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LIST OF FIGURES

1.1 Current Doctoral Level Employment by Sector ..............................................................6
1.2 Doctoral Level Hiring in Next 3 Years by Sector ............................................................7
1.3 Outlook on Employment in Next 3 Years as Seen by Managers of Microbiologists ..........7
1.4 Representation of Women and Minorities at the Doctoral Level by Sector .....................8
1.5 Current MS and BS Level Employment by Sector ..........................................................8
1.6 MS and BS Hiring in Next 3 Years by Sector .................................................................8
3.1 Employers of Microbiologists in the Education Sector ....................................................12
3.2 Primary Work in Departments in the Education Sector ..................................................12
3.3 Outlook on Employment in the Next 3 Years as Reported by Employers in Education .....13
3.4 Current Ph.D. Employment in Education by Specialization ............................................13
3.5 Future Hiring of Ph.D.s in Education by Specialization ..................................................13
3.6 Hard to Find Specializations in the Education Sector in Order of Scarcity .......................14
3.7 Important Skills in the Education Sector ........................................................................15
3.8 Current Employment in Education for Nondoctoral Level Staff ....................................15
3.9 Future Hiring in Education for Nondoctoral Level Staff ................................................15
4.1 Employers of Microbiologists in the Industrial Sector .....................................................17
4.2 Primary Work in Departments in the Industrial Sector ....................................................17
4.3 Outlook on Employment in the Next 3 Years as Reported by Employers in Industry .......18
4.4 Current Ph.D. Employment in Industry by Specialization ................................................19
4.5 Future Hiring of Ph.D.s in Industry by Specialization .......................................................20
4.6 Hard to Find Specializations in the Industrial Sector in Order of Scarcity .......................20
4.7 Important Skills in the Industrial Sector ........................................................................21
4.8 Current Employment in Industry for Nondoctoral Level Staff .......................................21
4.9 Future Hiring in Industry for Nondoctoral Level Staff .....................................................21
5.1 Employers of Microbiologists in the Government Sector ..............................................22
5.2 Primary Work in Departments in the Government Sector ..............................................22
5.3 Outlook on Employment in the Next 3 Years as Reported by Employers in Government ....23
5.4 Current Ph.D. Employment in Government by Specialization .......................................23
5.5 Future Hiring of Ph.D.s in Government by Specialization ...............................................24
5.6 Hard to Find Specializations in the Government Sector in Order of Scarcity .................25
5.7 Important Skills in the Government Sector .................................................................25
5.8 Current Employment in Government for Nondoctoral Level Staff ..................................25
5.9 Future Hiring in Government for Nondoctoral Level Staff ............................................25
6.1 Employers of Microbiologists in the Clinical-Medical Sector .......................................26
6.2 Primary Work in Departments in the Clinical-Medical Sector .......................................26
6.3 Outlook on Employment in the Next 3 Years as Reported by Employers in the Clinical-Medical Sector .................................................................27
6.4 Current Ph.D. Employment in the Clinical-Medical Sector by Specialization ................28
6.5 Future Hiring of Ph.D.s in the Clinical-Medical Sector by Specialization .........................28
6.6 Hard to Find Specializations in the Clinical-Medical Sector in Order of Scarcity ............28
6.7 Important Skills in the Clinical-Medical Sector .............................................................28
6.8 Current Employment in the Clinical-Medical Sector for Nondoctoral Level Staff ............30
6.9 Future Hiring in the Clinical-Medical Sector for Nondoctoral Level Staff .......................30

LIST OF APPENDIXES

A. Methodological Notes .................................................32
B. Calculation of Survey Weights, Estimates, and Sampling Errors ..................................34
C. Computation of Survey Weights .........................................36
D. Screener Questionnaire and Cover Letter ..................................40
E. Main Questionnaires and Cover Letters ..................................41
1. BACKGROUND

This report presents the results of a nationwide survey of current employment and future personnel needs in the microbiological sciences. The survey includes a wide range of organizations that rely on the microbiological sciences, including medical centers and clinical laboratories, pharmaceutical companies, biotechnology firms, food products manufacturers, colleges and universities, and government laboratories and agencies at the national, state, and local level. Because of scientific advancement, technological innovation, international competition, government reforms, and the restructuring of health care provision, many of these employers of microbiologists have experienced rapid change, with some reorganizing, others downsizing, and still others growing rapidly. Within individual organizations, the scientific specializations and technical skills required of the existing workforce may be changing rapidly in response to technological and societal forces. The survey presented here was designed to provide current and reliable data to assess the implications of these critical issues for the microbiology profession.

The American Society for Microbiology (ASM) has sponsored this survey as part of its mission to provide strategic leadership for the profession and to inform the public about sectors of employment that are vital to the health, safety, technological competitiveness, and economic well being of the nation.

Prior to implementing the survey reported here, the ASM sponsored a series of focus groups of leaders in various sectors and industries that employ microbiologists to help identify key issues that might be addressed by a national survey. The results of the focus groups were highly informative and provided a firm basis for the design of a national survey, which attempted to provide some quantitative data to address many of the issues that were identified by focus group participants.

It should be noted that for purposes of the survey, the microbiological sciences were defined broadly to include a wide range of scientific specializations related to the study of microorganisms and their application.

1. SURVEY METHODS

The survey was designed and conducted by Westat, Inc., one of the nation’s leading survey research firms. In addition to the use of focus groups to inform the design of the survey, the survey instrument and procedures were thoroughly pretested by Westat. Using initial mail contacts with ASM members, Westat was able to identify managers of operating units that employed persons with specialized training in the microbiological sciences. Managers were surveyed because they seemed most able to provide information on the changing employment patterns among microbiologists. Responses were received from 1,849 of these managers, divided nearly evenly over four major employment sectors: education, industry, government, and the clinical-medical sector. All estimates presented in this report have been statistically weighted to represent the U.S. population of microbiological professionals and the organizations that employ them.

1.3 MAJOR FINDINGS

Current employment of doctoral level microbiologists in the United States. There are about 35,300 doctoral level microbiologists currently employed in the four sectors surveyed. By far the largest sector, in terms of doctoral level employment, is the education sector, with 20,400 employees, followed by industry (7,100), government (5,500), and the clinical-medical sector (2,300). (See Figure 1.1.)

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1 See Focus group report to the American Society for Microbiology, prepared by Westat, Inc., February 15, 1994.
Postdoctoral fellowships currently constitute an important proportion of current employment of doctoral level microbiologists. Postdoctoral fellowships represent 17 percent of current employment of doctoral level microbiologists in both the government and education sectors, and 16 percent in the clinical-medical sector. In industry, however, postdoctoral fellows constitute only 11 percent of doctoral level microbiologists currently employed. (See Figure 1.1.)

Future employment opportunities for doctoral level microbiologists. The four sectors surveyed will be hiring about 6,600 doctoral level microbiologists in the next 3 years, representing a 6 percent yearly rate of employment growth. Future employment growth over the next 3 years will be led by the education sector, which anticipates hiring approximately 3,600 doctoral level employees, in the next 3 years, followed by industry with about 1,800 hires over the next 3 years, government with about 800 hires, and the clinical-medical sector with 300. (See Figure 1.2).

Employment outlook appears most positive in industry and education. In order to obtain an overall impression of future employment prospects, managers in each of the major four employment sectors were asked: “From your perspective, which of the following best describes the general employment outlook for your field or industry over the next 3 years?” The response categories ranged from very positive to very negative. Employment prospects in private industry over the next 3 years appear quite positive, with 57 percent of the managers surveyed reporting a positive outlook on employment and only 20 percent reporting a negative outlook (the remainder were neither positive nor negative). Relative employment prospects in the education sector also appear to be generally positive, with 44 percent of department heads reporting a positive outlook and 36 percent a negative one. (See Figure 1.3).

Employment outlook in government and the clinical-medical sector are less positive. The employment outlook in government, and especially the clinical-medical sector, appears much less sanguine. Thirty-one percent of government managers and only 23 percent of managers in the clinical-medical sector are positive about the employment outlook for their sectors over the next 3 years. Fully 50 percent of government managers and 54 percent of managers in the clinical-medical sector are negative about the employment outlook (the remainder were neither positive nor negative). (See Figure 1.3.)
Few women and fewer minorities are employed at the doctoral level in the microbiological sciences. There are relatively few women and especially minorities at the doctoral level in the microbiological sciences across sectors. The clinical-medical sector has a much higher percentage of women at the doctoral level (47 percent) than the other sectors surveyed. The clinical-medical sector also has a somewhat higher percentage of minorities (6 percent) than the other sectors. (See Figure 1.4).

Molecular biology leads specializations in highest demand. Molecular biology is clearly the prominent specialization at the doctoral level in every sector except the clinical-medical sector (where clinical-medical microbiology is the largest specialization). Molecular biology also emerges as the leading object of future hiring activity at the doctoral level over the next 3 years, again in all sectors except the clinical-medical sector. Other specializations likely to be prominent in future hiring activity across sectors include infectious disease and pathogenesis, biochemistry and biophysics, and molecular immunology. However, a host of sector-specific hiring activity for many other specializations is likely as well, as later chapters detail.

Industry leads in hiring MS and BS level microbiologists. Not including medical technologists, industry is the leading employer of MS and BS level microbiologists, both currently and in terms of hiring activity over the next 3 years. The government sector is also a significant employer of MS level microbiologists, but employs a relatively smaller number of BS level microbiologists. (See Figures 1.5 and 1.6.)

The clinical-medical sector leads in hiring medical technologists. The clinical-medical sector employs most of the medical technologists (almost 30,000 currently), but expects to hire relatively few (less than 900) in the next 3 years. (See Figures 1.5 and 1.6.)
BACKGROUND AND PURPOSE OF THE SURVEY

Because of scientific advancement, technological innovation, international competition, government reforms, and changes in the health care industry, those involved in the microbiological sciences share a widespread belief that their science and profession are changing rapidly. The American Society for Microbiology (ASM) has been in a unique position to recognize and respond to these changes as they emerge. In the process, however, the ASM has become increasingly aware of a lack of detailed, reliable data on the employment status and personnel needs of the various sectors that employ microbiologists. As a result, the ASM commissioned this national survey of the employment outlook in the microbiological sciences. The survey was conducted by Westat, Inc., one of the leading survey research firms in the nation.

Prior to implementing the survey, the ASM sponsored a series of focus groups of leaders in various sectors and industries that employ microbiologists to help identify key issues that might be addressed by a national survey. The focus groups also were used to help design appropriate survey procedures. Results of these focus groups confirmed that the microbiological sciences are becoming increasingly diverse, both in terms of scientific specializations and professional opportunities, and that the field is in a state of flux. Participants in the focus groups called attention to a number of broad trends affecting the microbiological sciences: health care reform and the trend toward cost containment in the health care sector; corporate downsizing and increasing international competition; the desire for a better fit between the specializations and skills taught in degree programs and the needs of employers; the large number of foreign nationals represented in the field; and the under-representation of minorities and women in the microbiological sciences. The results of the focus groups formed the basis for the national survey, which attempted to provide some quantitative data to address many of the issues identified.

SURVEY PROCEDURES

The survey involved a mail out/mail back questionnaire to managers of operating units (such as departments or laboratories within a larger organization) that employ persons with specialized training in the microbiological sciences. Operating units were chosen because the focus group results suggested that managers at this level could provide more reliable information on the scientific specialization of their employees and their future hiring plans, also by specialization. Chief executives or other senior level managers, while able to represent an entire organization, were not believed to be in a position to answer such detailed questions about individual employees.

A two step procedure was employed to construct a national list of managers of operating units that employ microbiologists. First, a sample of individuals on the ASM membership list were contacted and asked to identify the manager of the operating unit in which they were employed (including themselves if they were the manager). Second, questionnaires were mailed to the identified managers. An attempt was made to ensure approximately 500 responses in each of four main sectors: education, industry, government, and the clinical-medical sector. A total of 1,849 managers returned their questionnaires, which represents 47 percent of all those who were mailed questionnaires. Broken down by sector, responses totaled 39 percent for education, 52 percent for medicine, 48 percent for industry, and 48 percent for government. A full description of the survey procedures and response rates can be found in Appendix A.
2.3 ACCURACY OF SURVEY ESTIMATES

In this report, we present estimates for the U.S. population of microbiological professionals and the organizations that employ them. To provide national estimates from sample data, weighted estimates were used to adjust for the fact that larger employers had a higher probability of selection. This, in turn, results in a sample design effect that must be included, in addition to the sample size, in the calculation of sampling error and the associated 95 percent intervals on estimates. For percentage estimates (e.g., What percentage of government managers have a positive outlook on employment?), the accuracy (at the 95 percent confidence interval) in any one of the four major sectors (education, government, industry, medical) is conservatively approximated as follows:

<table>
<thead>
<tr>
<th>Percentage of about</th>
<th>95% confidence interval (approximate)</th>
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<tr>
<td>1%</td>
<td>±1.0%</td>
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<tr>
<td>5%</td>
<td>±3.0%</td>
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<td>10%</td>
<td>±4.0%</td>
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<tr>
<td>25%</td>
<td>±5.0%</td>
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<tr>
<td>50%</td>
<td>±6.0%</td>
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</table>

The above confidence intervals on sector estimates apply to percentage or proportion measures, and not to quantitative measures (e.g., the average number of employees in an operating unit). Such quantitative measures require more complex accuracy calculations, but the confidence intervals shown above are indicative of the accuracy provided throughout this report.

For more details on the sample weighting and computation of variances, see Appendix B.

2.4 CAVEATS AND LIMITATIONS

As with any survey, there are limitations and cautions that the reader should understand. The limitations on the accuracy of national estimates that result from using a sample rather than a full census were discussed above in Section 2.3. In addition, there are other caveats that should be noted, including coverage of the population, response errors, and non-response bias.

Coverage of the Population

We believe that the survey results represent a broad spectrum of professionals employed in the microbiology professions in the U.S. However, there are several limitations to the coverage of the survey:

- The sample frame consisted of only those organizations that employ at least one ASM member (i.e., firms with no ASM members were not included).
- Non-respondents might be somewhat different in some characteristics. The risk of non-response bias could be of some concern, since the non-response rate was about 50 percent of screener questionnaires and 50 percent of main questionnaires.
- This survey covers microbiology science professionals employed nationally in four major sectors:
  - Education;
  - Clinical-medical;
  - Industrial; and
  - Government.

While these sectors account for 88.4 percent of all ASM’s members, other sectors (such as consultants and others) are not included.
Response Errors

Response errors result when some respondents who answer questions are not able to give a completely accurate answer (for any of a variety of reasons). All responses in this survey are based on the respondent’s (usually department head, manager, or equivalent) best estimate for their operating unit. Respondents were not asked to consult their corporate records. Some answers require a judgment as to the proper category (e.g., “Are you a lab director, or lab supervisor, or research scientist? Do you work in agricultural services or food products manufacturing?”). Other questions require the respondent to estimate (e.g., “Approximately how many employees in your department are ASM members?”). The response to this last question was confirmed to give an estimate to the correct order of magnitude when weighted up to a total ASM membership, but was about 30 percent higher than the known total ASM membership. This should not be of great concern, since department heads can be expected to know the answers to most survey questions, such as how many professionals (with various degree levels or professional specialties) work for them, more accurately than they know “approximately” how many of the same people are currently members of ASM, which might be viewed as an outside professional (versus work), activity. Since the main sample weights depend on the respondent’s estimate of ASM members in the operating unit, the apparent bias of department heads overestimating this number may be of additional concern. As discussed in Appendix B, there is negligible effect on the weights due to any overestimate of ASM members. In fact, the direction of the negligible bias in the weights is that the weights are underestimated. Finally, some questions ask respondents to make judgments on employee motivations (e.g., “What were the reasons that people left your organization?”) and other questions call for predictions of future activities (“number expected to be hired in the next 36 months”). It is reasonable to expect that there is greater response error for such questions than for factual questions where the department head can know the facts.

Non-response Adjustment

While the response rates were about as expected, they are small enough that biased results are plausible, especially if non-respondents are substantially different from respondents in some characteristics. For instance, non-respondents may be department heads of operating units that do not work in the microbiological sciences, who would be classified as ineligible (i.e. outside our scope) had we not known they were not involved in microbiology. Estimated totals can be biased due to an invalid non-response adjustment. Estimated means, and even more so estimated proportions, are less affected by invalid non-response adjustments.

2.5 PRESENTATION OF RESULTS

The remainder of the report presents the detailed findings of the survey. These findings are organized by the four major sectors of employment included in the survey design:

- The education sector;
- The private industry sector;
- The government sector; and
- The clinical-medical sector.

In the interest of brevity, at times these sectors are referred to simply as education, industry, government, and medicine.

Each of the following chapters describes the types of organizations and operating units represented in the sector, the general outlook on employment in the sector, and a detailed assessment of current and future employment by scientific specialization. While the results focus on doctoral level employment, the chapters also contain an assessment of current and future employment of MS/BS level persons in the microbiological sciences.
THE EDUCATION SECTOR

3. CHARACTERISTICS OF EMPLOYERS IN THE EDUCATION SECTOR

As shown in Figure 3.1, most of the departments that employ microbiologists in the education sector are in undergraduate colleges, medical schools, or university graduate schools. Including all categories of employers in the education sector, there are an estimated 3,268 departments that employ microbiologists in educational institutions nationwide. These departments have a median of 35 total employees with a median of 8 employed primarily in the microbiological sciences. Not surprisingly, as Figure 3.2 shows, the primary work of departments in the education sector involves some combination of teaching and/or research.

3.2 GENERAL EMPLOYMENT OUTLOOK FOR DOCTORAL LEVEL PERSONNEL IN THE EDUCATION SECTOR

In terms of doctoral level employment, the education sector is by far the largest of the sectors surveyed, and by several indications the employment outlook for microbiologists in education appears moderately positive. According to the survey, there are an estimated 20,421 doctoral level employees currently employed in the education sector in the microbiological sciences. However, approximately 3,468 of this total are temporary post-doctoral positions, leaving an estimated number of 16,953 faculty or other permanent staff positions. Women represent an estimated 26 percent of all doctoral level employees (including post-doctoral positions) in the education sector, minorities (African Americans, Hispanics, and Native Americans) constitute only 4 percent, and foreign nationals 8 percent. Persons 60 years of age or older represent 8 percent of all doctoral level employees in the education sector, the largest such percentage of the four sectors.

In the next 3 years, the education sector will be hiring an estimated 3,638 doctoral level persons in the microbiological sciences, which represents an average annual growth rate of 5.6 percent. However, 1,972 of these hires (54 percent) are for temporary post-doctoral positions. Nevertheless, the overall amount of doctoral level hiring in the microbiological sciences again is by far the largest of those sectors surveyed. Hiring in education over the next 3 years seems more likely to be driven by retirements and replacements than by sector growth. Only about a third (38 percent) of the department heads surveyed report that the new hiring they will be doing will involve creation of new staff positions, the lowest rate of the four sectors. Nearly as many (36 percent) say such hiring will be required to fill existing positions left vacant by expected retirements.

On the whole, heads of departments surveyed are moderately optimistic with respect to the employment outlook in the education sector over the next 3 years. As Figure 3.3 shows, there are somewhat more department heads who are positive about the employment outlook for their field (44 percent) than negative (36 percent). The remaining respondents (20 percent) are neither positive nor negative with respect to the employment outlook in the education field. The small proportion of departments involved in basic research, diagnostic
services and testing, and healthcare are significantly less positive than the majority of departments involved in either teaching and research or teaching only.

3.3 SPECIALIZATIONS IN THE EDUCATION SECTOR

For doctoral level personnel, the survey gathered detailed information on current employment and future hiring by scientific specialization, with an emphasis on the many specializations that constitute the microbiological sciences. Figure 3.4 shows current employment of doctoral level personnel by specialization. Aside from the general categories of other life sciences and other health sciences, molecular biology stands out as the most frequent specialization of current doctoral level personnel in the education sector. Other specializations with substantial representation (more than 1,000 persons nationwide) include biochemistry and biophysics, infectious disease and pathogenesis, general immunology, cell biology, and general microbiology.
Future hiring by specialization over the next 3 years is shown in Figure 3.5. Molecular biology again stands out with nearly 900 hires expected nationwide, about three times the number of hires of the next most prominent specialization, infectious disease and pathogenesis. Reflecting their prominence in current employment, biochemistry and biophysics, general immunology, and cell biology are among the top specializations identified for future hiring as well. Another way to examine the data, however, is to consider future hiring as a percentage of current levels of employment. In terms of annual percentage growth, environmental microbiology (11.3 percent), industrial microbiology and fermentation (8.9 percent), bioremediation (8.3 percent), molecular biology (7.7 percent), and molecular immunology (7.4 percent) emerge as specializations likely to experience strong growth relative to current levels of employment.

Finally, the survey probed respondents to identify specializations in which they had sought to fill an available position but were unable to find. These hard to find specializations serve as an indicator of where demand in the education sector is strong, relative to the supply of doctoral level personnel, with appropriate qualifications. As Figure 3.6 indicates, genetics is the most prominent of the hard to find specializations in the education sector, followed by medical-clinical virology, infectious disease and pathogenesis, clinical-medical microbiology, molecular biology, and microbial ecology.
The survey asked managers to indicate the scientific and technical skills that are most important to the work done by doctoral level employees in their department or operating unit. As Figure 3.7 shows, managers listed the importance of computer skills, technical abilities in molecular biology and instrumentation, as well as teaching skills. Interestingly, writing and communication skills, particularly grant writing, are high on the list as well.

Future hiring in the education sector for nondoctoral level staff is indicated in Figure 3.9. The survey suggests that over the next 3 years the education sector will hire approximately 1,220 people with an MS or BS in the microbiological sciences, including medical technologists, representing a growth rate of 4.5 percent a year.

### 3.4 IMPORTANT SKILLS IN THE EDUCATION SECTOR

The survey asked managers to indicate the scientific and technical skills that are most important to the work done by doctoral level employees in their department or operating unit. As Figure 3.7 shows, managers listed the importance of computer skills, technical abilities in molecular biology and instrumentation, as well as teaching skills. Interestingly, writing and communication skills, particularly grant writing, are high on the list as well.

### 3.5 MS AND BS LEVEL EMPLOYMENT IN THE EDUCATION SECTOR

Current employment in education for nondoctoral level staff is shown in Figure 3.8. In terms of employment of persons with MS and BS level training in the microbiological sciences, including medical technologists, the education sector currently employs approximately 8,521 people according to the survey. For nondoctoral level staff in the microbiological sciences, the education sector currently employs mostly high school graduates.
HIGHLIGHTS OF KEY ISSUES IN THE EDUCATION SECTOR

The survey asked respondents about their viewpoints on a number of issues identified by earlier focus groups as important to their sector. Well over half (68 percent) of managers in the education sector report that Ph.D. graduates in the microbiological sciences are having a hard time finding full time professional positions: Nearly half (46 percent) of department heads in the education sector believe that, compared to most other degrees in the biological sciences, the MS, BS, or equivalent degree in microbiology is highly valued by employers. About half (48 percent) of the managers in education agree that, overall, universities are doing a good job of training Ph.D.s in the areas of specialization important to industries such as pharmaceutical, biotechnology, and food processing. About 30 percent of department heads in the education sector reported that Ph.D. graduates in the microbiological sciences are having a hard time finding post-doctoral fellowships. Finally, 55 percent of department heads report that an increase in scholarships is needed to encourage minorities to pursue a career in the microbiological sciences.
4. THE INDUSTRIAL SECTOR

4.1 CHARACTERISTICS OF EMPLOYERS IN THE INDUSTRIAL SECTOR

Figure 4.1 shows the wide variety of employers in the industrial sector. Pharmaceutical companies constitute the largest category of employers, followed by biotechnology firms, food products manufacturers, other private industry (research), and laboratory and medical suppliers. Including all categories of employers, there are an estimated 3,630 departments that employ microbiologists in private industry nationwide. These departments have a median of 20 total employees with a median of 6 employed primarily in the microbiological sciences. As Figure 4.2 shows, the work done by departments in the industrial sector primarily revolves around either applied research and development or production and quality control.

Figure 4.1

EMPLOYERS OF MICROBIOLOGISTS IN THE INDUSTRIAL SECTOR

Figure 4.2

PRIMARY WORK OF DEPARTMENTS
IN THE INDUSTRIAL SECTOR

The employment outlook in the industrial sector, which includes pharmaceutical and biotechnology companies, food and medical products manufacturers, and a variety of other companies that employ microbiologists in industry, appears to be quite positive overall. With an estimated 7,090 doctoral level employees in the microbiological sciences currently, it is expected that 1,844 doctoral level microbiologists will be hired in the industrial sector over the next 3 years. Moreover, compared to the other sectors surveyed, managers in the industrial sector are the most positive of all about the general employment outlook in their industry.
GENERAL EMPLOYMENT OUTLOOK FOR DOCTORAL LEVEL PERSONNEL IN THE INDUSTRIAL SECTOR

The industrial sector is the second largest employer of doctoral level microbiologists of the sectors surveyed, and the general employment outlook for microbiologists in industry appears quite positive. According to the survey, there are an estimated 7,090 doctoral level employees currently employed in private industry in the microbiological sciences. Most of these positions appear to be permanent, full time positions, with only 763 (11 percent) of the total representing post-doctoral positions. Women represent an estimated 23 percent of all doctoral level employees in the industrial sector, minorities (African Americans, Hispanics, and Native Americans) make up only 3 percent, and foreign nationals constitute 9 percent. Persons 60 years of age or older represent only about 4 percent of all doctoral level employees in the industrial sector, the smallest such percentage of the four sectors.

In the next 3 years, the industrial sector will be hiring 1,844 doctoral level persons in the microbiological sciences, which represents an average growth rate of 8 percent yearly, the highest of the four sectors. And only 505 of these positions (27 percent) will be temporary post-doctoral positions only, the lowest proportion of the four sectors. Over three quarters (76 percent) of the managers surveyed say that their future doctoral level hiring would involve the creation of new staff positions, by far the highest such indication of new job creation of the four sectors surveyed. In addition, industry managers report the lowest level of hiring due to expected retirements (15 percent), suggesting that, in terms of doctoral level employment in the microbiological sciences, the industrial sector overall can be characterized as young and growing.

Correspondingly, the managers of the operating units surveyed have a bright outlook on employment in the industrial sector over the next 3 years. As Figure 4.3 shows, 57 percent of managers surveyed were somewhat or very positive about the employment outlook in their industry, while only 20 percent of the managers were somewhat or very negative. The remainder (24 percent) were neither positive nor negative with respect to the employment outlook in their industry. Indeed, this is the most optimistic assessment of future employment of the four sectors surveyed. Operating units involved in diagnostic services and testing, environmental testing, and marketing and sales are the most positive about their employment outlook.

![Figure 4.3](image-url)
4.3 SPECIALIZATIONS IN THE INDUSTRIAL SECTOR

Figure 4.4 shows current employment of doctoral level personnel by specialization. As in the education sector, molecular biology is also by far the largest specialization in the industrial sector, with an estimated 1,400 current employees nationwide. Other prominent specializations in industry include biochemistry and biophysics, biotechnology, cell biology, and industrial microbiology and fermentation. However, the range of specializations employed in industry is quite large, as Figure 4.4 demonstrates.

Future hiring by specialization over the next 3 years is shown in Figure 4.5. Molecular biology is the largest specialization, with over 300 hires expected in the industrial sector nationwide in the next 3 years. Other specializations that will be the object of relatively strong future hiring activity are biochemistry and biophysics, industrial microbiology and fermentation, genetics, biotechnology, and general microbiology. Considering future hiring in terms of the yearly growth over current levels of employment, bacterial viruses (34.3 percent), molecular immunology (14.7 percent), and microbial chemistry (14.5 percent) stand out as specializations in which employment opportunities will grow at a very robust rate.
Finally, the survey identified specializations that industrial employers had searched for but were unable to find to fill a job opening at the doctoral level, indicating strong demand relative to the supply of qualified personnel. As Figure 4.6 indicates, antimicrobial chemotherapy, along with infectious diseases and pathogenesis, are the most prominent of these hard to find specializations in the industrial sector. Other hard to find specializations in industry include biotechnology, microbial physiology and metabolism, and clinical-medical microbiology.
**4.4 IMPORTANT SKILLS IN THE INDUSTRIAL SECTOR**

As Figure 4.7 shows, managers in the industrial sector reported that among the most important skills to the work done by doctoral level employees in their department or operating unit are computer skills, instrumentation, molecular biology, communication, and technical writing. Fermentation is high on the list as well.

**4.5 MS AND BS LEVEL EMPLOYMENT IN THE INDUSTRIAL SECTOR**

Figure 4.8 shows current employment of nondoctoral level staff in the industrial sector. The industrial sector is the largest employer of nondoctoral level staff. According to the survey, 12,421 persons are currently employed in the industrial sector with an MS or BS level degree in the microbiological sciences, including medical technologists.

Figure 4.9 shows the future hiring in the industrial sector for nondoctoral level staff. According to the survey, the industrial sector will hire the largest combined number of MS and BS level persons in the microbiological sciences out of the four sectors. Over the next 3 years the industrial sector will hire 2,200 persons at the MS or BS level in the microbiological sciences, including medical technologists, for a projected growth rate of 5.7 percent yearly.

**4.6 HIGHLIGHTS OF KEY ISSUES IN THE INDUSTRIAL SECTOR**

The survey asked respondents about their viewpoints on a number of issues identified by earlier focus groups as important to their sector. Data from the industrial sector show that, overall, the job applicants in the microbiological sciences are well qualified. Only 6 percent of managers say that a shortage of well qualified job applicants at the Ph.D./MD level is harming their company's ability to compete internationally. Only 16 percent of managers report a shortage of qualified job applicants at the MS/BS level. Only 18 percent of managers agreed that most of the well qualified job applicants in the microbiological sciences are foreign nationals. Almost half (49 percent) of the managers in the industrial sector agree that their departments are spending a significant amount of resources training people to become laboratory technologists and/or technicians. In addition, 44 percent of managers say that recent Ph.D.s or MDs in the microbiological sciences are often too specialized to adapt well to the kind of work performed in the industrial sector.
Government is a significant employer of personnel in the microbiological sciences, with an estimated 5,515 total doctoral level jobs nationwide. Most of these jobs are in the federal government, although state and local health departments remain a significant source of employment as well. In the next 3 years, the survey estimates only 828 doctoral level persons will be hired in the government sector nationally. Correspondingly, managers of departments that employ microbiologists in government have a somewhat negative outlook on employment in their sector over the next 3 years.

### 5.1 Characteristics of Employers in the Government Sector

Most of the operating units that employ microbiologists in the government sector are part of a federal government agency, as Figure 5.1 shows. Undoubtedly, this finding reflects the prominent role of the federal government, through such agencies as the National Institutes of Health and the Centers for Disease Control and Prevention, in biomedical research and public health monitoring. The Departments of Agriculture, Health and Human Services, Defense, and the Environmental Protection Agency also depend a great deal on the microbiological sciences. Beyond the federal government, state or local health departments remain a significant source of employment in the government sector as well. Combined, there are an estimated 1,369 departments that employ microbiologists in federal, state, and local government nationwide. These departments have a median of 30 total employees with a median of 10 employed primarily in the microbiological sciences. The primary work of departments in the government sector is quite diverse, as Figure 5.2 demonstrates, with diagnostic services and testing, applied research and development, basic research, and health care all important activities of government operating units that employ microbiologists.

### 5.2 General Employment Outlook for Doctoral Level Personnel in the Government Sector

The general employment outlook for microbiologists in the government sector is not a particularly good one, according to the survey findings. Currently, there are an estimated 5,515 doctoral level employees in the microbiological sciences in the government sector. However, 931 of these are temporary post-doctoral positions, not permanent full time jobs. Women represent 27 percent of all doctoral level microbiologists in government, minorities (African Americans, Hispanics, and Native Americans) only 5 percent, and foreign nationals 8 percent. Persons 60 years of age or older represent about 7 percent of all doctoral level employees in the government sector.

The government sector will be hiring 828 doctoral level persons in the microbiological sciences over the next 3 years, representing an average annual growth rate of 4.8 percent. But fully 545 of these positions (66 percent) will be post-doctoral fellowships only, the highest such proportion of the four sectors. This means that, over the next 3 years, according to the survey, only 283 permanent doctoral level jobs will be filled in the government sector. Of the sectors surveyed, managers in the government sector are most likely (37 percent) to report that the new hiring they will be doing will involve replacing persons expected to retire in the next 3 years, while less than half (46 percent) say that hiring will be the result of the creation of new positions.
The views of managers of operating units in government are similarly discouraging, with only 31 percent of those surveyed expressing somewhat or very positive outlooks on employment over the next 3 years.

In contrast, over 50 percent of government managers are somewhat or very negative about the employment outlook in their field. The remainder are neither positive nor negative with respect to the employment outlook in government. Departments involved in basic research and health care are most negative.

### SPECIALIZATIONS IN THE GOVERNMENT SECTOR

Figure 5.4 shows current employment of doctoral level personnel by specialization in the government sector. Once again, molecular biology is most prominent, with an estimated 627 current employees nationwide. However, a number of other specializations are nearly as prominent in the government sector, including clinical-medical microbiology, infectious disease and pathogenesis, and medical-clinical virology. Other specializations in the top ten are general microbiology, animal viruses, biochemistry and biophysics, veterinary microbiology, environmental microbiology, and molecular immunology.
Future hiring by specialization over the next 3 years is shown in Figure 5.5. Molecular biology is again the largest specialization, but with less than 100 hires in total expected in the next 3 years. Other specializations that ranked near the top of the list of future hiring activity are infectious disease and pathogenesis, animal viruses, medical-clinical virology, and bioremediation. In terms of the yearly growth in hiring relative to current levels of employment, bioremediation (18.2 percent), mycobacteriology (14.2 percent), medical mycology (13.2 percent), and bacterial viruses (13.2 percent) stand out as growth specializations in the government sector. However, it should again be noted that the absolute level of doctoral level hiring in the government sector remains low and that a significant number of these positions are expected to be post-doctoral fellowships only.

Finally, an examination of specializations that government employers unsuccessfully searched for to fill an available job opening provides an indication of specializations in short supply relative to demand. As shown in Figure 5.6, molecular biology stands out as the most frequent of the hard to find specializations in government, followed by medical-clinical virology and then microbial ecology. Aquatic or terrestrial microbiology and bacterial viruses are also fairly prominent hard to find specializations in the government sector.
### 5.4 IMPORTANT SKILLS IN THE GOVERNMENT SECTOR

As Figure 5.7 shows, managers in the government sector reported on scientific and technical skills that are most important to the work done by doctoral level employees in their department or operating unit. The highest ranking skills included computer skills, epidemiology, molecular biology, DNA, and instrumentation.

<table>
<thead>
<tr>
<th>Hard to Find Specializations in the Government Sector in Order of Scarcity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular biology</td>
</tr>
<tr>
<td>Medical/clinical virology</td>
</tr>
<tr>
<td>Microbial ecology</td>
</tr>
<tr>
<td>Aquatic or terrestrial microbiology</td>
</tr>
</tbody>
</table>

### 5.5 MS AND BS LEVEL EMPLOYMENT IN THE GOVERNMENT SECTOR

Current employment in the government sector for nondoctoral level staff is shown in Figure 5.8. In terms of the MS and BS level employment in the microbiological sciences, the government sector currently employs approximately 9,076 people at the MS and BS levels, including medical technologists.

Future hiring in the government sector for nondoctoral level staff is indicated in Figure 5.9. The survey suggests that over the next 3 years the government sector will hire only 775 people with an MS or BS in the microbiological sciences, including medical technologists, representing an average yearly increase of 2.9 percent.

### 5.6 HIGHLIGHTS OF KEY ISSUES IN THE GOVERNMENT SECTOR

The survey asked respondents, particularly federal government agencies, about their viewpoints on a number of issues identified by earlier focus groups as important to their sector. About 3 out of 5 (59 percent) of the managers of departments in Federal Government agencies reported that the administration’s National Performance Review Initiative (NPRI) has prevented them from adding needed staff positions to their department or laboratory. In addition, 54 percent of managers in the Federal Government reported that the NPRI will cause them to cut a number of staff positions from the department.
The employment outlook in the clinical-medical sector is the most negative of those sectors surveyed, reflecting the dramatic changes underway in the health care industry today. There are an estimated 2,264 doctoral level persons employed in the microbiological sciences in the clinical-medical sector currently, making it the smallest employment sector surveyed. Over the next 3 years, only 363 doctoral level persons in the microbiological sciences will be hired in the clinical-medical sector nationwide. Moreover, managers in the clinical-medical sector have the least optimistic outlook on the general employment prospects in their field.

### 6.1 CHARACTERISTICS OF EMPLOYERS IN THE CLINICAL-MEDICAL SECTOR

Private nonprofit hospitals are the institutional homes of the vast majority of departments that employ microbiologists in the clinical-medical sector, as Figure 6.1 highlights. The remainder are employed in various types of government and private hospitals and other health care facilities. Combined, there are an estimated 3,636 departments or operating units that employ microbiologists in the clinical-medical sector nationwide. These departments are the largest on average of those surveyed, with a median size of 50 total employees. However, the median number of persons in these operating units employed primarily in the microbiological sciences is only 9.

As Figure 6.2 shows, the primary work of departments in the clinical-medical sector is almost solely diagnostic services and testing or health care and medicine.
6.2 GENERAL EMPLOYMENT OUTLOOK FOR THE CLINICAL-MEDICAL SECTOR

In terms of employment of doctoral level microbiologists, the clinical-medical sector is the smallest of the sectors surveyed, and the general employment outlook for microbiologists in this sector appears uncertain. There are an estimated 2,264 doctoral level employees currently employed in the clinical-medical sector, with 354 of this total representing post-doctoral positions. Women represent an estimated 47 percent of all doctoral level employees in the clinical-medical sector and minorities (African Americans, Hispanics, and Native Americans) make up 6 percent, making this sector the most diverse in terms of gender, and race ethnicity of those surveyed. Foreign nationals constitute a full 14 percent of the doctoral level microbiologists in the clinical-medical sector, again the largest percentage of the sectors surveyed. Persons 60 years of age or older represent about 6 percent of all doctoral level employees in the clinical-medical sector.

In the next 3 years, the clinical-medical sector will be hiring only 336 doctoral level persons in the microbiological sciences, representing an average annual growth rate of 4.7 percent, the lowest of the four sectors surveyed. It is expected that 186 of these hires (55 percent) will be for temporary post-doctoral positions only. A quarter (25 percent) of managers report that their new hiring will be used to replace anticipated retirements, and less than half (45 percent) say that hiring will be driven by the creation of new staff positions.

According to the managers of the operating units surveyed, the outlook on employment in the clinical-medical sector over the next 3 years is also not very optimistic. As Figure 6.3 shows, only 23 percent of managers surveyed were somewhat or very positive about the employment outlook in the clinical-medical sector, while fully 54 percent of the managers were somewhat or very negative. The remainder (23 percent) were neither positive nor negative with respect to the employment outlook in their sector. This is the least positive assessment of future employment of the four sectors surveyed. The small proportion of operating units involved in research and teaching are somewhat more optimistic than operating units involved in production and quality control, diagnostic services and testing, and health care.

6.3 SPECIALIZATIONS IN THE CLINICAL-MEDICAL SECTOR

The clinical-medical sector is less diverse in terms of the specializations of current doctoral level personnel than the other sectors surveyed, as Figure 6.4 reveals. As expected, clinical-medical microbiology stands out as clearly the most prominent specialization in this sector, with an estimated 855 doctoral level personnel nationwide. Infectious disease and pathogenesis is also a fairly prominent specialization in the clinical-medical sector, followed somewhat distantly by medical-clinical virology, molecular biology, and molecular immunology.

Future hiring of doctoral level personnel in the clinical-medical sector by specialization is shown in Figure 6.5. Interestingly, molecular immunology emerges as the most frequent specialization that will be the object of hiring activity in the next 3 years, followed by clinical-medical microbiology, infectious disease and pathogenesis, and medical-clinical virology. While these results do indicate relatively strong hiring in molecular immunology, in relation to current levels of employment, they also reflect quite weak hiring in the two major specializations in this sector, clinical-medical microbiology and infectious disease and pathogenesis. In terms of the yearly percentage growth over current levels of employment, antibiotics (26.4 percent), molecular immunology (15.0 percent), medical-clinical virology (9.4 percent), and clinical immunology (8.6 percent) stand out as specializations in the clinical-medical sector that will grow at a relatively high rate.
Finally, the survey identified specializations that clinical-medical employers had searched for but were unable to find, to fill a job opening at the doctoral level. Molecular immunology emerges again as the most prominent of these hard to find specializations, as Figure 6.6 shows. Cell biology along with both general and clinical immunology, also appear to be relatively hard to find specializations in the clinical medical sector. These findings suggest that for these specializations potential shortages of qualified personnel may exist, despite an otherwise lackluster employment outlook for the sector overall.
**6.4 IMPORTANT SKILLS IN THE CLINICAL-MEDICAL SECTOR**

As Figure 6.7 shows, managers in the clinical-medical sector reported on the scientific and technical skills that are most important to the work done by doctoral level employees in the department or operating unit. The highest ranking skills included computer skills, instrumentation, molecular biology, medical physiology, and clinical skills. Management and administrative skills are high on the list as well.
6.5 MS AND BS LEVEL EMPLOYMENT IN THE CLINICAL-MEDICAL SECTOR

Figure 6.8 shows current employment of nondoctoral level staff in the clinical-medical sector. The clinical-medical sector has the largest number of medical technologists, employing 28,714 persons with this specialization. Approximately 5,672 persons are employed in the clinical-medical sector with a MS or BS level degree in the microbiological sciences.

Figure 6.9 shows future hiring in the clinical-medical sector for nondoctoral level staff. According to the survey, the clinical-medical sector will hire the largest number (896) of medical technologists out of the four sectors. However, this represents an average annual growth rate of only 1 percent. The clinical-medical sector will hire the least number of persons out of the four sectors with a MS or BS level degree in the microbiological sciences (245), representing an average annual growth rate of 1.3 percent.

6.6 HIGHLIGHTS OF KEY ISSUES IN THE CLINICAL-MEDICAL SECTOR

The survey asked respondents about their viewpoints on a number of issues identified by earlier focus groups as important to their sector. The majority (61 percent) of managers expressed concern that mergers of hospitals and other health care providers have reduced the number of clinical laboratories in their areas. Almost half (48 percent) of managers in the clinical-medical sector report that the trend toward managed health care has reduced the amount of analysis or testing conducted in the laboratory. Finding job applicants with specialized training appears to be difficult for managers in the clinical-medical sector. About half (49 percent) report that it is difficult to find MS, BS, or equivalent job applicants, and 46 percent indicate that their laboratory spends a significant amount of resources training people to become laboratory technologist and/or technicians. Finally, 53 percent of managers believe that new Ph.D.s or MDs in the microbiological sciences are often too specialized to adapt well to the kind of work conducted in their laboratory.

Regarding certification, only 16 percent of department heads agree that certification by the ABMM or ABMLI is an important qualification for doctoral level employees in their department or operating unit. Another 16 percent of department heads agree that certification by the National Registry of Microbiologists is an important qualification for MS/BS level employees in their department or operating unit. Just over 60 percent of department heads in the clinical-medical sector agreed that certification of MS/BS level by other organizations are more important than ASM credentials. Finally, 57 percent of managers agree that their state or other authority requires laboratory directors to be board certified.
APPENDIXES

A. METHODOLOGICAL NOTES ...............32
   A.1 Introduction .......................................32
   A.2 Screener .........................................32
   A.3 Main Questionnaire ............................33
   A.4 Sampling Methodology .........................33

B. CALCULATION OF SURVEY WEIGHTS,
   ESTIMATES, AND SAMPLING ERRORS ..........34
   B.1 Estimates Based on Main Sample ..........34
   B.2 Estimates Based on Screener Sample ....35

C. COMPUTATION OF SURVEY
   WEIGHTS ...........................................36
   C.1 Screener Sample .................................36
   C.2 Screener Weights ...............................36
   C.3 Main Sample ......................................37
   C.4 Main Sample Weight ............................37
   C.5 Caveats ...........................................39
   C.6 Coverage of the Population ................39
   C.7 Response Errors .................................39
   C.8 Non-response Adjustment ....................39

D. SCREENER QUESTIONNAIRE AND
   COVER LETTER ..................................40

E. MAIN QUESTIONNAIRES AND
   COVER LETTERS ..................................41

TABLES

A.1 Screener Response Rates ..................32
A.2 Number of Cases Mailed in each
   Employment Sector ..............................32
A.3 Disposition of Cases Not Mailed ......32
A.4 Main Survey Response Rates ..........33
A.5 Disposition of Cases Not Included
   in the Analysis .................................33

B.1 Design Effect and Effective Sample Size
   by Sector .........................................34
B.2 Standard Error Estimates for Estimated
   Proportions by Sector ..........................35
B.3 Summary of ASM Members by
   Member Type .....................................35

C.1 Summary of ASM Members by Their
   Recorded Type of Organization ..........36
C.2 Screener Responses by Member Type and
   Employer Type ..................................37
C.3 Summary of Main Sample by
   Employer Type ..................................37
A.1  INTRODUCTION

The national study began in late January, 1995 when Westat received a tape containing selected ASM membership list data. Westat randomly selected 4,400 names representing each of the four major sectors of concern (education, clinical microbiology, industry, and government), plus 4,000 additional names from members whose sector of employment was categorized as “Unknown” on the ASM membership list. Therefore, the total initial sample consisted of 8,400 ASM members who were mailed a screener questionnaire.

A.2  SCREENER

As called for in the survey plan, the sampled members were mailed an initial screener questionnaire, which was sent out by first class mail on March 9, 1995. The screener was the first of two stages in the survey and was designed to accomplish the following: (a) to identify the name and type of employer for which the member works, and (b) to ask for contact information on the head or manager of the department or operating unit in which the respondent works.

The rates of response to the screener questionnaire are shown in Table A-1.

By the end of the screener field period (March 9 - April 26), 4,682 screeners were returned. In addition, Westat received back 38 screeners that were non-deliverable. Of the 4,682 screeners returned, 273 could not be used because of either non-employment status or ineligible responses. Each screener respondent was asked to name a contact person in their organization. Because of overlap among the named contact persons or operating unit (437), and the 273 unusable cases, the 4,682 returned screeners resulted in 3,972 main questionnaires that were mailed out to employers of microbiologists. The distribution of the 3,972 eligible cases by the four employment sectors are shown in Table A-2.

There were 748 returned cases out of the 4,720 returned screeners, including the 38 non-deliverables, that were not mailed a main questionnaire. The disposition of these cases are shown in Table A-3.

The ASM members sampled from the ASM membership list (8,400) were mailed an initial screener. A reminder mailing was sent on April 5, 1995 to the 5,699 members of the sample who had not responded to the initial mailing.
Duplicates. Among the responses to the screener survey, “duplicate” does not mean two responses from the same respondent, but two different respondents who identified the same contact person or operating unit within the organization. Westat reviewed the returned screeners to ensure that the sample frame was cleaned and that only one department or operating unit within an organization was selected. A duplicate was deleted if, within the organization, the identical contact person or department or operating unit was identified.

Ineligible. Ineligible cases consisted of either a blank form received or the respondent selected “other” as the employment sector, and it was not able to be recoded into one of the four employment sectors.

A.3 MAIN QUESTIONNAIRE

Because the four sectors of employment are roughly equal in size, it was not necessary to sub-sample according to proportion of size, and each of the 3,972 sample members were mailed a main questionnaire.

Westat began mailing out the main questionnaires on May 8, 1995. Reminder letters and questionnaires were mailed on June 16, 1995. From the 3,972 main questionnaires mailed, Westat received a total of 1,952 questionnaires, 1,849 of which were completed questionnaire responses.

The rates of response to the main survey instruments are presented in Table A-4.

In addition to the 1,849 completed questionnaires received, 103 cases were not used in the analysis. The disposition of these cases is shown in Table A-5.

A.4 SAMPLING METHODOLOGY

The sample of national employers (operating units) of ASM members can be loosely described as a two-stage sample; a screener sample of ASM members, and a main sample of operating units among the sampled ASM members. The screener sample consisted of 8,400 ASM members, drawn randomly from the frame of 29,505 ASM members as of January, 1995. From the screener sample, 3,972 distinct operating units were identified. All 3,972 were included in the main sample. The following appendixes describe the screener sample and main sample in more detail.

Statistics derived from the sample account for the unequal probability of selection of each operating unit sent a main questionnaire. In addition, a non-response adjustment is made for the response rate. Each main questionnaire is assigned a weight; the weight is the product of the inverse probability of selection times the non-response adjustment. The weight can be thought of as the number of operating units each respondent represents. Appendix C describes the computation of weights corresponding to the screener, and main survey sampling, and response described above.
APPENDIX B.

B.1 ESTIMATES BASED ON MAIN SAMPLE

The accuracy of survey estimates is affected by the weights attached to each response. Accuracy consists of two parts: the variability and the bias. For example, the weighted estimated mean for a response \( y_i \) is computed as:

\[
\hat{y} = \frac{\sum w_i y_i}{\sum w_i}
\]

The unweighted mean would likely be biased, since large operating units have a larger probability of being included in the main sample than small operating units. For the weighted estimated mean, provided the weights are reasonable, the bias is negligible.

The variability of survey estimates is usually increased due to the weights, as compared to the variability of an estimate based on a simple random sample. Assuming homogeneity of variance, the variance of a survey estimated mean is estimated by

\[
\text{var} \hat{y} = \frac{\sum w_i^2}{(\sum w_i)^2} \text{var} y.
\]

In the case of a simple random sample (i.e., the weights are all equal), the variance estimate becomes

\[
\text{var} \hat{y}_{s.r.s.} = \frac{1}{n} \text{var} y.
\]

The increase in variability of the survey estimated mean compared to the simple random sample estimate is often expressed as a design effect,

\[
d.e. = \frac{n \times \sum w_i^2}{(\sum w_i)^2}
\]

The sample size divided by the design effect is called the effective sample size. Table B.1 shows the design effect and effective sample size by sectors. The variances of totals and proportions are similarly affected; that is, the variance estimate, as compared to a simple random sample, is multiplicatively increased by the design effect.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Responses</th>
<th>Design effect</th>
<th>Effective sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>423</td>
<td>1.538</td>
<td>275.03</td>
</tr>
<tr>
<td>Government</td>
<td>393</td>
<td>1.198</td>
<td>328.04</td>
</tr>
<tr>
<td>Industry</td>
<td>512</td>
<td>1.356</td>
<td>377.58</td>
</tr>
<tr>
<td>Medical</td>
<td>521</td>
<td>1.277</td>
<td>407.98</td>
</tr>
</tbody>
</table>

The large design effect in the education sector is, in part, due to the fact that a larger proportion of ASM members classified their member type as education, thus the sampling rate among these members was smaller, and the main sample weights for operating units were on average larger and more variable. Thus, while the government sector had the fewest actual number of responding operating units, the education sector has the lowest effective sample size. Nonetheless, the effective sample sizes are large enough that survey estimates can be expected to have reasonable accuracy. The variance of a single response seldom is larger than the square of the mean response; in other words, the coefficient of variation of a single response is usually less than 1. Therefore, the coefficient of variation of a survey estimate will usually be less than 1 divided by the effective sample size. Hence, survey estimates should be accurate to within about 12 percent (plus and minus twice the worst case coefficient of variation) or better.

When the survey estimate is an estimated proportion, the variance estimate simplifies further;

\[
\text{var} \hat{p} = \frac{\sum w_i^2}{(\sum w_i)^2} \hat{p} (1 - \hat{p}).
\]
Table B.2 shows standard error estimates (square root of variance estimates) for some selected estimated proportions.

The worst case coefficient of variation for survey estimated proportions is in the education sector when the estimated proportion is .5; the coefficient of variation is 12 percent (0.0301 / 0.5).

### Table B.2

<table>
<thead>
<tr>
<th>Sector</th>
<th>0.01</th>
<th>0.05</th>
<th>0.1</th>
<th>0.25</th>
<th>0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>0.0060</td>
<td>0.0131</td>
<td>0.0181</td>
<td>0.0261</td>
<td>0.0301</td>
</tr>
<tr>
<td>Government</td>
<td>0.0055</td>
<td>0.0120</td>
<td>0.0166</td>
<td>0.0239</td>
<td>0.0276</td>
</tr>
<tr>
<td>Industry</td>
<td>0.0051</td>
<td>0.0112</td>
<td>0.0154</td>
<td>0.0223</td>
<td>0.0257</td>
</tr>
<tr>
<td>Medical</td>
<td>0.0049</td>
<td>0.0108</td>
<td>0.0149</td>
<td>0.0214</td>
<td>0.0248</td>
</tr>
</tbody>
</table>

### B.2 ESTIMATES BASED ON SCREENER SAMPLE

The proportion of ASM members working nationally in one of the four sectors is estimated using the screener responses to be 88.4 percent. The standard error is .35 percent, hence an approximate 95 percent confidence interval is (87.7%, 89.1%). In this calculation, if member type is either not employed or recorded as working in some other sector, then the member is assumed to be not working nationally in one of the four sectors.

The methodology outlined is applicable to any proportion that can be answered using the screener questionnaire (Cochran, Sampling Techniques, p.107-108). It can also be applied, in addition to binary responses, to tertiary or greater responses. For example, in this instance, we could also estimate the proportion of ASM members employed in other sectors and the proportion of ASM members unemployed.

The proportion is estimated by:

\[ p = \frac{\sum N_j \times p_j}{N} \]

where \( N \) is the total number of ASM members and, \( N_j \), \( p_j \) are listed in Table B-3. The variance of the estimated proportion is estimated by:

\[ \text{var} (p) = \frac{1}{N^2} \sum N_j \times \frac{p_j (1-p_j)}{n_j} \left[ 1 - \frac{n_j}{N_j} \right] \]

### Table B.3

<table>
<thead>
<tr>
<th>Member type</th>
<th># Screener Responses Nationally Employed in one of Four Sectors</th>
<th>Estimated Portion</th>
</tr>
</thead>
<tbody>
<tr>
<td># Screeners</td>
<td># Members</td>
<td>n_j</td>
</tr>
<tr>
<td>Education</td>
<td>3,290</td>
<td>556</td>
</tr>
<tr>
<td>Government</td>
<td>1,597</td>
<td>916</td>
</tr>
<tr>
<td>Industry</td>
<td>2,520</td>
<td>629</td>
</tr>
<tr>
<td>Medical</td>
<td>2,697</td>
<td>622</td>
</tr>
<tr>
<td>Unknown</td>
<td>17,714</td>
<td>1,959</td>
</tr>
<tr>
<td>Other/not employed</td>
<td>1,687</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>29,505</td>
<td>4,682</td>
</tr>
</tbody>
</table>
C.1 SCREENER SAMPLE

The screening sample of ASM members was drawn from the frame of all ASM members as of January, 1995. The frame consisted of 29,505 members who were categorized by the type of organization in which the member was currently employed (member type), as shown in Table C.1. The members were categorized, since the purpose of the study was to survey four employer types (or sectors)-education, government, industry, and medical-and the member type was expected to be related to the employer type. Within each category of member type, a sample of members was drawn.

Many members (17,714 or 60.0%) did not report the type of organization in which they were employed. Since such members may have employers in one of the four sectors, a sample of members with unknown member type was also drawn. Conversely, some members (1,687 or 5.7%) reported they were either unemployed or their employers were of some other sector than one of the four sectors of interest. Thus, none of these members were sampled.

Sample sizes were determined such that the expected number of main questionnaire responses in each of the four sectors would be 500. The sample size computations used pretest results that indicated a 2/3 response rate on the screening questionnaire and a 50 percent response rate on the main questionnaire. The total sample size of ASM members for the screening sample was 8,400; the sample sizes within each category of member type are shown in Table C.1.

Rather than a simple random sample within each category of member type, samples were drawn by a systematic random sample, where the members within a category were sorted by the zip code of their address. Systematic random samples have properties that are similar to simple random samples, they are easier to implement, and they ensure some degree of even distribution of the sample. In this case the screener sample is distributed evenly geographically (because of sorting by zip code).

Of the 8,400 screener questionnaires sent, 4,720 were returned. The 38 screener questionnaires returned by the post office as non-deliverable (not returned by the ASM member), were not considered responses. Thus, there were 4,682 responses; the number of responses within each category of member type are shown in Table C.1.

C.2 SCREENER WEIGHTS

The screener weight is the product of the inverse probability of selection in the screener sample times the non-response adjustment in the screener sample. The screener weight is the number of ASM members each screener respondent represents.

The probability of selection of the $i$th ASM member in the screener sample depends on the member type of the $i$th ASM member, and is the ratio of the number of screeners to the number of members by member type;

$$\text{pr}_{\text{screen}} = \frac{850}{3,290} \text{ if member type = education}$$
$$\frac{1,400}{1,597} \text{ government}$$
$$\frac{1,100}{2,520} \text{ industry}$$
$$\frac{1,050}{2,697} \text{ medical}$$
$$\frac{4,000}{17,714} \text{ unknown}$$

Since not all ASM members selected in the screener sample responded, a non-response adjustment is necessary. The non-response adjustment described herein is valid under the assumption that the screener respondents within a category of member type are simply a random sample of the screener sample within a category of member type. This is a major assumption, and not likely to be completely true. For instance, unemployed ASM members may be less likely to respond. An invalid non-response adjustment can introduce some bias to results. Provided the response rate is high, the bias is negligible. The overall screener response rate is 56 percent (4682/8400). Thus appreciable bias is plausible. Although, there appears no reason to believe that the response rate is appreciably different for any particular characterization of ASM members. Therefore, while appreciable bias is plausible, there is no reason to believe that the bias is not negligible.
The non-response adjustment is based only on information known about respondents and non-respondents. Specifically, the response rate is allowed to vary according to the member type of the ASM member. The screener non-response adjustment for the $i$th ASM member is defined as the ratio of the number of screeners to the number of responses by member type;

$$\text{nr}_{\text{screen}}_i = \frac{850}{556} \text{ if member type= education}$$

$$\frac{1400}{916} \text{ government}$$

$$\frac{1100}{629} \text{ industry}$$

$$\frac{1050}{622} \text{ medical}$$

$$\frac{4000}{1959} \text{ unknown}$$

Alternative non-response adjustments could be defined using external sources of information or expert opinion to infer differences between respondents and non-respondents. Nevertheless, the non-response adjustment defined herein is simple and probably adequate.

The screener weight is then the inverse probability of screener selection times the screener non-response adjustment:

$$\text{wt}_{\text{screen}}_i = \left(\frac{1}{\text{pr}_{\text{screen}}_i}\right) \times \text{nr}_{\text{screen}}_i.$$ 

### C.3 MAIN SAMPLE

The 4,682 screener responses were categorized by the member type (recorded on ASM list) and by employer type (reported on screener questionnaire), and are shown in Table C.2. For 273 screener respondents, the employer type was categorized as other (the respondent was either unemployed, worked in some other sector, or worked internationally). These respondents did not identify operating units eligible for the main questionnaire, hence these respondents were deemed ineligible.

Further, among the remaining 4,409 screener responses, many operating units were identified multiple times. After deleting 437 duplicates, there remained 3,972 distinct operating units identified from the screener sample. All 3,972 operating units make up the main sample; they are a sample from among all national employers in one of the four sectors that employ at least one ASM member.

There were 1,849 responses to the main questionnaire. The main sample and responses by employer type are shown in Table C.3.

### C.4 MAIN SAMPLE WEIGHT

Each of the 3,972 operating units had some probability of selection from among all national employers in one of the four sectors that employ at least one ASM member. This probability is not known directly; instead it must be estimated. Combined with a non-response adjustment to account for the fact that not all operating units sent the main questionnaire responded, a weight can be defined for each responding operating unit. The weight is the number of operating units each respondent represents.

A particular operating unit is identified by selecting and getting a response to the screening questionnaire of any ASM member that works in the given operating unit. Thus, the probability that a particular operating unit is not in the identified is equal to the probability no ASM member in the operating unit responds to the screener. If all ASM members have the same probability of screener selection and response, say $p$, and the number of ASM members in the operating unit $i$ is $\text{ASM}_i$, then the probability can be expressed:

$$\text{Pr}\{\text{operating unit } i \text{ is identified}\} = 1 - (1 - p)^{\text{ASM}_i}.$$
Unfortunately, all ASM members do not have the same probability of screener selection and response, this probability depends on the member type. Thus,

\[
\Pr(\text{operating unit } i \text{ is identified}) = 1 - \prod_{j} (1 - p_{ij})^{\text{ASM}_{j}},
\]

where \(p_{ij}\) is the probability of screener selection and response for an ASM member of member type \(j\) (inverse screener weight) and \(\text{ASM}_{j}\) is the number of ASM members in operating unit \(i\) of member type \(j\). The number of ASM members in operating unit \(i\), \(\text{ASM}_{i}\), is reported on the main questionnaire; although the number of ASM members in an operating unit \(i\) of member type \(j\) is not reported, hence must be estimated.

An estimate of the number of ASM members in the \(i\)th operating unit (which is of employer type \(k\)) and of member type \(j\) is:

\[
\text{ASM}_{ij} = \text{ASM}_{i} \times a_{jk},
\]

where \(a_{jk}\) is the estimated proportion of ASM members of member type \(j\) and employer type \(k\) among ASM members of member type \(j\). An estimate of \(a_{jk}\) is:

\[
a_{jk} = \frac{\text{wt}_{\text{screen}}_{i} \times n_{jk}}{\sum_{i} \text{wt}_{\text{screen}}_{i} \times n_{ij}},
\]

where \(n_{jk}\) is the number of screener respondents of member type \(j\) and employer type \(k\) (see Table C-2).

Thus, the estimated probability of identifying the \(i\)th operating unit (which is of employer type \(k\)) is then estimated by:

\[
\text{pr}_{\text{iden}}_{ik} = 1 - \prod_{j} (1 - \frac{1}{\text{wt}_{\text{screen}}_{i}})^{\text{ASM}_{j} \times a_{jk}}.
\]

This estimated probability depends on the main questionnaire response \(\text{ASM}_{i}\) and on the estimate \(a_{jk}\). Thus, the main sample weights are estimates and could potentially be improved. First, \(\text{ASM}_{i}\) is the respondent’s guess at the number of ASM members in the operating unit. If the guess tends to be an overestimate, the estimated probability is also overestimated, hence the main sample weight is underestimated. Nonetheless, a large overestimate of ASM has a small effect on the weight. Second, the estimate \(a_{jk}\) has little impact on the weight, since the screening weights are not that different from each other (range 1.7 to 9.0), and the sum of \(a_{jk}\) over \(j\) is necessarily equal to 1.

In a few respondents the main questionnaire response for \(\text{ASM}_{i}\) was missing; in these instances value was imputed. The imputed value was the average number of ASM members in an operating unit unless this imputed value could be improved by knowledge of the number of employees or employees working in the microbiological sciences.

The screener responses identified a total of 3,972 operating units. The screener response rate had originally been anticipated to be higher (66% anticipated v. 56% observed); hence a greater number of operating units would have been identified, and a subsample of identified operating units would constitute the main sample. Instead, all 3,972 operating units were sent the main questionnaire. Therefore, the probability of selection of the operating unit \(i\) (of employer type \(k\)) is equal to the probability of identifying the operating unit \(i\) (of employer type \(k\)):

\[
\text{pr}_{\text{main}}_{ik} = \text{pr}_{\text{iden}}_{ik}.
\]

Similar to the screener non-response adjustment, a main non-response adjustment is defined:

\[
\text{nr}_{\text{main}}_{k} = 1073/421 \quad \text{if employer type} = \text{education}
\]
\[
823/400 \quad \text{government}
\]
\[
1076/514 \quad \text{industry}
\]
\[
1000/523 \quad \text{medical}
\]

The non-response adjustment could be further refined, as discussed earlier, for the screener non-response adjustment. Additionally, information from the screener questionnaire could be used. For instance, screener respondents who indicate themselves as the contact for the main questionnaire may be more likely to respond to the main questionnaire (this was seen to be true in the pretest). Also, in the screener questionnaire the ineligibles and duplicates were considered responses, since the sampling frame was ASM members. In the main questionnaire the ineligibles and duplicates were considered non-responses, since the sampling frame is national employers in one of the four sectors. Since there were very few main questionnaire ineligibles and duplicates (45 and 13 respectively), refining the non-response adjustment to account for ineligibles and duplicates differently would have very little effect on the weights.

The main weight may or may not be improved by slight refinements in the non-response adjustments; using information not available for the screener non-response adjustment may be detrimental, possible decreases in bias of results can be offset by increases in the variances of results, or there may be other considerations. The overall main questionnaire response rate was 47 percent (1858/3972), close to the expected response rate of 50 percent, although small enough that appreciable bias in results is plausible.
Then, similar to the screener weight, the main sample weight is the inverse probability of selection times the non-response adjustment:

\[ wt_{\text{main}}_{ik} = \left( \frac{1}{pr_{\text{main}}_{ik}} \right) \times nr_{\text{main}}_{k}. \]

The main sample weight is the number of operating units each respondent represents.

**C.5 CAVEATS**

As with any survey, there are limitations and cautions that the reader should understand. The limitations on the accuracy of national estimates that result from using a sample rather than a full census were discussed above in Section 1.1 of the main report. In addition, there are other caveats that should be noted.

**C.6 COVERAGE OF THE POPULATION**

We believe that the survey results represent a broad spectrum of professionals employed in the microbiology professions in the U.S. However the following limitations are noted:

- The sample frame consisted of only those organizations that employ at least one ASM member (i.e., firms with no ASM members were not included).

- Non-respondents might be somewhat different in some characteristics. The risk of non-response bias could be of some concern, since the non-response rate was about 50 percent of screener questionnaires and 50 percent of main questionnaires.

- This survey covers microbiology science professionals employed nationally in only four major sectors:
  - Education;
  - Clinical-medical;
  - Industrial; and
  - Government.

While these sectors account for 88.4 percent of all ASM’s members, other sectors (such as consultants and others) are not included.

**C.7 RESPONSE ERRORS**

Response errors result when some respondents who answer questions are not able to give a completely accurate answer (for any of a variety of reasons). All responses in this survey are based on the respondent’s (usually department head, manager, or equivalent) best estimate for their operating unit. Respondents were not asked to consult their corporate records. Some answers require a judgment as to the proper category (e.g., “Are you a lab director, or lab supervisor, or research scientist? Do you work in agricultural services or food products manufacturing?”). Other questions require the respondent to estimate (e.g., “Approximately how many employees in your department are ASM members?”). The response to this last question was confirmed to give an estimate to the correct order of magnitude when weighted up to a total ASM membership, but was about 30 percent higher than the known total ASM membership. This discrepancy should not be of great concern, since department heads can be expected to know the answers to most survey questions, such as how many professionals (with various degree levels or professional specialties) work for them, more accurately than they know “approximately” how many of the same people are currently members of ASM, which might be viewed as an outside professional, versus work, activity. Since the main sample weights depend on the respondent’s estimate of ASM members in the operating unit, the apparent bias of department heads overestimating this number may be of additional concern. As discussed in Appendix A, there is negligible effect on the weights due to any overestimate of ASM members. In fact, the direction of the negligible bias in the weights is that the weights are underestimated.

Finally, some questions ask respondents to make judgments on employee motivations (e.g., “What were the reasons that people left your organization?”), and other questions call for predictions of future activities (“number expected to be hired in the next 36 months”). It is reasonable to expect that there is greater “response error” for such questions than for factual questions where the department head can know the facts.

**C.8 NON-RESPONSE ADJUSTMENT**

While the response rates were about as expected, they are small enough that biased results are plausible, especially if non-respondents are substantially different from respondents in some characteristics. For instance, non-respondents may be department heads of operating units that do no work in the microbiological sciences, who would be classified as ineligible (i.e. outside our scope) had we known they were not involved in microbiology. Estimated totals can be biased due to an invalid non-response adjustment. Estimated means, and even more so estimated proportions, are less affected by invalid non-response adjustments.
AMERICAN SOCIETY for MICROBIOLOGY

March 3, 1995

Dr. Edward Smith
123 Main Street
Anytown, USA 12345

Dear Dr. Smith:

The science and profession of microbiology is experiencing rapid change as a result of technological innovation, international competition, restructuring of the U.S. health care system, and changes in federal funding. The impact of these changes on the need for persons with specialized training in the microbiological sciences is unknown. At the same time, federal policy makers increasingly demand more accurate information to establish funding priorities for research and training in the life sciences.

As an ASM member, you can help us by taking a few minutes to answer the five questions on the enclosed questionnaire and returning it to us postage-free. The information you provide will remain confidential and will help ASM conduct a national survey of managers that will assess employment and training issues in the microbiological sciences. Results from the survey will be used to inform U.S. science policy makers and provide a valuable service to ASM members.

Please mail your survey in the pre-paid envelope to the ASM Survey processing center by March 17 so that Westat, our survey contractor, can begin processing. If you have any questions, please feel free to call 1-800-434-6347. We very much appreciate your cooperation with this important effort.

Sincerely,

David Schlesinger, Ph.D.
President, American Society for Microbiology

Kenneth J. Berra, M.D., Ph.D.
Chair, Public and Scientific Affairs Board, ASM

Cover Letter

American Society for Microbiology

AMERICAN SOCIETY for MICROBIOLOGY

BRIEF QUESTIONNAIRE

Q.1 Please provide the following information on your employer.
   □ Check here if you are not currently employed. (Thank you for your cooperation. You need not answer any more questions, but please return this form in the postage-free envelope.)
   a. Name of primary employer:
   b. Name of the department or operating unit in which you work:

Q.2 How would you describe your primary employer? (Check one box)
   □ 1 Clinical/medical laboratory, hospital, or other medical facility
   □ 2 University, professional school, college, or other educational institution
   □ 3 Private industry (pharmaceuticals, biotechnology, food, or other industry)
   □ 4 Federal, state, or local government agency
   □ 5 Other (Specify)

Q.3 About how many people are employed in your department or operating unit? (Your best guess)
   □□□□□ Number of persons employed in your department or operating unit

Q.4 Approximately, how many of those employees are employed in the microbiological sciences?
   □□□□□ Number of employees employed in the microbiological sciences

Q.5 Please provide the name of the person in your department or operating unit who would be able to respond to a national survey on staffing and training issues in the microbiological sciences. (Note: This could be you, your department head, or someone else in your department or operating unit.)
   Name of head person: (Dr. / M.D. / Ph.D.)
   Title:
   Business Address:
   City: State: Zip:
   Telephone Number: ( ) Extension:
   The ASM thanks you very much for your cooperation! Please return this brief questionnaire in the postage-free envelope.
May 5, 1995

Dr. Edward Smith
123 Main Street
Anytown, USA 12345

Dear Dr. Smith:

As an employee, educational institutions like yours depend on a skilled workforce with specialized training in the microbiological sciences. However, little is known about the number of such persons needed nationwide and the specialized training they should be receiving, particularly at the doctorate level. At the same time, federal policy makers increasingly demand more accurate information to establish funding priorities for research and training in the life sciences.

As a representative of a unit in your organization that employs persons with specialized training in the microbiological sciences, you can help us by completing the enclosed questionnaire and returning it to us postage-free. The information you provide on this questionnaire will be compiled with other responses, so the answers you give are totally anonymous. Results of the survey will be published by the American Society for Microbiology as a public service. We will gladly send you a copy of these results as soon as they are available.

If you have any questions, please feel free to call 1-800-434-6347. We very much appreciate your cooperation with this important effort.

Sincerely,

David Scheltinga, Ph.D.
President, American Society for Microbiology

Kenneth L. Beres, M.D.
Chair, Public and Scientific Affairs Board, ASM

INSTRUCTIONS:
- Answer each question as indicated:
- Check the appropriate answer box:
- Circled the appropriate answer code: 04
- Enter a number:
- Answer each question for persons of only. Do not include temporary or retired staff.
- The may consult with the appropriate individuals in your organization if you are unable to provide responses to certain questions.

Q.1 Check the category that best describes your organization. (Check one box.)
Graduate department of university, .................................................. 01
Undergraduate college, .................................................................. 02
Medical school, ............................................................................. 03
Dental school, ............................................................................... 04
Veterinary school, ......................................................................... 05
Other professional school, ............................................................. 06
Junior or community college, ......................................................... 07
Other educational institution? ......................................................... 08

Q.2 From your perspective, which of the following best describes the general employment outlook for your field or industry over the next three years:
Very positive, ........................................................ 01
Slightly positive, ........................................................... 02
Neither positive nor negative, .................................................. 03
Slightly negative, ............................................................. 04
Very negative, ................................................................. 05

Q.3 Approximately how many employees does your entire organization or institution have in the U.S.?
(Your best guess.)


Number of employees in the U.S

Q.4 How many of the employees in Q.3 are employed in your department or operating unit? (For small organizations, the number as in Q.3 may be appropriate.)


Number of employees in department/operating unit

Q.5 Approximately, how many of these employees are employed in the microbiological sciences?


Number of employees employed in the microbiological sciences
**Education Questionnaire continued**

Q. 6 About how many departments or operating units are there in your organization or institution that conduct work related to basic, clinical, or applied microbiology (include your department, if appropriate)?

| _______ | Number of microbiology-related departments/operating units |

Q. 7 Which of the following best describes the primary work of your department or operating unit?

<table>
<thead>
<tr>
<th>Option</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching</td>
<td>01</td>
</tr>
<tr>
<td>Research and Teaching</td>
<td>02</td>
</tr>
<tr>
<td>Basic Research</td>
<td>03</td>
</tr>
<tr>
<td>Applied Research / R &amp; D</td>
<td>04</td>
</tr>
<tr>
<td>Production / Quality Control</td>
<td>05</td>
</tr>
<tr>
<td>Diagnostic Services / Testing</td>
<td>06</td>
</tr>
<tr>
<td>Health Care / Medicine</td>
<td>07</td>
</tr>
<tr>
<td>Marketing / Sales, or</td>
<td>08</td>
</tr>
<tr>
<td>Other? (Specify)</td>
<td>09</td>
</tr>
</tbody>
</table>

Q. 8 Approximately, how many employees in your department or operating unit are ASM members?

| _______ | Employees in department or operating unit that are ASM members |

Q. 9 Which of the following best describes your current position in the department or operating unit where you work?

<table>
<thead>
<tr>
<th>Option</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrator or manager</td>
<td>1</td>
</tr>
<tr>
<td>Laboratory director</td>
<td>2</td>
</tr>
<tr>
<td>Laboratory supervisor</td>
<td>3</td>
</tr>
<tr>
<td>Research scientist</td>
<td>4</td>
</tr>
<tr>
<td>Department chair</td>
<td>5</td>
</tr>
<tr>
<td>Professor (full, associate, or assistant professor)</td>
<td>6</td>
</tr>
<tr>
<td>Other? (Specify)</td>
<td>7</td>
</tr>
</tbody>
</table>

Q. 10 Which of the following best describes your highest level of education?

<table>
<thead>
<tr>
<th>Option</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.S., M.S. or equivalent</td>
<td>1</td>
</tr>
<tr>
<td>M.D., Ph.D.</td>
<td>2</td>
</tr>
<tr>
<td>M.S., Ph.D. or equivalent</td>
<td>3</td>
</tr>
<tr>
<td>Other? (Specify)</td>
<td>4</td>
</tr>
</tbody>
</table>

Q. 11 Using the list of codes on Page 3, what specialization best describes your current area of scientific activity?

| _______ | |

**Complete Q. 12, Q. 13, and Q. 14 for doctoral-level employees in your department/operating unit. List each staff member only once. Not all these specializations may apply to your organization.**

<table>
<thead>
<tr>
<th>Code</th>
<th>Specialization</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>General microbiology</td>
</tr>
<tr>
<td>02</td>
<td>Flow cytometry</td>
</tr>
<tr>
<td>03</td>
<td>Molecular biology</td>
</tr>
<tr>
<td>04</td>
<td>Genetics</td>
</tr>
<tr>
<td>05</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>06</td>
<td>General biology</td>
</tr>
<tr>
<td>07</td>
<td>Other specializations</td>
</tr>
</tbody>
</table>
Q.15 How many of the doctorate-level persons represented in your answer to Q.12 on page 3 fall into each of the following categories? (Enter 0 if none.)

1. Postdoctoral fellows
2. Women
3. Blacks, Hispanics, or Native Americans
4. Foreign nationals
5. 60 years of age or older

Check here if there are no doctorate-level activities currently on staff.

Q.18 If you entered a number(s) in Q.13 on page 3, which of the following best describes the new thing you will be doing?

Yes  No
a. Replacement of people who have already left
b. Replacement of people expected to retire or otherwise leave in next 24 months
c. Addition of new positions to the staff

Do not expect to hire doctorate-level staff

In the next 24 months

Q.17 How many of the doctorate-level persons represented in your answer to Q.13 on page 3 do you expect to be postdoctoral fellows? (Enter 0 if none.)

1. Postdoctoral fellows

Do not expect to hire doctorate-level staff in the next 24 months

Q.19 If you entered a number(s) in Q.14 on page 3, which of the following best describes why the person(s) left?

Yes  No
a. Retirement
b. Illness or death
c. Layoff
d. Transferred within organization
e. Too much stress or work (not laid off)
f. Terminated

Check here if there are no doctorate-level staff who have left in the past 24 months.

Q.20 Using the numbers in the column labeled "Code" on page 3, circle any specializations in the column labeled "specialization" that you have searched for but were unable to find for a doctorate-level job opening in your department/operating unit in the past 24 months.

Q.21 Please list the scientific and technical skills (such as computer skills or instrumentation) that are most important to the work done by doctorate-level employees in your department/operating unit.

Q.22 In terms of the needs of your department/operating unit for doctorate-level people trained in the microbiological sciences (see item on page 3), which statement best describes your recent experience? (Check one box.)

There are many well-qualified applicants for our job openings.

There are many well-qualified applicants, but few with the specific qualifications we need.

There are very few well-qualified applicants for our job openings, or...

Other? (Specify)

The next question is about non-doctoral employees in your department or operating unit.

Q.23 For each degree/area of specialization, complete columns (a) through (c) for non-doctoral employees in your department or operating unit.

(a) Number currently on staff
(b) Number expected to be hired in the next 24 months
(c) Number who left in the past 24 months

LIST EACH STAFF MEMBER ONLY ONCE

1. BS microbiological sciences
2. BS other sciences
3. MD
4. Medical technology
5. Associate degree
6. High school graduate
7. Other (Specify)
As a representative of your department/operating unit, indicate the extent to which you agree or disagree with each of the following statements.

<table>
<thead>
<tr>
<th>Question</th>
<th>Agree strongly</th>
<th>Agree</th>
<th>Neither agree nor disagree</th>
<th>Disagree</th>
<th>Disagree strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q.26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Q.27</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Q.28</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Q.29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Is there anything else that you would like to tell us about the employment outlook for the microbiological sciences, or any other comments you wish to make? If so, please use this space for that purpose.

Your contribution to this effort is very greatly appreciated. If you would like a summary of the results, please print your name and address on the back of the return envelope (NOT this questionnaire). We will see that you get it. If you have any questions, please call 1-800-434-6347.

Return to:
ASME Survey
Westat, Inc.
1660 Research Blvd.
Rockville, MD 20850-3139
Industrial Cover Letter

AMERICAN SOCIETY FOR MICROBIOLOGY

Public and Scientific Affairs Board
1925 Massachusetts Ave., N.W.
Washington, D.C. 20036-4111
Phone: (202) 221-7270
Fax: (202) 962-9033

May 5, 1995

Dr. Edward Smith
123 Main Street
Anytown, USA 22345

Dear Dr. Smith:

Companies like yours depend on a skilled workforce with specialized training in the microbiological sciences. However, little is known about the number of such persons needed nationwide and the specialized training they should be receiving, particularly at the doctoral level. At the same time, federal policy makers increasingly demand more accurate information to establish funding priorities for research and training in the life sciences.

As a representative of a unit in your organization that employs persons with specialized training in the microbiological sciences, you can help us by completing the enclosed questionnaire and returning it to us postage-free. The information you provide on this questionnaire will be compiled with other responses, so the answers you give are anonymous. Results of the survey will be published by the American Society for Microbiology as a public service. We will gladly send you a copy of these results as soon as they are available.

If you have any questions, please feel free to call 1-800-434-0347. We very much appreciate your cooperation with this important effort.

Sincerely,

David Schlessinger, Ph.D.
President, American Society for Microbiology

Kenneth J. Beren, M.D.,
Chief, Public and Scientific Affairs Board, ASM

Industrial Questionnaire

INSTRUCTIONS:

Answer each question as indicated:

Check the appropriate answer box:□

Check the appropriate answer code:

Enter a number:

Answer each question for permanent staff only. Do not include temporary or visiting staff.

You may consult with the appropriate individuals in your organization if you are unable to provide responses in certain questions.

Q.1 Check the category that best describes your organization. (Check one box.)

Agricultural or veterinary services, □

Food products manufacturing, □

Pharmaceutical preparations, □

Biotechnology preparations, □

Chemical preparations, □

Toilet preparations or cosmetics, □

Water management or bioremediation, □

Laboratory and medical instruments and supplies, □

Other private industry, (Specify) □

Nonprofit research organization, or □

Contract research organization, □

Q.2 From your perspective, which of the following best describes the general employment outlook for your field or industry over the next three years:

Very positive, □

Somewhat positive, □

Neither positive nor negative, □

Somewhat negative, □

Very negative, □

Q.3 Approximately how many employees does your entire organization or institution have in the US? (Your best guess.)

Number of employees in the US

Q.4 How many of the employees in Q.3 are employed in your department or operating unit? (For small organizations, the same number as in Q.3 may be appropriate.)

Number of employees in department/operating unit

Q.5 Approximately, how many of these employees are employed in the microbiological sciences?

Number of employees employed in the microbiological sciences
Industrial Questionnaire continued

Complete Q.12, Q.13, and Q.14 for doctoral-level employees in your department/operating unit. LIST EACH STAFF MEMBER ONLY ONCE. If more than one specialization applies to a staff member, assign the specialization most important to the staff member's current job. Not all of these specializations may apply to your organization. We have grouped similar items together.

Q.6 About how many departments or operating units are there in your organization or institution that conduct work related to basic, clinical, or applied microbiology (include your department, if appropriate)?
   ________ Number of microbiology-related departments/operating units

Q.7 Which of the following best describes the primary work of your department or operating unit?
   (Check one box.)
   Basic Research: ____________________________ 01
   Applied Research / R & D: ____________________ 02
   Production / Quality Control: __________________ 03
   Diagnostic Services / Testing: ________________ 04
   Environmental Testing: ________________________ 05
   Health Care / Medicine: _______________________ 06
   Marketing / Sales, or other: ____________________ 07
   Other: (Specify) ______________________________ 08

Q.8 Approximately, how many members in your department/operating unit are ASM members?
   (Include yourself, if appropriate - your best guess.)
   ________ Employees in department/operating unit that are ASM members

Q.9 Which of the following best describes your current position in the department/operating unit where you work?
   Administrator or manager: _____________________ 01
   Laboratory director: __________________________ 02
   Laboratory supervisor: _________________________ 03
   Research scientist, or other: ____________________ 04
   Other: (Specify) ________________________________ 05

Q.10 Which of the following best describes your highest level of education?
   PhD, MD, or equivalent: ________________________ 01
   MS / M.S.: _________________________________ 02
   MT (ASCP), CLS (NCA) or equivalent, or other: 03
   Other: (Specify) ________________________________ 04

Q.11 Using the list of codes on Page 3, what specialization best describes your current area of scientific activity?
   ________

AMERICAN SOCIETY for MICROBIOLOGY Page 2
Q.16 How many of the doctoral-level persons represented in your answer to Q.13 on page 3 fall into each of the following categories? (Enter 0 if none.)

1. Postdoctoral fellows.................................................. 1 2
   2. Women........................................................................ 1 2
   3. Blacks, Hispanics, or Native Americans........................ 1 2
   4. Foreign nationals (include permanent U.S. residents and U.S. citizens)................................................. 1 2
   5. 60 years of age or older............................................... 1 2

   Check here if there are no doctoral-level scientists currently in staff........................................... 90

Q.17 If you entered a number(s) in Q.13 on page 3, which of the following best describes the new hiring you will be doing?  

   a. Replacement of people who have already left.............. 1 2
   b. Replacement of people expected to retire or otherwise leave in next 36 months.......................... 1 2
   c. Addition of new positions to the staff........................ 1 2
   d. Do not expect to hire doctoral-level staff in the next 36 months.................................................. 90

Q.18 If you entered a number(s) in Q.14 on page 3, which of the following best describes why the person(s) left?  

   a. Retirement..................................................................... 1 2
   b. Illness or death.............................................................. 1 2
   c. Layoff........................................................................... 1 2
   d. Transferred within organization...................................... 1 2
   e. Accepted a position elsewhere but will return.............. 1 2
   f. Terminated..................................................................... 1 2

   Check here if there are no doctoral-level staff who have left in the past 24 months.......................... 90

Q.19 If you put a check in any of the boxes numbered 1 through 6 in the previous question (Q.18), which of the following best describes your department/operating unit's response?  

   a. We have already replaced the person(s)......................... 1 2
   b. We have not replaced the person(s) but expect to........... 1 2
   c. We have not replaced the person(s) and do not expect to.. 1 2

Q.20 Using the numbers in the columns labeled 'Code' on page 3, circle any specializations in the column labeled 'Specialization' that you have searched for but were unable to find for a doctoral-level job opening in your department/operating unit in the past 24 months.

Q.21 Please list the scientific and technical skills (such as computer skills or instrumentation) that are most important to the work done by doctoral-level employees in your department/operating unit.

   1. ..................................................................................  
   2. ..................................................................................  
   3. ..................................................................................  

Q.22 In terms of the needs of your department/operating unit for doctoral-level people trained in the microbiological sciences (see list on page 3), which statement best describes your recent experience? (Check one box.)

   There are many well-qualified applicants for our job openings.............................................................. 1
   There are many well-qualified applicants, but few with the specific qualifications we need.......................... 2
   There are very few well-qualified applicants for our job openings, or ................................................................ 3
   Other (Specify)........................................................................ 4

   The next question is about non-doctoral employees in your department or operating unit.

Q.23 For each degree/area of specialization, complete columns (a) through (c) for non-doctoral employees in your department or operating unit.

<table>
<thead>
<tr>
<th>(a) Number of staff currently</th>
<th>(b) Number of staff to work on staff</th>
<th>(c) Number of staff to be hired in the next 24 months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

LIST EACH STAFF MEMBER ONLY ONCE

1. MS microbiological science
2. MS other science
3. BS microbiological science
4. BS other science
5. Medical technology
6. Associate degree
7. High school graduate
8. Other (Specify)
As a representative of your department/operating unit, indicate the extent to which you agree or disagree with each of the following statements.

<table>
<thead>
<tr>
<th>Question</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.24 A shortage of job applicants well qualified in the microbiological sciences at the PhD/MD level is harming our company's ability to compete internationally.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q.25 A shortage of job applicants well qualified in the microbiological sciences at the MS/BS level is harming our company's ability to compete internationally.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Q.26 My company has transferred jobs in the microbiological sciences to other countries because of a shortage of qualified labor in the US.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Q.27 Most of the well qualified job applicants we see for positions in the microbiological sciences are foreign nationals.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Q.28 Recent PhDs or MDs trained in the US have the knowledge and skills needed to translate laboratory discoveries into industrial processes and products.</td>
<td></td>
<td></td>
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<tr>
<td>Q.29 My department/laboratory spends a significant amount of resources training people to become laboratory technologists/technicians.</td>
<td></td>
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</tr>
<tr>
<td>Q.30 It is difficult to find MS, BS or equivalent level job applicants with specialized training in microbiology.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Q.31 Recent PhDs or MDs in the microbiological sciences are often too specialized to adapt well to the kind of work we do in our industry.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Q.32 Overall, universities are doing a good job of training PhDs and MDs in the areas of specialization important to our industry.</td>
<td></td>
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</tr>
<tr>
<td>Q.33 We are concerned about a shortage of PhDs with expertise in fermentation and microbial physiology to meet our needs.</td>
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<td></td>
</tr>
</tbody>
</table>
Government Cover Letter

AMERICAN SOCIETY for MICROBIOLOGY

Public and Scientific Affairs Board
123 Main Street
Washington, D.C. 20006-4171
Tel.: (202) 786-6141
Fax: (202) 962-5535

May 5, 1995

Dr. Edward Smith
123 Main Street
Anytown, USA 12345

Dear Dr. Smith:

Government agencies like yours depend on a skilled work force with specialized training in the microbiological sciences. However, little is known about the number of such persons needed nationwide and the specialized training they should be receiving, particularly at the doctoral level. At the same time, federal policy makers increasingly demand more accurate information to establish funding priorities for research and training in the life sciences.

As a representative of a unit in your organization that employs persons with specialized training in the microbiological sciences, you can help us by completing the enclosed questionnaire and returning it to us postage-free. The information you provide on this questionnaire will be compiled with other responses, so the answers you give are anonymous. Results of the survey will be published by the American Society for Microbiology as a public service. We will gladly send you a copy of these results as soon as they are available.

If you have any questions, please feel free to call 1-800-434-6347. We very much appreciate your cooperation with this important effort.

Sincerely,

David Schnitzer, Ph.D.
President, American Society for Microbiology

Kenneth I. Berns, M.D.
Chair, Public and Scientific Affairs Board, ASM

Government Questionnaire

INSTRUCTIONS:
- Answer each question as indicated.
- Check the appropriate answer box:
- Circle the appropriate answer code:
- Enter a number:

Q.1 Check the category that best describes your organization. (Check one box.)

- Federal agency: ____________________________
- State or local health department or laboratory: ____________________________
- Other state or local government agency: ____________________________

Q.2 From your perspective, which of the following best describes the general employment outlook for your field or industry over the next three years:

- Very positive: ____________________________
- Somewhat positive: ____________________________
- Neither positive nor negative: ____________________________
- Somewhat negative: ____________________________
- Very negative: ____________________________

Q.3 Approximately how many employees does your entire organization or institution have in the U.S.? (Your best guess.)

[ ] [ ] [ ] [ ] [ ] Number of employees in the U.S.

Q.4 How many of the employees in Q.3 are employed in your department or operating unit? (For small organizations, the same number as in Q.3 may be appropriate.)

[ ] [ ] [ ] [ ] Number of employees in department/operating unit

Q.5 Approximately, how many of these employees are employed in the microbiological sciences?

[ ] [ ] [ ] Number of employees employed in the microbiological sciences

Q.6 About how many departments or operating units are there in your organization or institution that conduct work related to basic, clinical, or applied microbiology (include your department, if appropriate)?

[ ] [ ] [ ] Number of microbiology-related departments/operating units
Q.7 Which of the following best describes the primary work of your department or operating unit? (Check one box.)

- Basic Research
- Applied Research / R & D
- Production / Quality Control
- Diagnostic Services / Testing
- Health Care / Medicine
- Marketing / Sales, or
- Other? (Specify)

Q.8 Approximately, how many employees in your department/operating unit are ASM members? (Include yourself, if appropriate – your best guess.)

[__] Employees in department/operating unit that are ASM members

Q.9 Which of the following best describes your current position in the department/operating unit where you work?

- Administrator or manager
- Laboratory director
- Laboratory supervisor
- Research scientist, or
- Other? (Specify)

Q.10 Which of the following best describes your highest level of education?

- PhD, MD or equivalent
- MD / DDS
- MA / MS / BS
- MAT / ASCRP, CLS (NCA), or equivalent, or
- Other? (Specify)

Q.11 Using the list of codes on Page 3, what specialization best describes your current area of scientific activity?

[__] [__] [__]
Q.15 How many of the doctoral-level persons represented in your answer to Q.12 on page 3 fall into each of the following categories? (Enter 0 if none.)

1. Postdoctoral fellows
2. Women
3. Black, Hispanic, or Native American
4. Foreign nationals (include permanent U.S. residents and U.S. citizens)
5. 60 years of age or older

Check here if there are no doctoral-level scientists currently on staff.

Q.16 If you entered a number(s) in Q.13 on page 3, which of the following best describes the work you will be doing?

- Replacement of people who have already left
- Replacement of people expected to retire or otherwise leave in next 36 months
- Addition of new positions to the staff
- Do not expect to hire doctoral-level staff in the next 36 months

Q.17 How many of the doctoral-level persons represented in your answer to Q.13 on page 3 do you expect to be postdoctoral fellows? (Enter 0 if none.)

- Postdoctoral fellows
- Do not expect to hire doctoral-level staff in the next 36 months

Q.18 If you entered a number(s) in Q.14 on page 3, which of the following best describes why the person(s) left?

- Retirement
- Illness or death
- Layoff
- Transferred within organization
- poor performance
- Termination

Check here if there are no doctoral-level staff who have left in the past 36 months.

Q.19 If you put a check in any of the boxes numbered a through f in the previous question (Q.18), which of the following best describes your department/operating unit's response?

- We have already replaced the person(s)
- We have not yet replaced the person(s) but expect to
- We have not replaced the person(s) and do not expect to

Q.20 Using the numbers in the column labeled "Code" on page 3, circle any specializations in the column labeled "specialization" that you have searched for but were unable to find for a doctoral-level job opening in your department/operating unit in the past 24 months.

Q.21 Please list the scientific and technical skills (such as computer skills or instrumentation) that are most important to the work done by doctoral-level employees in your department/operating unit.

-__________________________
-__________________________
-__________________________

Q.22 In terms of the needs of your department/operating unit for doctoral-level people trained in the microbiological sciences (see list on page 3), which statement best describes your recent experience? (Check one box.)

- There are many well qualified applicants for our job openings.
- There are many well qualified applicants, but few with the specific qualifications we need.
- There are very few well qualified applicants for our job openings.
- Other? (Specify)

The next question is about non-doctoral employees in your department or operating unit.

Q.23 For each degree/area of specialization, complete columns (a) through (c) for non-doctoral employees in your department or operating unit.

<table>
<thead>
<tr>
<th>(a) Number currently on staff</th>
<th>(b) Number expected to be hired in the next 36 months</th>
<th>(c) Number who left in the past 24 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. MS microbiological science</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>2. MS other science</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>3. BS microbiological science</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>4. BS other science</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>5. Medical technology</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>6. Associates degree</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>7. High school graduate</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>8. Other (Specify)</td>
<td>_______</td>
<td>_______</td>
</tr>
</tbody>
</table>
As a representative of your department/operating unit, indicate the extent to which you agree or disagree with each of the following statements.

<table>
<thead>
<tr>
<th>Q.24</th>
<th>It is difficult for us to compete with the private sector for qualified PhDs in the microbiological sciences.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agree strongly</td>
</tr>
<tr>
<td>2</td>
<td>Agree</td>
</tr>
<tr>
<td>3</td>
<td>Neither agree nor disagree</td>
</tr>
<tr>
<td>4</td>
<td>Disagree</td>
</tr>
<tr>
<td>5</td>
<td>Disagree strongly</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q.25</th>
<th>New technologies in the microbiological sciences are reducing our need for skilled laboratory personnel.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agree strongly</td>
</tr>
<tr>
<td>2</td>
<td>Agree</td>
</tr>
<tr>
<td>3</td>
<td>Neither agree nor disagree</td>
</tr>
<tr>
<td>4</td>
<td>Disagree</td>
</tr>
<tr>
<td>5</td>
<td>Disagree strongly</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q.26</th>
<th>It is difficult to find MS, BS or equivalent level job applicants with specialized training in microbiology.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agree strongly</td>
</tr>
<tr>
<td>2</td>
<td>Agree</td>
</tr>
<tr>
<td>3</td>
<td>Neither agree nor disagree</td>
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<td>4</td>
<td>Disagree</td>
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<td>5</td>
<td>Disagree strongly</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q.27</th>
<th>Recent PhDs or MDs in the microbiological sciences are often too specialized to adapt well to the kind of work we do in this department/laboratory.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agree strongly</td>
</tr>
<tr>
<td>2</td>
<td>Agree</td>
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<tr>
<td>3</td>
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<td>5</td>
<td>Disagree strongly</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q.28</th>
<th>Overall, universities are doing a good job of training PhDs and MDs in the areas of specialization important to our department/laboratory.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agree strongly</td>
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<tr>
<td>2</td>
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</tr>
</tbody>
</table>

Federal Government Agencies Only:

<table>
<thead>
<tr>
<th>Q.29</th>
<th>The Administration's National Performance Review Initiative has prevented us from adding needed staff positions to our department/laboratory.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agree strongly</td>
</tr>
<tr>
<td>2</td>
<td>Agree</td>
</tr>
<tr>
<td>3</td>
<td>Neither agree nor disagree</td>
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<tr>
<td>5</td>
<td>Disagree strongly</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q.30</th>
<th>The Administration's National Performance Review Initiative will cause us to cut a number of staff positions from our department/laboratory.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agree strongly</td>
</tr>
<tr>
<td>2</td>
<td>Agree</td>
</tr>
<tr>
<td>3</td>
<td>Neither agree nor disagree</td>
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<td>4</td>
<td>Disagree</td>
</tr>
<tr>
<td>5</td>
<td>Disagree strongly</td>
</tr>
</tbody>
</table>

Is there anything else that you would like to tell us about the employment outlook for the microbiological sciences, or any other comments you wish to make? If so, please use this space for that purpose.

Your contribution to this effort is very greatly appreciated. If you would like a summary of the results, please print your name and address on the back of the return envelope (NOT this questionnaire). We will see that you get it. If you have any questions, please call 1-800-434-6347.

Return to:
ASM Survey
Westat, Inc.
1600 Research Blvd.
Rockville, MD 20850-3129
Clinical-Medical Cover Letter

May 5, 1995

Dr. Edward Smith
123 Main Street
Anytown, USA 12345

Dear Dr. Smith:

Medical and health care organizations like yours depend on a skilled workforce with specialized training in the microbiological sciences. However, little is known about the number of such persons needed nationwide and the specialized training they should be receiving, particularly at the doctoral level. At the same time, federal policy makers increasingly demand more accurate information to establish funding priorities for research and training in the life sciences.

As a representative of a unit in your organization that employs persons with specialized training in the microbiological sciences, you can help us by completing the enclosed questionnaire and returning it to us postage-free. The information you provide on this questionnaire will be compiled with other responses, so the answers you give are anonymous. Results of the survey will be published by the American Society for Microbiology as a public service. We will gladly send you a copy of these results as soon as they are available.

If you have any questions, please feel free to call 1-800-434-6347. We very much appreciate your cooperation with this important effort.

Sincerely,

David Schlesinger, Ph.D.
President, American Society for Microbiology

Kenneth L. Baron, M.D.
Chair, Public and Scientific Affairs Board, ASM

Clinical-Medical Questionnaire

INSTRUCTIONS:

1. Answer each question at the level:
   Check the appropriate answer box:
   [ ] 3.0 or above
   [ ] 3.0 or below
   [ ] 4.0 or above
   [ ] 4.0 or below
   [x] 5.0

2. Over a number:
   ________

3. Answer each question for permanent staff only. Do not include temporary or visiting staff.

4. You may consult with the appropriate individuals in your organization if you are unable to provide response to certain questions.

Q.1 Check the category that best describes your organization. (Check one box.)

   [ ] VA hospital
   [ ] Other federal hospital
   [ ] State or local government hospital
   [ ] Private non-profit hospital
   [ ] For-profit hospital
   [ ] University hospital
   [ ] Private clinical laboratory
   [ ] Health maintenance organization
   [ ] Health practitioners office, or
   [ ] Other health care facility? (Specify...)

Q.2 From your perspective, which of the following best describes the general employment outlook for your field or industry over the next three years:

   [ ] Very positive
   [ ] Somewhat positive
   [ ] Neither positive nor negative
   [ ] Somewhat negative
   [ ] Very negative

Q.3 Approximately how many employees does your entire organization or institution have in the US?
   (Your best guess.)

   _______ _______ _______ _______ Number of employees in the US

Q.4 How many of the employees in Q.3 are employed in your department or operating unit? (For small organizations, the same number as in Q.3 may be appropriate.)

   _______ _______ _______ _______ Number of employees in department/operating unit

Q.5 Approximately, how many of these employees are employed in the microbiological sciences?

   _______ _______ _______ _______ Number of employees employed in the microbiological sciences
Q.6 About how many departments or operating units are there in your organization or institution that conduct work related to basic, clinical, or applied microbiology (include your department, if appropriate)?

[ ] [ ] [ ] Number of microbiology-related departments/operating units

Q.7 Which of the following best describes the primary work of your department or operating unit? (Check one box.)

- Teaching
- Research and Test/Ph.D.
- Basic Research
- Applied Research / R & D
- Production / Quality Control
- Diagnostic Services / Testing
- Health Care / Medicine
- Marketing / Sales, or
- Other? (Specify)

Q.8 Approximately how many employees in your department/operating unit are ASM members? (Include yourself, if appropriate - your best guess.)

[ ] [ ] [ ] Employees in department/operating unit that are ASM members

Q.9 Which of the following best describes your current position in the department/operating unit where you work?

- Administrator or manager
- Laboratory director
- Laboratory supervisor
- Research scientist
- Department chair/professor
- Other? (Specify)

Q.10 Which of the following best describes your highest level of education?

- Ph.D., M.D. or equivalent
- M.S. / B.S.
- MT/ASCP, CLS (NGS) or equivalent, or
- Other? (Specify)

Q.11 Using the list of codes on Page 2, what specialization best describes your current area of scientific activity?

[ ] [ ] [ ]

American Society for Microbiology
Q.15 How many of the doctoral-level persons represented in your answer to Q.12 on page 3 fall into each of the following categories? (Enter 0 if none.)

1. Postdoctoral fellows
2. Women
3. Blacks, Hispanics, or Native Americans
4. Foreign nationals (excluding permanent U.S. residents and U.S. citizens)
5. 60 years of age or older

Check here if there are no doctoral-level scientists currently on staff.

Q.16 If you entered a number(s) in Q.13 on page 3, which of the following best describes the new hiring you will be doing?

- Yes
- No

a. Replacement of people who have already left
b. Replacement of people expected to retire or otherwise leave in next 30 months
c. Addition of new positions to the staff

D. Do not expect to hire doctoral-level staff in the next 30 months

Q.17 How many of the doctoral-level persons represented in your answer to Q.13 on page 3 do you expect to be postdoctoral fellows? (Enter 0 if none.)

1. Postdoctoral fellows

D. Do not expect to hire doctoral-level staff in the next 30 months

Q.18 If you entered a number(s) in Q.14 on page 3, which of the following best describes why the person(s) left?

- Yes
- No

a. Retirement
b. Illness or death
c. Layoff
d. Transferred within organization
e. Accepted a position elsewhere (not last off)
f. Terminated

g. There are no doctoral-level staff who have left in the past 24 months

Q.19 If you put a check in any of the boxes numbered a through f in the previous question (Q.18), which of the following best describes your department/operating unit's response?

- Yes
- No

We have already replaced the person(s)
We have not yet replaced the person(s) but expect to
We have not replaced the person(s) and do not expect to

The next question is about non-doctoral employees in your department or operating unit.

Q.20 Using the numbers in the column labeled "Code" on page 3, circle any specializations in the column labeled "Specialization" that you have searched for but were unable to find for a doctoral-level job opening in your department/operating unit in the past 24 months.

Q.21 Please list the scientific and technical skills (such as computer skills or instrumention) that are most important in the work done by doctoral-level employees in your department/operating unit.

1.
2.
3.

Q.22 In terms of the needs of your department/operating unit for doctoral-level people trained in the microbiological sciences (see list on page 3), which statement best describes your recent experience? (Check one box.)

There are many well-qualified applicants for our job openings.
There are many well-qualified applicants, but few with the specific qualifications we need.
There are very few well-qualified applicants for our job openings.
Other (Specify)

Q.23 For each degree/area of specialization, complete columns (a) through (c) for non-doctoral employees in your department or operating unit.

<table>
<thead>
<tr>
<th>(a) Number of staff currently on staff</th>
<th>(b) Number of staff expected to be hired in the next 30 months</th>
<th>(c) Number of staff who left in the past 24 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. MS microbiological science</td>
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<tr>
<td>2. MS other science</td>
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<tr>
<td>3. BS microbiological science</td>
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<td>4. BS other science</td>
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<td>5. Medical technologist</td>
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<td>6. Associate degree</td>
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<td>7. High school graduate</td>
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<tr>
<td>8. Other (Specify)</td>
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</tbody>
</table>
As a representative of your department/operating unit, indicate the extent to which you agree or disagree with each of the following statements.

<table>
<thead>
<tr>
<th>Q.24</th>
<th>The trend toward managed health care has reduced the amount of analysis or testing done by my laboratory.</th>
<th>Agree strongly 1</th>
<th>Agree 2</th>
<th>Neither agree nor disagree 3</th>
<th>Disagree 4</th>
<th>Disagree strongly 5</th>
</tr>
</thead>
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<tr>
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<tr>
<td>Q.25</td>
<td>Margins of hospitals and other health care providers has reduced the number of clinical laboratories in my area.</td>
<td>Agree strongly 1</td>
<td>Agree 2</td>
<td>Neither agree nor disagree 3</td>
<td>Disagree 4</td>
<td>Disagree strongly 5</td>
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<tr>
<td>Q.26</td>
<td>New technologies in the microbiological sciences are reducing our need for skilled laboratory personnel.</td>
<td>Agree strongly 1</td>
<td>Agree 2</td>
<td>Neither agree nor disagree 3</td>
<td>Disagree 4</td>
<td>Disagree strongly 5</td>
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<td>Q.27</td>
<td>My laboratory spends a significant amount of resources training people to become laboratory technologists/technicians.</td>
<td>Agree strongly 1</td>
<td>Agree 2</td>
<td>Neither agree nor disagree 3</td>
<td>Disagree 4</td>
<td>Disagree strongly 5</td>
</tr>
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<tr>
<td>Q.28</td>
<td>There is a shortage of persons trained in medical technology to work as laboratory technologists/technicians.</td>
<td>Agree strongly 1</td>
<td>Agree 2</td>
<td>Neither agree nor disagree 3</td>
<td>Disagree 4</td>
<td>Disagree strongly 5</td>
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<tr>
<td>Q.29</td>
<td>It is difficult to find BS, MS or equivalent level job applicants with specialized training in microbiology.</td>
<td>Agree strongly 1</td>
<td>Agree 2</td>
<td>Neither agree nor disagree 3</td>
<td>Disagree 4</td>
<td>Disagree strongly 5</td>
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<td>Q.30</td>
<td>NOEs or MDs in the microbiological sciences are often too specialized to adapt well to the kind of work we do in this laboratory.</td>
<td>Agree strongly 1</td>
<td>Agree 2</td>
<td>Neither agree nor disagree 3</td>
<td>Disagree 4</td>
<td>Disagree strongly 5</td>
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<tr>
<td>Q.31</td>
<td>Overall, universities are doing a good job of training NOEs and MDs in the areas of specialization important to our department/lab.</td>
<td>Agree strongly 1</td>
<td>Agree 2</td>
<td>Neither agree nor disagree 3</td>
<td>Disagree 4</td>
<td>Disagree strongly 5</td>
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<td>Q.32</td>
<td>Certification by the American Board of Medical Microbiology (ABMM) or the American Board of Medical Laboratory Immunologists (ABMLI) is an important qualification for level employees in my department/lab.</td>
<td>Agree strongly 1</td>
<td>Agree 2</td>
<td>Neither agree nor disagree 3</td>
<td>Disagree 4</td>
<td>Disagree strongly 5</td>
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<tr>
<td>Q.33</td>
<td>Certification by the National Registry of Microbiology is an important qualification for BS level employees in my department/lab.</td>
<td>Agree strongly 1</td>
<td>Agree 2</td>
<td>Neither agree nor disagree 3</td>
<td>Disagree 4</td>
<td>Disagree strongly 5</td>
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<tr>
<td>Q.34</td>
<td>Certification of MS/BS level employees by other organizations (e.g., MT [ASCP], CMLS [NCA] or equivalent) are more important than ABMM credentials.</td>
<td>Agree strongly 1</td>
<td>Agree 2</td>
<td>Neither agree nor disagree 3</td>
<td>Disagree 4</td>
<td>Disagree strongly 5</td>
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<tr>
<td>Q.35</td>
<td>Our State or other authority requires laboratory directors to be board certified.</td>
<td>Agree strongly 1</td>
<td>Agree 2</td>
<td>Neither agree nor disagree 3</td>
<td>Disagree 4</td>
<td>Disagree strongly 5</td>
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</table>

Is there anything else that you would like to tell us about the employment outlook for the microbiological sciences, or any other comments you wish to make? If so, please use this space for that purpose.

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Your contribution to this effort is very greatly appreciated. If you would like a summary of the results, please print your name and address on the back of the return envelope (NOT this questionnaire). We will see that you get it. If you have any questions, please call 1-800-454-5647.

Return to:
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1650 Research Blvd.
Rockville, MD 20850-5129