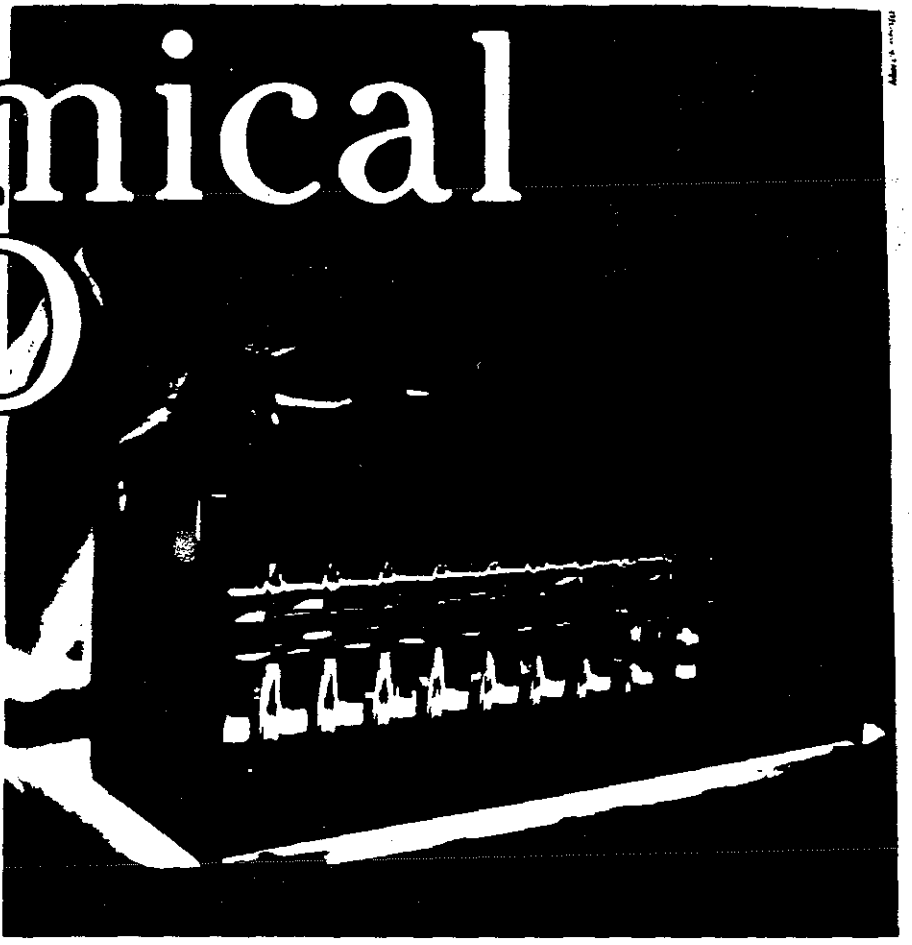
Richard Bennof
634-4673

# Facts & Figures for Chemical R&D



**Rebecca L. Rawls**, C&EN Washington

Research and development in the U.S. is growing modestly. Total expenditures for R&D are expected to top $122 billion in 1987, an increase of 6% over R&D spending from all sources last year. That's the smallest year-to-year change in the past decade, a decade that has seen R&D funding nearly triple, in current dollars, from 1977's $42.8 billion. For the decade as a whole, R&D spending in the U.S. has been growing 11% per year—nearly twice the rate at which it is growing now.

Still, although significantly more modest than in the recent past, the increase in R&D funding expected this year does represent real growth, outpacing anticipated inflation by some 2%. In keeping with the recent pattern, about half that money comes from the federal government—$60 billion in 1987—and almost all the rest from industry. Universities and other nonprofit institutions will kick in a relatively modest $4.2 billion, only 3% of the total, this year.

Government spending for R&D is actually growing a good deal

faster than federal spending as a whole. If Gramm-Rudman deficit reduction targets are to be met in this year's budget—an event that most observers consider unlikely—the overall federal budget probably will rise only a very modest 1% for the year ending Sept. 30. Federal R&D support, by contrast, is expected to be up 7% for 1987 as a whole. In general, the Reagan Administration and Congress have been relatively kind to R&D budgets during the past seven years, doubling federal support for R&D from its pre-Reagan level of $29.5 billion in 1980. Even when inflation is taken into account, federal R&D support has grown 46% since 1980.

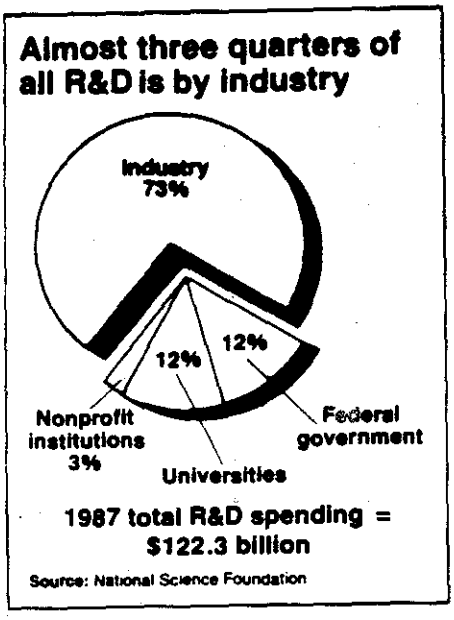
Until recently, industrial support for R&D has kept pace with the federal effort. In 1986 and again in 1987, however, preliminary figures indicate that industry's support for R&D is lagging behind that of government. R&D spending by all industry is expected to rise 5% this year, following a 6% increase in 1986 and one of 7% in 1985. Federal support over the same period rose, on average, 10% per year.

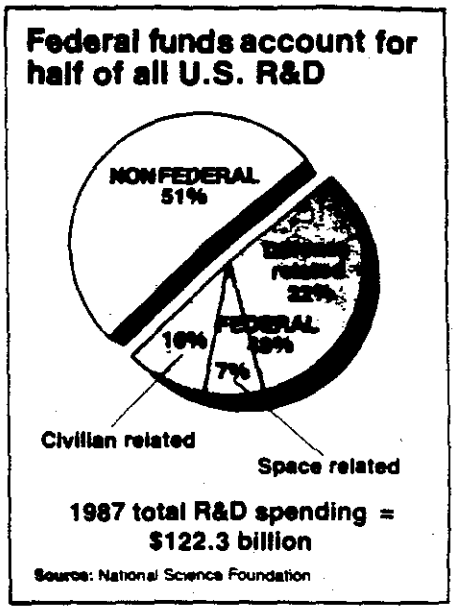
Considered in a broader context, however, current levels of support for R&D in the U.S. are quite high. R&D spending appears to be leveling off at about 2.7% of gross national product. For most of the past two decades it has been considerably lower than that, reaching its most recent nadir in 1978 at just above 2.1%. Not since the mid-1960s, when massive efforts in space and defense led the federal government to spend twice what industry did to support R&D, has such a large fraction of the nation's total output of goods and services, as measured by GNP, been devoted to supporting R&D. Though the rate of growth may be declining, overall support for R&D in the U.S. appears strong.

Chemical R&D, of course, is only a small piece of the total R&D picture. Just how much of the total national effort focuses on chemistry is never easy to measure, in part because the point where chemical R&D breaks off and R&D begins in some closely related field—materials science, say, or biotechnology—has never been clearly defined.

This year, separating out that part of the overall R&D effort that can reasonably be called chemical is even harder than usual. That's because some of the key data, particularly on the industrially financed half of the R&D picture, have yet to be compiled by the National Science Foundation. NSF is the chief source of statistical information on R&D in the U.S., and its data—collected in large part by the Census Bureau—form much of the basis of this special report. Recent reorganizations at both the Census Bureau and NSF's division of science resources studies have delayed the compilation of some of these data by three or four months. As a result, the most recent data available for many aspects of industrial R&D spending are based on information collected in 1983, too long ago to give a precise picture of the state of that R&D effort now.

Of the federally funded half of U.S. R&D, the biggest share—69% for the 1987 fiscal year—is funded by the Defense Department. Defense's share of the federal R&D budget has been climbing steadily in recent years, from a level of about 45% that prevailed throughout the late 1970s. That shift parallels another one that is taking place, name-




ly that more and more federal funds are going into the development part of R&D—72% in 1987, up from 64% five years ago. The Defense Department is the overwhelming source of federal development funds, supplying almost 90% in 1987.

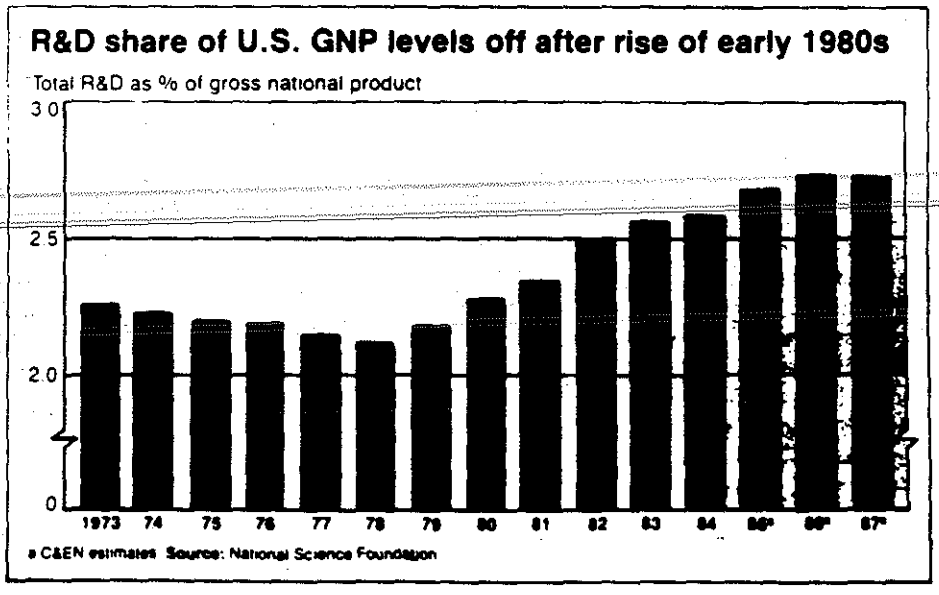
Chemical research also finds its single largest federal patron in the Defense Department, which in the 1987 budget year is expected to spend $185 million for it. That's 28% of total federal chemical research support, which is estimated to reach $671 million. Defense Department support is up 10% from 1986 levels. Growing even faster is support from the National Science Foundation, which expects a 17% boost in its funding for chemical research in fiscal 1987. That would bring its support to $132 million, nearly to the level of the second largest supporter of chemical research in the federal government—the Department of Energy, which expects to spend $139 million on such research in fiscal 1987, down 6% from 1986. In fact, except for the Defense Department and NSF, all the major supporters of chemical research in the federal government will decrease their spending in this area in 1987. The net effect is a 3% rise overall for federal support for chemical research—no change at all when inflation is taken into account.

At universities, where half of the nation's basic research is performed, overall budgets for basic research were up a healthly 8% in 1986. Funds for applied R&D, which together account for only a third of total R&D spending at universities, also were up 8% in 1986. Spending at universities on chemical R&D reached $450 million in 1986, also an 8% hike from 1985. The federal government is the principal funder of university R&D—supplying nearly two thirds of the $11.1 billion universities expect to spend on R&D in 1987.

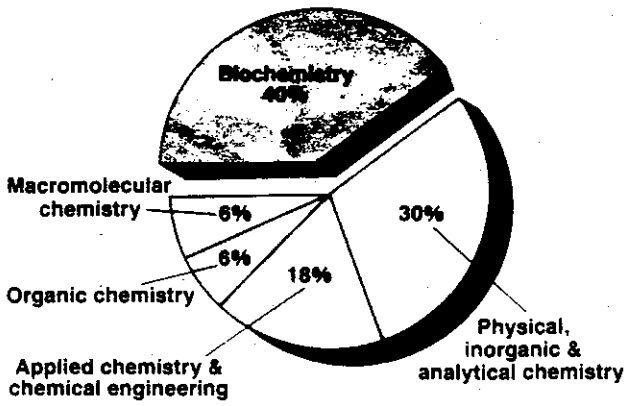
Though universities have a major role in performing basic research in the U.S., they trail far behind industry when it comes to carrying out applied research or development. In fact, industry will do 73% of the total R&D conducted in the U.S. this year, a fraction that has held essentially constant for the past decade. Universities and government-run R&D facilities each perform about equal shares of the remainder.

Historically, the overall chemicals and allied products industry performs about 70% of all the applied R&D done on chemicals or drugs by industry. R&D performed by companies in the chemicals and allied products industry is estimated to have increased 10% in 1986 to $9.5 billion. That level of growth is off a bit from the 12% average annual rate of increase for the past decade. When adjusted for inflation, however, the real growth in spending for 1986, at 7%, is slightly better than the 6% annual rate for the decade as a whole.

Growth in R&D at major industrial chemical companies was not so high as that for the chemicals and allied products industry as a whole in 1986—up only 4%. Some of this difference comes about because drug companies, which are part of the chemicals and allied products industry, are increasing their R&D spending faster than are basic chemical companies. Another contributing factor is a major divestment that took place at Union Carbide in 1986. The company sold off nearly $2 billion of its assets, largely in consumer products fields. The much smaller Union Carbide spent less on R&D in 1986 than its predecessor company had in 1985. When this change is taken into account, major chemical company R&D spending rose 7% in 1986. □



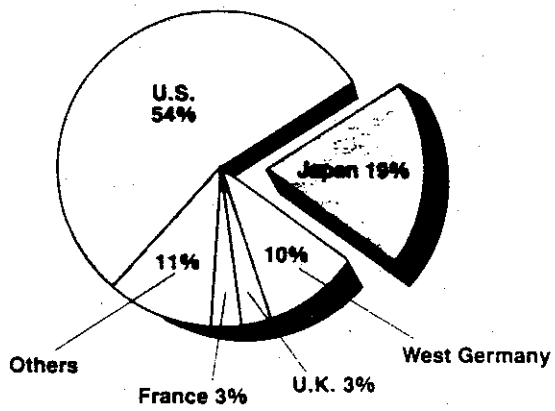
## Two fifths of chemistry papers are in biochemistry




**1986 total papers[a] = 474,429**

a Number of abstracts of papers published in *Chemical Abstracts*.
**Source:** Chemical Abstracts Service

## Japanese now receive nearly 20% of U.S. patents




**1986 total U.S. patents issued = 70,860**

**Source:** U.S. Patent & Trademark Office

## PERFORMERS OF R&D: Industry's share is six times that of government

| | $ Billions (current) | | | | | | | | | | | Annual change | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1987[a] | 1986[a] | 1985[a] | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | 1986-87 | 1977-87 |
| **Industry** | $ 88.7 | $ 84.4 | $ 78.2 | $71.5 | $63.4 | $58.0 | $51.8 | $44.5 | $38.2 | $33.3 | $29.8 | 5% | 12% |
| **Federal government** | 15.1 | 13.4 | 13.0 | 11.6 | 10.6 | 9.1 | 8.4 | 7.6 | 7.4 | 6.8 | 6.0 | 13 | 10 |
| **Universities and colleges** | 10.7 | 10.3 | 9.5 | 8.5 | 7.8 | 7.3 | 6.8 | 6.1 | 5.4 | 4.6 | 4.1 | 4 | 10 |
| **University-associated FFRDCs[b]** | 4.0 | 3.8 | 3.5 | 3.1 | 2.7 | 2.5 | 2.5 | 2.2 | 1.9 | 1.7 | 1.4 | 5 | 11 |
| **Other nonprofit institutions** | 3.7 | 3.4 | 3.3 | 3.0 | 2.7 | 2.4 | 2.3 | 2.2 | 2.0 | 1.7 | 1.5 | 9 | 9 |
| **TOTAL** | **$122.3** | **$115.2** | **$107.5** | **$97.6** | **$87.2** | **$79.3** | **$71.8** | **$62.6** | **$54.9** | **$48.1** | **$42.8** | **6%** | **11%** |
| | $ Billions (1982, constant) | | | | | | | | | | | | |
| **Industry** | $ 74.5 | $ 73.7 | $70.1 | $66.9 | $61.0 | $58.0 | $55.1 | $51.9 | $48.7 | $46.1 | $44.3 | 1% | 5% |
| **Federal government** | 12.7 | 11.7 | 11.7 | 10.8 | 10.2 | 9.1 | 9.0 | 9.0 | 9.5 | 9.5 | 9.0 | 9 | 4 |
| **Universities and colleges** | 9.0 | 9.0 | 8.5 | 7.9 | 7.5 | 7.3 | 7.3 | 7.2 | 6.9 | 6.4 | 6.1 | 0 | 4 |
| **University-associated FFRDCs[b]** | 3.4 | 3.3 | 3.1 | 2.9 | 2.6 | 2.5 | 2.7 | 2.7 | 2.5 | 2.4 | 2.1 | 3 | 5 |
| **Other nonprofit institutions** | 3.1 | 3.0 | 3.0 | 2.8 | 2.6 | 2.4 | 2.4 | 2.5 | 2.5 | 2.3 | 2.2 | 3 | 3 |
| **TOTAL** | **$102.7** | **$100.6** | **$96.4** | **$90.5** | **$83.9** | **$79.3** | **$76.6** | **$73.2** | **$70.1** | **$66.8** | **$63.7** | **2%** | **5%** |

a C&EN estimates. b Federally funded R&D centers. Those administered by both industry and by nonprofit institutions are included in totals for their respective sectors.
**Source:** National Science Foundation

## CHARACTER OF R&D: Uniform growth in all three sectors

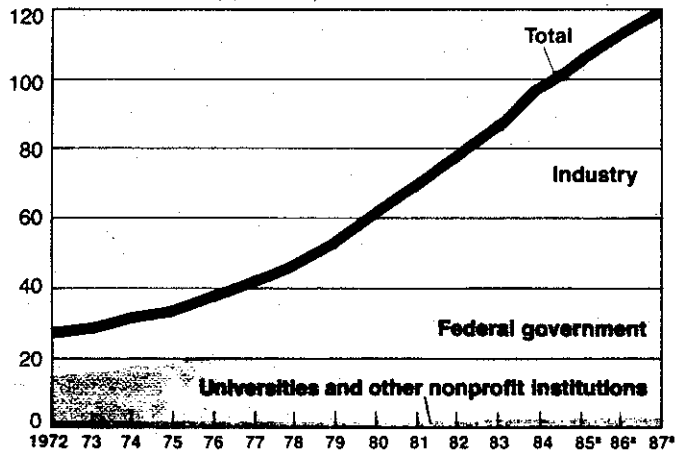
| | $ Billions (current) | | | | | | | | | | | Annual change | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1987[a] | 1986[a] | 1985[a] | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | 1986-87 | 1977-87 |
| **Basic research** | $ 14.7 | $ 13.8 | $ 13.0 | $12.1 | $11.0 | $ 9.9 | $ 9.2 | $ 8.1 | $ 7.3 | $ 6.4 | $ 5.5 | 7% | 10% |
| **Applied research** | 26.4 | 24.7 | 23.4 | 22.3 | 20.4 | 18.5 | 16.9 | 14.1 | 12.3 | 10.8 | 9.7 | 7 | 11 |
| **Development** | 81.2 | 76.5 | 71.1 | 62.9 | 55.8 | 50.9 | 45.8 | 40.5 | 35.3 | 30.9 | 27.5 | 6 | 11 |
| **TOTAL** | **$122.3** | **$115.2** | **$107.5** | **$97.6** | **$87.2** | **$79.3** | **$71.8** | **$62.6** | **$54.9** | **$48.1** | **$42.8** | **6%** | **11%** |
| | $ Billions (1982, constant) | | | | | | | | | | | | |
| **Basic research** | $ 12.3 | $ 12.1 | $11.7 | $11.2 | $10.6 | $ 9.9 | $ 9.8 | $ 9.5 | $ 9.3 | $ 8.9 | $ 8.3 | 2% | 4 |
| **Applied research** | 22.2 | 21.6 | 21.0 | 20.7 | 19.6 | 18.5 | 18.0 | 16.5 | 15.8 | 15.1 | 14.5 | 3 | 4 |
| **Development** | 68.2 | 66.8 | 63.8 | 58.3 | 53.7 | 50.9 | 48.8 | 47.3 | 45.0 | 42.8 | 40.9 | 2 | 5 |
| **TOTAL** | **$102.7** | **$100.6** | **$96.4** | **$90.5** | **$83.9** | **$79.3** | **$76.6** | **$73.2** | **$70.1** | **$66.8** | **$63.7** | **2%** | **5%** |

a C&EN estimates. **Source:** National Science Foundation

# R&D • Overview

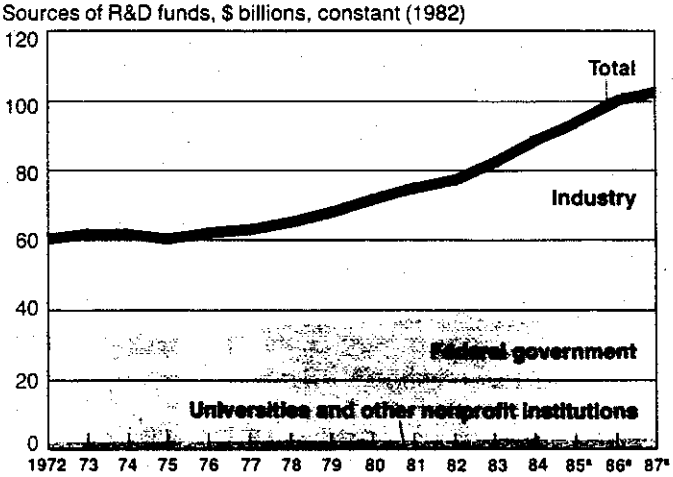
## Although U.S. outlays for R&D are up fourfold in the past 15 years . . .

Sources of R&D funds, $ billions, current




## . . . they are only two thirds higher if inflation is taken into account

Sources of R&D funds, $ billions, constant (1982)




a C&EN estimates. **Source:** National Science Foundation

## SOURCES OF R&D FUNDS: Industry and federal government each contribute nearly half

| | $ Billions (current) | | | | | | | | | | | Annual change | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1987a | 1986a | 1985a | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | 1986-87 | 1977-87 |
| Industry | $ 58.1 | $ 55.3 | $ 52.2 | $48.8 | $43.5 | $40.1 | $35.9 | $30.9 | $26.1 | $22.5 | $19.6 | 5% | 11% |
| Federal government | 60.0 | 56.0 | 51.8 | 45.6 | 40.7 | 36.5 | 33.4 | 29.5 | 26.8 | 23.9 | 21.6 | 7 | 11 |
| Universities and colleges | 2.7 | 2.5 | 2.3 | 2.0 | 1.9 | 1.7 | 1.5 | 1.3 | 1.2 | 1.0 | 0.9 | 8 | 12 |
| Other nonprofit institutions | 1.5 | 1.4 | 1.3 | 1.2 | 1.1 | 1.0 | 1.0 | 0.9 | 0.8 | 0.8 | 0.7 | 7 | 8 |
| **TOTAL** | **$122.3** | **$115.2** | **$107.5** | **$97.6** | **$87.2** | **$79.3** | **$71.8** | **$62.6** | **$54.9** | **$48.1** | **$42.8** | **6%** | **11%** |
| **ANNUAL CHANGE** | **6%** | **7%** | **10%** | **12%** | **10%** | **10%** | **15%** | **14%** | **14%** | **12%** | **10%** | | |

| | $ Billions (1982, constant) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Industry | $ 48.8 | $ 48.3 | $46.8 | $45.2 | $41.9 | $40.1 | $38.3 | $36.1 | $33.2 | $31.1 | $29.2 | 1% | 5% |
| Federal government | 50.4 | 48.9 | 46.5 | 42.3 | 39.2 | 36.5 | 35.7 | 34.5 | 34.3 | 33.2 | 32.2 | 3 | 5 |
| Universities and colleges | 2.3 | 2.2 | 2.1 | 1.9 | 1.8 | 1.7 | 1.6 | 1.6 | 1.5 | 1.4 | 1.3 | 5 | 6 |
| Other nonprofit institutions | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 1.0 | 1.1 | 1.1 | 1.1 | 1.0 | 8 | 3 |
| **TOTAL** | **$102.7** | **$100.6** | **$96.4** | **$90.5** | **$83.9** | **$79.3** | **$76.6** | **$73.2** | **$70.1** | **$66.8** | **$63.7** | **2%** | **5%** |
| **ANNUAL CHANGE** | **2%** | **4%** | **7%** | **8%** | **6%** | **4%** | **5%** | **4%** | **5%** | **5%** | **2%** | | |

a C&EN estimates. **Source:** National Science Foundation

## PATENT ACTIVITY OF U.S. COMPANIES:[a] Significant decline for chemicals in 1986

| Number of patents issued | 1986 | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | Total 1977-86 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CHEMICAL COMPANIES** | | | | | | | | | | | |
| **Dow Chemical** | 371 | 335 | 328 | 246 | 276 | 260 | 249 | 217 | 334 | 297 | **2,913** |
| **Du Pont** | 329 | 342 | 348 | 326 | 283 | 343 | 289 | 227 | 386 | 431 | **3,304** |
| **Ciba-Geigy** | 244 | 305 | 290 | 244 | 281 | 345 | 309 | 248 | 347 | 354 | **2,967** |
| **Union Carbide** | 208 | 242 | 231 | 182 | 202 | 262 | 211 | 197 | 215 | 224 | **2,174** |
| **PPG Industries** | 124 | 128 | 137 | 137 | 177 | 189 | 166 | 118 | 190 | 196 | **1,562** |
| **Monsanto** | 110 | 100 | 138 | 136 | 131 | 211 | 205 | 144 | 264 | 192 | **1,631** |
| **American Cyanamid** | 92 | 115 | 111 | 128 | 129 | 188 | 205 | 143 | 225 | 215 | **1,551** |
| **Olin** | 81 | 117 | 112 | 85 | 80 | 80 | 106 | 82 | 99 | 91 | **933** |
| **Ethyl** | 77 | 105 | 76 | 44 | 31 | 43 | 51 | 25 | 41 | 46 | **539** |
| **International Flavors & Fragrances** | 76 | 104 | 95 | 87 | 87 | 96 | 76 | 60 | 80 | 52 | **813** |
| **Stauffer Chemical** | 75 | 104 | 95 | 81 | 87 | 94 | 93 | 80 | 132 | 116 | **957** |
| **Celanese** | 66 | 67 | 94 | 57 | 56 | 58 | 56 | 44 | 71 | 70 | **639** |
| **Hercules** | 43 | 41 | 39 | 37 | 30 | 52 | 23 | 24 | 49 | 51 | **389** |
| **W. R. Grace** | 42 | 45 | 57 | 52 | 49 | 68 | 72 | 56 | 76 | 63 | **580** |
| **Rohm & Haas** | 33 | 31 | 37 | 55 | 49 | 77 | 74 | 77 | 95 | 94 | **622** |
| **GAF** | 12 | 23 | 19 | 21 | 32 | 47 | 48 | 54 | 57 | 26 | **339** |
| **TOTAL[b]** | **1983** | **2204** | **2207** | **1918** | **1980** | **2413** | **2233** | **1796** | **2661** | **2518** | **21,913** |
| **ANNUAL CHANGE** | **−10%** | **0%** | **15%** | **−3%** | **−18%** | **8%** | **24%** | **−33%** | **6%** | **−9%** | |

a Includes U.S. chemical companies or U.S.-based subsidiaries of foreign companies that have received more than 999 U.S. patents since 1962. b These totals include patents issued to the chemical companies shown in this table only. Source: U.S. Patent & Trademark Office

## U.S. PATENTS: Those of foreign origin rose 2% in 1986 as those of U.S. origin declined 4%

| Number of patents issued | 1986 | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979[a] | 1978 | 1977 | Total 1977-86 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **U.S. origin** | **38,124** | **39,554** | **38,365** | **32,871** | **33,896** | **39,223** | **37,356** | **30,079** | **41,254** | **41,485** | **372,207** |
| to U.S. corporations | 27,324 | 28,944 | 28,002 | 24,038 | 24,085 | 27,623 | 25,967 | 21,145 | 29,421 | 29,566 | **266,115** |
| to U.S. government | 1,011 | 1,124 | 1,228 | 1,043 | 1,003 | 1,117 | 1,232 | 961 | 1,233 | 1,484 | **11,436** |
| to individuals in the U.S. | 9,461 | 9,243 | 8,887 | 7,562 | 8,539 | 10,241 | 9,940 | 7,804 | 10,399 | 10,249 | **92,325** |
| to foreign-owned corporations in the U.S. | 328 | 243 | 248 | 228 | 269 | 242 | 217 | 169 | 201 | 186 | **2,331** |
| **Foreign origin** | **32,736** | **32,107** | **28,835** | **23,989** | **23,992** | **26,548** | **24,463** | **18,775** | **24,848** | **23,784** | **260,077** |
| to U.S.-owned corporations abroad | 2,231 | 2,274 | 2,032 | 1,660 | 1,715 | 1,839 | 1,694 | 1,364 | 1,961 | 1,970 | **18,740** |
| to foreign corporations | 26,196 | 25,721 | 22,985 | 19,019 | 18,589 | 20,549 | 18,665 | 14,447 | 18,875 | 17,879 | **202,925** |
| to foreign governments | 471 | 483 | 440 | 336 | 368 | 249 | 253 | 186 | 249 | 215 | **3,250** |
| to foreign individuals | 3,838 | 3,629 | 3,378 | 2,974 | 3,320 | 3,911 | 3,851 | 2,778 | 3,763 | 3,720 | **35,162** |
| **TOTAL** | **70,860** | **71,661** | **67,200** | **56,860** | **57,888** | **65,771** | **61,819** | **48,854** | **66,102** | **65,269** | **632,284** |
| **% FOREIGN** | **46.2%** | **44.8%** | **42.9%** | **42.2%** | **41.4%** | **40.4%** | **39.6%** | **38.4%** | **37.6%** | **36.4%** | **41.1%** |

a Patent figures were low in 1979 because the U.S. Patent & Trademark Office was short of funds to print patents it might otherwise have issued. Source: U.S. Patent & Trademark Office

## HOLDERS OF U.S. PATENTS: Japan's share doubles in past decade

| % of patents | 1986 | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | Total 1977-86 | Total 1963-76 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **U.S. origin** | **54** | **55** | **57** | **58** | **59** | **60** | **60** | **62** | **62** | **64** | **59** | **73** |
| **Foreign origin[a]** | **46** | **45** | **43** | **42** | **41** | **40** | **40** | **38** | **38** | **36** | **41** | **27** |
| Japan | 19 | 18 | 17 | 15 | 14 | 13 | 12 | 11 | 10 | 10 | 14 | 5 |
| West Germany | 10 | 9 | 9 | 10 | 9 | 10 | 9 | 9 | 9 | 8 | 9 | 7 |
| U.K. | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| France | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Switzerland | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Canada | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Sweden | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Italy | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Netherlands | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| U.S.S.R. | — | — | — | — | — | 1 | 1 | 1 | 1 | 1 | — | — |
| Others | 2 | — | — | — | — | — | — | — | — | — | 3 | 2 |

a Data for individual countries may not equal this number because of rounding. Source: U.S. Patent & Trademark Office

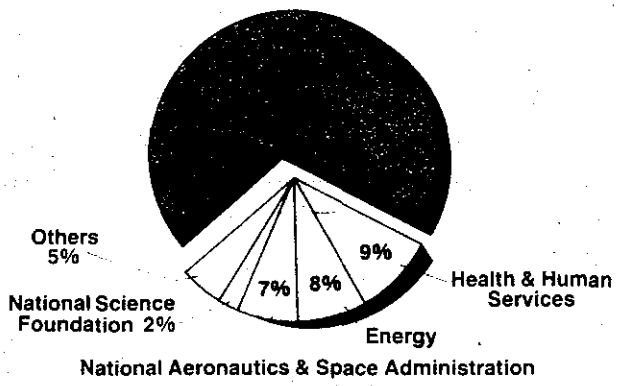
## ABSTRACTS OF PAPERS IN *CHEMICAL ABSTRACTS:* Biochemistry's share holds steady at 40%

| | 1986 | 1985 | 1984 | 1983 | 1982 | 1981 | 1976 | Percentage point change, 1976–86 |
|---|---|---|---|---|---|---|---|---|
| BIOCHEMISTRY | 40.4% | 40.5% | 40.5% | 38.3% | 39.5% | 39.0% | 38.8% | 1.6% |
| | | | % of all biochemistry abstracts | | | | | |
| **Mammalian hormones[a]** | 12.5% | 12.3% | 12.4% | 12.9% | 12.2% | 6.8% | 5.9% | 6.6% |
| **Pharmacology** | 12.2 | 12.3 | 11.6 | 11.8 | 12.0 | 12.4 | 12.0 | 0.2 |
| **Mammalian biochemistry[a]** | 10.8 | 11.1 | 11.3 | 11.1 | 11.6 | 15.6 | 16.3 | −5.5 |
| **Toxicology** | 7.8 | 7.9 | 8.0 | 8.5 | 8.1 | 8.7 | 6.4 | 1.4 |
| **Immunochemistry** | 6.1 | 5.3 | 4.8 | 4.2 | 4.4 | 3.4 | — | — |
| **Biochemical genetics[b]** | 6.1 | 5.2 | 4.2 | 3.8 | 3.3 | — | — | — |
| **Microbial biochemistry[a]** | 5.7 | 5.7 | 5.2 | 5.1 | 5.3 | 5.6 | 5.0 | 0.7 |
| **Enzymes** | 5.6 | 5.6 | 5.8 | 6.1 | 5.9 | 5.9 | 6.4 | −0.8 |
| **Plant biochemistry[a]** | 5.2 | 5.5 | 6.2 | 5.9 | 6.2 | 5.8 | 6.1 | −0.9 |
| **Biochemical methods** | 5.0 | 4.9 | 4.9 | 4.9 | 4.6 | 5.7 | — | — |
| **General biochemistry** | 4.7 | 4.9 | 5.3 | 5.8 | 6.0 | 7.5 | 7.1 | −2.4 |
| **Others** | 18.3 | 19.3 | 20.3 | 19.9 | 20.4 | 22.6 | 34.8 | — |
| PHYSICAL, INORGANIC, AND ANALYTICAL CHEMISTRY | 29.8 | 29.8 | 28.8 | 29.6 | 28.5 | 28.0 | 27.5 | 2.3 |
| | | | % of all physical, inorganic, and analytical chemistry abstracts | | | | | |
| **Spectra** | 20.0 | 18.4 | 18.0 | 17.6 | 17.2 | 18.0 | 17.8 | 2.2 |
| **Nuclear chemistry** | 19.9 | 21.8 | 22.2 | 22.5 | 22.6 | 21.6 | 19.7 | 0.2 |
| **Electric phenomena** | 10.8 | 10.8 | 10.8 | 10.0 | 10.5 | 11.0 | 10.5 | 0.3 |
| **Crystallography and liquid crystals** | 7.0 | 7.5 | 7.8 | 8.3 | 8.7 | 8.9 | 9.7 | −2.7 |
| **General physical chemistry** | 7.0 | 6.9 | 6.9 | 7.3 | 7.3 | 7.2 | 7.0 | 0.0 |
| **Analytical chemistry** | 6.8 | 6.1 | 6.3 | 6.2 | 5.4 | 5.8 | 6.6 | 0.2 |
| **Others** | 28.5 | 28.5 | 28.0 | 28.1 | 28.3 | 27.5 | 28.7 | −0.2 |
| APPLIED CHEMISTRY AND CHEMICAL ENGINEERING | 18.2 | 18.4 | 17.6 | 19.4 | 19.5 | 19.1 | 18.8 | −0.6 |
| | | | % of all applied chemistry and chemical engineering abstracts | | | | | |
| **Water, wastes, and pollution** | 21.9 | 20.2 | 21.0 | 19.6 | 21.7 | 24.0 | 18.6 | 3.3 |
| **Metals and alloys** | 20.8 | 20.0 | 18.9 | 19.1 | 22.2 | 17.9 | 27.8 | −7.0 |
| **Mineralogical and geological chemistry** | 12.0 | 12.5 | 14.6 | 14.1 | 13.6 | 14.1 | 17.6 | −5.6 |
| **Fossil fuels, derivatives, and related products** | 9.0 | 10.1 | 10.1 | 10.3 | 9.4 | 9.4 | 6.0 | 3.0 |
| **Unit operations and processes** | 7.1 | 7.5 | 7.0 | 7.5 | 6.9 | 6.4 | 4.8 | 2.3 |
| **Others** | 29.2 | 29.7 | 28.4 | 29.4 | 26.2 | 28.2 | 25.2 | 4.0 |
| ORGANIC CHEMISTRY | 5.9 | 6.4 | 7.6 | 7.3 | 7.2 | 8.7 | 8.7 | −2.8 |
| | | | % of all organic chemistry abstracts | | | | | |
| **Physical organic chemistry** | 27.3 | 30.6 | 32.0 | 30.5 | 31.5 | 37.0 | 38.4 | −11.1 |
| **Organometallic and organometalloidal compounds** | 18.3 | 16.2 | 17.1 | 16.3 | 14.8 | 8.3 | 8.7 | 9.6 |
| **Heterocyclic compounds[a]** | 15.0 | 16.1 | 15.6 | 16.2 | 15.6 | 18.2 | 17.4 | −2.4 |
| **Carbohydrates** | 7.8 | 5.7 | 5.7 | 5.8 | 5.8 | 5.4 | 5.1 | 2.7 |
| **Aromatic compounds[a]** | 7.3 | 6.3 | 6.3 | 7.1 | 7.2 | 8.7 | 8.0 | −0.7 |
| **Biomolecules and their synthetic analogs[b]** | 5.0 | 4.9 | 4.4 | 4.5 | 3.7 | — | — | — |
| **Aliphatic compounds[a]** | 4.4 | 4.2 | 3.6 | 4.3 | 5.2 | 6.6 | 6.5 | −2.1 |
| **Amino acids, peptides, and proteins[a]** | 3.9 | 4.6 | 4.6 | 4.5 | 4.4 | 4.2 | 4.3 | −0.4 |
| **Others** | 11.0 | 11.4 | 10.5 | 10.8 | 11.8 | 11.6 | 11.6 | — |
| MACROMOLECULAR CHEMISTRY | 5.7 | 4.9 | 5.5 | 5.4 | 5.3 | 5.2 | 6.2 | −0.5 |
| | | | % of all macromolecular chemistry abstracts | | | | | |
| **Synthetic high polymers** | 34.1 | 34.1 | 34.0 | 34.4 | 34.7 | 30.3 | 28.3 | 5.8 |
| **Plastics manufacture and uses** | 23.8 | 25.3 | 24.2 | 24.4 | 21.9 | 26.4 | 26.8 | −3.0 |
| **Cellulose, lignin, paper, and other wood products** | 9.8 | 9.1 | 9.6 | 9.1 | 9.7 | 10.1 | 9.1 | 0.7 |
| **Textiles** | 6.8 | 6.2 | 7.3 | 7.9 | 8.9 | 9.9 | 11.1 | −2.3 |
| **Coatings, inks, and related products** | 7.2 | 7.2 | 7.8 | 6.6 | 7.6 | 7.5 | 7.6 | −0.4 |
| **Synthetic elastomers and natural rubber** | 6.7 | 6.8 | 7.3 | 7.5 | 7.8 | 7.9 | 8.6 | −1.9 |
| **Others** | 9.6 | 9.3 | 9.8 | 10.1 | 9.4 | 7.9 | 8.5 | 1.1 |

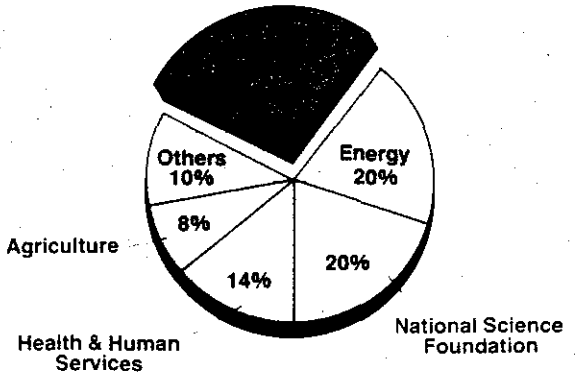
How to read this table: Using biochemistry as an example, 40.4% of all the papers abstracted by Chemical Abstracts Service in 1986 are in the various subdisciplines of biochemistry; 12.5% of all abstracts in biochemistry, in turn, are in the subdiscipline of mammalian hormones, 12.2% of biochemistry abstracts are in pharmacology, and so on. a Definition of section changed in 1982. b New section in 1982. Source: Chemical Abstracts Service

# Defense's share of federal support grows

## Defense gets nearly 70% of federal R&D funding but less than a third of funds for chemistry




Estimated fiscal 1987 total federal R&D obligations = $59.2 billion




Estimated fiscal 1987 federal chemistry research obligations = $671 million

Source: National Science Foundation

## FEDERAL OBLIGATIONS FOR R&D: Up strongly thanks to big boost for military funds

| $ Millions | 1987[a] | 1986[a] | 1985 | 1984 | 1983 | 1982 | Annual change 1986–87 | Annual change 1982–87 |
|---|---|---|---|---|---|---|---|---|
| **Defense** | **$40,678.8** | **$33,646.3** | **$29,791.5** | **$25,372.9** | **$22,992.8** | **$20,622.6** | **21%** | **15%** |
| Air Force | 17,356.5 | 13,757.5 | 13,260.9 | 12,091.6 | 10,812.6 | 9,357.9 | 26 | 13 |
| Navy | 10,700.8 | 10,137.3 | 9,127.4 | 7,605.6 | 6,068.2 | 5,845.1 | 6 | 13 |
| Army | 5,710.2 | 4,850.2 | 4,570.8 | 4,225.5 | 3,998.1 | 3,760.5 | 18 | 9 |
| Defense agencies[b] | 6,775.3 | 4,790.7 | 2,781.7 | 1,391.5 | 2,052.3 | 1,618.1 | 41 | 33 |
| **Health & Human Services** | **5,270.8** | **5,611.3** | **5,451.0** | **4,830.7** | **4,352.5** | **3,940.7** | **−6** | **6** |
| National Institutes of Health | 4,672.3 | 4,977.3 | 4,827.7[a] | 4,257.4 | 3,789.2 | 3,433.1 | −6 | 3 |
| Alcohol, Drug Abuse & Mental Health Administration | 383.1 | 396.2 | 377.6 | 337.2 | 302.2 | 248.1 | −3 | 9 |
| **Energy** | **4,770.7** | **4,691.6** | **4,996.0** | **4,673.6** | **4,536.7** | **4,708.2** | **2** | **0** |
| **National Aeronautics & Space Administration** | **3,926.0** | **3,478.4** | **3,327.2** | **2,821.9** | **2,661.6** | **3,077.9** | **13** | **5** |
| **National Science Foundation** | **1,508.3** | **1,333.5** | **1,345.6** | **1,202.8** | **1,062.0** | **975.3** | **13** | **9** |
| **Agriculture** | **909.2** | **923.0** | **943.0** | **866.2** | **847.6** | **797.3** | **−1** | **3** |
| Agricultural Research Service | 497.0 | 463.1 | 469.7 | 451.3 | 443.4 | 404.9 | 7 | 4 |
| Cooperative State Research Service | 234.4 | 263.1 | 284.3 | 235.7 | 232.3 | 219.0 | −11 | 1 |
| Forest Service | 111.5 | 120.1 | 113.1 | 108.4 | 107.7 | 112.1 | −7 | 0 |
| **Interior** | **350.6** | **388.3** | **391.7** | **410.9** | **382.5** | **381.1** | **−10** | **−2** |
| Geological Survey | 207.6 | 218.6 | 214.9 | 208.9 | 157.0 | 152.6 | −5 | 6 |
| **Environmental Protection Agency** | **309.6** | **333.6** | **320.4** | **261.2** | **240.7** | **335.1** | **−7** | **−2** |
| **Commerce** | **300.9** | **391.1** | **398.8** | **358.2** | **335.0** | **336.3** | **−23** | **−2** |
| National Oceanic & Atmospheric Administration | 196.3 | 268.1 | 269.8 | 244.3 | 222.0 | 222.0 | −27 | −2 |
| National Bureau of Standards | 91.4 | 99.3 | 100.5 | 95.5 | 95.0 | 88.8 | −8 | 1 |
| **Others** | **1,184.7** | **1,264.7** | **1,367.1** | **1,426.5** | **1,300.1** | **1,258.1** | **−6** | **−1** |
| **TOTAL** | **$59,209.6** | **$52,061.8** | **$48,332.3** | **$42,224.9** | **$38,711.5** | **$36,432.6** | **14%** | **10%** |
| **ANNUAL CHANGE** | **14%** | **8%** | **14%** | **9%** | **6%** | **4%** | | |

Note: Fiscal years a Estimated b Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, and others Source: National Science Foundation

## PERFORMERS OF FEDERALLY FUNDED RESEARCH: 54% is undertaken by industry

| $ Millions | 1987[a] | 1986[a] | 1985 | 1984 | 1983 | 1982 | Annual change 1986–87 | Annual change 1982–87 |
|---|---|---|---|---|---|---|---|---|
| **Industry** | $31,787.9 | $26,847.9 | $23,774.3 | $20,361.5 | $18,649.0 | $18,698.6 | 18% | 11% |
| **Federal intramural programs** | 15,396.7 | 13,533.4 | 12,998.4 | 11,572.3 | 10,581.9 | 9,141.0 | 14 | 11 |
| **Universities and colleges** | 6,558.7 | 6,554.7 | 6,299.0 | 5,565.1 | 4,966.4 | 4,605.5 | 0 | 7 |
| **University-associated FFRDCs[b]** | 2,712.8 | 2,446.2 | 2,534.5 | 2,324.9 | 2,265.8 | 1,976.7 | 11 | 7 |
| **Nonprofit institutions** | 2,451.3 | 2,318.1 | 2,365.0 | 2,094.4 | 1,822.9 | 1,612.3 | 6 | 9 |
| **Foreign** | 219.8 | 257.8 | 255.9 | 175.8 | 239.5 | 214.3 | −15 | 1 |
| **State and local governments** | 82.4 | 103.6 | 105.2 | 130.9 | 186.0 | 184.3 | −20 | −15 |
| **TOTAL** | **$59,209.6** | **$52,061.8** | **$48,332.3** | **$42,224.9** | **$38,711.5** | **$36,432.6** | **14%** | **10%** |

**Note:** Fiscal years. a Estimated. b Federally funded R&D centers. Those administered by both industry and by nonprofit institutions are included in totals for their respective sectors. **Source:** National Science Foundation

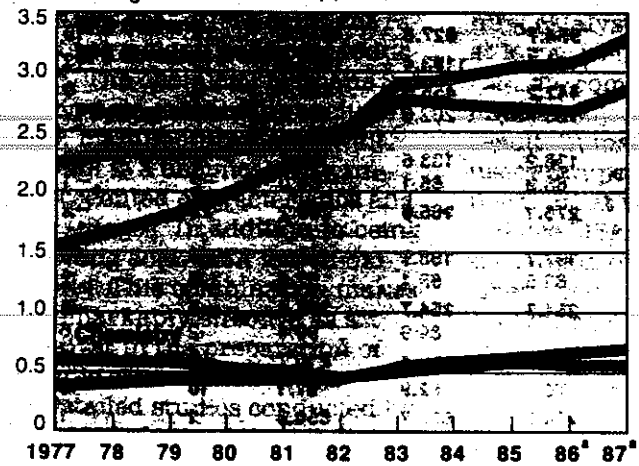
## FEDERAL OBLIGATIONS FOR SCIENTIFIC DISCIPLINES: Slow growth for chemistry this year

| $ Millions for research only | 1987[a] | 1986[a] | 1985 | 1984 | 1983 | 1982 | Annual change 1986–87 | Annual change 1982–1987 |
|---|---|---|---|---|---|---|---|---|
| **Life sciences** | **$ 6,289.2** | **$ 6,457.6** | **$ 6,366.2** | **$ 5,635.9** | **$ 5,177.9** | **$ 4,745.5** | **−3%** | **6%** |
| **Engineering** | **3,857.8** | **3,684.4** | **3,628.5** | **3,624.1** | **3,517.0** | **3,386.5** | **5** | **3** |
| Chemical | 186.0 | 243.5 | 254.1 | 144.5 | 145.0 | 95.1 | −24 | 14 |
| Metallurgy and materials | 465.5 | 464.1 | 439.1 | 341.1 | 332.5 | 309.1 | 0 | 9 |
| **Physical sciences** | **3,300.3** | **3,071.8** | **3,044.0** | **2,969.0** | **2,891.4** | **2,500.4** | **7** | **6** |
| Chemistry | 670.9 | 653.4 | 644.5 | 606.4 | 520.3 | 481.2 | 3 | 7 |
| Physics | 1,965.4 | 1,829.4 | 1,820.0 | 1,836.4 | 1,854.6 | 1,610.5 | 7 | 4 |
| **Environmental sciences** | **1,483.4** | **1,458.2** | **1,403.6** | **1,275.9** | **1,251.2** | **1,148.3** | **2** | **5** |
| **Mathematics and computer sciences** | **759.0** | **665.0** | **577.5** | **440.3** | **419.4** | **350.1** | **14** | **17** |
| **Other sciences** | **1,151.4** | **1,117.7** | **1,110.3** | **1,033.6** | **996.6** | **891.4** | **3** | **5** |
| **TOTAL** | **$16,841.1** | **$16,454.7** | **$16,130.1** | **$14,978.8** | **$14,253.5** | **$13,022.2** | **2%** | **5%** |
| **ANNUAL CHANGE** | **2%** | **2%** | **8%** | **5%** | **9%** | **7%** | | |

a Estimated. **Source:** National Science Foundation

## Federal support for physical science little changed since 1983 in real dollars

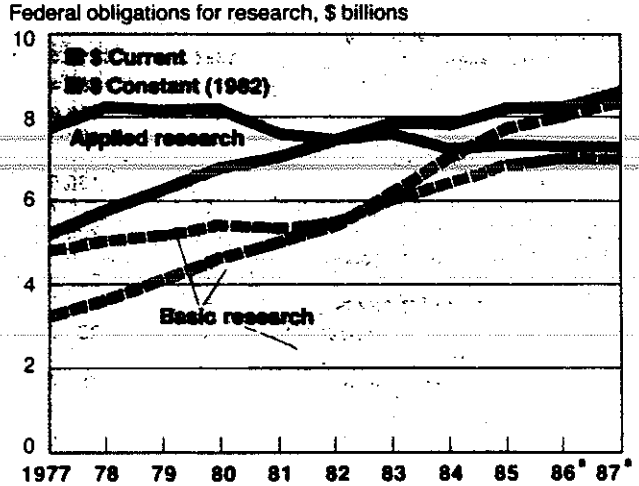
Federal obligations for research, $ billions




**Note:** Fiscal years. a Estimated. **Source:** National Science Foundation

## Government funding of basic research catching up with applied research support

Federal obligations for research, $ billions




**Note:** Fiscal years. a Estimated. **Source:** National Science Foundation

## FEDERAL OBLIGATIONS FOR BASIC RESEARCH: **Little growth this year**

| $ Millions | 1987[a] | 1986[a] | 1985 | 1984 | 1983 | 1982 | Annual change 1986–87 | Annual change 1982–1987 |
|---|---|---|---|---|---|---|---|---|
| **Health & Human Services** | **$3162.4** | **$3357.1** | **$3232.5** | **$2814.5** | **$2475.4** | **$2144.7** | **−6%** | **8%** |
| National Institutes of Health | 2938.3 | 3133.6 | 3018.0[a] | 2624.8 | 2313.0 | 2020.7 | −6 | 8 |
| Alcohol, Drug Abuse & Mental Health Administration | 204.4 | 206.2 | 196.8 | 170.8 | 145.0 | 117.3 | −1 | 12 |
| **National Science Foundation** | **1422.6** | **1255.7** | **1261.8** | **1132.3** | **999.1** | **916.1** | **13** | **9** |
| **Energy** | **1063.1** | **945.9** | **942.6** | **830.4** | **767.7** | **642.2** | **12** | **11** |
| **Defense** | **995.9** | **994.3** | **861.4** | **847.9** | **785.6** | **686.7** | **0** | **8** |
| Navy | 385.6 | 350.5 | 343.1 | 315.8 | 305.4 | 280.3 | 10 | 7 |
| Air Force | 284.5 | 234.4 | 198.3 | 192.4 | 164.2 | 145.8 | 21 | 14 |
| Army | 249.3 | 242.4 | 240.8 | 222.1 | 208.3 | 187.7 | 3 | 6 |
| Defense agencies[b] | 76.5 | 167.0 | 79.2 | 117.6 | 107.7 | 72.9 | −54 | 1 |
| **National Aeronautics & Space Administration** | **986.1** | **850.4** | **750.9** | **754.5** | **617.0** | **535.7** | **16** | **13** |
| **Agriculture** | **434.1** | **432.7** | **445.4** | **392.6** | **362.0** | **330.8** | **0** | **6** |
| Agricultural Research Service | 267.2 | 247.6 | 250.2 | 240.6 | 215.3 | 192.9 | 8 | 7 |
| Cooperative State Research Service | 115.8 | 126.2 | 141.5 | 99.6 | 98.8 | 91.3 | −8 | 5 |
| Forest Service | 43.1 | 50.5 | 44.1 | 41.2 | 38.8 | 38.7 | −15 | 2 |
| **Interior** | **115.7** | **137.6** | **138.3** | **125.9** | **103.0** | **76.5** | **−16** | **9** |
| Geological Survey | 79.5 | 83.4 | 80.5 | 78.9 | 64.7 | 52.6 | −3 | 9 |
| **Environmental Protection Agency** | **37.0** | **39.3** | **38.6** | **29.6** | **22.2** | **32.7** | **−6** | **3** |
| **Commerce** | **19.5** | **22.1** | **23.2** | **20.6** | **19.2** | **16.9** | **−12** | **3** |
| National Bureau of Standards | 19.1 | 21.2 | 22.1 | 20.2 | 18.4 | 16.5 | −10 | 3 |
| National Oceanic & Atmospheric Administration | 0 | 0 | 0 | 0 | 0 | 0 | — | — |
| **Others** | **111.3** | **110.0** | **124.0** | **119.1** | **108.9** | **99.3** | **1** | **2** |
| **TOTAL** | **$8347.7** | **$8145.1** | **$7818.7** | **$7067.4** | **$6260.1** | **$5481.6** | **2%** | **9%** |
| **ANNUAL CHANGE** | **2%** | **4%** | **11%** | **13%** | **14%** | **9%** | | |

Note: Fiscal years. a Estimated. b Includes Defense Advanced Projects Agency, Defense Nuclear Agency, and others. Source: National Science Foundation

## FEDERAL OBLIGATIONS FOR APPLIED RESEARCH: **Increases for Defense, NASA, and NSF**

| $ Millions | 1987[a] | 1986[a] | 1985 | 1984 | 1983 | 1982 | Annual change 1986–87 | Annual change 1982–1987 |
|---|---|---|---|---|---|---|---|---|
| **Defense** | **$2636.1** | **$2364.8** | **$2306.9** | **$2200.7** | **$2437.0** | **$2266.1** | **11%** | **3%** |
| Army | 719.4 | 551.3 | 582.6 | 486.7 | 485.3 | 451.6 | 30 | 10 |
| Air Force | 562.2 | 573.4 | 538.4 | 547.7 | 524.2 | 488.1 | −2 | 3 |
| Navy | 464.6 | 463.9 | 448.2 | 449.6 | 521.6 | 498.4 | 0 | −1 |
| Defense agencies[b] | 889.9 | 776.2 | 737.7 | 716.6 | 905.9 | 828.1 | 15 | 1 |
| **Health & Human Services** | **1724.0** | **1834.0** | **1795.8** | **1651.5** | **1545.4** | **1460.9** | **−6** | **3** |
| National Institutes of Health | 1368.2 | 1452.8 | 1410.1[a] | 1285.6 | 1165.2 | 1103.8 | −6 | 4 |
| Alcohol, Drug Abuse & Mental Health Administration | 177.5 | 188.8 | 179.7 | 165.2 | 155.4 | 128.7 | −6 | 7 |
| **National Aeronautics & Space Administration** | **1396.5** | **1114.4** | **1032.7** | **954.7** | **927.8** | **871.4** | **25** | **10** |
| **Energy** | **913.3** | **1080.4** | **1198.4** | **1194.5** | **1193.4** | **1063.9** | **−15** | **−3** |
| **Agriculture** | **444.0** | **458.8** | **465.6** | **442.2** | **455.5** | **435.7** | **−3** | **0** |
| Agricultural Research Service | 202.4 | 188.1 | 191.8 | 183.7 | 202.6 | 186.2 | 8 | 2 |
| Cooperative State Research Service | 118.7 | 136.9 | 142.8 | 136.2 | 133.5 | 127.7 | −13 | −1 |
| Forest Service | 65.4 | 66.7 | 65.7 | 63.9 | 65.1 | 69.0 | −2 | −1 |
| **Commerce** | **236.7** | **304.4** | **361.0** | **276.1** | **295.6** | **250.2** | **−22** | **−2** |
| National Oceanic & Atmospheric Administration | 163.8 | 229.7 | 224.4 | 197.7 | 186.9 | 186.5 | −29 | −3 |
| National Bureau of Standards | 63.5 | 65.6 | 64.5 | 63.5 | 63.1 | 57.4 | −3 | 2 |
| **Interior** | **210.9** | **227.5** | **231.0** | **254.3** | **264.7** | **278.6** | **−7** | **−5** |
| Geological Survey | 118.2 | 127.5 | 130.0 | 125.1 | 99.9 | 99.4 | 2 | 6 |
| **Environmental Protection Agency** | **170.0** | **180.4** | **176.0** | **142.3** | **152.4** | **210.7** | **−6** | **−4** |
| **National Science Foundation** | **86.7** | **77.5** | **83.8** | **70.5** | **62.9** | **57.1** | **10** | **8** |
| **Others** | **676.2** | **667.0** | **720.3** | **724.6** | **698.7** | **668.6** | **1** | **1** |
| **TOTAL** | **$8463.4** | **$8309.5** | **$8311.5** | **$7911.4** | **$7909.4** | **$7548.6** | **2%** | **2%** |
| **ANNUAL CHANGE** | **2%** | **0%** | **5%** | **−1%** | **5%** | **5%** | | |

Note: Fiscal years. a Estimated. b Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, and others. Source: National Science Foundation

## FEDERAL OBLIGATIONS FOR DEVELOPMENT: **Nearly 90% goes for military work**

| $ Millions | 1987[a] | 1986[a] | 1985 | 1984 | 1983 | 1982 | Annual change 1986–87 | Annual change 1982–87 |
|---|---|---|---|---|---|---|---|---|
| **Defense** | **$37,046.8** | **$30,287.2** | **$26,623.2** | **$22,324.3** | **$19,770.1** | **$17,669.8** | **22%** | **16%** |
| Air Force | 16,509.8 | 12,949.7 | 12,524.3 | 11,351.5 | 10,124.2 | 8,724.0 | 27 | 14 |
| Navy | 9,850.6 | 9,322.9 | 8,336.1 | 6,840.2 | 5,241.2 | 5,066.4 | 6 | 14 |
| Army | 4,741.6 | 4,056.6 | 3,747.4 | 3,516.8 | 3,304.5 | 3,121.3 | 17 | 9 |
| Defense agencies[b] | 5,808.9 | 3,847.5 | 1,964.8 | 557.3 | 1,038.7 | 717.1 | 51 | 52 |
| **Energy** | **2,794.4** | **2,665.3** | **2,825.0** | **2,648.7** | **2,575.6** | **3,012.1** | **5** | **−1** |
| **National Aeronautics & Space Administration** | **1,543.4** | **1,513.6** | **1,543.6** | **1,112.7** | **1,116.8** | **1,670.7** | **2** | **−2** |
| **Health & Human Services** | **384.3** | **420.2** | **422.7** | **364.7** | **331.7** | **335.2** | **−9** | **3** |
| National Institutes of Health | 365.8 | 390.9 | 399.6[a] | 347.0 | 311.0 | 308.7 | −6 | 3 |
| Alcohol, Drug Abuse & Mental Health Administration | 1.2 | 1.2 | 1.1 | 1.2 | 1.8 | 2.1 | 0 | −11 |
| **Environmental Protection Agency** | **102.6** | **113.9** | **105.8** | **89.2** | **66.1** | **91.7** | **−10** | **2** |
| **Commerce** | **44.7** | **64.6** | **74.6** | **61.5** | **50.2** | **60.2** | **−31** | **−6** |
| National Oceanic & Atmospheric Administration | 32.5 | 38.4 | 45.4 | 46.6 | 33.1 | 33.5 | −15 | −1 |
| National Bureau of Standards | 8.8 | 12.5 | 14.0 | 11.8 | 13.6 | 14.9 | −30 | −10 |
| **Agriculture** | **31.1** | **31.5** | **32.0** | **31.3** | **30.0** | **30.8** | **−1** | **0** |
| Agricultural Research Service | 27.4 | 27.4 | 27.7 | 27.0 | 25.5 | 25.8 | 0 | 1 |
| Forest Service | 3.0 | 2.9 | 3.3 | 3.3 | 3.8 | 4.5 | 3 | −8 |
| Cooperative State Research Service | 0 | 0 | 0 | 0 | 0 | 0 | — | — |
| **Interior** | **24.0** | **23.2** | **22.4** | **30.7** | **24.8** | **29.6** | **3** | **−4** |
| Geological Survey | 9.9 | 7.4 | 4.4 | 4.9 | 2.3 | 0.5 | 34 | 82 |
| **National Science Foundation** | **0** | **0** | **0** | **0** | **0** | **2.2** | **—** | **—** |
| **Others** | **397.2** | **487.6** | **552.8** | **583.0** | **492.7** | **508.1** | **−19** | **−5** |
| **TOTAL** | **$42,368.5** | **$35,607.1** | **$32,202.1** | **$27,246.1** | **$24,458.0** | **$23,410.4** | **19%** | **13%** |
| **ANNUAL CHANGE** | **19%** | **11%** | **18%** | **11%** | **4%** | **3%** | | |

Note: Fiscal years. a Estimated. b Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, and others. Source: National Science Foundation

## UNIVERSITY RESEARCH: **Not much change in funding overall, but chemistry gets more**

| Federal obligations, $ millions | 1987[a] | 1986[a] | 1985 | 1984 | 1983 | 1982 | Annual change 1986–87 | Annual change 1982–87 |
|---|---|---|---|---|---|---|---|---|
| **Life sciences** | **$3124.8** | **$3288.8** | **$3192.2** | **$2800.2** | **$2460.0** | **$2205.0** | **−5%** | **7%** |
| **Physical sciences** | **816.9** | **757.2** | **749.7** | **697.8** | **596.5** | **559.1** | **8** | **8** |
| Chemistry | 287.0 | 259.7 | 266.8 | 242.3 | 205.7 | 189.6 | 11 | 9 |
| Physics | 429.8 | 406.5 | 401.8 | 375.2 | 328.8 | 306.0 | 6 | 7 |
| **Engineering** | **577.8** | **559.0** | **507.1** | **474.2** | **408.7** | **361.5** | **3** | **10** |
| Chemical | 43.7 | 48.8 | 45.6 | 51.2 | 23.6 | 19.4 | −10 | 18 |
| Metallurgy and materials | 121.1 | 125.9 | 107.2 | 87.7 | 86.0 | 75.3 | −4 | 10 |
| **Environmental sciences** | **410.2** | **380.2** | **361.1** | **319.5** | **316.9** | **274.7** | **8** | **8** |
| **Mathematics and computer sciences** | **338.3** | **302.8** | **253.1** | **181.6** | **172.4** | **139.7** | **12** | **19** |
| **Other sciences** | **360.6** | **367.4** | **347.8** | **304.1** | **297.8** | **255.7** | **−2** | **7** |
| **TOTAL** | **$5628.6** | **$5655.4** | **$5411.0** | **$4777.4** | **$4252.3** | **$3795.7** | **0%** | **8%** |
| **ANNUAL CHANGE** | **0%** | **5%** | **13%** | **12%** | **12%** | **2%** | | |

Note: Fiscal years. a Estimated. Source: National Science Foundation

## UNIVERSITY BASIC RESEARCH: **More than half goes for life sciences**

| Federal obligations, $ millions | 1987[a] | 1986[a] | 1985 | 1984 | 1983 | 1982 | Annual change 1986–87 | Annual change 1982–87 |
|---|---|---|---|---|---|---|---|---|
| **Life sciences** | **$2267.5** | **$2378.2** | **$2308.8** | **$1979.6** | **$1701.7** | **$1483.7** | **−5%** | **9%** |
| **Physical sciences** | **714.1** | **646.7** | **628.8** | **561.9** | **502.2** | **455.3** | **10** | **9** |
| Chemistry | 259.3 | 227.9 | 234.9 | 212.1 | 181.9 | 165.3 | 14 | 9 |
| Physics | 362.3 | 332.8 | 317.0 | 293.9 | 264.7 | 238.6 | 9 | 9 |
| **Engineering** | **448.0** | **419.7** | **386.8** | **340.3** | **295.5** | **259.0** | **7** | **12** |
| Chemical | 33.7 | 29.9 | 27.6 | 29.6 | 18.9 | 16.8 | 13 | 15 |
| Metallurgy and materials | 108.7 | 116.3 | 95.8 | 79.9 | 76.8 | 69.6 | −7 | 9 |
| **Environmental sciences** | **380.4** | **350.2** | **330.7** | **288.9** | **284.3** | **256.0** | **9** | **8** |
| **Mathematics and computer sciences** | **202.1** | **202.0** | **172.1** | **152.6** | **146.8** | **118.8** | **0** | **11** |
| **Other sciences** | **202.2** | **187.8** | **168.0** | **147.4** | **147.2** | **120.5** | **8** | **11** |
| **TOTAL** | **$4214.3** | **$4186.5** | **$3974.0** | **$3496.7** | **$3077.7** | **$2693.3** | **1%** | **9%** |
| **ANNUAL CHANGE** | **1%** | **5%** | **14%** | **13%** | **14%** | **9%** | | |

Note: Fiscal years. a Estimated. Source: National Science Foundation

## BASIC RESEARCH IN PHYSICAL SCIENCE: **NSF, Defense score biggest gains for chemistry**

| Federal obligations, $ millions | 1987[a] | | 1986[a] | | 1985 | | 1984 | | 1983 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Physical sciences | Chemistry | Physical sciences | Chemistry | Physical sciences | Chemistry | Physical sciences | Chemistry | Physical sciences | Chemistry |
| **Energy** | $ 852.5 | $112.1 | $ 743.1 | $108.5 | $ 736.1 | $102.3 | $ 688.4 | $108.4 | $ 639.2 | $104.3 |
| **National Aeronautics & Space Administration** | 535.6 | 7.8 | 437.7 | 5.1 | 377.9 | 10.2 | 338.7 | 5.4 | 329.5 | 7.7 |
| **National Science Foundation** | 380.7 | 128.9 | 340.6 | 109.9 | 347.9 | 112.7 | 330.2 | 106.8 | 283.5 | 88.5 |
| **Defense** | 213.2 | 82.1 | 212.7 | 73.9 | 185.5 | 70.1 | 212.2 | 60.0 | 198.4 | 55.6 |
| Navy | 87.5 | 30.3 | 84.8 | 26.1 | 73.9 | 26.7 | 100.4 | 20.7 | 98.0 | 18.7 |
| Air Force | 77.6 | 32.7 | 63.9 | 27.0 | 54.1 | 22.8 | 48.3 | 20.3 | 39.3 | 17.5 |
| Army | 46.2 | 19.0 | 51.7 | 20.8 | 54.3 | 20.6 | 59.8 | 19.1 | 58.7 | 19.4 |
| Defense agencies[b] | 1.8 | 0 | 12.3 | 0 | 3.2 | 0 | 3.7 | 0 | 2.5 | 0 |
| **Health & Human Services** | 81.4 | 73.4 | 86.8 | 78.3 | 83.6 | 75.4 | 72.0 | 65.0 | 61.8 | 55.0 |
| National Institutes of Health | 79.3 | 71.4 | 84.6 | 76.1 | 81.5[a] | 73.3[a] | 70.8 | 63.8 | 60.9 | 54.2 |
| Alcohol, Drug Abuse & Mental Health Administration | 2.1 | 2.0 | 2.2 | 2.1 | 2.1 | 2.1 | 1.2 | 1.2 | 0.9 | 0.9 |
| **Agriculture** | 33.5 | 33.3 | 35.6 | 33.5 | 35.6 | 33.6 | 45.4 | 43.5 | 40.0 | 38.2 |
| Agricultural Research Service | 26.9 | 25.5 | 25.0 | 23.7 | 25.2 | 23.9 | 37.4 | 36.0 | 33.5 | 32.2 |
| Cooperative State Research Service | 4.6 | 4.6 | 6.1 | 6.1 | 6.4 | 6.4 | 5.4 | 5.4 | 4.1 | 4.1 |
| Forest Service | 3.9 | 3.2 | 4.6 | 3.7 | 4.0 | 3.3 | 2.6 | 2.1 | 2.4 | 1.9 |
| **Commerce** | 15.9 | 5.2 | 18.1 | 6.7 | 19.7 | 7.2 | 16.3 | 4.8 | 15.7 | 4.7 |
| National Bureau of Standards | 15.9 | 5.2 | 17.6 | 6.3 | 18.9 | 6.4 | 16.3 | 4.8 | 15.7 | 4.6 |
| **Interior** | 7.0 | 5.5 | 7.9 | 6.3 | 7.6 | 6.0 | 7.1 | 5.6 | 2.9 | 1.8 |
| Geological Survey | 7.0 | 5.5 | 7.9 | 6.3 | 7.6 | 6.0 | 7.1 | 5.6 | 2.6 | 1.8 |
| **Environmental Protection Agency** | 3.4 | 2.9 | 3.6 | 3.1 | 3.5 | 3.0 | 3.0 | 3.0 | 2.3 | 1.9 |
| **Others** | 17.8 | 0.4 | 15.6 | 0.2 | 16.6 | 0.3 | 14.7 | 0.9 | 13.5 | 3.5 |
| **TOTAL** | $2141.0 | $451.3 | $1901.7 | $425.4 | $1814.0 | $420.8 | $1728.0 | $403.4 | $1587.2 | $362.2 |
| **ANNUAL CHANGE** | 13% | 6% | 5% | 1% | 5% | 4% | 9% | 11% | 14% | 16% |

Note: Fiscal years. a Estimated. b Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, and others. Source: National Science Foundation

## ENGINEERING RESEARCH: **Support for chemical engineering drops sharply this year but is still twice th**

| $ Millions | 1987[a] | | | 1986[a] | | | 1985 | |
|---|---|---|---|---|---|---|---|---|
| | Engineering | Chemical engineering | Metallurgy & materials | Engineering | Chemical engineering | Metallurgy & materials | Engineering | Chemical engineering |
| **Defense** | $1624.9 | $ 54.5 | $281.1 | $1523.9 | $ 50.3 | $277.9 | $1502.0 | $ 53.3 |
| Air Force | 488.1 | 3.2 | 36.9 | 472.7 | 3.3 | 34.3 | 423.9 | 1.7 |
| Army | 434.9 | 23.5 | 41.3 | 336.1 | 20.9 | 37.7 | 344.3 | 26.7 |
| Navy | 409.9 | 27.8 | 120.1 | 408.5 | 26.1 | 121.1 | 421.2 | 24.8 |
| Defense agencies[b] | 292.1 | 0 | 82.8 | 306.6 | 0 | 84.8 | 312.6 | 0.1 |
| **National Aeronautics & Space Administration** | 1270.0 | 0.9 | 23.4 | 1021.6 | 0.8 | 17.7 | 931.6 | 0.6 |
| **Energy** | 322.0 | 58.8 | 73.8 | 463.6 | 126.2 | 68.7 | 511.3 | 136.6 |
| **National Science Foundation** | 231.3 | 41.2 | 47.6 | 196.6 | 34.4 | 42.1 | 183.3 | 32.6 |
| **Interior** | 66.6 | 4.4 | 25.4 | 84.9 | 4.9 | 46.9 | 106.2 | 4.8 |
| **Transportation** | 44.1 | 0.4 | 1.0 | 53.9 | 0.7 | 2.5 | 49.4 | 0.6 |
| **Environmental Protection Agency** | 43.7 | 17.5 | 2.5 | 46.6 | 18.1 | 2.7 | 44.8 | 18.0 |
| **Commerce** | 36.0 | 2.3 | 10.5 | 43.7 | 1.9 | 11.2 | 30.8 | 1.7 |
| **Agriculture** | 28.9 | 5.8 | 0 | 29.1 | 5.8 | 0 | 26.7 | 5.8 |
| **Others** | 186.3 | 0.3 | 0.5 | 212.5 | 0.4 | 0.4 | 227.4 | 0.4 |
| **TOTAL** | $3857.8 | $186.0 | $466.5 | $3884.4 | $243.5 | $404.1 | $3628.5 | $254.1 |
| **ANNUAL CHANGE** | 5% | −24% | 0% | 2% | −4% | 8% | 6% | 76% |

Note: Fiscal years. a Estimated. b Includes Defense Advanced Projects Agency, Defense Nuclear Agency, and others. Source: National Science Foundation

## APPLIED RESEARCH IN PHYSICAL SCIENCE: **Chemical funding down slightly this year**

| $ Millions[b] | 1987[a] | | 1986[a] | | 1985 | | 1984 | | 1983 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Physical sciences | Chemistry | Physical sciences | Chemistry | Physical sciences | Chemistry | Physical sciences | Chemistry | Physical sciences | Chemistry |
| **Energy** | $ 511.6 | $ 24.9 | $ 538.7 | $ 37.3 | $ 606.1 | $ 40.6 | $ 603.5 | $ 32.0 | $ 584.8 | $ 13.3 |
| **Defense** | 434.8 | 102.7 | 415.1 | 93.4 | 412.0 | 86.3 | 477.2 | 79.8 | 562.0 | 66.3 |
| Army | 129.7 | 71.0 | 116.4 | 62.1 | 124.2 | 57.5 | 77.4 | 47.2 | 86.9 | 39.9 |
| Air Force | 59.0 | 17.0 | 60.2 | 17.3 | 57.5 | 16.7 | 58.6 | 16.4 | 54.5 | 13.7 |
| Navy | 55.6 | 13.9 | 53.9 | 13.4 | 50.7 | 11.6 | 69.2 | 15.9 | 135.2 | 12.3 |
| Defense agencies[c] | 190.5 | 0.8 | 184.6 | 0.6 | 179.6 | 0.4 | 272.1 | 0.3 | 285.4 | 0.3 |
| **National Aeronautics & Space Administration** | 81.9 | 6.0 | 79.9 | 6.0 | 76.3 | 6.1 | 25.6 | 1.9 | 40.4 | 1.7 |
| **Commerce** | 34.0 | 9.8 | 35.1 | 10.4 | 35.2 | 10.5 | 36.9 | 10.5 | 33.9 | 9.3 |
| National Bureau of Standards | 25.1 | 8.5 | 25.0 | 8.4 | 25.3 | 9.0 | 28.1 | 9.3 | 26.7 | 8.1 |
| National Oceanic & Atmospheric Administration | 8.9 | 1.3 | 10.1 | 2.0 | 9.9 | 1.4 | 8.9 | 1.3 | 7.2 | 1.2 |
| **Health & Human Services** | 26.5 | 23.0 | 28.4 | 24.6 | 27.3 | 23.6 | 24.7 | 21.3 | 22.6 | 19.2 |
| National Institutes of Health | 24.6 | 21.1 | 26.1 | 22.4 | 25.4[a] | 21.8[a] | 23.6 | 20.3 | 21.5 | 18.1 |
| Alcohol, Drug Abuse & Mental Health Administration | 1.9 | 1.9 | 2.3 | 2.2 | 1.9 | 1.9 | 1.1 | 1.1 | 1.2 | 1.1 |
| **Agriculture** | 24.2 | 22.2 | 25.8 | 23.8 | 26.4 | 24.4 | 27.3 | 25.5 | 27.6 | 25.6 |
| Agricultural Research Service | 13.9 | 12.9 | 12.9 | 12.0 | 13.1 | 12.2 | 16.9 | 15.6 | 18.6 | 17.2 |
| Cooperative State Research Service | 6.8 | 6.8 | 9.3 | 9.3 | 9.7 | 9.7 | 8.1 | 8.1 | 6.7 | 6.7 |
| Forest Service | 3.5 | 2.4 | 3.6 | 2.5 | 3.5 | 2.4 | 2.4 | 1.8 | 2.3 | 1.7 |
| **Environmental Protection Agency** | 15.4 | 14.1 | 16.1 | 14.9 | 15.7 | 14.5 | 13.8 | 12.9 | 13.9 | 12.8 |
| **Interior** | 14.5 | 12.5 | 16.2 | 13.9 | 15.5 | 13.3 | 15.7 | 13.6 | 5.5 | 4.4 |
| Geological Survey | 14.5 | 12.5 | 16.2 | 13.9 | 15.5 | 13.3 | 14.9 | 12.8 | 4.7 | 3.8 |
| **National Science Foundation** | 12.5 | 3.1 | 11.3 | 2.7 | 11.8 | 2.9 | 10.9 | 3.1 | 9.4 | 3.9 |
| **Others** | 3.9 | 1.3 | 3.3 | 1.0 | 3.8 | 1.4 | 5.4 | 2.4 | 4.2 | 1.6 |
| **TOTAL** | $1159.3 | $219.6 | $1170.0 | $228.0 | $1230.1 | $223.6 | $1241.0 | $203.0 | $1304.3 | $158.1 |
| **ANNUAL CHANGE** | −1% | −4% | −5% | 2% | −1% | 10% | −5% | 28% | 1% | −7% |

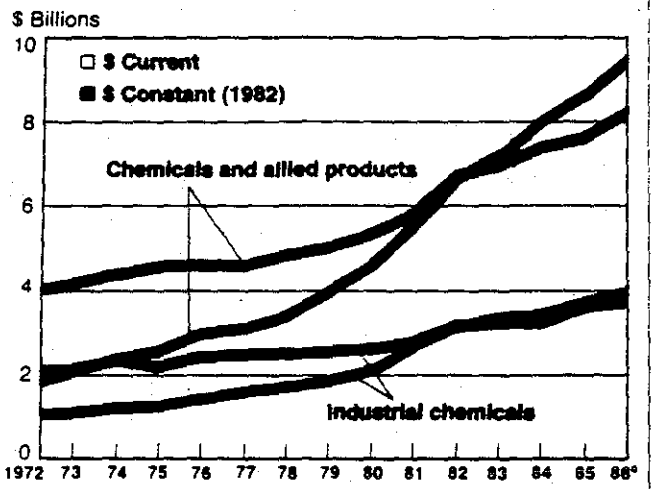
Note: Fiscal years a Estimated. b Obligations c Includes Defense Advanced Research Projects Agency, Defense Nuclear Agency, and others. Source: National Science Foundation

## the level of five years ago

| 1985 | 1984 | | | 1983 | | | 1982 | | |
|---|---|---|---|---|---|---|---|---|---|
| Metallurgy & materials | Engineering | Chemical engineering | Metallurgy & materials | Engineering | Chemical engineering | Metallurgy & materials | Engineering | Chemical engineering | Metallurgy & materials |
| $260 9 | $1488.4 | $ 38.4 | $180.3 | $1573.9 | $ 44.9 | $179.3 | $1473.3 | $39.0 | $159.3 |
| 28 6 | 439 5 | 3.5 | 30.3 | 419.3 | 3.1 | 38.2 | 387.3 | 2.9 | 35.1 |
| 42 2 | 324 8 | 23.5 | 35.5 | 318.9 | 29.3 | 28.4 | 297.2 | 24.4 | 31.7 |
| 121 1 | 398.4 | 11.3 | 53.9 | 395.5 | 11.9 | 50.0 | 378.0 | 11.6 | 49.3 |
| 69.0 | 325.7 | 0.2 | 60.6 | 440.2 | 0.6 | 62.8 | 410.8 | 0.2 | 43.1 |
| 15.8 | 987.8 | 0.3 | 14.2 | 799.6 | 1.0 | 19.1 | 771.7 | 0.4 | 16.2 |
| **68.4** | **439.0** | **46.1** | **68.7** | **440.2** | **51.8** | **62.6** | **420.8** | **1.1** | **61.2** |
| **42.7** | **164.9** | **27.7** | **27.3** | **142.5** | **21.5** | **27.3** | **128.9** | **18.8** | **26.4** |
| **39.8** | **111.4** | **4.5** | **42.2** | **91.4** | **0.4** | **31.5** | **87.1** | **1.4** | **32.8** |
| **1.5** | **51.1** | **1.2** | **1.9** | **56.1** | **1.0** | **1.4** | **48.3** | **0.5** | **1.0** |
| **2.6** | **37.8** | **17.8** | **0** | **47.8** | **16.7** | **3.5** | **76.4** | **26.0** | **5.2** |
| **6.9** | **35.3** | **1.8** | **6.4** | **37.4** | **1.3** | **7.8** | **32.0** | **2.0** | **7.1** |
| **0** | **56.7** | **6.4** | **0** | **54.7** | **6.2** | **0** | **51.2** | **5.8** | **0** |
| **0.5** | **271.7** | **0.3** | **0.1** | **273.4** | **0.1** | **0** | **296.8** | **0.1** | **0** |
| **$439.1** | **$3624.1** | **$144.5** | **$341.1** | **$3517.0** | **$145.0** | **$332.5** | **$3386.6** | **$86.1** | **$309.1** |
| **29%** | **3%** | **0%** | **3%** | **4%** | **53%** | **8%** | **10%** | **36%** | **21%** |

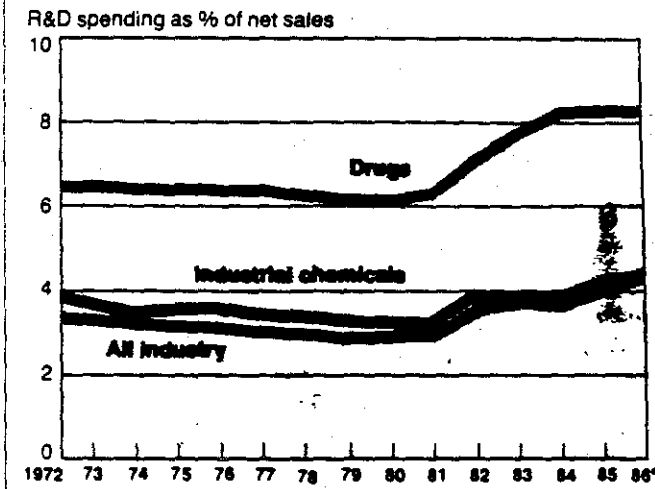
# Industrial support for R&D up only 5%

**With inflation low, chemical companies' R&D outlays rise smartly in real terms**




a C&EN estimates Source: National Science Foundation

**Outlays for industrial R&D are rising at slightly faster rate than industrial sales**




a C&EN estimates Source: National Science Foundation

## TOTAL FUNDS FOR INDUSTRIAL R&D: Drug producers continue to set a fast pace

| $ Millions | 1986a | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | 1976 | Annual change 1985–86 | Annual change 1976–86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chemicals and allied products | $ 9,500 | $ 8,667 | $ 8,028 | $ 7,293 | $ 6,659 | $ 5,625 | $ 4,636 | $ 4,038 | $ 3,580 | $ 3,202 | $ 3,017 | 10% | 12% |
| Industrial chemicals | 4,150 | 3,915 | 3,512 | 3,411 | 3,301 | 2,802 | 2,197 | 1,962 | 1,798 | 1,668 | 1,524 | 6 | 11 |
| Drugs | 4,070 | 3,548 | 4,516 | 3,882 | 3,358 | 2,823 | 1,777 | 1,517 | 1,308 | 1,117 | 1,091 | 15 | 14 |
| Other chemicals | 1,280 | 1,204 | | | | | 662 | 559 | 474 | 417 | 401 | 6 | 12 |
| Other industries | 74,900 | 69,512 | 63,442 | 56,110 | 51,337 | 46,185 | 39,869 | 34,188 | 29,724 | 26,623 | 23,980 | 8 | 12 |
| TOTAL | $84,400 | $78,179 | $71,470 | $63,403 | $57,996 | $51,810 | $44,505 | $38,226 | $33,304 | $29,825 | $26,997 | 8% | 12% |

a C&EN estimates Source: National Science Foundation

## COMPANY FUNDS FOR INDUSTRIAL R&D: Chemical industry spends about a sixth of the total

| $ Millions | 1986 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | 1976 | 1975 | Annual change 1984–86 | Annual change 1975–86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chemicals and allied products | $ 8,352 | $ 7,797 | $ 6,845 | $ 6,226 | $ 5,206 | $ 4,264 | $ 3,682 | $ 3,250 | $ 2,907 | $ 2,751 | $ 2,480 | 7% | 13% |
| Industrial chemicals | 3,618 | 3,289 | 2,970 | 2,879 | 2,393 | 1,856 | 1,617 | 1,473 | 1,387 | 1,275 | 1,173 | 10 | 12 |
| Drugs | 3,545 | 3,381 | 2,937 | 2,490 | 2,064 | 1,756 | 2,075 | 1,777 | 1,520 | 1,476 | 1,317 | 5 | 14 |
| Other chemicals | 1,189 | 1,126 | 938 | 856 | 747 | 653 | | | | | | 6 | |
| Other industries | 43,344 | 40,511 | 36,016 | 33,286 | 30,223 | 26,212 | 22,016 | 18,866 | 16,433 | 14,686 | 13,092 | 7 | 13 |
| TOTAL | $51,696 | $48,308 | $42,861 | $39,512 | $35,428 | $30,476 | $25,700 | $22,116 | $19,340 | $17,436 | $15,572 | 7% | 13% |

Source: National Science Foundation

## FEDERAL FUNDS FOR INDUSTRIAL R&D: Of little significance for the chemical industry

| $ Millions | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | 1976 | 1975 | Annual change 1984–85 | Annual change 1975–85 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Chemicals and allied products** | **$ 316** | **$ 232** | **$ 448** | **$ 434** | **$ 421** | **$ 372** | **$ 346** | **$ 330** | **$ 295** | **$ 266** | **$ 236** | **36%** | **3%** |
| Industrial chemicals | 298 | 223 | 440 | 423 | 409 | 341 | 345 | 325 | 281 | 249 | 218 | 34 | 3 |
| Drugs and other chemicals | 18 | 9 | 8 | 11 | 12 | 31 | 1 | 5 | 14 | 17 | 18 | 100 | 0 |
| **Other industries** | **26,168** | **22,930** | **20,094** | **18,049** | **15,961** | **13,657** | **12,172** | **10,859** | **10,190** | **9295** | **8369** | **14** | **12** |
| **TOTAL** | **$26,484** | **$23,162** | **$20,542** | **$18,483** | **$16,382** | **$14,029** | **$12,518** | **$11,189** | **$10,485** | **$9561** | **$8605** | **14%** | **12%** |

Source: National Science Foundation

## R&D BY U.S. COMPANIES ABROAD: Relatively small but expanding steadily

| $ Millions | 1986[a] | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | 1976 | Annual change 1985–86 | Annual change 1976–86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Chemicals and allied products** | **$ 900** | **$ 816** | **$ 793** | **$ 732** | **$ 684** | **$ 715** | **$ 603** | **$ 500** | **$ 395** | **$ 332** | **$ 312** | **10%** | **11%** |
| Industrial and other chemicals | 440 | 409 | 363 | 354 | 313 | 287 | 245 | 199 | 151 | 133 | 108 | 8 | 15 |
| Drugs | 460 | 406 | 430 | 378 | 371 | 428 | 357 | 301 | 244 | 199 | 204 | 13 | 8 |
| **Other industries** | **3100** | **2931** | **2786** | **2544** | **2413** | **2679** | **2562** | **2254** | **1814** | **1545** | **1347** | **6** | **9** |
| **TOTAL** | **$4000** | **$3747** | **$3579** | **$3276** | **$3097** | **$3393** | **$3165** | **$2754** | **$2209** | **$1877** | **$1659** | **7%** | **9%** |

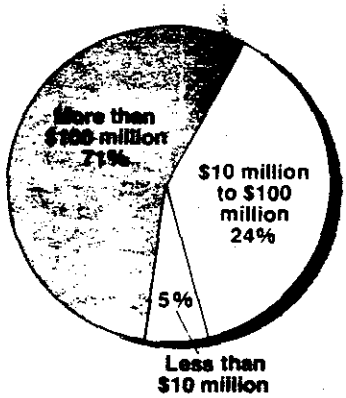
a C&EN estimates. Source: National Science Foundation

## CHEMICAL R&D SPENDING: Slight rise last year largely reflects Carbide's major divestments

| $ Millions | 1986 | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | 1976 | 1986 R&D spending as % of sales |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Air Products** | $ 61 | $ 51 | $ 44 | $ 40 | $ 37 | $ 32 | $ 30 | $ 24 | $ 23 | $ 24 | $ 19 | 3.1% |
| **American Cyanamid** | 278 | 251 | 232 | 208 | 185 | 166 | 148 | 130 | 108 | 96 | 83 | 7.3 |
| **Dow Chemical** | 605 | 547 | 507 | 492 | 460 | 404 | 314 | 269 | 232 | 203 | 188 | 5.4 |
| **Du Pont**[a] | 1070 | 1080 | 1000 | 875 | 775 | 647 | 591 | 509 | 461 | 367 | 353 | 9.0 |
| **Ethyl** | 47 | 47 | 40 | 39 | 39 | 37 | 34 | 29 | 25 | 28 | 25 | 3.0 |
| **W. R. Grace** | 94 | 92 | 81 | 73 | 64 | 57 | 45 | 42 | 37 | 32 | 28 | 2.5 |
| **Hercules** | 71 | 76 | 72 | 74 | 74 | 65 | 57 | 50 | 43 | 40 | 37 | 2.7 |
| **International Flavors** | 39 | 34 | 32 | 32 | 31 | 30 | 29 | 27 | 24 | 20 | 16 | 6.3 |
| **Lubrizol** | 51 | 44 | 33 | 37 | 36 | 33 | 28 | 23 | 21 | 19 | 17 | 5.2 |
| **Monsanto** | 596 | 470 | 370 | 290 | 264 | 233 | 208 | 161 | 136 | 132 | 114 | 8.7 |
| **Nalco Chemical** | 33 | 32 | 32 | 30 | 33 | 30 | 28 | 21 | 17 | 14 | 12 | 4.5 |
| **Olin** | 56 | 53 | 52 | 49 | 45 | 38 | 31 | 26 | 25 | 25 | 23 | 3.3 |
| **Pennwalt** | 45 | 39 | 36 | 33 | 31 | 27 | 24 | 22 | 23 | 21 | 19 | 4.1 |
| **Petrolite** | 12 | 12 | 12 | 13 | 10 | 8 | 7 | 6 | 5 | 5 | 4 | 4.3 |
| **PPG Industries** | 204 | 176 | 150 | 127 | 127 | 119 | 103 | 83 | 70 | 61 | 56 | 4.3 |
| **Rohm & Haas** | 133 | 124 | 109 | 100 | 92 | 77 | 67 | 54 | 49 | 45 | 43 | 6.4 |
| **Union Carbide**[b] | 148 | 275 | 265 | 245 | 240 | 207 | 166 | 161 | 156 | 156 | 143 | 2.4 |
| **TOTAL** | **$3543** | **$3403** | **$3067** | **$2757** | **$2543** | **$2210** | **$1910** | **$1637** | **$1455** | **$1288** | **$1180** | **5.7%** |
| **ANNUAL CHANGE** | **4%** | **11%** | **11%** | **8%** | **15%** | **16%** | **17%** | **13%** | **13%** | **9%** | **8%** | |

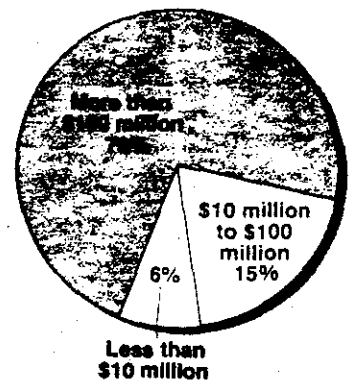
a Figures exclude petroleum and coal segments. b Union Carbide divested a substantial part of its businesses in 1986; on a pro forma basis, R&D spending was $181 million in 1985 and $178 million in 1984. Source: Company data

## Companies whose annual R&D budgets top $100 million do more than 70% of all R&D




1985 chemicals and allied products R&D funds = $8.7 billion


1985 industrial chemicals R&D funds = $3.9 billion




1985 industry R&D funds = $78.2 billion

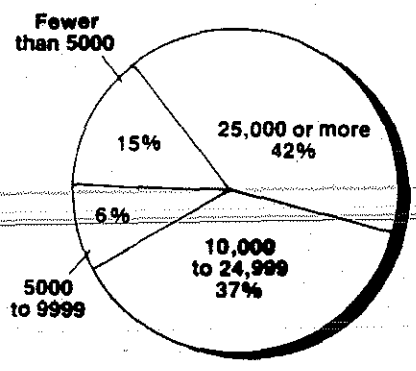
Note: Ranges indicate size of companies' 1985 R&D program. Source: National Science Foundation

## R&D SCIENTISTS AND ENGINEERS IN INDUSTRY: Increasing faster for chemicals

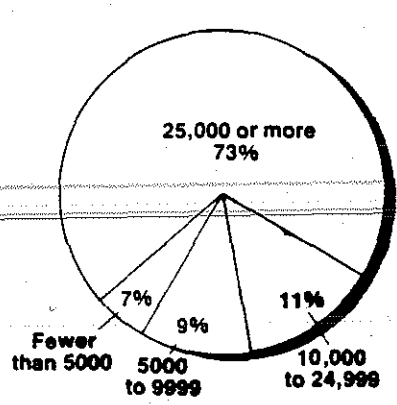
| Thousands[a] | 1986 | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | 1976 | Annual change 1985–86 | Annual change 1976–86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Chemicals and allied products** | **71.3** | **67.0** | **67.1** | **66.0** | **61.6** | **54.7** | **51.4** | **50.0** | **48.3** | **46.4** | **44.4** | **6%** | **5%** |
| Industrial chemicals | 26.8 | 25.0 | 26.7 | 27.2 | 25.9 | 21.6 | 20.9 | 21.4 | 21.3 | 20.6 | 20.1 | 7 | 3 |
| Drugs | 33.3 | 30.7 | 30.1 | 28.2 | 25.6 | 23.3 | 21.6 | 20.8 | 19.5 | 17.8 | 16.6 | 8 | 7 |
| Other chemicals | 11.2 | 11.3 | 10.3 | 10.6 | 10.1 | 9.8 | 8.9 | 7.8 | 7.5 | 8.0 | 7.8 | −1 | 4 |
| **Other industries** | **509.0** | **493.2** | **477.4** | **456.1** | **448.2** | **433.1** | **399.2** | **373.9** | **356.1** | **336.4** | **320.0** | **3** | **5** |
| **TOTAL** | **580.3** | **560.2** | **544.5** | **522.1** | **509.8** | **487.8** | **450.6** | **423.9** | **404.4** | **382.8** | **364.4** | **4%** | **5%** |

Note: Data as of January of each year. a Full-time equivalent. Source: National Science Foundation

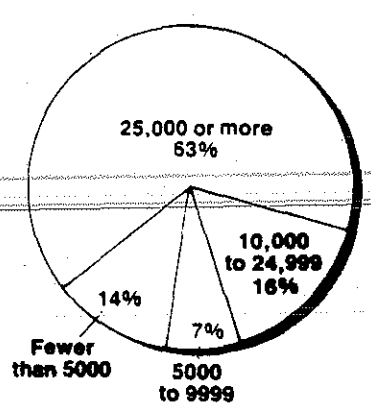
## Chemical companies with 10,000 to 25,000 employees perform more than a third of R&D




1985 chemicals and allied products R&D funds = $8.4 billion[a]



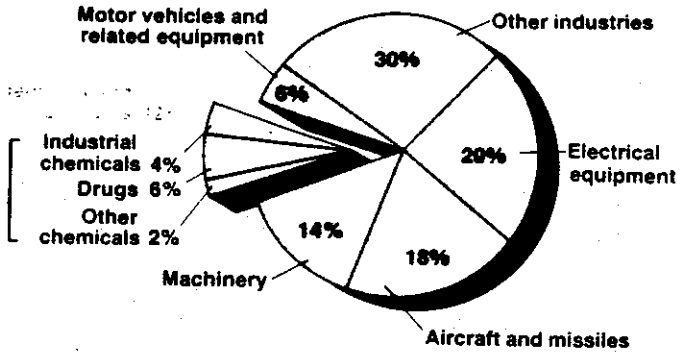

1985 industrial chemicals R&D funds = $3.6 billion[a]




1985 industry R&D funds = $51.7 billion[a]

Note: Ranges indicate companies' number of employees in 1985. a Excludes federal funding. Source: National Science Foundation

## Chemical and drug companies provide jobs for 12% of all industrial scientists and engineers




1986 total industrial R&D scientists and engineers[a] = 580,300

a Full-time equivalent, as of January 1986. Source: National Science Foundation

## R&D SCIENTISTS AND ENGINEERS PER 1000 EMPLOYEES: At new high in chemical industry

| | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | 1976 | 1975 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Chemicals and allied products** | 55 | 54 | 54 | 51 | 44 | 42 | 42 | 43 | 42 | 40 | 41 |
| Industrial chemicals | 42 | 44 | 45 | 44 | 37 | 36 | 36 | 38 | 38 | 36 | 38 |
| Drugs | 93 | 88 | 82 | 74 | 66 | 60 | 62 | 65 | 62 | 64 | 59 |
| Other chemicals | 38 | 37 | 36 | 36 | 33 | 30 | 27 | 27 | 29 | 28 | 29 |
| **All industry** | 36 | 36 | 35 | 33 | 29 | 27 | 27 | 27 | 27 | 27 | 26 |

Source: National Science Foundation

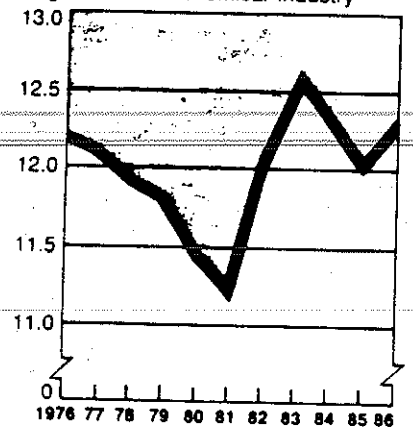
## COST PER INDUSTRIAL R&D SCIENTIST OR ENGINEER: More than doubled in past decade

| $ Thousands | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978 | 1977 | 1976 | 1975 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Chemicals and allied products** | $125.2 | $119.1 | $109.6 | $104.4 | $ 96.6 | $ 87.4 | $79.6 | $72.8 | $67.6 | $66.5 | $60.9 |
| Industrial chemicals | 151.1 | 135.1 | 126.6 | 124.3 | 118.0 | 103.4 | 92.8 | 84.2 | 79.6 | 74.7 | 67.5 |
| Drugs | a | 111.2 | 100.7 | a | a | 79.2 | 71.4 | 64.8 | 59.9 | 63.4 | 60.9 |
| Other chemicals | a | a | a | a | a | 66.5 | 66.5 | 61.6 | 53.8 | 50.8 | 43.2 |
| **All industry** | $137.0 | $129.7 | $118.9 | $112.4 | $103.9 | $ 94.9 | $87.4 | $80.4 | $75.8 | $72.2 | $66.5 |

a Not separately available but included in chemicals and allied products. Source: National Science Foundation

## Chemical firms' share of R&D personnel up in 1986

% of total industrial R&D scientists and engineers in the chemical industry[a]




a Full-time equivalent, as of January of each year
Source: National Science Foundation

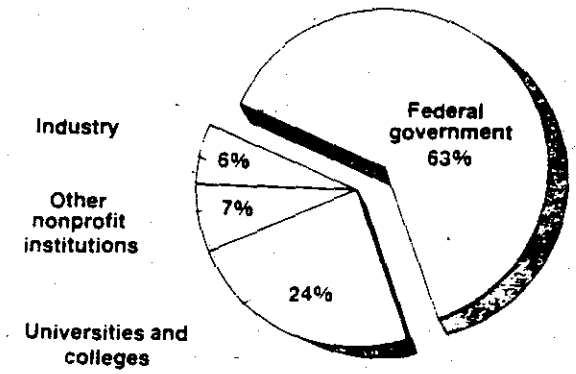
## CHEMISTS IN INDUSTRY: Drugs biggest employer

| Industry | % of industrial chemists | | | | Mean salary ($ thousands)[a] | | |
|---|---|---|---|---|---|---|---|
| | All chemists | B.S. | M.S. | Ph.D. | B.S. | M.S. | Ph.D. |
| **Pharmaceuticals[b]** | 18% | 17% | 20% | 17% | $40.3 | $42.4 | $57.2 |
| **Specialty chemicals** | 15 | 13 | 12 | 16 | 41.8 | 45.7 | 53.3 |
| **Basic chemicals** | 7 | 4 | 5 | 9 | 40.8 | 43.8 | 58.2 |
| **Plastics** | 5 | 5 | 6 | 6 | 42.3 | 47.6 | 56.6 |
| **Petroleum and natural gas** | 5 | 3 | 4 | 6 | 45.1 | 49.4 | 63.6 |
| **Agricultural chemicals** | 4 | 2 | 4 | 5 | 37.8 | 46.0 | 54.4 |
| **Coatings** | 4 | 5 | 4 | 3 | 41.6 | 47.7 | 50.6 |
| **Electronics** | 4 | 3 | 4 | 4 | 41.2 | 46.2 | 56.9 |
| **Food** | 3 | 5 | 4 | 2 | 39.8 | 46.2 | 56.5 |
| **Metals and minerals** | 2 | 4 | 2 | 1 | 40.2 | 38.8 | 47.0 |
| **Rubber** | 2 | 3 | 2 | 2 | 40.7 | 37.8 | 54.7 |
| **Biochemical products** | 2 | 1 | 2 | 2 | 35.1 | 35.5 | 57.5 |
| **Soaps and detergents** | 1 | 1 | 1 | 2 | 36.3 | 47.2 | 59.8 |
| **Paper** | 1 | 1 | 1 | 1 | 37.2 | 37.8 | 54.8 |
| **Other manufacturing** | 17 | 20 | 17 | 16 | 41.2 | 44.1 | 55.1 |
| **Nonmanufacturing** | 10 | 13 | 12 | 7 | 40.7 | 41.0 | 50.1 |

a As of March 1, 1987; to facilitate comparison, mean salaries are adjusted for differences in average length of experience for each group. b Includes personal care products. Source: ACS survey

# University R&D increased 8% last year

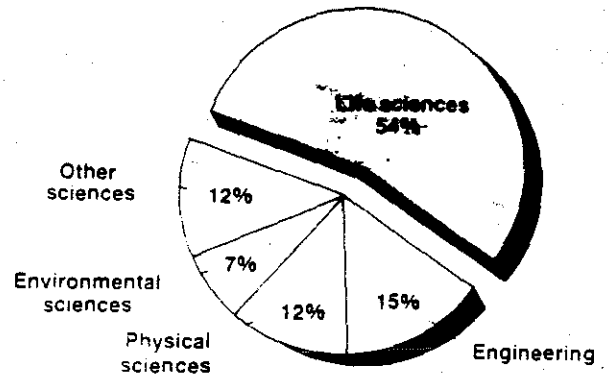
**Nearly two thirds of academic R&D funding comes from federal government**




Estimated fiscal 1986 academic R&D expenditures = $10.25 billion

Source: National Science Foundation

**More than half of academic R&D is in the life sciences**




Estimated fiscal 1986 academic R&D expenditures = $10.25 billion

Source: National Science Foundation

## CHARACTER OF UNIVERSITY R&D SPENDING: Basic research gets two thirds

| $ Millions | 1986[a] | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978[b] | 1977 | 1976 | Annual change 1985–86 | Annual change 1976–86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Basic research** | $ 6,900 | $6377 | $5638 | $5269 | $4857 | $4576 | $4026 | $3612 | $3176 | $2800 | $2549 | 8% | 10% |
| **Applied research** | 2,760 | 2580[a] | 2370[a] | 2101 | 2004 | 1866 | 1691 | 1465 | 1213 | 1067 | 1015 | 7 | 11 |
| **Development** | 590 | 517[a] | 495[a] | 437 | 415 | 377 | 343 | 284 | 236 | 200 | 164 | 8 | 14 |
| **TOTAL** | **$10,250** | **$9504** | **$8503** | **$7807** | **$7276** | **$6819** | **$6060** | **$5361** | **$4625** | **$4067** | **$3729** | **8%** | **11%** |
| **ANNUAL CHANGE** | **8%** | **12%** | **9%** | **7%** | **7%** | **13%** | **13%** | **16%** | **14%** | **9%** | **9%** | | |

**Note:** Data for institutional fiscal years. a C&EN estimates b Estimated, based on data from Ph.D.-granting institutions only **Source:** National Science Foundation

## SOURCE OF UNIVERSITY R&D FUNDS: Federal share is largest, but it is falling

| $ Millions | 1986[a] | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978[b] | 1977 | 1976 | Annual change 1985–86 | Annual change 1976–86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Federal government** | $ 6,400 | $6003 | $5388 | $4960 | $4752 | $4562 | $4096 | $3595 | $3059 | $2726 | $2512 | 7% | 10% |
| **Industry** | **580** | 538 | 458 | 379 | 334 | 291 | 237 | **194** | 170 | 139 | 123 | 8 | 17 |
| **Universities** | 2,500 | 2258 | 2024 | 1881 | 1690 | 1520 | 1319 | 1198 | 1037 | 888 | 810 | 11 | 12 |
| **Other sources** | 770 | 704 | 633 | 587 | 500 | 446 | 409 | 374 | 359 | 314 | 284 | 9 | 10 |
| **TOTAL** | **$10,250** | **$9504** | **$8503** | **$7807** | **$7276** | **$6819** | **$6060** | **$5361** | **$4625** | **$4067** | **$3729** | **8%** | **11%** |

**Note:** Data for institutional fiscal years. a C&EN estimates b Estimated, based on data from Ph.D.-granting institutions only **Source:** National Science Foundation

## FIELDS OF UNIVERSITY R&D SPENDING: Biggest growth for computers and math

| $ Millions | 1986[a] | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978[b] | 1977 | 1976 | Annual change 1985–86 | Annual change 1976–86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **All sciences** | **$ 8,730** | **$8120.5** | **$7296.5** | **$6695.5** | **$6250.2** | **$5857.6** | **$5195.4** | **$4593.0** | **$4023.6** | **$3568.5** | **$3297.3** | **8%** | **10%** |
| Life | 5,510 | 5138.5 | 4607.3 | 4233.0 | 3972.4 | 3673.1 | 3216.9 | 2832.5 | 2538.0 | 2258.8 | 2101.7 | 7 | 10 |
| Physical | 1,230 | 1136.6 | 996.9 | 898.9 | 824.3 | 766.3 | 677.4 | 601.9 | 469.4 | 423.5 | 379.4 | 8 | 12 |
| Physics | 600 | 549.9 | 470.8 | 414.4 | 366.2 | 357.2 | 322.2 | 292.0 | 235.1 | 201.7 | 183.1 | 9 | 13 |
| Chemistry | 435 | 414.5 | 371.2 | 336.0 | 309.4 | 285.1 | 244.0 | 206.4 | 183.1 | 159.4 | 140.1 | 5 | 12 |
| Environmental | 755 | 707.0 | 649.5 | 620.5 | 559.3 | 550.3 | 509.1 | 452.9 | 379.4 | 319.4 | 288.5 | 7 | 10 |
| Computer | 340 | 277.7 | 222.7 | 175.5 | 149.5 | 113.1 | 114.2 | 97.9 | 67.4 | 55.6 | 44.5 | 22 | 23 |
| Mathematical | 145 | 129.4 | 124.4 | 108.4 | 98.9 | 89.1 | 78.6 | 78.5 | 58.8 | 52.3 | 42.5 | 12 | 13 |
| Others | 750 | 731.3 | 635.7 | 659.1 | 645.8 | 645.8 | 599.1 | 539.3 | 483.7 | 458.9 | 440.7 | 3 | 5 |
| **Engineering** | **1,520** | **1383.2** | **1206.4** | **1111.3** | **1025.8** | **961.0** | **864.9** | **768.4** | **601.1** | **498.5** | **431.7** | **10** | **13** |
| Chemical | 115 | 109.0 | 96.2 | 90.8 | 83.6 | 83.2 | 67.6 | na | na | na | na | 6 | na |
| **TOTAL** | **$10,250** | **$9503.7** | **$8503.0** | **$7806.8** | **$7276.1** | **$6818.6** | **$6060.3** | **$5361.4** | **$4624.7** | **$4067.0** | **$3729.0** | **8%** | **11%** |
| **ANNUAL CHANGE** | **8%** | **12%** | **9%** | **7%** | **7%** | **13%** | **13%** | **16%** | **14%** | **9%** | **9%** | | |

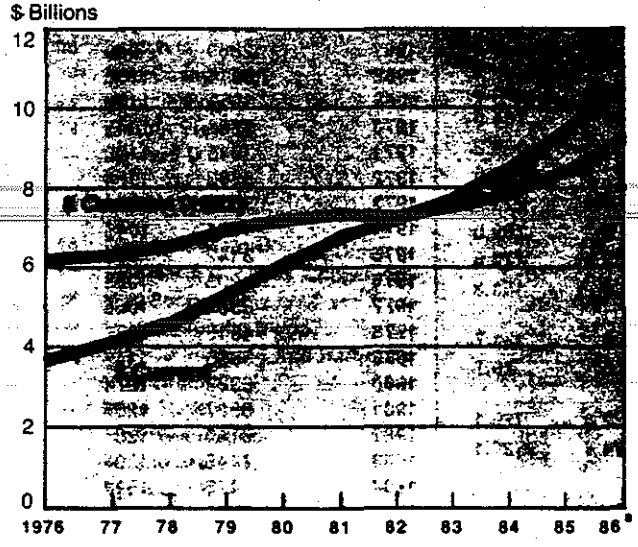
**Note:** Data for institutional fiscal years. a C&EN estimates. b NSF estimates, based on data from Ph.D.-granting institutions only. na = not available. **Source:** National Science Foundation

## FEDERALLY FINANCED R&D SPENDING AT UNIVERSITIES: Growth slows in physical science

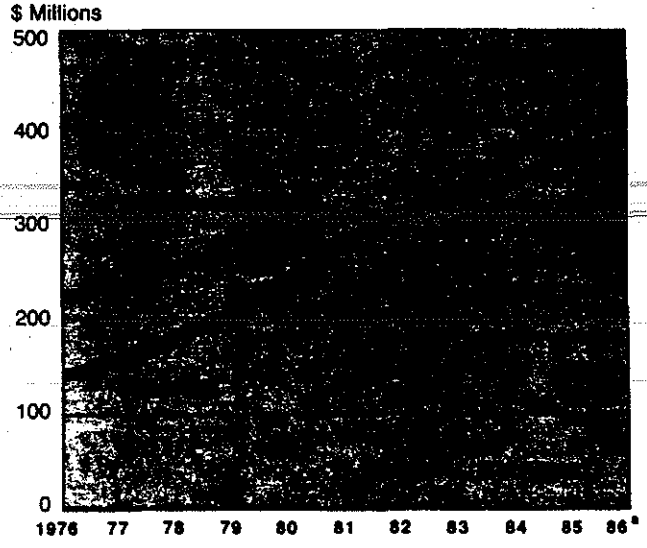
| $ Millions | 1986[a] | 1985 | 1984 | 1983 | 1982 | 1981 | 1980 | 1979 | 1978[b] | 1977 | 1976 | Annual change 1985–86 | Annual change 1976–86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **All sciences** | **$5420** | **$5145.0** | **$4609.4** | **$4221.8** | **$4054.0** | **$3899.3** | **$3500.6** | **$3068.9** | **$2651.2** | **$2389.4** | **$2221.3** | **5%** | **9%** |
| Life | 3290 | 3138.7 | 2793.9 | 2565.3 | 2494.4 | 2364.2 | 2094.0 | 1818.8 | 1626.4 | 1474.0 | 1380.8 | 5 | 9 |
| Physical | 920 | 883.3 | 779.3 | 698.5 | 650.0 | 619.0 | 554.8 | 490.7 | 392.3 | 338.8 | 305.4 | 4 | 12 |
| Physics | 480 | 454.7 | 387.9 | 340.0 | 306.2 | 308.7 | 279.9 | 252.5 | 199.2 | 171.9 | 156.1 | 6 | 12 |
| Chemistry | 320 | 308.4 | 278.9 | 248.6 | 231.1 | 216.8 | 189.4 | 156.5 | 138.0 | 121.5 | 107.9 | 4 | 11 |
| Environmental | 500 | 480.7 | 451.5 | 427.9 | 392.2 | 392.7 | 372.5 | 329.2 | 275.1 | 238.6 | 211.8 | 4 | 9 |
| Computer | 230 | 193.1 | 161.6 | 127.8 | 107.0 | 93.5 | 77.0 | 69.2 | 41.2 | 37.5 | 32.9 | 19 | 21 |
| Mathematical | 115 | 96.1 | 91.3 | 76.7 | 72.1 | 67.9 | 61.1 | 60.4 | 44.1 | 40.6 | 32.9 | 20 | 13 |
| Others | 365 | 353.1 | 331.8 | 325.5 | 338.4 | 361.9 | 341.2 | 300.6 | 272.0 | 259.9 | 257.4 | 3 | 4 |
| **Engineering** | **980** | **857.5** | **778.6** | **737.9** | **698.2** | **662.5** | **595.4** | **526.4** | **407.5** | **336.7** | **290.5** | **14** | **13** |
| Chemical | 65 | 57.9 | 54.4 | 52.1 | 49.6 | 55.2 | 46.1 | na | na | na | na | 12 | na |
| **TOTAL** | **$6400** | **$6002.6** | **$5388.0** | **$4959.7** | **$4752.2** | **$4561.8** | **$4096.0** | **$3595.3** | **$3058.7** | **$2726.1** | **$2511.9** | **7%** | **10%** |
| **ANNUAL CHANGE** | **7%** | **11%** | **9%** | **4%** | **4%** | **11%** | **14%** | **18%** | **12%** | **9%** | **10%** | | |

**Note:** Data for institutional fiscal years. a C&EN estimates. b NSF estimates, based on data from Ph.D.-granting institutions only. na = not available. **Source:** National Science Foundation.

### Money for academic R&D, in constant dollars, is growing strongly . . .




### . . . and funding for R&D in chemistry also forges higher in real terms



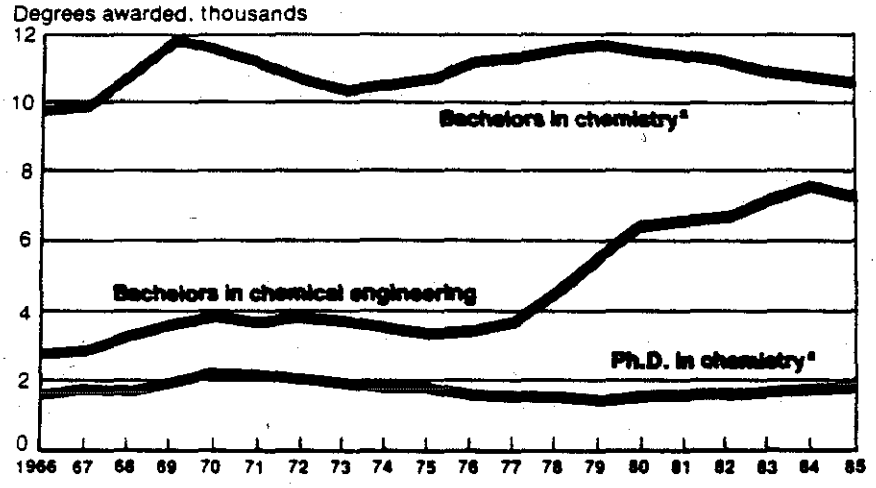

**Note:** Data for institutional fiscal years. a C&EN estimates. **Source:** National Science Foundation

## TOP 10 UNIVERSITIES IN R&D SPENDING: 21% of total goes to top 10 institutions

| $ Millions, fiscal 1985 | Physical sciences | Chemistry[a] | Engineering | Environmental sciences | Life sciences | Math and computer sciences | Other sciences[b] | Total |
|---|---|---|---|---|---|---|---|---|
| 1 Johns Hopkins U | $ 58.3 | $ 4.2 | $ 116.8 | $ 28.3 | $ 99.6 | $ 71.7 | $ 13.9 | $ 388.8 |
| 2 Massachusetts Inst. of Technology | 70.7 | 12.4 | 103.8 | 12.5 | 31.1 | 13.4 | 11.5 | 243.0 |
| 3 U of Wisconsin, Madison | 23.7 | 5.2 | 21.8 | 17.8 | 115.8 | 7.4 | 21.9 | 208.4 |
| 4 Cornell U | 36.2 | 6.3 | 30.6 | 5.2 | 114.5 | 6.6 | 10.1 | 203.2 |
| 5 Stanford U | 35.2 | 7.1 | 58.3 | 3.2 | 83.1 | 14.1 | 5.3 | 199.2 |
| 6 U of Minnesota | 11.2 | 3.3 | 18.1 | 3.7 | 127.2 | 3.4 | 9.7 | 173.3 |
| 7 U of Washington | 11.6 | 2.0 | 11.9 | 18.0 | 99.8 | 3.8 | 18.9 | 164.0 |
| 8 U of Michigan | 11.4 | 2.3 | 23.0 | 9.6 | 79.3 | 3.7 | 36.7 | 163.7 |
| 9 U of California, Berkeley | 31.8 | 9.9 | 31.9 | 2.4 | 62.6 | 2.8 | 18.4 | 149.9 |
| 10 U of California, Los Angeles | 15.5 | 6.7 | 18.5 | 8.8 | 93.3 | 1.2 | 12.4 | 149.7 |
| TOTAL, TOP 10 INSTITUTIONS | $ 305.7 | $ 59.4 | $ 434.7 | $109.4 | $ 906.4 | $128.1 | $158.7 | $2043.0 |
| TOTAL, ALL INSTITUTIONS | $1136.6 | $308.4 | $1383.2 | $707.0 | $5138.5 | $407.1 | $731.3 | $9503.7 |

a Included in physical sciences. b Includes social sciences, psychology, and other sciences not listed separately. **Source:** National Science Foundation

## Fewer degrees awarded at undergraduate level




Note: Academic fiscal years. a Excludes biochemistry and geochemistry.
Source: National Center for Education Statistics

## TOP 10 UNIVERSITY R&D CENTERS: 40% of funding goes to support work in physical sciences

| $ Millions, fiscal 1985 | Physical sciences | Engineering | Environmental sciences | Math and computer sciences | Total[a] |
|---|---|---|---|---|---|
| 1 Lawrence Livermore Lab | $ 230.5 | $ 432.2 | $ 26.4 | $ 95.0 | $ 805.3 |
| 2 Los Alamos National Lab | 335.8 | 233.0 | 16.9 | 64.1 | 704.0 |
| 3 Jet Propulsion Lab | 72.7 | 295.2 | 61.8 | 236.5 | 666.2 |
| 4 Lincoln Lab | 50.3[b] | 186.2[b] | 0 | 27.8[b] | 264.5 |
| 5 Argonne National Lab | 69.3 | 116.5 | 24.5 | 2.3 | 223.7 |
| 6 Brookhaven National Lab | 134.7 | 29.5 | 9.4 | 0.7 | 199.0 |
| 7 Lawrence Berkeley Lab | 103.6[b] | 16.5[b] | 17.6[b] | 5.5[b] | 174.6 |
| 8 Fermi National Accelerator Lab | 151.3 | 0 | 0 | 0 | 151.3 |
| 9 Plasma Physics Lab | 131.7 | 0 | 0 | 0 | 131.7 |
| 10 Stanford Linear Accelerator Center | 79.7 | 0 | 0 | 0 | 79.7 |
| All others | 70.2 | 3.3 | 45.8 | 2.4 | 129.1 |
| TOTAL, ALL FEDERALLY FUNDED R&D CENTERS | $1429.8 | $1312.4 | $202.4 | $434.3 | $3629.1 |

Note: Data for university-administered, federally funded R&D centers. a Includes life sciences and other sciences not listed separately. b Estimated. Source: National Science Foundation

## CHEMICAL DEGREES: Doctorates increase

| Academic fiscal year | Bachelors | Masters | Ph.D.s |
|---|---|---|---|
| DEGREES IN CHEMISTRY | | | |
| 1966 | 9,735 | 1839 | 1571 |
| 1967 | 9,872 | 1831 | 1744 |
| 1968 | 10,847 | 2014 | 1757 |
| 1969 | 11,807 | 2070 | 1941 |
| 1970 | 11,617 | 2146 | 2208 |
| 1971 | 11,183 | 2284 | 2160 |
| 1972 | 10,721 | 2259 | 1971 |
| 1973 | 10,226 | 2230 | 1882 |
| 1974 | 10,525 | 2138 | 1828 |
| 1975 | 10,649 | 2006 | 1824 |
| 1976 | 11,107 | 1796 | 1623 |
| 1977 | 11,322 | 1775 | 1571 |
| 1978 | 11,474 | 1892 | 1525 |
| 1979 | 11,643 | 1765 | 1518 |
| 1980 | 11,446 | 1733 | 1551 |
| 1981 | 11,347 | 1654 | 1622 |
| 1982 | 11,062 | 1751 | 1722 |
| 1983 | 10,746 | 1604 | 1746 |
| 1984 | 10,704 | 1667 | 1744 |
| 1985 | 10,482 | 1719 | 1789 |
| DEGREES IN CHEMICAL ENGINEERING | | | |
| 1966 | 2848 | 994 | 354 |
| 1967 | 2869 | 949 | 305 |
| 1968 | 3211 | 1156 | 367 |
| 1969 | 3557 | 1136 | 409 |
| 1970 | 3720 | 1045 | 438 |
| 1971 | 3615 | 1100 | 406 |
| 1972 | 3663 | 1154 | 394 |
| 1973 | 3636 | 1051 | 397 |
| 1974 | 3454 | 1045 | 400 |
| 1975 | 3142 | 990 | 346 |
| 1976 | 3203 | 1031 | 308 |
| 1977 | 3581 | 1086 | 291 |
| 1978 | 4615 | 1237 | 259 |
| 1979 | 5655 | 1149 | 304 |
| 1980 | 6383 | 1271 | 284 |
| 1981 | 6527 | 1267 | 300 |
| 1982 | 6740 | 1285 | 311 |
| 1983 | 7145 | 1304 | 319 |
| 1984 | 7475 | 1514 | 330 |
| 1985 | 7146 | 1544 | 418 |

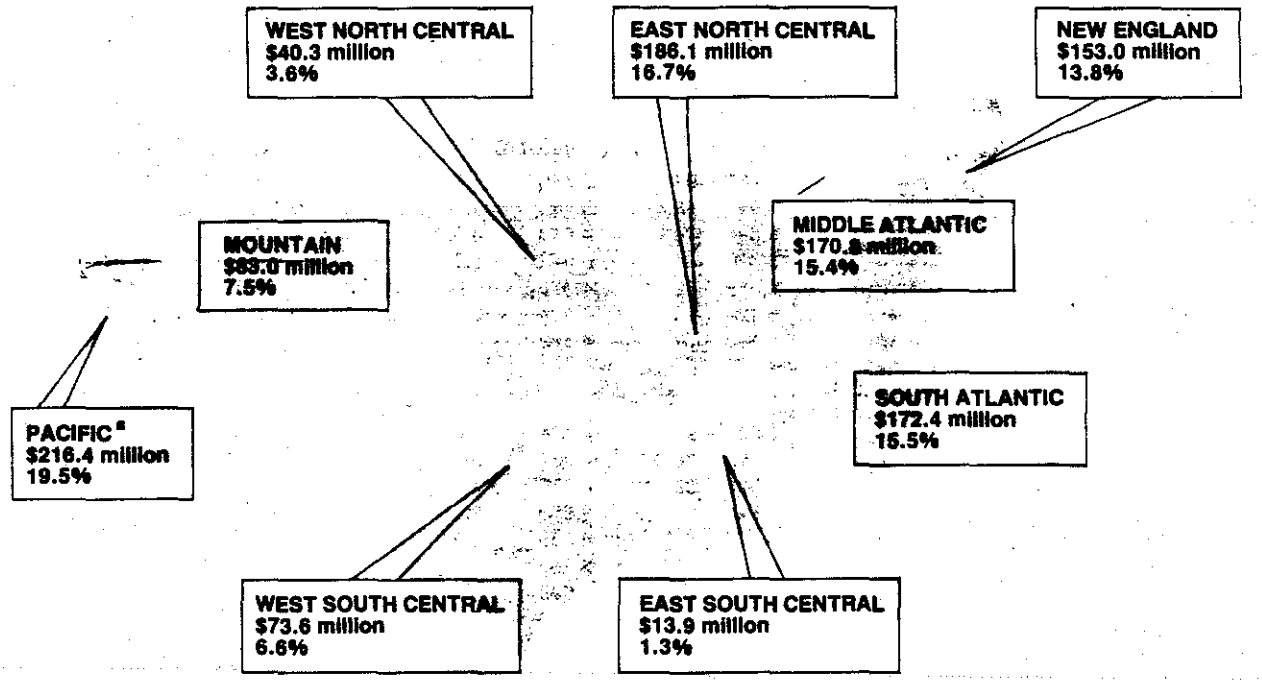
a Excludes biochemistry and geochemistry.
Source: National Center for Education Statistics

## SCHOOLS SPENDING MOST ON CHEMICAL R&D: More than 20 spent at least $5 million in 1985

| Rank 1985 | Rank 1984 | | 1985 Total spending ($ thousands) | 1985 % federal funds | 1984 | 1983 | 1982 ($ thousands) | 1981 | 1980 | Annual change 1984–85 | Annual change 1980–85 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | Massachusetts Inst. of Technology | $ 13,221 | 94% | $ 11,741 | $ 8,914 | $ 9,792 | $ 8,222 | $ 6,764 | 13% | 14% |
| 2 | 3 | U of California, Berkeley | 10,804 | 92 | 7,850 | 7,945 | 6,283 | 6,553 | 6,022 | 38 | 12 |
| 3 | 2 | Harvard U | 8,663 | 76 | 8,327[a] | 6,898[a] | 5,512[a] | 6,123[a] | 4,797[a] | 4 | 13 |
| 4 | 5 | Stanford U | 8,354 | 85 | 6,809 | 6,375 | 6,116 | 5,564 | 4,788 | 23 | 12 |
| 5 | 6 | Cornell U | 7,962 | 79 | 6,710 | 5,717[a] | 6,239[a] | 4,618 | 3,808 | 19 | 16 |
| 6 | 8 | California Inst. of Technology | 7,605 | 92 | 6,446 | 6,994 | 6,136 | 6,901 | 6,328 | 18 | 4 |
| 7 | 12 | U of Wisconsin, Madison | 7,350 | 70 | 6,076 | 5,310 | 4,567 | 4,122 | 3,976 | 21 | 13 |
| 8 | 9 | U of Maryland, College Park | 7,289 | 46 | 6,324 | 6,333[a] | 4,718[a] | 3,109 | 2,766 | 15 | 21 |
| 9 | 4 | U of California, Los Angeles | 7,243 | 93 | 7,219 | 5,496 | 5,187 | 4,420 | 4,159 | 0 | 12 |
| 10 | 10 | U of Illinois, Urbana | 7,079 | 76 | 6,284 | 5,886 | 6,422 | 5,239 | 4,261 | 13 | 11 |
| | | Total, first 10 institutions | 85,570 | 82% | 73,786 | 65,868 | 60,972 | 54,871 | 47,669 | 16% | 12% |
| 11 | 16 | Pennsylvania State U | 6,509 | 90 | 5,124 | 4,729 | 3,564 | 3,413 | 2,973 | 27 | 17 |
| 12 | 26 | U of Colorado | 6,360 | 85 | 4,134 | 3,302 | 3,492 | 4,047 | 3,332 | 54 | 14 |
| 13 | 11 | U of Massachusetts, Amherst | 6,291 | 63 | 6,137 | 5,162 | 4,364 | 3,230 | 1,889 | 3 | 27 |
| 14 | 13 | U of Chicago | 6,287 | 91 | 5,735 | 4,798[a] | 4,396 | 4,139[a] | 3,958[a] | 10 | 10 |
| 15 | 15 | Purdue U | 6,018 | 90 | 5,443 | 4,542 | 4,459 | 4,600 | 3,596 | 11 | 11 |
| 16 | 19 | Texas A&M U | 5,896 | 71 | 4,610 | 4,963 | 4,521 | 4,069 | 4,097 | 28 | 8 |
| 17 | 14 | Indiana U | 5,820 | 84 | 5,642 | 5,551 | 5,341 | 3,637 | 3,147 | 3 | 13 |
| 18 | 17 | U of Notre Dame | 5,549 | 92 | 4,760 | 4,022 | 4,020 | 3,855 | 3,457 | 17 | 10 |
| 19 | 27 | Ohio State U | 5,422 | 71 | 4,104 | 3,739 | 2,907 | 3,227 | 2,654 | 32 | 15 |
| 20 | 18 | Columbia U, main division | 5,188 | 87 | 4,662 | 4,281 | 4,700 | 3,564 | 4,437 | 11 | 3 |
| | | Total, first 20 institutions | 144,910 | 82% | 124,137 | 110,957 | 102,736 | 92,652 | 81,209 | 17% | 12% |
| 21 | 25 | Yale U | 5,096 | 90 | 4,134 | 3,341 | 2,875 | 2,781 | 2,023 | 23 | 20 |
| 22 | 20 | Northwestern U | 5,062 | 78 | 4,557 | 3,413 | 3,026 | 2,995 | 2,367 | 11 | 16 |
| 23 | 21 | U of Pennsylvania | 5,025 | 88 | 4,375 | 4,982 | 3,068 | 3,386 | 3,688 | 15 | 6 |
| 24 | 34 | U of Utah | 4,840 | 91 | 3,830 | 3,638 | 3,364 | 3,076 | 2,811 | 26 | 11 |
| 25 | 22 | U of California, San Diego | 4,642 | 87 | 4,355 | 3,910 | 3,894 | 4,430 | 4,425[a] | 7 | 1 |
| 26 | 23 | U of Oregon, main campus | 4,640 | 85 | 4,255 | 3,351 | 2,971 | 1,389 | 1,119 | 9 | 33 |
| 27 | 7 | U of Texas, Austin | 4,588 | 47 | 6,639 | 5,938 | 4,843 | 4,779 | 3,970 | −31 | 3 |
| 28 | 31 | U of Pittsburgh | 4,580 | 84 | 3,965 | 3,267 | 2,714 | 2,039 | 1,641 | 16 | 23 |
| 29 | 29 | Johns Hopkins U | 4,466 | 93 | 4,030 | 4,592[a] | 4,721 | 4,066 | 4,652 | 11 | −1 |
| 30 | 30 | U of Florida | 4,380 | 53 | 4,024 | 2,347 | 2,248 | 2,302 | 2,283[a] | 9 | 14 |
| | | Total, first 30 institutions | 192,229 | 81% | 168,301 | 149,736 | 136,460 | 123,895 | 110,188 | 14% | 12% |
| 31 | 28 | U of Minnesota | 4,167 | 79 | 4,067 | 4,047 | 4,297 | 4,260 | 2,642 | 2 | 10 |
| 32 | 36 | Princeton U | 3,963 | 78 | 3,670 | 3,509 | 3,062 | 2,513 | 2,065 | 8 | 14 |
| 33 | 37 | U of South Carolina | 3,729 | 75 | 3,423 | 2,721 | 2,483 | 1,087[b] | 970[a] | 9 | 31 |
| 34 | 33 | Georgia Inst. of Technology | 3,684 | 56 | 3,846 | 3,401 | 3,327 | 3,660 | 3,655 | −4 | 0 |
| 35 | 40 | State U of New York, Stony Brook | 3,481 | 67 | 3,084 | 2,607 | 2,783 | 2,691 | 1,966 | 13 | 12 |
| 36 | 38 | Lehigh U | 3,456 | 39 | 3,361 | 3,664 | 2,584 | 1,680 | 1,066 | 3 | 27 |
| 37 | 24 | U of Connecticut | 3,429 | 44 | 4,135 | 2,720 | 2,049 | 1,748 | 1,300 | −17 | 21 |
| 38 | 44 | Virginia Polytechnic Inst. & State U | 3,339 | 59 | 2,633 | 2,206 | 1,740 | 1,581 | 1,612 | 27 | 16 |
| 39 | 39 | Florida State U | 3,276 | 32 | 3,137 | 2,500 | 2,959 | 3,012 | 2,791 | 4 | 3 |
| 40 | — | Howard U | 3,269 | 91 | 3,672 | 2,336 | 982 | 1,406 | 1,287 | −11 | 20 |
| | | Total, first 40 institutions | 228,022 | 79% | 203,329 | 179,447 | 162,726 | 147,533 | 129,542 | 12% | 12% |
| 41 | 44 | Michigan State U | 3,222 | 60 | 2,869[b] | 2,714 | 2,493 | 2,178 | 1,838 | 12 | 14 |
| 42 | 41 | U of North Carolina, Chapel Hill | 3,201 | 90 | 2,945 | 2,397 | 2,240 | 2,016 | 1,789 | 9 | 12 |
| 43 | 32 | U of Rochester | 3,196 | 90 | 3,858 | 3,167 | 3,123 | 2,966 | 2,069 | −17 | 9 |
| 44 | — | U of California, Irvine | 3,142 | 97 | 2,177 | 1,777 | 1,661 | 1,915 | 1,398 | 44 | 18 |
| 45 | — | U of California, Santa Barbara | 3,060 | 89 | 2,172 | 1,902 | 1,698 | 1,834 | 1,434 | 41 | 16 |
| 46 | — | U of Virginia | 3,046 | 71 | 2,516 | 2,069 | 1,778 | 1,781 | 1,203 | 21 | 20 |
| 47 | — | Iowa State U | 2,988 | 41 | 2,239 | 1,903 | 1,462 | 1,272 | 1,159 | 33 | 21 |
| 48 | — | U of Washington | 2,964 | 68 | 2,340 | 2,162 | 2,276 | 1,500 | 1,326 | 27 | 17 |
| 49 | 40 | Wayne State U | 2,093 | 99 | 3,071 | 2,645 | 2,856 | 2,261 | 2,163 | −32 | −1 |
| 50 | — | Syracuse U | 2,900 | 52 | 2,110 | 2,171 | 2,868 | 2,259 | 764 | 37 | 31 |
| | | Total, first 50 institutions | $258,644 | 78% | $229,626 | $202,354 | $184,981 | $167,515 | $144,505 | 13% | 12% |
| | | NATIONAL TOTAL | $414,529 | 74% | $371,182 | $336,025 | $309,371 | $285,520 | $244,454 | 12% | 11% |

Note: Data for institutional fiscal years. a Estimated. b Imputed. Source: National Science Foundation

## East and West Coast schools account for 64% of R&D spending in physical sciences




**Key to map:** Using the Middle Atlantic states as an example, $170.8 million, or 15.4%, of all R&D expenditures in the physical sciences by all Ph.D.-granting universities and colleges are made in this geographical area. **Note:** Data are based on R&D expenditures of $1.11 billion in the physical sciences during the 1985 fiscal year.
a Includes Alaska, Hawaii, and outlying areas. **Source:** National Science Foundation

## GRADUATE SCIENCE STUDENTS: **Chemistry, biochemistry, chemical engineering total 8%**

| | | | | | | | | | | | | Annual change | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Thousands** | **1985** | **1984** | **1983** | **1982** | **1981** | **1980** | **1979** | **1978** | **1977** | **1976** | **1975** | **1984–85** | **1975–85** |
| **Physical sciences** | **29.4** | **28.4** | **27.7** | **26.5** | **25.8** | **25.4** | **24.9** | **24.7** | **24.8** | **24.8** | **24.5** | **4%** | **2%** |
| Chemistry | 17.3 | 16.6 | 16.5 | 15.8 | 15.2 | 15.1 | 14.9 | 14.8 | 14.6 | 14.4 | 14.1 | 4 | 2 |
| Physics | 11.3 | 11.0 | 10.5 | 10.0 | 9.9 | 9.6 | 9.3 | 9.2 | 9.5 | 9.6 | 9.6 | 3 | 2 |
| **Life sciences** | **93.8** | **92.5** | **91.2** | **90.7** | **90.9** | **90.7** | **87.5** | **85.9** | **83.3** | **77.2** | **73.6** | **1** | **2** |
| Biochemistry | 4.7 | 4.5 | 4.2 | 4.1 | 4.0 | 4.0 | 3.9 | 4.0 | 3.8 | 3.7 | 3.7 | 4 | 2 |
| **Engineering** | **91.8** | **88.3** | **86.4** | **78.2** | **74.4** | **70.1** | **67.2** | **64.3** | **64.4** | **62.9** | **64.6** | **4** | **4** |
| Chemical | 7.0 | 7.2 | 7.4 | 6.9 | 6.3 | 5.9 | 5.4 | 5.2 | 5.1 | 5.1 | 4.9 | −3 | 4 |
| Metallurgical & materials | 3.8 | 3.6 | 3.3 | 3.0 | 3.0 | 2.8 | 2.7 | 2.5 | 2.5 | 2.3 | 2.3 | 6 | 5 |
| Petroleum | 0.8 | 0.7 | 0.7 | 0.6 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 14 | 10 |
| **Environmental sciences** | **14.3** | **14.3** | **14.3** | **13.8** | **13.1** | **12.8** | **12.6** | **12.2** | **12.3** | **11.7** | **11.0** | **0** | **3** |
| **Mathematical and computer sciences** | **39.0** | **35.4** | **33.2** | **30.3** | **27.1** | **25.0** | **22.7** | **21.5** | **21.1** | **21.7** | **21.3** | **7** | **6** |
| **Psychology and social sciences** | **102.8** | **104.5** | **105.4** | **107.3** | **108.7** | **109.7** | **105.8** | **101.2** | **100.6** | **99.8** | **98.7** | **−2** | **0** |
| **TOTAL** | **371.1** | **363.5** | **358.1** | **346.8** | **340.0** | **333.7** | **320.6** | **309.8** | **306.6** | **298.2** | **293.8** | **2%** | **2%** |
| **ANNUAL CHANGE** | **2%** | **2%** | **3%** | **2%** | **2%** | **4%** | **3%** | **1%** | **3%** | **1%** | **—** | | |

**NOTE:** Data for Ph.D.-granting institutions only. **Source:** National Science Foundation