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A STATISTICAL SUMMARY OF CHEMISTS IN THE UNITED STATES

How many chemists are there and where do they work? As an occupational category, "chemists" generally refer to bench chemists, but many people who have chemistry degrees consider themselves chemists even though they work across a broad spectrum of occupations. Until recently, a general answer was that chemists work everywhere and do all sorts of jobs. This article seeks to apply some specific figures to these general statements using federal statistics. New federal databases provide fresh information on chemists, including a look backward at the generations of people trained during the past 50 years; information about a number of basic characteristics of those with chemistry as their highest degree; and forecasts of chemists' employment trends during the first decade of the 21st century. This article presents highlights from the available federal statistics and indicates where much more information can be found.

Federal statistics on people in technical fields have improved greatly in recent years. The National Center for Education Statistics (NCES), the nation's main source of data on college enrollments and degrees, is generating results reliably, rapidly, and in great detail. The National Science Foundation (NSF) has developed a new science and engineering statistics system, SESTAT, which allows unprecedented access to NSF's wealth of survey data. The Bureau of Labor Statistics (BLS) has a new historical version of its invaluable industry/occupation matrix, the nation's principal tool for forecasts of employment trends, and last fall, BLS released new projections of job growth between now and 2008. More important, these separate, independent sources of information now yield results that are not only consistent, but complement each other as well. This has not always been the case in the past. In general, federal statistical agencies have reached a new level of quality and timeliness in their work.

50 Years of Chemistry Degrees

Production of new degrees in chemistry shot up after the end of World War II, as thousands of returning veterans made use of the educational support offered by the G.I. Bill of Rights. Awards of bachelor's degrees in chemistry peaked in 1950, as this wave of students passed through the system (Table 1). Subsequent generations of new chemists were influenced by broad demographic forces: that is, the post-World War II baby boom (circa 1946–1964) and the subsequent baby bust (circa 1965–1980) when the annual number of births dropped well below the 3.6 million level of the beginning of the baby boom. Both births and levels of immigration increased sharply during the last decades of the 20th century, and now enrollments and degrees are on the rise again.

Over the 50-year period of 1948 through 1997, almost 470,000 bachelor's degrees in chemistry were awarded, along with over 160,000 graduate degrees. In 1997, the National Science Foundation counted

Table 1. Number of Degrees in Chemistry, 1948–1997

Year	B.A./B.S.	M.S.	Ph.D.
1947–1948	7429	1360	969
1948–1949	9132	1409	1031
1949–1950	10,597	1576	953
1950–1951	8696	1493	992
1951–1952	6794	1409	1031
1952–1953*	6273	1254	1022
1953–1954	5752	1098	1013
1954–1955*	5947	1131	1000
1955–1956	6141	1164	986
1956–1957	6591	1047	1003
1957–1958	6982	1125	939
1958–1959	7308	1145	1009
1959–1960	7569	1228	1048
1960–1961	7604	1313	1131
1961–1962	8047	1401	1114
1962–1963	8823	1463	1254
1963–1964	9660	1560	1271
1964–1965	10,047	1715	1414
1965–1966	9687	1817	1533
1966–1967	9872	1897	1628
1967–1968	10,783	1831	1744
1968–1969	11,807	2070	1941
1969–1970	11,519	2138	2207
1970–1971	11,063	2275	2159
1971–1972	10,590	2248	1971
1972–1973	10,128	2225	1872
1973–1974	10,438	2125	1823
1974–1975	10,549	1986	1822
1975–1976	11,022	1783	1621
1976–1977	11,215	1767	1568
1977–1978	11,315	1886	1521
1978–1979	11,509	1757	1516
1979–1980	11,232	1723	1545
1980–1981	11,347	1654	1622
1981–1982	11,062	1751	1722
1982–1983	10,796	1622	1746
1983–1984	10,704	1667	1744
1984–1985	10,482	1719	1789
1985–1986	10,116	1754	1908
1986–1987	9670	1738	1976
1987–1988	9052	1708	1995
1988–1989	8625	1774	2037
1989–1990	8132	1682	2183
1990–1991	8321	1665	2238
1991–1992	8641	1780	2280
1992–1993	8914	1842	2261
1993–1994	9425	1999	2353
1994–1995	9722	2099	2273
1995–1996	10,415	2254	2287
1996–1997	10,644	2240	2259
50-Year Total	468,189	84,447	80,419

Sources: National Center for Educational Statistics, 1999 (www.nces.ed.gov);
Digest of Educational Statistics (Washington, D.C.: National Science Foundation, Survey of Earned Doctorates, 1999 (www.nsf.gov/srs).
Asterisked years (*) estimated by interpolation.

Figure 1: BS Degrees in Chemistry, by Sex, 1948–96
(Source: National Center for Education Statistics)

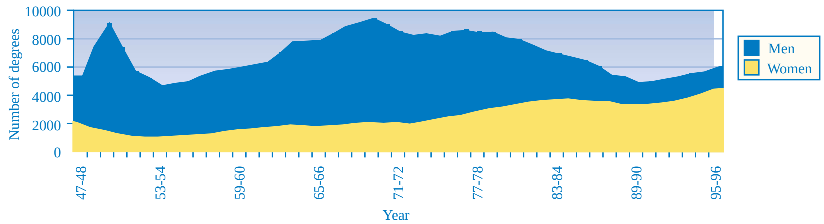


Figure 2: MS Degrees in Chemistry, by Sex, 1948–96
(Source: National Center for Education Statistics)

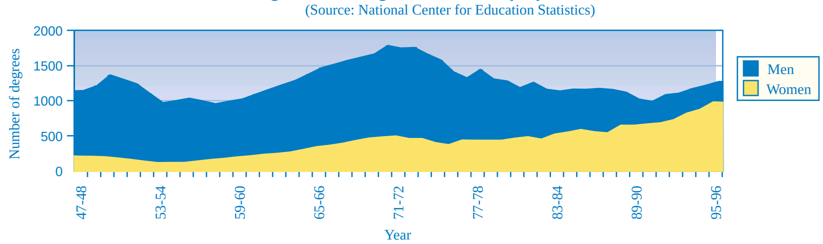
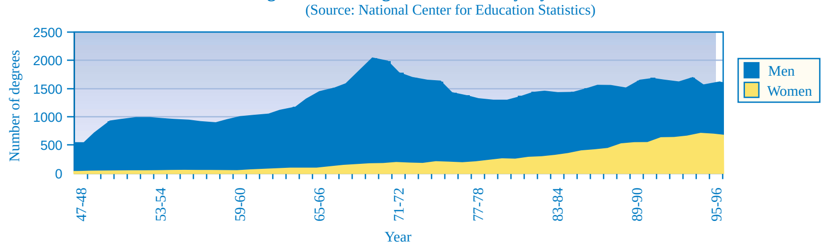


Figure 3: PhD Degrees in Chemistry, by Sex, 1948–96
(Source: National Center for Education Statistics)



U.S. Department of Education, "Digest of Educational Statistics" Center for Statistics www.nces.ed.gov
National Science Foundation/NRC, Survey of Earned Doctorates, "Science and Engineering Degrees," www.nsf.gov/srs/

360,000 people in the United States with chemistry as their highest degree, a figure that seems to fit well with the record of academic production. Many of the 470,000 persons who earned chemistry bachelor's degrees went on to earn graduate chemistry degrees. Some earned other higher degrees, often in science disciplines and professions. Still others are deceased, so the current stock of persons with chemistry credentials, even considering immigration, would be expected to be smaller than the total number of bachelor's degrees awarded during the past half century.

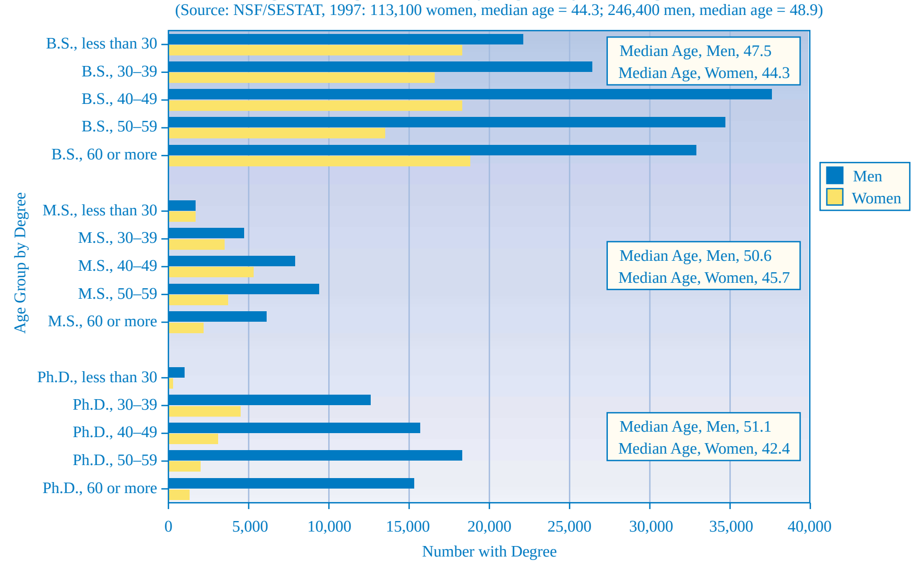
Unlike some other scientific and technical disciplines, significant numbers of women have participated in chemistry for many years. Major increases in these numbers began in the 1970s and have continued to the present, although there was a small decline in awards of chemistry Ph.D.s to women in 1996. Note in Figures 1–3 that the scale for bachelor's degrees is highly compressed, compared to those for graduate degrees. The growth in the numbers of women with chemistry degrees is more stable than that of men, who may react more strongly to ups and downs in the job market for chemists. Similar reactions by women may be masked by the powerful effects of the strong trend of increased participation by women in the workforce, in general, and in the professions, in particular.

Chemistry as the Highest Degree in 1997

A consequence of rapid increases in the participation of women in the chemical profession is that the typical age of a woman chemist has gone down. Among those whose highest earned degree is a bachelor's, the median age for a female chemist is 44.3 years old, while the median age for a male chemist is 47.5. The gap widens to 45.7 and 50.6, respectively, for those with master's degrees and to 42.4 and 51.1, respectively, for people with Ph.D.s (Figure 4). These differences mean that overall comparisons of women and men chemists are also influenced by the effects of age. For example, among all chemists one would expect women to earn somewhat less than men simply because women are typically younger and less experienced. Still, differences in pay remain when groups are matched in age.

Among each of the three groups, whose highest earned degrees are bachelor's, master's, or doctor's, respectively, the distribution of age among male chemists conforms to age patterns for the entire U.S. population, with the largest groups of people in the middle years of age (baby boomers). Women chemists depart from this pattern, with women more evenly dis-

Figure 4: Highest Chemistry Degrees by Level, Age, and Sex
(Source: NSF/SESTAT, 1997: 113,100 women, median age = 44.3; 246,400 men, median age = 48.9)



tributed across age groups. Among bachelor's degree holders, which includes most of the youngest chemists, women under 30 years of age are more numerous than women aged 30–39, because of the rapid growth of participation by women in the discipline.

Among the younger chemists, women with master's degrees are beginning to match men in their numbers, but there are still major gaps between the sexes in the population of those with chemistry Ph.D.s. Younger women who do have doctorates appear to be acquiring them rapidly, early in their careers.

More than 80% of all those with chemistry as their highest degree in the United States are White, and almost 60% of the remainder, or 11% of the total, have Asian origins (Figure 5). Members of "under-represented" minority groups make up about 8% of the degreed chemists (4.6% Black, 2.9% Hispanic, 0.3% "Other"). Asian-origin persons are not under-represented in chemistry. They account for 16% of the chemistry Ph.D.s. Among those whose highest chemistry degree is a bachelor's, Asian women outnumber Asian men.

The higher the level of the chemistry degree, the more likely it is that the holder of the degree is not a U.S. citizen. Many talented non-U.S. chemists gravitate to the United States. They are pulled by the quality of U.S. higher education, the general attractiveness of the country, and by an understandable interest on the part of employers in tapping into this flow of highly qualified people. Thus, it is not surprising that noncitizen chemists are especially common at the highest degree levels of the profession (Figure 6).

A relatively small proportion of the noncitizen chemists are here on temporary work visas. Congress has recently raised the number of permissible visas for workers under the professional "H1-B" category and is considering raising it again. Other temporary workers come here under the "L" visa class for foreign employees of U.S. firms, so the numbers of these foreign chemists will rise. They are most common at the master's level. By the time these degree holders get a doctorate, they are likely to have become permanent residents. As the data show, most then go on to become naturalized citizens.

Figure 7 summarizes the labor force status of people with chemistry degrees in 1997. Of those who were in the workforce—89% had full-time jobs, 8.7% had part-time jobs, and 2.3% were unemployed and looking for work, a rate that was a bit lower than that of the overall civilian labor force. More than one-fifth of the population of those with chemistry as their highest degree were not in the labor force (77,700 of 359,600). 13.9% were retired. Most of the remainder are neither working nor looking for a job. Women are much more apt than men to be in this last group, at both the bachelor's and master's levels, so child rearing and homemaking are likely to account for many of this group, especially at the older ages.

Employed Chemists in 1997

These data on degreed chemists come from NSF's SESTAT database, updated last fall with new statistics for 1997. The

Figure 5: Highest Chemistry Degrees by Level, Ethnicity, and Sex
(Source: NSF/SESTAT, 1997: 113,100 women; 246,400 men)

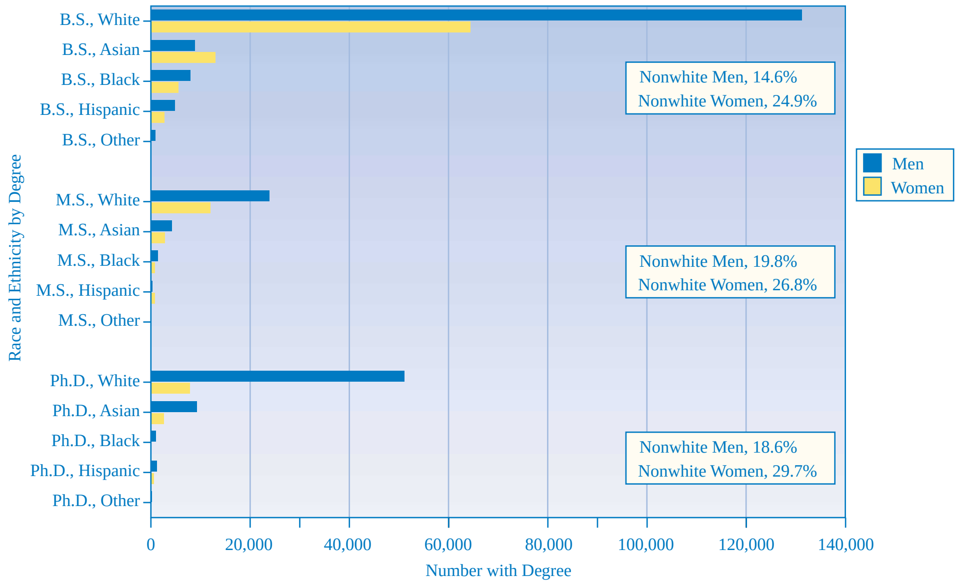
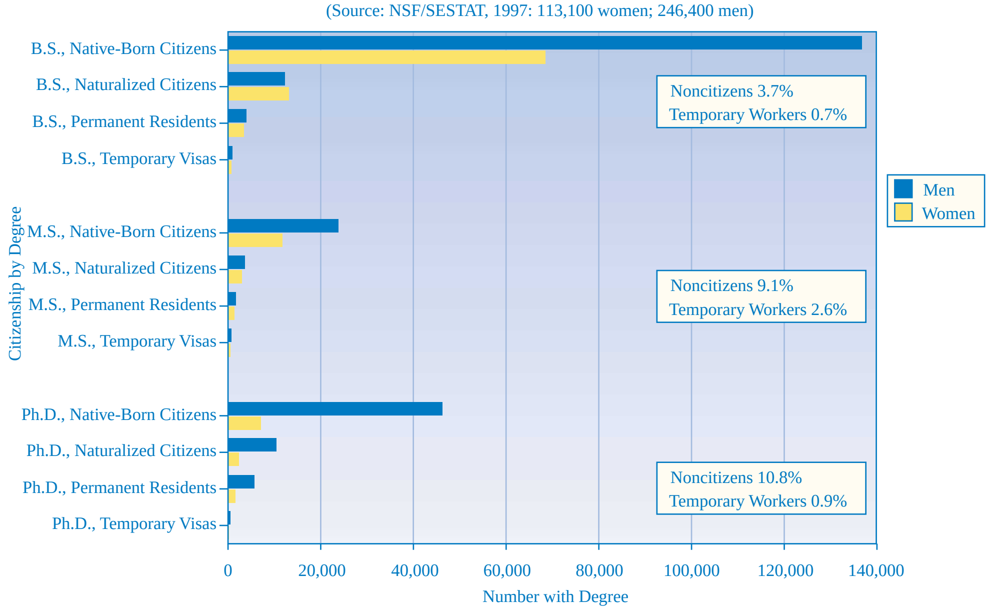


Figure 6: Highest Chemistry Degrees by Level, Citizenship, and Sex
(Source: NSF/SESTAT, 1997: 113,100 women; 246,400 men)



same source also supports a closer look at those who are employed. In Figure 8, the distribution of an estimated 275,100 working in the United States with chemistry as their highest degree is summarized. Industry is by far the largest employer of chemists, followed by academic institutions and government. Women chemists are much more likely to be as numerous as the men in nonindustrial settings.

For the SESTAT data, an “employed chemist” is one working as a federally defined chemist, which is typically a bench chemist working in R&D. SESTAT will count you as a chemist if you do such work, but many of those with chemistry degrees hold other kinds of positions, as Figure 9 indicates. Chemists in industry and some academic positions account for the largest single cluster of the working chemists, and other scientific and engineering positions account for the next largest share of those with graduate degrees and a substantial number of the remaining chemists with bachelor’s degrees. Another large group of chemists has “closely related nonscience and engineering” employment, typically as high school teachers, managers, and administrators (which include technical and scientific management). In a “somewhat related non-S&E” cluster are such persons as technical writers, journalists, and patent agents. Finally, a group of chemists, including a substantial share of those whose highest degree is a bachelor’s, are employed in nonrelated jobs. These people may have elected to pursue other kinds of careers totally apart from the science and engineering fields.

There are significant variations in the distribution of working chemists among different regions of the United States. Geographic regions vary widely in the overall size of their populations, and that difference alone accounts for much of the data in Figure 10. For example, the total population of the Pacific states is much larger than that of the Mountain states, so it is not surprising that the Pacific states also have more chemists. But not all of the regional data fit this pattern. For example, the South Atlantic region, which includes the greater Washington, D.C., area, has the most bachelor-level chemists, and employment with the federal government

Figure 7: Highest Chemistry Degrees by Level, Workforce Status, and Sex
(Source: NSF/SESTAT, 1997: 113,100 women; 246,400 men)

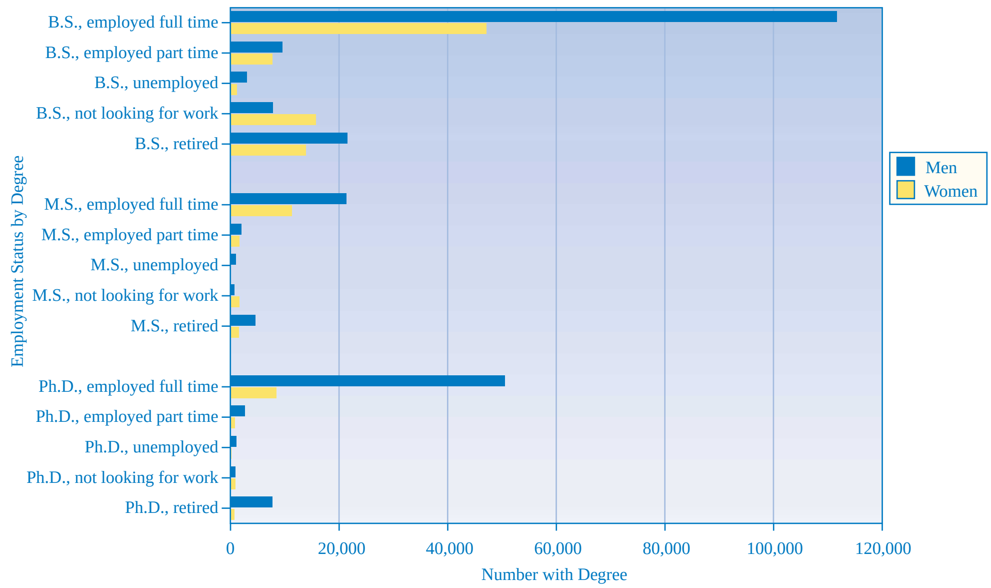


Figure 8: Employed Chemistry Degrees by Employment Sector, Level, and Sex
(Source: NSF/SESTAT, 1997: 113,100 women; 246,400 men)

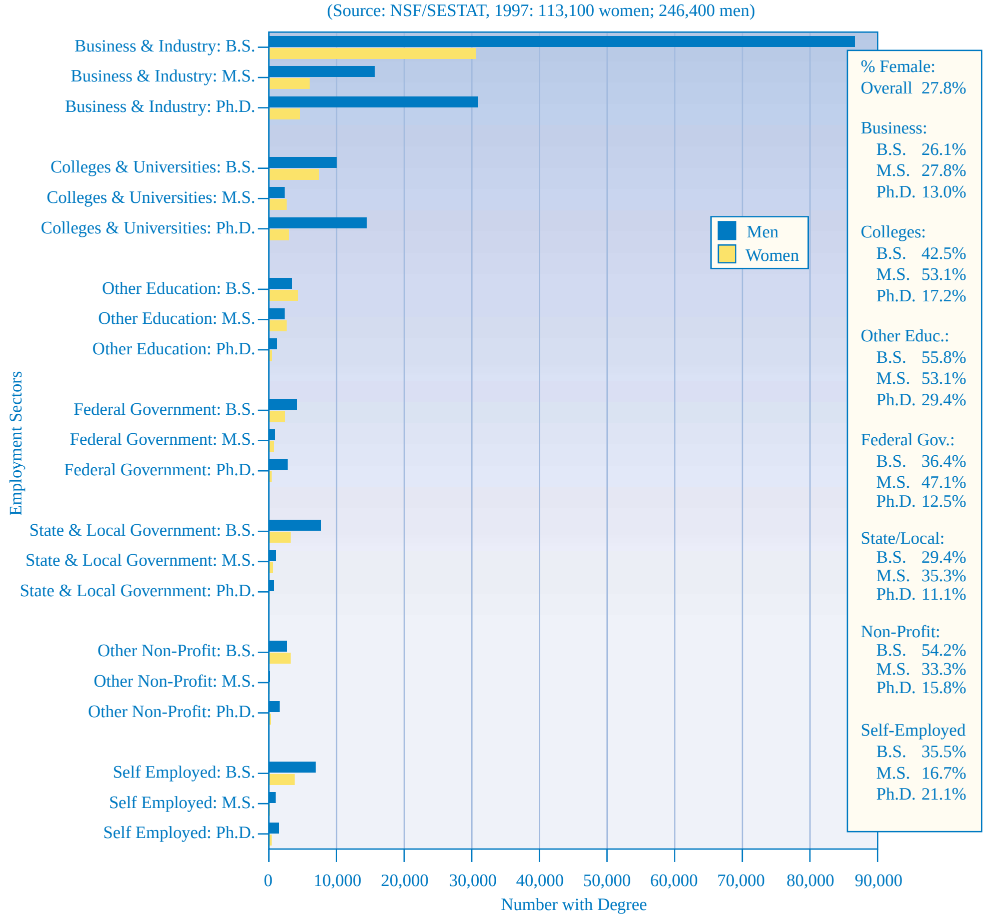


Figure 9: Employed Chemistry Degrees by Level and Broad Occupational Field
(Source: NSF/SESTAT, 1997: 113,100 women; 246,400 men)

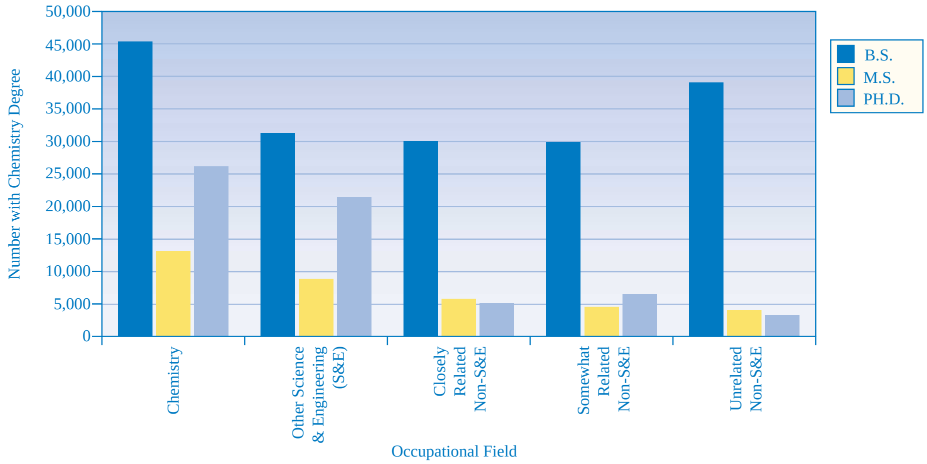
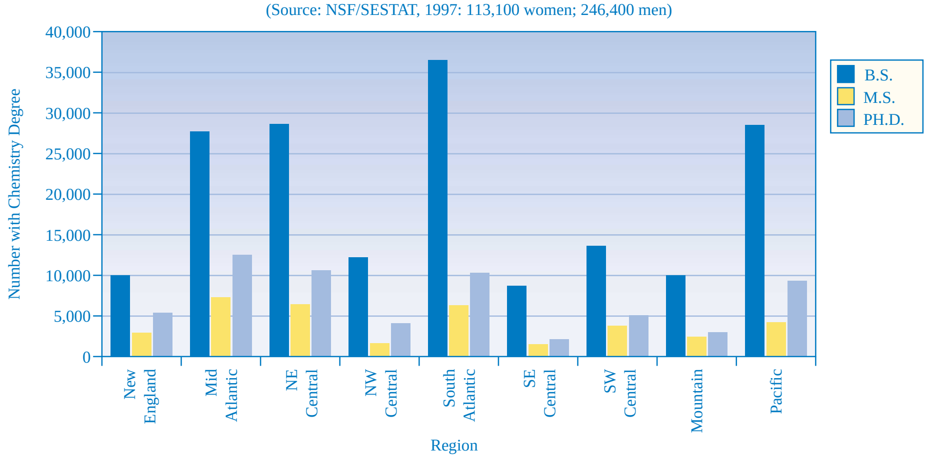


Figure 10: Employed Chemistry Degrees by Level and Geographic Region
(Source: NSF/SESTAT, 1997: 113,100 women; 246,400 men)



perhaps is one reason for that result. Similarly, the high concentration of chemical and drug companies in the Mid-Atlantic region explains why that area has the most chemists at the master's and doctoral levels.

Such regional variations in the distribution of professional people are usually a result of functions of variations in the concentration of particular industries. Chemists contemplating moves to a different region will do well to keep this fact in mind. To illustrate, the typical compensation for all chemists may be especially good in the Mid-Atlantic region of the country. But those high rates may not apply to you if you are not a specialist in the pharmaceutical or specialty chemical industries.

The Job Outlook: Chemists as an Occupation 1998–2008

This section refers to the "chemist" occupation, not necessarily the degree. As stated earlier, the federal government has a relatively narrow definition of a chemist. However, as noted in the earlier discussion of the SESTAT data, even if those with a chemistry degree do not work as chemists, they tend to remain closely aligned with the occupation—working in chemical-related industries and occupations that use their chemistry degrees. Thus, any forecasting of chemists' jobs likely reflects the forecasts for the many people in related occupations or industries.

Table 2 provides data from the Bureau of Labor Statistics' latest forecast, released in November 1999, of trends in employment. These data are the principal statistical source for the biennial editions of the *U.S. Occupational Outlook Handbook*, a guide for career counselors, employers, and educators that can be found in virtually every public library in the nation. This article is the first publication based on the detailed 1999 BLS forecast for chemists.

BLS's forecasts draw on its surveys of employers. A matrix of several hundred occupational and industry combinations is formed and assessed. Individual combinations of specialties and employers are examined and whenever changes seem imminent, the Bureau prepares specific comments explaining its expectations at these detailed levels.

The "occupations" forecasts have not been perfect. No forecasting scheme can anticipate everything, and, in fact, economic recessions and other manifestations of business cycles can upset predictions based on long-run trends. But on the whole, the BLS's track record is excellent, at least for the direction of change, if not the magnitude. In fact, no better guide exists to what may lie ahead for jobs.

For the chemist occupation, BLS expects overall employment to grow at roughly the same rate as employment in general during the next eight years. Manufacturing, traditionally the main source of work for many technical people, has been declining in importance for some time, and this trend is expected to continue for most areas of the chemical and allied companies. Most manufacturing employment for chemists will remain at roughly the same levels that were seen in the forecast's baseline year of 1998. One major sector, the pharmaceutical industry, will at least keep pace with the larger economy in terms of job generation for chemists.

Like other technical professionals, chemists must now look to the service sector for many of their jobs and virtually all of the growth opportunities. Employment of chemists in services generally is forecast to grow by 50% by 2008. Independent research and testing services will be the fastest-growing employment sector; in these areas, chemist employment is predicted to rise by 74%.

The BLS data are a source of much other valuable intelligence on trends in jobs and careers. The big growth fields continue to be the information technology occupations

Table 2: Employment of Chemists by Industry, 1998 and Projected 2008

(Source: Occupation-Industry Matrix, 1998-2008 (Washington: Office of Employment Projections, U.S. Bureau of Labor Statistics, 1999). Only industry sectors which employ chemists are shown.)

Industry	1998	2008
Total employment, all industries	96,372	109,732
Self-employed workers, primary job, any industry	1,508	1,440
Wage and salary employment, all industries	94,864	108,292
Agriculture, forestry, and fishing	**782**	**703**
Oil and gas extraction	**464**	**248**
Metal, coal, and mineral extraction	**176**	**134**
Construction	**52**	**56**
All Manufacturing	**46,580**	**45,409**
All Durable goods	8,179	7,722
Stone, clay, and glass products	300	268
Primary metal industries	906	762
Fabricated metal products	206	207
Industrial machinery and equipment	484	484
Electronic and other electrical equipment	433	457
Transportation equipment	721	704
Instruments and related products	4,965	4,674
Miscellaneous manufacturing industries	142	143
Nondurable goods	38,401	37,687
Food and kindred products	2,340	2,312
Tobacco products	1,887	1,357
Textile mill products	506	461
Paper and allied products	825	849
Printing and publishing	88	92
Chemicals and allied products	30,804	30,752
Industrial inorganic chemicals	1,910	1,508
Plastics materials and synthetics	2,173	1,677
Drugs	13,676	15,440
Soap, cleaners, and toilet goods	3,334	3,156
Industry (continued)	**1998**	**2008**
Paints and allied products	1,735	1,527
Industrial organic chemicals	4,539	3,881
Agricultural chemicals	400	368
Miscellaneous chemical products	3,038	3,196
Petroleum and coal products	970	823
Petroleum refining	574	441
Miscellaneous petroleum and coal products	396	382
Rubber and miscellaneous plastics products	944	1,012
Transportation and public utilities	**2,024**	**2,293**
Wholesale and retail trade	**2,785**	**3,130**
Finance, insurance, and real estate	**67**	**81**
Services	**28,341**	**42,738**
Business services	2,630	3,957
Personnel supply services	2,083	3,137
Computer and data processing services	79	156
Miscellaneous and other business services	468	664
Health services	761	877
Hospitals, public and private	438	464
Medical and dental laboratories	278	348
All other health services	45	65
Education, public and private (not teachers)	6,061	6,755
Membership organizations (such as ACS)	59	69
Engineering and management services	18,536	30,680
Engineering and architectural services	2,142	2,709
Research and testing services	14,647	25,433
All other engineering and management services	1,747	2,538
All other services	294	469
Government	**13,593**	**13,502**
Federal government	6,700	5,887
State government, except education and hospitals	2,928	3,174
Local government, except education and hospitals	3,965	4,441

and employment clusters, suggesting that one way chemists can enhance their own careers will be to acquire secondary skills with computers, information systems, and other tools of the new information economy.

Where To Learn More

This review of some of the latest statistical information on chemists barely scratches the surface. It provides broad background, but for many purposes the real value of these sources of data is in their details. Individual readers may find that many special topics can be illuminated with the sources described here. Educators can identify growth rates in particular academic disciplines with the NCES data, a step that can be responsive to the common demands of administrators, trustees, and legislators for evidence in support of proposals for new programs, departments, or other initiatives. The BLS occupational forecasts serve similar needs.

For detailed information on chemistry degrees, no other source matches SESTAT. Literally hundreds of factors are being tracked by this system, including data on compensation, work histories, employer characteristics, and a host of other attributes: authorship of professional publications, development of patents, supervisory responsibilities, and much more. In many cases, it will be possible to obtain detailed data from this system directly, through the use of the SESTAT Web site (identified below). For some queries, assistance from the system's staff may be required.

Gateways to ther main data resources are located at **http://nces.ed.gov/index.html** for NCES; at **http://srsstats.sbe.nsf.gov** for SESTAT; and at **http://stats.bls.gov** for BLS.

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