such situations, the recovery rate may not cover the actual expenses incurred by the U-M to support some of these projects.
Federal sponsored projects provide nearly 90 percent of indirect cost recovery funds.


\(^5\) Based on 2018 U.S. Consumer Price Index.
A fall 2018 snapshot of personnel paid under sponsored projects shows that grants and contracts fund the full-time equivalent of 4,584 faculty members, post-docs, staff and students.

9.2 Sponsored Research Workforce by Full-Time Equivalents (FTEs), Fall 2018.

Students 759 (16%)

Faculty 536 (12%)

Research Faculty 456 (10%)

Post-doctoral Fellows 759 (17%)

Admin. & Research Staff 2073 (45%)

SOURCE: U-M Human Resources Data

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 2018 total represents an increase of 169 FTEs (3.8 percent) supported on sponsored projects compared to Fall 2017.

This FTE total does not include faculty, staff, and student involvement in research and scholarship whose activities are paid for by the General Fund.
U-M spends more on research than any other U.S. public university and second most among all universities.

9.3 University R&D Expenditures, U-M and Other Leading Institutions, FY2013-17.

<table>
<thead>
<tr>
<th>Institution</th>
<th>FY2013</th>
<th>FY2014</th>
<th>FY2015</th>
<th>FY2016</th>
<th>FY2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johns Hopkins</td>
<td>$2,169M</td>
<td>$2,242M</td>
<td>$2,306M</td>
<td>$2,431M</td>
<td>$2,562M</td>
</tr>
<tr>
<td>MICHIGAN</td>
<td>$1,375M</td>
<td>$1,349M</td>
<td>$1,369M</td>
<td>$1,436M</td>
<td>$1,530M</td>
</tr>
<tr>
<td>UC San Francisco</td>
<td>$1,043M</td>
<td>$1,084M</td>
<td>$1,127M</td>
<td>$1,294M</td>
<td>$1,409M</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>$828M</td>
<td>$828M</td>
<td>$864M</td>
<td>$1,296M</td>
<td>$1,374M</td>
</tr>
<tr>
<td>Washington</td>
<td>$1,193M</td>
<td>$1,176M</td>
<td>$1,181M</td>
<td>$1,278M</td>
<td>$1,348M</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>$1,124M</td>
<td>$1,109M</td>
<td>$1,069M</td>
<td>$1,158M</td>
<td>$1,193M</td>
</tr>
<tr>
<td>UC San Diego</td>
<td>$1,076M</td>
<td>$1,067M</td>
<td>$1,101M</td>
<td>$1,087M</td>
<td>$1,133M</td>
</tr>
<tr>
<td>Duke</td>
<td>$993M</td>
<td>$1,037M</td>
<td>$1,037M</td>
<td>$1,056M</td>
<td>$1,123M</td>
</tr>
<tr>
<td>Harvard</td>
<td>$1,013M</td>
<td>$934M</td>
<td>$1,014M</td>
<td>$1,077M</td>
<td>$799M</td>
</tr>
<tr>
<td>Stanford</td>
<td>$945M</td>
<td>$959M</td>
<td>$1,023M</td>
<td>$1,066M</td>
<td>$1,110M</td>
</tr>
</tbody>
</table>

SOURCE: National Science Foundation, Higher Education Research and Development Survey

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 FY2017. 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 FY2016, APL R&D expenditures totaled $1.403M, 58% of JHU’s total for the year.
Since 2008, U-M faculty, staff and students have reported 4,274 inventions, have engaged in 1,474 licensing agreements, and have been issued 1,315 U.S. patents.


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 $273 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, FY2008-18.

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 2008, 140 new companies employing U-M discoveries have been launched.

9.4.3 Formation of Start-up Companies that Utilize U-M Technology, FY2008-18.

SOURCE: U-M Office of Technology Transfer

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. Health Media, developer of health support programs, was acquired in 2008 by Johnson & Johnson. 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. And in April 2018, Boston Scientific, a major company in the medical devices sector, bought U-M start-up Securus Medical Group and its FDA-cleared thermal monitoring technology.

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.

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, FY2016.

<table>
<thead>
<tr>
<th>Institution (FY2016 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 ($2,431M)</td>
<td>503</td>
<td>161</td>
<td>149</td>
<td>22</td>
<td>$58.0M</td>
</tr>
<tr>
<td>MICHIGAN ($1,436M) 2nd</td>
<td>428 (4(^{th}))</td>
<td>176 (3(^{rd}))</td>
<td>173 (2(^{nd}))</td>
<td>12 (6(^{th}))</td>
<td>$23.4M (7(^{th}))</td>
</tr>
<tr>
<td>Pennsylvania ($1,296M)</td>
<td>391</td>
<td>111</td>
<td>156</td>
<td>13</td>
<td>$50.0</td>
</tr>
<tr>
<td>Washington ($1,278M)</td>
<td>363</td>
<td>98</td>
<td>326</td>
<td>21</td>
<td>$19.6M</td>
</tr>
<tr>
<td>Wisconsin ($1,158M)</td>
<td>415</td>
<td>187</td>
<td>70</td>
<td>9</td>
<td>$23.6M</td>
</tr>
<tr>
<td>Harvard ($1,077M)</td>
<td>509</td>
<td>122</td>
<td>84</td>
<td>13</td>
<td>$38.1M</td>
</tr>
<tr>
<td>Stanford ($1,066M)</td>
<td>472</td>
<td>264</td>
<td>141</td>
<td>32</td>
<td>$94.2M</td>
</tr>
<tr>
<td>Duke ($1,056M)</td>
<td>309</td>
<td>71</td>
<td>76</td>
<td>9</td>
<td>$34.2M</td>
</tr>
<tr>
<td>North Carolina ($1,045M)</td>
<td>196</td>
<td>49</td>
<td>53</td>
<td>8</td>
<td>$4.1M</td>
</tr>
<tr>
<td>Cornell ($974M)</td>
<td>359</td>
<td>107</td>
<td>83</td>
<td>11</td>
<td>$12.3M</td>
</tr>
</tbody>
</table>

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 FY2016.

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

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\(^7\) 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.
Federally funded research projects at the University of Michigan have served as feeders of highly trained personnel who later moved to jobs in all 50 states.

Counts of U-M faculty, staff and students involved in federal research on the Ann Arbor campus who then took positions at other institutions or companies, by state, 2002-2015.

Thousands of faculty, staff and students participate in research projects funded by the federal government every year. This graphic represents the flow of people and ideas into the economy by showing how many research-trained University of Michigan faculty, postdoctoral researchers, staff and students paid on federal research have taken jobs in other locations across the country. Most who leave U-M are concentrated in the state of Michigan. The top three geographic destinations for U-M trained researchers who leave the state of Michigan are, in order, California, New York, and Illinois.

The Institute for Research on Innovation and Science (IRIS) is national consortium of more than 30 research universities that conduct about $22.6 billion in R&D (~31% of the national total). These schools granted nearly 15,000 doctorates in 2016, about 27% of the nation's total. IRIS collects detailed administrative data from its members to produce an IRB-approved data repository that can support research and reporting that aids our ability to understand, explain and improve the public value of research and training. For more information about IRIS, see iris.isr.umich.edu.

8 This graphic was created in conjunction with data from the U.S. Census Bureau, DRB Decision #CBDRB-FY2018-411.