

BACCALAUREATE ORIGINS OF S&E DOCTORATE RECIPIENTS

by Joan Burrelli, Alan Rapoport, and Rolf Lehming¹

Research universities (defined for purposes of this report as doctorate-granting institutions with very high research activity), though few in number (96), produce about 36% of U.S. science and engineering (S&E) bachelor's degrees (NSB 2008).² Baccalaureate colleges produce 13% of S&E bachelor's degrees, but they are important contributors to producing future S&E PhDs. Over the years, numerous reports (NSB 1986, Carrier and Davis-Van Atta 1987, Fuller 1989, NSF 1996, Research Corporation 2002) have called attention to the contribution of baccalaureate colleges to scientific research and to producing future S&E doctorate recipients.

This InfoBrief addresses the role of various types of colleges and universities as baccalaureate-origin institutions of S&E doctorate recipients. It examines trends by field of doctorate (total S&E, natural sciences, social and behavioral sciences, and engineering), Carnegie type of institution,³ and institutional control (public or private). The analysis focuses on two types of output variables: the absolute number of S&E doctorates and the institutional yield—the number of S&E doctorates in a given year per hundred bachelor's degrees awarded in all fields 9 years prior to that year.⁴ It covers all Carnegie groups of institutions, both public and private, includes all S&E fields as well as major field groups, and provides data through 2006.

Baccalaureate-Origin Institutions of S&E Doctorate Recipients

S&E doctorate recipients from U.S. universities completed their undergraduate education at a wide variety

of types of institutions in the United States and abroad. A large proportion of individuals earning S&E doctorates from U.S. universities had undergraduate degrees from foreign institutions: 37% in 2006, up from 28% in 1997 (table 1). An additional 9% did not provide information about their baccalaureate institutions in 2006. Of those with known U.S. baccalaureate institutions, almost half (47%) earned their bachelor's degree from research universities. The remainder earned their bachelor's degrees from other doctorate-granting institutions (18%), master's-granting institutions (17%), or baccalaureate colleges (16%).

Baccalaureate-Origin Institutions of S&E Doctorate Recipients Normalized for Number of Bachelor's Degrees Awarded

Baccalaureate colleges graduate relatively small numbers of undergraduate degree holders compared to doctorate- and master's-granting institutions. However, when normalized by the number of bachelor's degrees awarded, the baccalaureate colleges as a group yield more future S&E doctorates per hundred bachelor's awarded than other types of institutions, except research universities (figure 1). A group of 50 small, private baccalaureate schools (the Oberlin 50⁵) was studied in the mid-1980s and was found at that time to contribute greatly to producing future S&E doctorates.⁶ These schools have long outproduced (by yield) even the research universities. Over the 1997–2006 decade, the yield ratios of all of these types of institutions and the differences among types of institutions varied little, with slight drops in yield through 2002 reflecting declining numbers of S&E doctorates awarded.



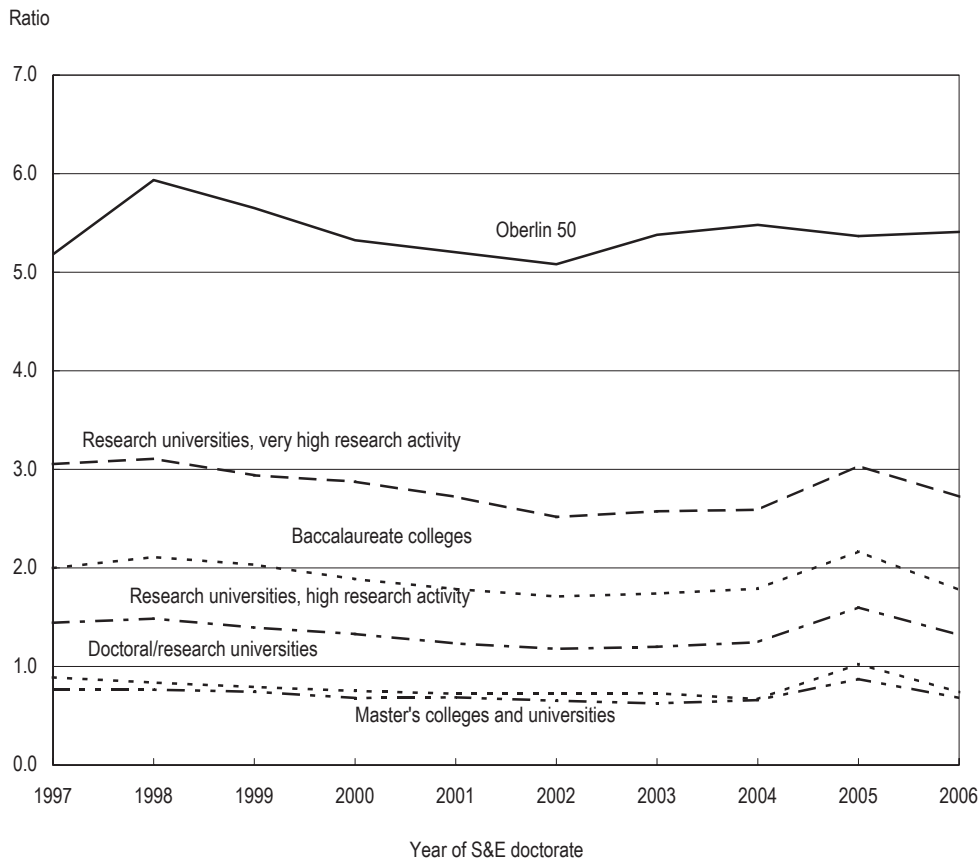
TABLE 1. S&E doctorate recipients, by 2005 Carnegie classification of baccalaureate institution: 1997–2006

Year	All institutions	Research universities	Other doctorate-granting institutions	Master's colleges and universities	Baccalaureate colleges	Other/unclassified Carnegie group	Foreign institutions	Unknown baccalaureate institutions
1997	28,650	8,277	3,034	2,640	2,461	290	8,129	3,819
1998	28,772	8,592	3,148	2,716	2,663	263	8,255	3,135
1999	27,338	8,368	3,033	2,754	2,636	262	7,675	2,610
2000	27,557	8,386	2,997	2,662	2,586	206	7,832	2,888
2001	27,069	8,226	2,920	2,784	2,576	220	7,980	2,363
2002	26,262	7,686	2,905	2,748	2,503	268	7,661	2,491
2003	26,914	7,784	2,926	2,677	2,541	254	8,343	2,389
2004	27,995	7,675	2,897	2,831	2,617	262	8,970	2,743
2005	29,774	7,830	3,077	2,873	2,602	263	10,464	2,665
2006	31,760	8,074	3,093	2,960	2,735	318	11,657	2,923

NOTES: Research universities are the Carnegie group doctorate-granting universities, very high research activity. Other doctorate-granting institutions include the two other Carnegie categories of doctorate-granting institutions—high research activity and doctoral/research universities. Other/unclassified Carnegie group includes associate's colleges, special focus institutions, and tribal colleges.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, 1997–2006.

FIGURE 1. S&E doctorates per hundred bachelor's degrees awarded in all fields 9 years earlier, by 2005 Carnegie classification and Oberlin 50: 1997–2006



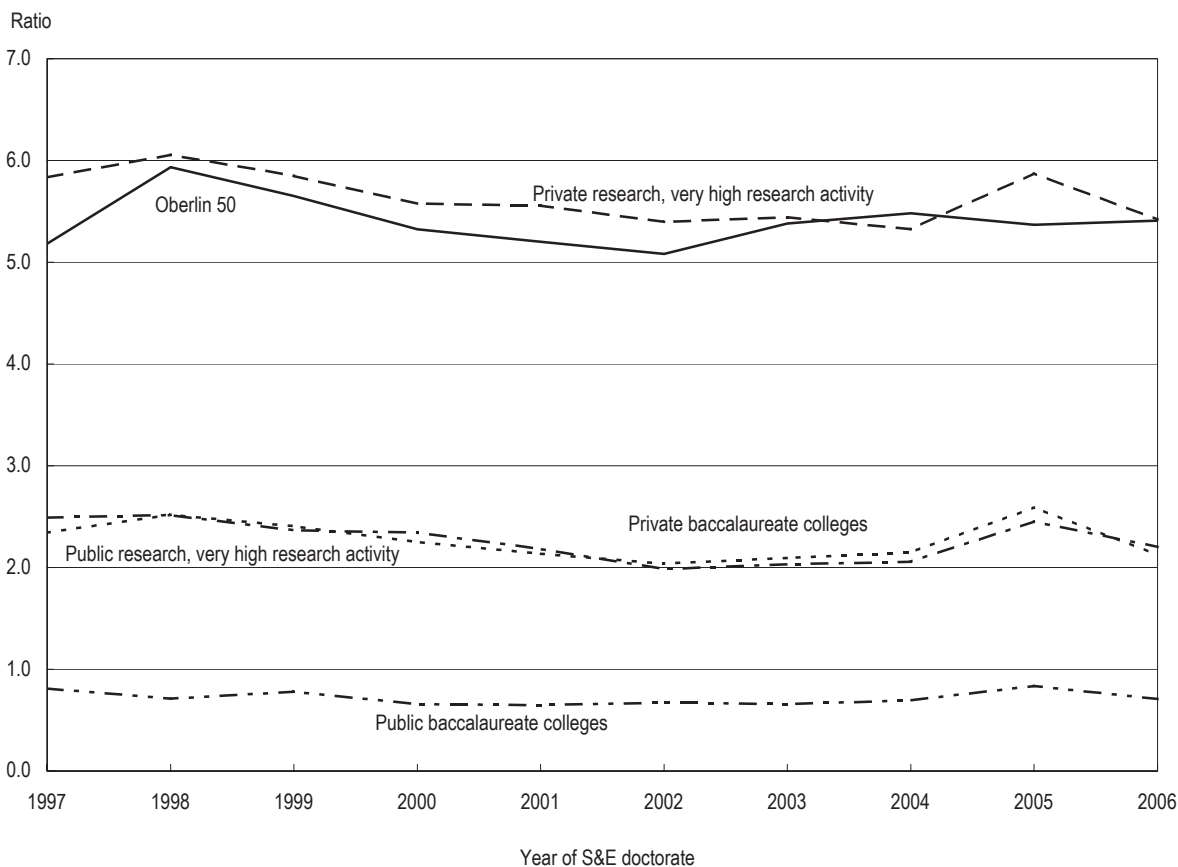
SOURCES: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, 1997–2006 and special tabulations of U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey, 1988–1997.

Comparing just private institutions, however, the research universities have very similar institutional yields as the Oberlin 50 schools. Private institutions, whether research universities or baccalaureate colleges, outperform public institutions in the proportion of their bachelor's degree recipients becoming future S&E doctorate recipients. The number of 1997–2006 S&E doctorate recipients per hundred bachelor's degrees awarded in all fields 9 years earlier is higher among private research universities and the Oberlin 50 liberal arts schools. All private bachelor's colleges as a group have about the same yield as public research universities (figure 2).

Baccalaureate-Origin Institutions of Natural Sciences, Social and Behavioral Sciences, and Engineering Doctorate Recipients

The patterns described above hold for social and behavioral sciences and natural sciences, but not for engineering, which produces strikingly different results (figure 3). The Oberlin 50 colleges have a higher yield in the social and behavioral sciences and about the same yield in the natural sciences but a far lower yield in engineering than the private research universities. All private baccalaureate colleges grouped together have a higher yield of future social and behavioral sciences

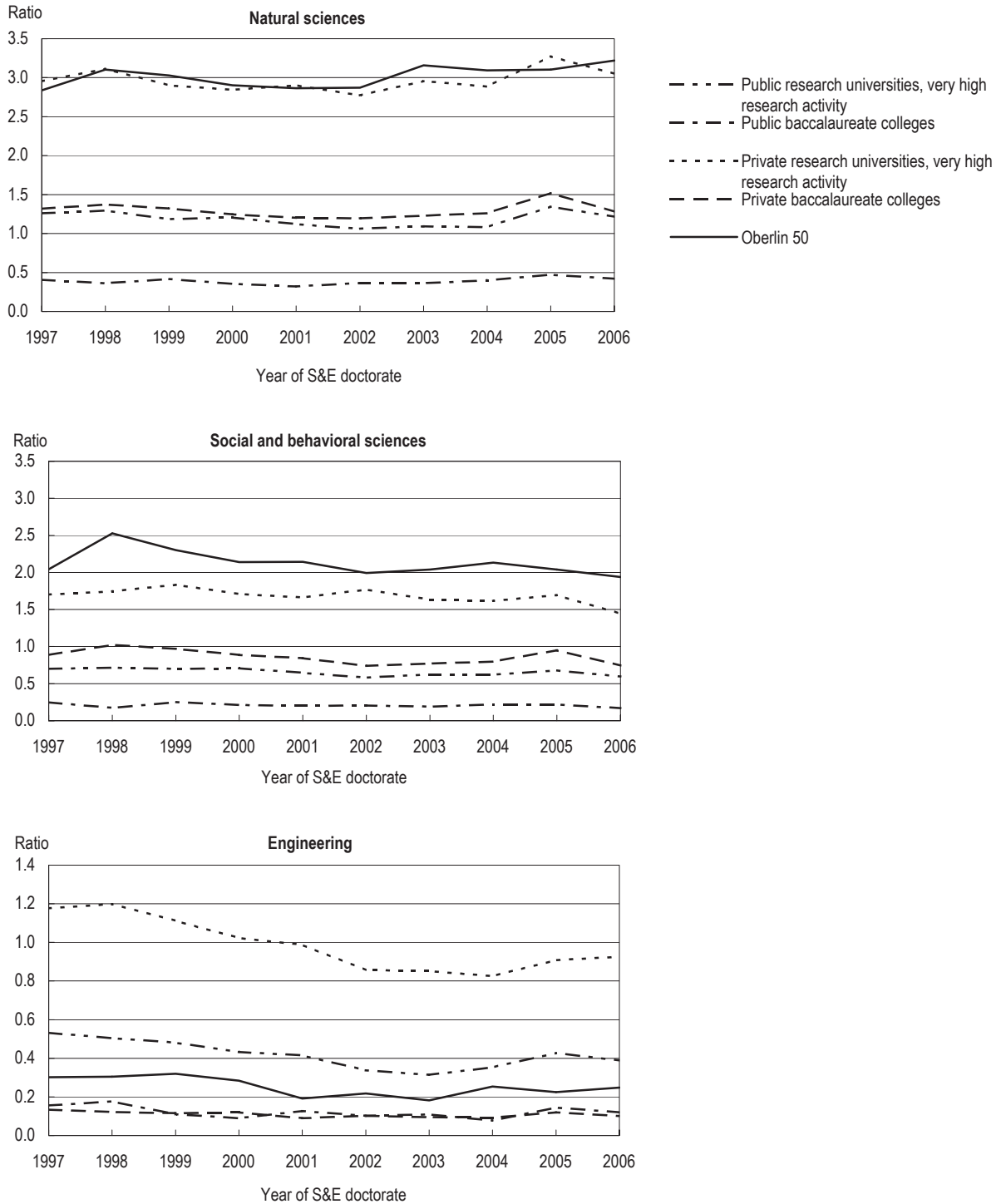
FIGURE 2. S&E doctorate recipients per hundred bachelor's awarded in all fields 9 years earlier, by selected 2005 Carnegie group, Oberlin 50, and institutional control: 1997–2006



NOTE: Private includes both for profit and nonprofit.

SOURCES: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, 1997–2006 and special tabulations of U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey, 1988–1997.

FIGURE 3. S&E doctorate recipients per hundred bachelor's awarded in all fields 9 years earlier, by broad field, selected 2005 Carnegie group, Oberlin 50, and institutional control: 1997–2006



NOTES: Private includes both for profit and nonprofit. To show detail, the scale for the engineering plot was expanded.

SOURCES: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, 1997–2006 and special tabulations of U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey, 1988–1997.

doctorates and about the same in natural sciences doctorates as public research universities. In engineering, the research universities, both public and private, yield more future doctorates than either public or private baccalaureate colleges.

Top Schools From Which S&E Doctorate Recipients Received Bachelor's Degrees

After normalizing for number of bachelor's awarded 9 years earlier, more than half of the top 50 baccalaureate-origin institutions of 1997–2006 S&E doctorate recipients were baccalaureate colleges, and most of the rest were private research universities (table 2). The top 5 baccalaureate-origin institutions in terms of number of S&E doctorates per hundred bachelor's awarded in all fields 9 years earlier were: California Institute of Technology, Harvey Mudd College, Massachusetts Institute of Technology, Reed College, and Swarthmore College.

This finding contrasts sharply with the baccalaureate origins of the absolute number of S&E PhDs. The top 50 known U.S. baccalaureate-origin institutions of 1997–2006 S&E doctorate recipients are almost all research institutions with very high research activity, and more than half are public institutions (table 3). Two (Brigham Young University and College of William and Mary) have high research activity. None are baccalaureate colleges. The top 5 baccalaureate-origin institutions of 1997–2006 S&E doctorate recipients are: University of California Berkeley, Cornell University, University of Michigan Ann Arbor, University of Illinois Urbana-Champaign, and Massachusetts Institute of Technology.

Notes

1. Joan Burrelli, Science and Engineering Indicators Program, Division of Science Resources Statistics, National Science Foundation, 4201 Wilson Boulevard, Suite 965, Arlington VA 22230 (jburrell@nsf.gov; 703-292-7793).

Alan Rapoport, Science and Engineering Indicators Program, Division of Science Resources Statistics, National Science Foundation, 4201 Wilson Boulevard, Suite 965, Arlington VA 22230 (arapopor@nsf.gov; 703-292-7811).

Rolf Lehming, Science and Engineering Indicators Program, Division of Science Resources Statistics, National Science Foundation, 4201 Wilson Boulevard, Suite 965, Arlington VA 22230 (rlehming@nsf.gov; 703-292-7810).

2. In this report, science and engineering includes health fields.

3. The 2005 version of the Carnegie Foundation for the Advancement of Teaching's Basic Classification scheme for colleges and universities categorizes academic institutions on the basis of highest degree conferred, level of degree production, and research activity. Doctorate-granting universities are institutions that award at least 20 doctoral degrees per year. These have three subgroups: very high research activity, high research activity, and doctoral/research universities, based on level of research activity. Master's colleges and universities are institutions that award at least 50 master's degrees and fewer than 20 doctoral degrees per year. Baccalaureate colleges are institutions that award fewer than 50 master's degrees or 20 doctoral degrees per year and at which baccalaureate degrees are at least 10% of all undergraduate degrees. See <http://www.carnegiefoundation.org/classifications/> for more information on the Carnegie classification scheme.

4. Nine years was the median time from bachelor's-to-doctorate receipt for S&E doctorates received in 2006. Time to degree was somewhat shorter in physical sciences (7.7 years) and in engineering (8.1 years) than in life sciences (8.6 years) and social sciences (9.6 years). Explorations of the data with 8- and 10-year lags produced similar results.

5. The Oberlin 50 institutions are: Albion College, Alma College, Amherst College, Antioch University, Barnard College, Bates College, Beloit College, Bowdoin College, Bryn Mawr College, Bucknell University, Carleton College, Colgate University, Colorado College, Davidson College, Denison University, DePauw University, Earlham College, Franklin and Marshall College, Grinnell College, Hamilton College, Hampton University, Harvey Mudd College, Haverford College, College of the Holy Cross, Hope College, Kalamazoo College, Kenyon College, Lafayette College, Macalester College, Manhattan College, Middlebury College, Mount Holyoke College,

TABLE 2. Top 50 baccalaureate-origin institutions of 1997–2006 S&E doctorate recipients, by S&E doctorate recipients per hundred bachelor's degrees awarded in all fields 9 years earlier, institutional control, and 2005 Carnegie classification

Rank	Academic institution	Institutional control	2005 Carnegie classification	1997–2006 S&E doctorate recipients	1997–2006 S&E doctorate recipients per hundred bachelor's awarded 9 years earlier
1	California Institute of Technology	Private	Research-very high	713	35.2
2	Harvey Mudd College	Private	Baccalaureate	329	24.9
3	Massachusetts Institute of Technology	Private	Research-very high	1,867	16.6
4	Reed College	Private	Baccalaureate	353	13.8
5	Swarthmore College	Private	Baccalaureate	482	12.9
6	Carleton College	Private	Baccalaureate	525	11.7
7	University of Chicago	Private	Research-very high	873	10.8
8	Grinnell College	Private	Baccalaureate	338	10.5
9	Rice University	Private	Research-very high	664	10.5
10	Princeton University	Private	Research-very high	1,135	10.3
11	Harvard University	Private	Research-very high	1,775	9.9
12	Bryn Mawr College	Private	Baccalaureate	276	9.7
13	Haverford College	Private	Baccalaureate	264	9.5
14	Pomona College	Private	Baccalaureate	323	9.1
15	New Mexico Institute of Mining and Technology	Public	Master's granting	118	8.7
16	Williams College	Private	Baccalaureate	428	8.4
17	Yale University	Private	Research-very high	1,087	8.4
18	Oberlin College	Private	Baccalaureate	577	8.2
19	Stanford University	Private	Research-very high	1,351	8.1
20	Johns Hopkins University	Private	Research-very high	691	7.7
21	Kalamazoo College	Private	Baccalaureate	195	7.7
22	Cornell University, all campuses	Public/private	Research-very high	2,536	7.6
23	Case Western Reserve University	Private	Research-very high	491	7.5
24	Washington College	Private	Baccalaureate	27	7.5
25	Brown University	Private	Research-very high	1,076	7.4
26	Wesleyan University	Private	Baccalaureate	497	7.1
27	Carnegie Mellon University	Private	Research-very high	660	7.1
28	Macalester College	Private	Baccalaureate	268	6.9
29	Amherst College	Private	Baccalaureate	285	6.8
30	Duke University	Private	Research-very high	1,050	6.8
31	Beloit College	Private	Baccalaureate	146	6.5
32	Bowdoin College	Private	Baccalaureate	243	6.5
33	Wellesley College	Private	Baccalaureate	381	6.5
34	Rensselaer Polytechnic Institute	Private	Research-very high	632	6.4
35	Earlham College	Private	Baccalaureate	147	6.2
36	Franklin and Marshall College	Private	Baccalaureate	262	6.0
37	Lawrence University	Private	Baccalaureate	153	6.0
38	University of Rochester	Private	Research-very high	671	5.7
39	University of California-Berkeley	Public	Research-very high	3,199	5.7
40	Dartmouth College	Private	Research-very high	609	5.7
41	Occidental College	Private	Baccalaureate	218	5.7
42	Hendrix College	Private	Baccalaureate	115	5.6
43	Vassar College	Private	Baccalaureate	319	5.6
44	Trinity University	Private	Master's granting	274	5.6
45	College of William and Mary	Public	Research-high	698	5.6
46	St John's College (Annapolis, MD)	Private	Baccalaureate	48	5.5
47	Bates College	Private	Baccalaureate	227	5.5
48	Whitman College	Private	Baccalaureate	154	5.4
49	Brandeis University	Private	Research-very high	374	5.4
50	Hampshire College	Private	Baccalaureate	123	5.3

NOTE: Institutions are ranked on unrounded ratios.

SOURCES: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, 1997–2006 and special tabulations of U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey, 1988–1997.

TABLE 3. Top 50 baccalaureate-origin institutions of 1997–2006 S&E doctorate recipients, by institutional control and 2005 Carnegie classification

Rank	Academic institution	Institutional control	2005 Carnegie classification	S&E doctorates
na	All baccalaureate-origin institutions	na	na	282,091
na	Foreign institutions	na	na	87,836
na	Unknown institutions	na	na	28,280
1	University of California-Berkeley	Public	Research-very high	3,199
2	Cornell University, all campuses	Public/private	Research-very high	2,536
3	University of Michigan at Ann Arbor	Public	Research-very high	2,181
4	University of Illinois at Urbana-Champaign	Public	Research-very high	2,057
5	Massachusetts Institute of Technology	Private	Research-very high	1,867
6	Pennsylvania State University, main campus	Public	Research-very high	1,817
7	Harvard University	Private	Research-very high	1,775
8	University of Wisconsin-Madison	Public	Research-very high	1,721
9	University of Texas at Austin	Public	Research-very high	1,700
10	University of California-Los Angeles	Public	Research-very high	1,674
11	University of California-Davis	Public	Research-very high	1,499
12	University of California-San Diego	Public	Research-very high	1,441
13	University of Florida	Public	Research-very high	1,382
14	Brigham Young University, main campus	Private	Research-high	1,368
15	Stanford University	Private	Research-very high	1,351
16	Texas A&M University, main campus	Public	Research-very high	1,351
17	Purdue University, main campus	Public	Research-very high	1,211
18	University of Minnesota-Twin Cities	Public	Research-very high	1,210
19	Rutgers the State University of New Jersey New Brunswick	Public	Research-very high	1,205
20	University of Virginia, main campus	Public	Research-very high	1,201
21	Virginia Polytechnic Institute and State University	Public	Research-very high	1,179
22	Michigan State University	Public	Research-very high	1,147
23	Princeton University	Private	Research-very high	1,135
24	University of Washington-Seattle	Public	Research-very high	1,117
25	Ohio State University, main campus	Public	Research-very high	1,115
26	University of Pennsylvania	Private	Research-very high	1,097
27	University of Maryland at College Park	Public	Research-very high	1,089
28	Yale University	Private	Research-very high	1,087
29	Brown University	Private	Research-very high	1,076
30	Duke University	Private	Research-very high	1,050
31	University of Colorado at Boulder	Public	Research-very high	1,009
32	University of Arizona	Public	Research-very high	967
33	University of North Carolina at Chapel Hill	Public	Research-very high	940
34	University of California-Santa Cruz	Public	Research-very high	892
35	University of Chicago	Private	Research-very high	873
36	University of California-Santa Barbara	Public	Research-very high	846
37	Northwestern University	Private	Research-very high	807
38	University of California-Irvine	Public	Research-very high	795
39	North Carolina State University at Raleigh	Public	Research-very high	790
40	Boston University	Private	Research-very high	782
41	Iowa State University	Public	Research-very high	776
42	University of Massachusetts at Amherst	Public	Research-very high	772
43	Indiana University at Bloomington	Public	Research-very high	765
44	Georgia Institute of Technology, main campus	Public	Research-very high	758
45	California Institute of Technology	Private	Research-very high	713
46	SUNY at Buffalo	Public	Research-very high	708
47	College of William and Mary	Public	Research-high	698
48	Johns Hopkins University	Private	Research-very high	691
49	Columbia University in the City of New York	Private	Research-very high	690
50	University of Notre Dame	Private	Research-very high	683

na = not applicable.

NOTE: Institutions with the same number of doctorate recipients are listed alphabetically.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates.

Oberlin College, Occidental College, Ohio Wesleyan University, Pomona College, Reed College, Smith College, St. Olaf College, Swarthmore College, Trinity College (CT), Union College (NY), Vassar College, Wabash College, Wellesley College, Wesleyan University, Wheaton College (IL), Whitman College, Williams College, and College of Wooster. Two of these institutions (Hampton University and Manhattan College) are now Carnegie master's-granting institutions.

6. The schools met twice (in June 1985 and June 1986) at Oberlin College. The report of these conferences argued that baccalaureate colleges had been prolific sources of scientists and called for more federal and nonfederal support for research at undergraduate institutions (Carrier and Davis-Van Atta 1987).

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