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National Laboratory Capacity Assessment, 2011

Findings and Recommendations for Strengthening the U.S. Workforce in Public Health, Environmental and Agricultural Laboratories

A report of the University of Michigan Center of Excellence in Public Health Workforce Studies and the Association of Public Health Laboratories

University of Michigan School of Public Health
Center of Excellence in Public Health Workforce Studies

APHL ASSOCIATION OF PUBLIC HEALTH LABORATORIES

August 17, 2012

Matthew L. Boulton, MD, MPH
Director, Center of Excellence for Public Health Workforce Studies
University of Michigan School of Public Health
1415 Washington Heights
Ann Arbor, MI 48109-2029

Dear Dr. Boulton,

As you may know, "Workforce" is the first of the six priorities listed in APHL's current (2010-2013) and previous (2006-2009) Strategic Plans. A crucial strength of our Association's on-going Workforce Development Program is multi-component workforce research. Over the past two years access to support provided by the University of Michigan's Center of Excellence for Public Health Workforce Studies has greatly accelerated this research program.

We are most grateful to the Center and you personally for undertaking the initial characterization of the public health, environmental, and agricultural laboratory (PHEAL) workforce, an undertaking that has provided an excellent assessment and a solid base on which to build future PHEAL workforce research and products needed to expand the PHEAL workforce pipeline. Thank you for forwarding the final draft of the National Laboratory Capacity Assessment. This collaborative initiative has resulted in a summary document rich with information that has provided an exceptional profile of our public health, environmental, and agricultural laboratories.

On behalf of the Workforce Development Committee and the APHL Board of Directors, we extend our appreciation for a truly productive and effective collaboration. Lastly, we hope that in the future we might have opportunities to collaborate again with you and your team.

Sincerely,

Scott J. Becker
Executive Director

Jack DeBoy, DrPH
Chair, APHL Workforce Development Committee

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ACKNOWLEDGEMENTS

This report is produced by the Association of Public Health Laboratories (APHL) Workforce Research and Pipeline Subcommittee (WRAPS) members (John M. DeBoy, WRAPS chair; David F. Carpenter, Lou F. Turner, Musau Wakabongo, and Susanne Zanto), APHL staff members Deborah Kim, Eva Perlman, and Pandora Ray, and University of Michigan Center of Excellence in Public Health Workforce Studies Director, Matthew L. Boulton, and Research Specialist, Angela J. Beck. We acknowledge the contributions of University of Michigan School of Public Health student Kay Leopold, and staff member Brad Carlson for their assistance with data analysis and report writing. We also wish to acknowledge the support, leadership, and advocacy for this study provided by Scott Becker, Executive Director of APHL, from the idea's inception to the production of this report.

Matthew L. Boulton and Angela J. Beck are the primary authors of this report.

APHL is a national nonprofit dedicated to working with its members to strengthen governmental laboratories with a public health mandate. By promoting effective programs and public policy, APHL strives to provide public health laboratories with the resources and infrastructure needed to protect the health of US residents and to prevent and control disease globally.

The University of Michigan Center of Excellence in Public Health Workforce Studies is funded by the Public Health Foundation through a cooperative agreement with the Centers for Disease Control and Prevention and Health Resources and Services Administration. This project was supported through contract number DRDA 10-PAF-1243.

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EXECUTIVE SUMMARY

Background

The public health, environmental and agricultural laboratory (PHEAL) workforce is a vital component of our nation's public health infrastructure. Well-trained laboratorians are essential to providing protection against newly emergent and endemic diseases and other health hazards through provision of clinical diagnostic testing, laboratory-based reporting and surveillance, chemical, toxicological, environmental and radiological testing, emergency response support, applied research, laboratory training, and other essential services for the communities they serve. State public health laboratories perform these important activities and services in every state and territory in the U.S. and their work is often augmented by a network of local or regional public health laboratories, which may be found in settings ranging from large metropolitan areas to small rural locales. Environmental and agricultural laboratory testing, which are also key elements of our national public health laboratory capacity, may be performed at the state public health laboratory or at separate environmental or agricultural health laboratories. In all cases, the PHEALs comprise a system that collectively equips our nation to analyze public health threats, provide the answers needed to mount an effective response, and generate the information needed to act in protecting the public in collaboration with other decision makers. Fundamental to promoting the optimal capacity of PHEALs to perform their core public health functions is the need to insure there is an adequately trained and well-characterized laboratory workforce which is fully prepared to make their critical contribution to safeguarding the public's health.[1]

The Association of Public Health Laboratories (APHL) and the University of Michigan Center of Excellence in Public Health Workforce Studies (CEPHS) partnered to develop a national laboratory workforce assessment to gauge capacity in all U.S. PHEALs. The results of the multilevel study, which focused specifically on size, composition, experience and competence of the laboratory workforce, and capacity of the laboratory to perform activities and services in

specific program areas, is the first of its kind to gather comprehensive workforce and infrastructure information across multiple types of governmental laboratories.

Methods

The 2011 National Laboratory Workforce Capacity Assessment was developed by APHL staff, Workforce Research and Pipeline Subcommittee members, and CEPHS. The individual-level survey collected information on laboratorians' demographics, education, job classification and function, and job satisfaction. The organizational-level survey collected number of workers by degree and job classification, equipment quality, and program area capacity. Pilot questionnaires collecting organizational-level and individual-level data were distributed to 4 PHEAL Laboratory Directors and 13 laboratory staff, respectively. APHL disseminated the online individual-level survey to 105 PHEAL Directors in the 50 states, D.C. and Puerto Rico in April 2011. The Directors distributed the individual-level survey to their scientific laboratory staff for completion; data collection took place until June 2011. In July 2011, APHL disseminated the online organizational-level survey to the PHEAL Directors, who were given approximately 8 weeks to complete the questionnaire. APHL staff followed up with Laboratory Directors by email and phone throughout the individual-level and organizational-level data collection period to encourage maximum response.

Results and Conclusions

This report provides a comprehensive assessment of the status of workforce capacity in the nation's PHEALs. The survey's main findings are as follows:

I. National laboratory infrastructure is below optimal capacity in many areas.

- A significant portion of PHEALs reported low capacity (i.e., no, minimal or only partial capacity) to perform activities in the program areas of:
  - Agricultural microbiology (54% of labs reported low capacity)
  - Agricultural chemistry (50%)

  - Toxicology (45%)
- Fewer than 25% of laboratories reported high capacity (i.e., substantial or full capacity) to perform activities in agricultural chemistry (13%), agricultural microbiology (14%), clinical chemistry/hematology (19%), and toxicology (24%).
- Over half of responding laboratories (51%) report no, minimal or only partial capacity to provide education and training to their workers.
- Slightly over half of laboratories (51%) rated the overall quality of their equipment and instrumentation as "fair".

II. The education and training of the PHEAL workforce needs to be strengthened.

- Only 1% of the laboratory workforce possesses a professional doctoral degree (e.g. MD, DVM, DDS), which is substantially lower than for epidemiologists, who represent the other primary scientific-technical job classification in the public health workforce.
- Only one-quarter (26%) of the laboratorian workforce has a graduate (i.e. doctorate or masters) or professional doctoral degree.
- Approximately three-quarters (74%) of the laboratory workforce has a bachelors (60%), associate degree (6%) or high school equivalency (8%).
- Laboratorian respondents self-evaluated low competence (40% or more indicating "No Competence") in many critical areas including:
  - Design/evaluation of surveillance systems (63% of respondents reported no competence)
  - Public health law (53%)
  - Public health administration (49%)
  - Public health policy in state and federal government (46%)
  - Writing (45%)
  - Epidemiology (45%)
  - Virology lab (44%)
  - Public health information management systems for data handling (42%)
  - Biostatistics (42%)

  - Public health laboratory management (41%)
  - Health education/health behavior (40%)
- In addition, at least 50% of the laboratorian respondents self-evaluated low or no competence in multiple areas including:
  - Environmental/water microbiology (65%)
  - Virology (64%)
  - Environmental health science (60%)
  - Molecular biology and diagnostics (57%)
  - Emergency preparedness (54%)
  - Lab design, workflow, operations (52%)
  - Biochemistry (53%)
  - Immunology (53%)
  - Clinical, medical, pathogenic bacteriology (50%)
- Lack of training opportunities was reported as a barrier to recruitment by 26% of laboratories and as a barrier to retention by 38% of laboratories.
- Availability of training opportunities was reported as important/very important to recruitment of well-qualified laboratorians by 54% of individual respondents and to retention of laboratorians by 64%.

III. Laboratories face significant challenges in maintaining and enhancing the workforce pipeline.

- 30% of individual laboratorian respondents plan to leave the workforce within the next 4 years.
- 25% of laboratory workers are older than 55 years.
- 10 labs reported losing more than 15% of their workforce in 2010; 38 labs anticipate losing more than 15% of their workforce in the next 5 years.
- The greatest recruitment/retention barriers according to laboratories are: lack of a career path (76% and 83% reported barrier for recruitment and retention, respectively), promotion opportunities (76% and 80%, respectively), and salary scale (74% and 73%, respectively).

- The greatest barriers to recruitment/retention according to workers were: lack of job security (87% and 93% reported important/very important for recruitment and retention, respectively), inadequate benefits package (82% and 93%, respectively), poor work/life balance (81% and 85%, respectively), and lack of safe/secure work environment (79% and 83%, respectively).
- Laboratories lack a standard set of commonly agreed upon job classifications to use when assessing the laboratory workforce.

IV. The national laboratory workforce lacks racial diversity, particularly in leadership positions.

- Less than 15% of the laboratory workforce self-identified as Black/African American, Native Hawaiian/Pacific Islander, or Hispanic/Latino.
- Over three-quarters (81%) of the laboratorian workforce self-identifies as either White or Asian.
- 90% of senior-level PHEAL administrators (Directors and Deputy Directors) are Non-Hispanic White.

Recommendations

1) Develop strategies to attain full capacity in all laboratory program areas.
    - The US Centers for Disease Control and Prevention (CDC) and the APHL should use findings of this assessment to develop quantifiable goals for improving laboratory infrastructure and capacity.
    - APHL should enhance marketing efforts to further awareness and encourage use of Laboratory System Improvement Plan (LSIP) standards by all public health laboratories as a means for assessing laboratory performance and capacity needs.
    - Through public health preparedness funding, CDC and other federal agencies should support states in attaining full capacity in the following areas of need: agricultural chemistry, agricultural microbiology, education and training, and toxicology.

- In order to demonstrate the value of optimal laboratory capacity, CDC and APHL should profile model states with high-level laboratory infrastructure that employ a well-integrated PHEAL system.
- Local, state and federal agencies responsible for insuring adequate laboratory capacity should engage in ongoing discussions to develop methodologies for addressing structural deficiencies in the PHEAL network.

2) Develop training and educational opportunities to improve core competencies for current lab workers.
    - APHL, CDC, and state and local partners should encourage development and implementation of competency-based learning models using nationally accepted standards for applied laboratory training.
    - Work should continue, with input from APHL, CDC, and the Association of Schools of Public Health (ASPH), to establish competencies with applicability in public health practice and academic public health.
    - Future national laboratory capacity assessments should incorporate an evaluation of worker competency using a standardized framework.

3) Increase the number of laboratory science degree programs in schools and programs of public health.
    - APHL should partner with ASPH to develop strategies to prevent further erosion of laboratory training programs while also focusing on sustaining existing programs.
    - APHL should encourage universities and states to form educational consortiums to share responsibility and resource commitment to support laboratory training programs.
    - Schools and programs of public health should be encouraged to consider developing reduced-credit certificate programs in laboratory science to increase training opportunities for laboratory workers.

- APHL should explore opportunities for community colleges to provide laboratory training at the associate's degree level.
- Special focus should be placed on preserving and expanding existing doctoral programs for laboratorians, including the development of innovative recruitment strategies to increase student enrollment.
- CDC should consider expanding the Emerging Infectious Disease (EID) program for masters and doctoral trainees, accompanied by a significant expansion of training placements in state and local governmental PHEAL.

4) Conduct regular monitoring of the size and composition of the national public health laboratory workforce.
    - APHL, CDC, and other responsible federal entities should commit to the conduct of future periodic assessments of the national PHEAL workforce using a methodology that is repeatable, affordable, and consistent over time.
    - Future assessments of the national PHEAL workforce should be refined to include evaluation of worker competency and collect additional information related to job functions performed by laboratory workers, in addition to measures of program area, information technology, and automated surveillance capacity at the organizational level.
    - APHL should support and participate in efforts being led by the University of Michigan Center of Excellence in Public Health Workforce Studies to standardize methods for continuous monitoring of the size and composition of the national public health workforce.

5) Devise strategies to increase the diversity of the laboratory workforce, especially in leadership positions.
    - APHL should consider convening a minority task force to specifically focus on development of strategies to increase the diversity of the national laboratory workforce.

- Schools and programs of public health should be strongly encouraged to develop special outreach efforts to recruit underrepresented minorities to graduate degree programs, especially doctoral degree programs, in laboratory science.
- APHL should consider designating a staff person to focus specifically on assisting PHEALs with minority recruitment, retention, and promotion.

BACKGROUND

The public health, environmental and agricultural laboratory (PHEAL) workforce is a vital component of our nation's public health infrastructure. Well-trained laboratorians are essential to providing protection against newly emergent and endemic diseases and other health hazards through provision of clinical diagnostic testing, laboratory-based reporting and surveillance, chemical, toxicological, environmental and radiological testing, emergency response support, applied research, laboratory training, and other essential services for the communities they serve. State public health laboratories perform these important activities and services in every state and territory in the U.S. and their work is often augmented by a network of local or regional public health laboratories, which may be found in settings ranging from large metropolitan areas to small rural locales. Environmental and agricultural laboratory testing, which are also key elements of our national public health laboratory capacity, may be performed at the state public health laboratory or at separate environmental or agricultural health laboratories. In all cases, PHEALs comprise a system that collectively equips our nation to analyze public health threats, provide the answers needed to mount an effective response, and generate the information needed to act in protecting the public in collaboration with other decision makers. Fundamental to promoting the optimal capacity of PHEALs to perform their core public health functions is the need to insure there is an adequately trained and well-characterized laboratory workforce which is fully prepared to make their critical contribution to safeguarding the public's health.[1]

The Healthy People 2010 Objective 23-13 reads, *Increase the proportion of tribal and state health agencies that provide or assure comprehensive laboratory services to support essential public health services*.[2] Despite this national commitment to the provision of comprehensive laboratory services through our public health system, often in partnership with state agricultural, environmental or private clinical laboratories, a number of critical obstacles to the future of the national laboratory workforce remain.[3] These challenges include the need to: better define the field of laboratory science; engage in a regular and systematic enumeration of the laboratory workforce; undertake formal credentialing of laboratory professionals; insure

the ongoing and future education of laboratory scientists; and encourage a more rigorous workforce research agenda to examine issues of lab worker recruitment, retention, retirement, compensation and curriculum amongst others. As the national professional public health organization representing workers in public health, environmental, and agricultural laboratories, the Association of Public Health Laboratories (APHL) has a long and distinguished history of addressing these challenging issues. These efforts were initiated with APHL's publication of a white paper in 2000 entitled, "Core Functions and Capabilities of State Public Health Laboratories" which specified the core functions expected of state laboratories.[4] It was also at this time that the U.S. Centers for Disease Control and Prevention (CDC) first introduced the concept of a National Laboratory System (NLS), comprising a coordinated public-private network of laboratories to deliver essential services of public health, particularly in assuring high-quality and timely laboratory services and public health surveillance.[5,6] The concept of a NLS was further enhanced with the 2004 launch of the State Public Health Laboratory System Performance Standards Program which later became the Laboratory Systems Improvement Program, or LSIP, as a joint APHL- CDC collaboration which was intended to be used as a performance measurement tool to better insure optimal laboratory performance.[7,8] Complementing the LSIP is APHL's Comprehensive Laboratory Services Survey, which has been conducted biannually to specifically assess state public health laboratory performance and improvement.[9,10]

In concert with these efforts, APHL has also administered a series of workforce surveys to its members, most recently in 2007, which focus on laboratory position titles and salary ranges.[11] Among the findings of concern was that, "the public health laboratory workforce is facing- and is expected to continue to face- extensive shortages of qualified scientists to oversee the core functions of both the state public health laboratory and the larger laboratory system".[11] As a way to further assess workforce shortage and capacity, APHL and the University of Michigan Center of Excellence in Public Health Workforce Studies (CEPHS) partnered to develop a national laboratory workforce capacity assessment for all U.S. PHEALs. The results of the multilevel study, which focused specifically on size, composition, experience and competence of the laboratory workforce, and capacity of the laboratory to perform activities and services in

specific program areas, is the first of its kind to gather comprehensive workforce and infrastructure information across multiple types of governmental laboratories.

METHODS

Instrument Development and Distribution

In August 2010, APHL staff and Workforce Research and Pipeline Subcommittee (WRAPS) members convened a two-day meeting with University of Michigan CEPHS to discuss the development of a multilevel survey to assess PHEAL workforce capacity. Over the ensuing 8 months, the survey strategy and questionnaire items for National Laboratory Workforce Capacity Assessment were developed. The survey methodology consisted of a two-stage design, which included providing an organizational-level survey to all PHEAL directors, and collecting individual-level survey data using a separate questionnaire from all PHEAL laboratory workers. The organizational-level questionnaire was piloted with Laboratory Directors in North Dakota, New Mexico, Michigan, and Vermont; the individual-level questionnaire was piloted with a total of 13 laboratory workers in Arizona, Florida, Kansas, Maryland, Minnesota, and Tennessee. APHL and CEPHS staff performed cognitive interviews with all pilot testers to obtain feedback on survey design. Recommendations from pilot testers were used to revise the survey instruments.

The *mrInterview* platform was used to develop the online survey questionnaires. The surveys were disseminated using a phased approach. For phase I of the assessment, APHL distributed the individual-level survey to 105 PHEAL directors in all 50 states, the District of Columbia (D.C.), and Puerto Rico, including 50 state public health laboratories, 41 local public health laboratories, 8 environmental laboratories, and 6 agricultural laboratories. Data collection took place from April to June 2011. Laboratory Directors were asked to disseminate the survey link by email to all scientific laboratory staff. For phase II, APHL distributed the organizational-level survey via email to PHEAL Directors in July 2011 and asked them to respond directly. Data collection took place for approximately 8 weeks. APHL staff followed up with laboratory

directors by email and phone throughout the individual-level and organizational-level data collection period to maximize response.

Survey Themes

The individual-level survey collected demographics, employment and laboratory information, job classification, education and training background, professional memberships, competence in designated topical areas, recruitment and retention factors, and job satisfaction from laboratorians. The organizational-level survey collected information on laboratory type, equipment quality, program area and LSIP capacity, number of workers by degree, job classification and program area, staff recruitment and retention factors, and continuing education and professional development opportunities for staff. Both surveys used the following standardized job classifications and descriptions for laboratory staff:

Job Classifications used in PHEAL National Laboratory Workforce Capacity Assessment, 2011

Job Classification	Description
PHEAL Aide/Assistant	• High school diploma or equivalent • Entry level position, no prior experience required • Responsibilities include routine tasks and laboratory procedures • Grade level equivalent to the complexity of work and level of supervision required
PHEAL Technician	• Associate degree in a laboratory science or medical laboratory technology from an accredited institution • Entry level position, no prior experience required • Responsibilities include processing specimens/samples, performing moderate to high complexity testing, and reporting test results • Grade level equivalent to the complexity of work and level of supervision required
PHEAL Scientist	• Bachelor's degree in a laboratory science or medical technology from an accredited institution • Entry level position, no prior experience required • Responsibilities include those of PHEAL technician in addition to other higher level laboratory duties • Grade level equivalent to the complexity of work and level of supervision required

PHEAL Scientist-Supervisor	• Bachelor's degree in a laboratory science or medical technology from an accredited institution or equivalent years of experience • Position attained through hiring or promotions; prior laboratory experience required • Responsibilities include scientific, supervisory and administrative duties • Grade level equivalent to track record and time in grade
PHEAL Scientist-Manager	• Masters or doctoral degree from an accredited institution or equivalent years of experience • Prior scientific and supervisory work experience required in a PHEAL or research laboratory • Responsibilities include developing, overseeing, and consulting on a full range of tests, services, and operations related to a particular field of public health laboratory practice • Grade level equivalent to track record, years of experience in the job, and laboratory-wide managerial responsibilities
PHEAL Developmental Scientist	• Master's or doctoral degree in an appropriate laboratory science from an accredited institution or equivalent years of experience • Prior scientific knowledge, skills, and applied or basic research experience required • Responsibilities include developing new diagnostic assays and technologies, researching and validating new analytical procedures, preparing grant proposals and writing scientific publications as well as providing technical oversight of lower-level developmental scientists • Grade level equivalent to level of supervision, track record, and years experience in the job
Environmental or Agricultural Laboratory Assistant Director, Deputy Director or Director	• Master's or doctoral degree in an appropriate laboratory science from an accredited institution • Six or more years work experience in an environmental or agricultural laboratory • Responsibilities include laboratory-wide scientific, supervisory, and/or managerial duties
Public Health Laboratory Assistant Director or Deputy Director	• Master's or doctoral degree in an appropriate laboratory science from an accredited institution • Six or more years work experience in an environmental or agricultural laboratory • Responsibilities include laboratory-wide scientific, supervisory, and/or managerial duties
Public Health Laboratory Director	• Doctoral degree in an appropriate laboratory science from an accredited institution • Eight years experience working in an appropriate laboratory • National certification and sufficient experience to meet pertinent federal and state qualifications to direct a medical laboratory in one or more laboratory specialties • Responsibilities include laboratory-wide scientific, supervisory, and/or managerial duties

The University of Michigan Institutional Review Board (IRB) reviewed the study design and materials for the 2011 National Laboratory Workforce Capacity Assessment and deemed the study as exempt from ongoing IRB review.

Statistical Analysis

Data were analyzed using Microsoft Excel 2010 and SPSS version 19. Results were tabulated in aggregate for all responses from laboratories and workers from the 50 states, D.C., and Puerto Rico. Descriptive analyses, including frequencies, mean and median values are presented for each survey question. Too few laboratories responded to the LSIP capacity assessment section of the survey to report results.

ORGANIZATIONAL-LEVEL RESULTS

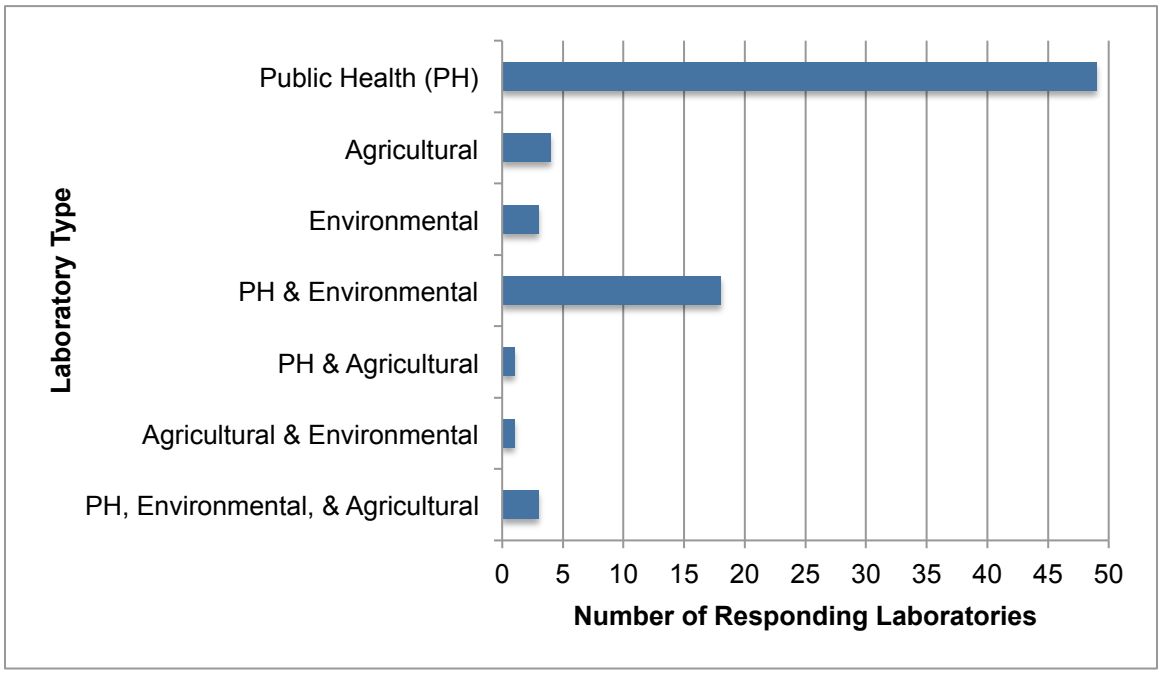
A total of 80 laboratories completed the organizational-level survey for a response rate of 76% (80/105). Some laboratories chose not to answer some of the questions; therefore denominators vary and are identified for each results section.

Laboratory Information

Laboratory Type (n=79)

In response to a "check all that apply" question, 49 laboratories (61%) identified as public health laboratories, while 3 (4%) identified as environmental and 4 (5%) identified as agricultural. Eighteen laboratories (23%) reported being both a public health and environmental laboratory; 3 (4%) laboratories were public health, environmental and agricultural; and 1 (1%) laboratory each was a public health and agricultural laboratory or agricultural and environmental laboratory (Figure 1). Twenty-six responding laboratories were state laboratories; 7 identified as local laboratories; 5 as both state and “other”; 1 as both state and university; 1 as local and “other”; and 1 as state, university, and “other”. No respondents were federal; 39 laboratories did not respond to this part of the question.

Figure 1. Laboratory type, PHEAL respondents- 2011 (n=79 laboratories)



Employee Funding (n=80 laboratories)

On average, 38% of laboratory employees were funded through state funding sources; 21% were funded through local sources, 20% were funded by federal funds, and 19% were funded through fee-for-service. The remaining 2% were funded by other sources.

Workforce Enumeration and Characteristics

The 80 responding laboratories enumerated a total of 6,657 employees, 5,555 (83%) of which were laboratory staff holding one of the eight job classifications identified by the survey. An additional 894 (13%) were administrative staff, which included operational staff, human resources staff and secretarial/administrative staff; and 207 (4%) were information technology staff, defined as staff with an information technology or informatics focus (Table 1).

The number of full-time equivalent scientific laboratory staff were enumerated by laboratory program area. The program areas with the greatest number of employees were environmental chemistry (780; 14%), bacteriology (558; 10%), laboratory administration and operation (533; 10%), and newborn screening (514; 9%). The fewest employees were working in the areas of

agricultural microbiology (74; 1%), clinical chemistry/hematology (70; 1%), laboratory safety and security (64; 1%), parasitology (61; 1%), and mycology (48; 1%). (Table 1.)

Table 1. Number and Percent of Full-Time Equivalent Scientific, Administrative, and Information Technology Staff in PHEALs- 2011

Program Area	Number (%) FTE Employees
Agricultural chemistry	133 (2%)
Agricultural microbiology	74 (1%)
Bacteriology	558 (10%)
Clinical chemistry/hematology	70 (1%)
Education and training	84 (2%)
Emergency preparedness and response	414 (7%)
Environmental microbiology	241 (4%)
Environmental chemistry	780 (14%)
Laboratory administration/ operation	533 (10%)
Laboratory quality assurance	127 (2%)
Laboratory regulation and inspection	343 (6%)
Laboratory safety and/or security	64 (1%)
Molecular biology	286 (5%)
Mycology	48 (1%)
Newborn screening	514 (9%)
Parasitology	61 (1%)
Serology/ immunology	325 (6%)
Toxicology	136 (2%)
Virology	284 (5%)
Other	480 (9%)
Total Scientific Laboratory Staff	**5555**
Administrative Staff	**894**
Information Technology Staff	**207**
TOTAL LABORATORY EMPLOYEES	**6657**

A Bachelor's degree is held by the greatest percentage (60%) of laboratorians, followed by a master's degree (14%) and a doctoral degree (11%). Eight percent (8%) hold high school or equivalent degrees and 6% hold associate's degrees. Only 1% of laboratorians hold professional doctoral degrees (e.g. MD, DVM, DDS). Laboratory scientists comprise the greatest percentage of laboratorians (2885, 59%). 13% (660) are laboratory scientist supervisors, 9% (437) are laboratory technicians, 7% (338) are laboratory aides or assistants, and 6% (303) are laboratory scientist managers. Only 1% (69) are assistant or deputy directors, 2% (103) are directors, and 3% (132) are laboratory development scientists (Table 2).

Table 2. Number of PHEAL workers by laboratory position by degree type

Position: Degree	Aide/ Asst	Technician	Scientist	Scientist supervisor	Scientist manager	Developmental scientist	Asst/deputy director	Director	Total No. (%)
Doctoral degree	1	1	168	67	120	81	30	61	529 (11%)
Professional degree (MD, DVM, DDS)	1	2	21	13	4	3	2	12	58 (1%)
Master's degree	5	9	399	143	83	17	23	22	701 (14%)
Bachelor's degree	70	167	2177	416	94	31	14	5	2974 (60%)
Associate's degree	44	120	94	14	1	0	0	2	275 (6%)
High school/ equivalent	217	138	26	7	1	0	0	1	390 (8%)
Total	338	437	2885	660	303	132	69	103	4927*(100%)
	7%	9%	59%	13%	6%	3%	1%	2%	

*Position and degree information was not reported for 628 laboratorians

The most common fields of study for laboratorians' highest degrees were biology or zoology (26%), microbiology (21%), and analytical chemistry (20%). Thirteen percent hold degrees in medical technology or medical laboratory science and 4% hold degrees in biochemistry. The least common fields were molecular biology (3%) and public health (3%). 9% of laboratorians hold degrees in other fields (Table 3).

Table 3. Degree type by field of study

	Bachelor's degree	Master's degree	Doctoral/ Professional degree	Total No. (%)
Biology or zoology	716 (31%)	69 (14%)	26 (8%)	811 (26%)
Molecular biology	53 (2%)	29 (6%)	24 (8%)	106 (3%)
Microbiology	504 (22%)	77 (16%)	72 (23%)	653 (21%)
Biochemistry	56 (2%)	19 (4%)	38 (12%)	113 (4%)
Analytical chemistry	457 (20%)	86 (18%)	87 (28%)	630 (20%)
Public health	4 (1%)	68 (14%)	17 (5%)	89 (3%)
Medical technology	377 (16%)	31 (7%)	2 (1%)	410 (13%)
Other	136 (6%)	101 (21%)	49 (15%)	286 (9%)
Total	**2303 (100%)**	**480 (100%)**	**315 (100%)**	**3098 (100%)**

Certification and Job Experience

Over half of responding laboratories (54%; 43) reported requiring a minimum level of laboratory experience of entry-level laboratory scientists. Twelve of these 43 laboratories require less than 1 year of experience; 26 of the laboratories require 1-2 years of experience, and 5 of the laboratories require more than 2 years of experience. Just over half of all responding laboratories (51%; 41) require individual-level certification of their workers as a condition of employment for any scientific staff classification, although only one-third (33%; 26) require individual-level licensure as a condition of employment. On average, 27% of doctoral-level laboratory staff hold general or specialty certification, while approximately 35% of master's or bachelor's level laboratory staff hold general or specialty certification.

Capacity Assessment and Performance Measurement

Laboratory Program Area Capacity (n=80 laboratories)

Approximately 98% of responding laboratories reported substantial to full capacity to perform all necessary laboratory activities (Table 4). At least half of responding laboratories reported either no, minimal, or partial capacity to perform activities in the program areas of agricultural chemistry (50%), agricultural microbiology (54%), and education and training (51%). Fewer than 25% of laboratories reported no, minimal, or partial capacity to perform activities in molecular biology (8%), bacteriology (9%), laboratory safety and security (9%), emergency preparedness and response (11%), laboratory administration and operation (14%), serology/immunology (14%), laboratory regulation and inspection (16%), laboratory quality assurance (18%), and virology (24%).

Over 75% of laboratories reported substantial to full capacity to perform activities in emergency preparedness and response (89%), laboratory safety and security (89%), bacteriology (86%), laboratory administration and operation (86%), molecular biology (86%), laboratory quality assurance (83%), and serology/immunology (78%). Fewer than 25% of laboratories reported substantial to full capacity to perform activities in agricultural chemistry (13%), agricultural microbiology (14%), clinical chemistry/hematology (19%), and toxicology (24%).

Table 4. Public health, environmental and agricultural laboratory program area capacity

Program Area	No to partial capacity	Substantial to full capacity	Not Applicable
	No. Labs (%)	No. Labs (%)	No. Labs (%)
Overall	1 (1%)	76 (98%)	N/A (N/A)
Agricultural chemistry	40 (50%)	10 (13%)	30 (38%)
Agricultural microbiology	43 (54%)	11 (14%)	26 (33%)
Bacteriology	7 (9%)	69 (86%)	4 (5%)
Clinical chemistry/ hematology	32 (40%)	15 (19%)	33 (41%)
Education and training	41 (51%)	34 (43%)	5 (6%)
Emergency preparedness and response	9 (11%)	71 (89%)	0 (0%)
Environmental microbiology	28 (35%)	48 (60%)	4 (5%)
Environmental chemistry	21 (26%)	45 (56%)	14 (18%)
Laboratory administration/operation	11 (14%)	69 (86%)	0 (0%)
Laboratory quality assurance	14 (18%)	66 (83%)	0 (0%)
Laboratory regulation and inspection	13 (16%)	51 (64%)	16 (20%)
Laboratory safety and/or security	7 (9%)	71 (89%)	2 (3%)
Molecular biology	6 (8%)	69 (86%)	5 (6%)
Mycology	31 (39%)	35 (44%)	14 (18%)
Newborn screening	28 (35%)	29 (36%)	23 (29%)
Parasitology	30 (38%)	43 (54%)	7 (9%)
Serology/ immunology	11 (14%)	62 (78%)	7 (9%)
Toxicology	36 (45%)	19 (24%)	25 (31%)
Virology	19 (24%)	55 (69%)	6 (8%)

Laboratory Instrumentation (n=80 laboratories)

When asked to rate the overall quality of the instrumentation and equipment in their laboratory on a 5-point scale, 39 laboratories (49%) rated the general quality of laboratory equipment as “good” or “very good”, while the remaining 41 laboratories (51%) rated their instrumentation and equipment as “fair”. No laboratories rated their instrumentation and equipment as “poor” or “very poor”.

Staff Recruitment and Retention

Retention (n=80 laboratories)

A total of 627 laboratory staff retired, resigned, or were released in 2010, which included an average of 7.8 employees leaving their positions per laboratory (range: 0-137 employees; median: 3.5 employees). Seventy laboratories (88%) reported that 15% or less of their workforce retired, resigned, or was released in 2010, while 7 (9%) laboratories reported that that percentage was between 16-25% and 3 (4%) laboratories reported that it was between 26-50%. None of the laboratories reported that more than 50% of their workforce retired, resigned, or was released in 2010.

Over half (53%; 42) of laboratories reported that they anticipate that 15% of their workforce will retire, resign, or be released in the next five years; 27 (34%) laboratories anticipate losing between 16 and 25% of their workforce; and 10 (13%) anticipate losing between 26 and 50% of their workforce during that time period. Only one laboratory (1%) expects to lose more than 75% of their workforce in the next 5 years (Table 5).

Table 5. Proportion of laboratory workers released, retired, or resigned by responding labs in 2010 and over the next 5 years

Proportion of laboratory workforce	Released, retired, or resigned in 2010	Retiring in next 5 years
	No. (%) of Labs	No. (%) of Labs
15% or less	70 (88%)	42 (53%)
16%-25%	7 (9%)	27 (34%)
26%-50%	3 (3%)	10 (12%)
51% or more	0 (0%)	1 (1%)
Total	**80 (100%)**	**80 (100%)**

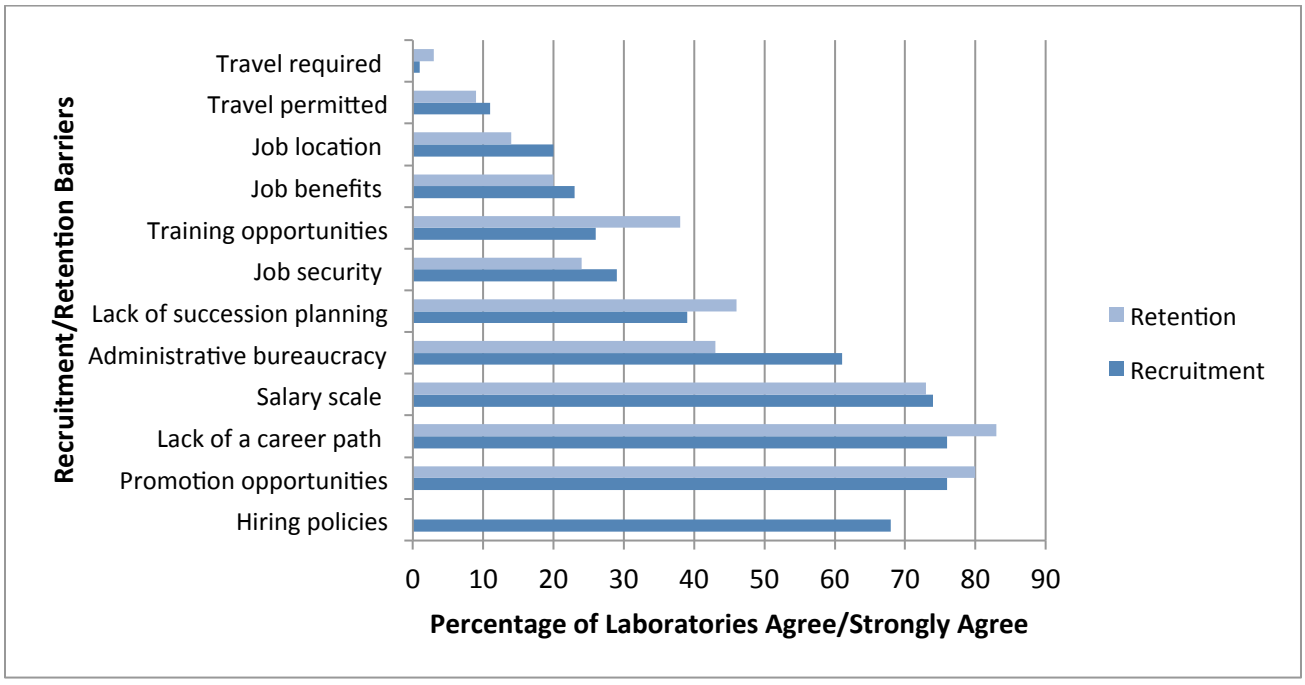
Recruitment and Retention Barriers

The lack of available opportunities for promotion and the lack of a career path for employee growth (61; 76% for each) were the barriers reported to recruitment by the highest percentage of laboratories. Other significant barriers reported to recruitment were the salary scale (59; 74%), policies and procedures for hiring personnel (54; 68%), and the complexity of the administrative bureaucracy (49; 61%). Between 25% and 50% of labs reported lack of succession planning (31;

39%), inadequate opportunities for training and professional development (21; 26%), and poor job security (23; 29%) as recruitment barriers. Fewer than 25% of laboratories reported job benefits (18; 23%), job location (16; 20%), travel permitted by staff (9; 11%), and the travel required of staff (1; 1%) as significant barriers for recruitment.

The same two barriers that were the leading obstacles to recruitment - lack of a career path for employee growth and lack of availability of opportunities for promotion – were reported as the leading obstacles to retention of employees (66; 83% and 64; 80%, respectively). Another significant barrier reported to retention was the salary scale (58; 73%). Between 25% and 50% of laboratories reported lack of succession planning (37; 46%), complexity of administrative bureaucracy (34; 43%), and frequency of opportunities for training and professional development (30; 38%) as retention barriers. Fewer than 25% of laboratories reported job security (19; 24%), job benefits (16; 20%), travel permitted by staff (15; 19%), job location (11; 14%), and the travel required of staff (2; 3%) as significant barriers for retention (Figure 2).

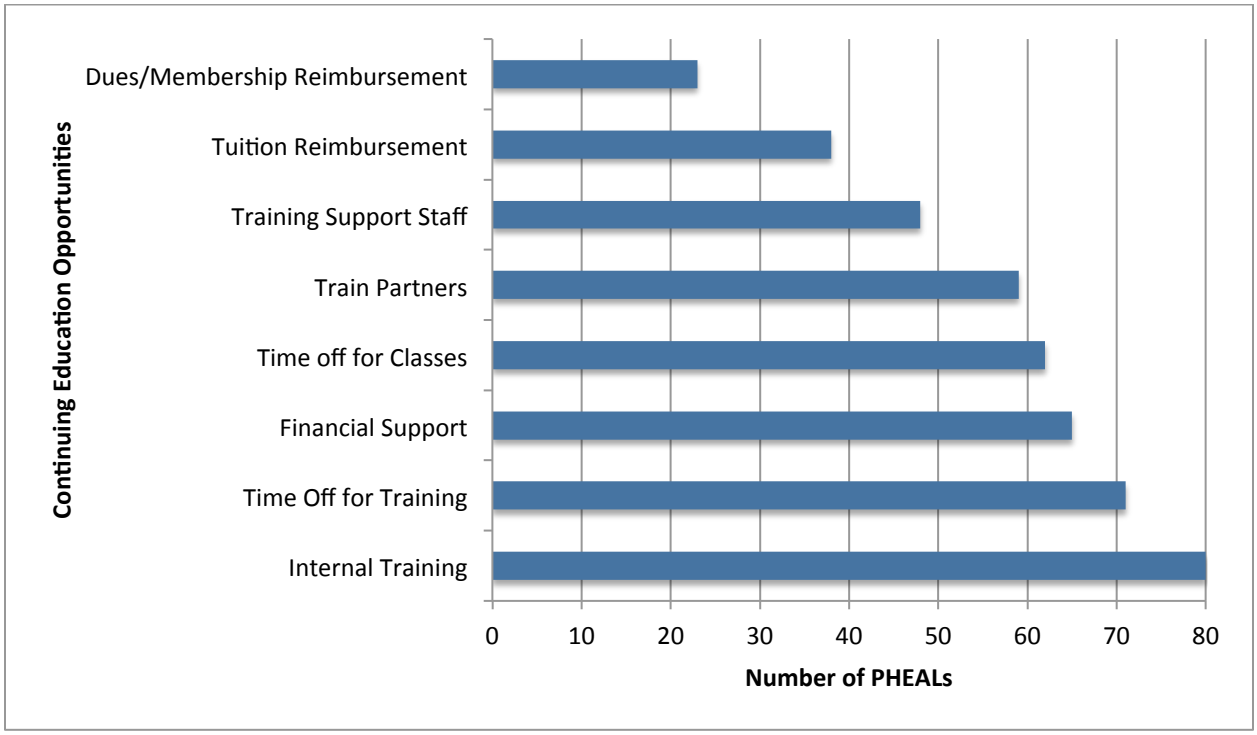
Figure 2. Percentage of laboratories reporting agree/strongly agree for barriers to recruitment and retention



Continuing Education (n=80 laboratories)

When asked whether provisions are made for laboratory staff to pursue continuing education or professional development opportunities, all 80 laboratories reported offering internal training opportunities to staff; 71 (89%) laboratories allow staff to take time off to attend external training or participate in distance learning trainings; 65 (81%) laboratories reported providing financial support for courses, such as registration fees and travel; 62 (78%) laboratories permit staff to take time away from their jobs to attend classes; and 59 (73%) laboratories provide training for local public health laboratory or clinical laboratory partners. Forty-eight (60%) laboratories have support staff positions responsible for monitoring, developing or providing internal training. Fewer than half of laboratories reported providing tuition reimbursement (38; 48%) or reimbursing dues or professional society membership fees (23; 29%). (Figure 3.)

Figure 3. Continuing education opportunities provided by PHEALs for workers



INDIVIDUAL-LEVEL RESULTS

A total of 1,943 PHEAL workers completed the individual-level survey, representing 83 of the 105 (79%) laboratories surveyed. Sixty-six laboratories responded to both the organizational and individual-level surveys, 14 responded to the organizational survey but had no individual-level respondents, 18 had individual-level survey respondents but did not complete an organizational survey, and 7 PHEALs did not participate in either survey. Most of the 22 laboratories that did not have individual-level survey respondents were local public health (11), environmental (4), or agricultural (4) laboratories. The overall individual-level response rate for this survey is approximately 35% (1943/5498) which is an estimate derived from the laboratories which completed the organizational-level survey and provided an enumeration of their workforce. Response denominators for individual questions vary throughout the survey and are noted in the results.

Demographic Profile of Workers in Public Health, Environmental and Agricultural Laboratories

Nearly two-thirds of survey respondents were female (1243; 64%). The mean age of respondents was 46 years (median 48 years). Ages ranged from 19 years to 87 years, with the largest proportion of respondents aged 46 to 55 years. Approximately 71% of respondents identified themselves as White, 11% as Asian, 8% as Black or African American. Fewer than 1% were American Indian/Alaska Native, Native Hawaiian or Pacific Islander. Nearly 2% identified themselves as multiracial, and 7% chose “other” or “don’t know” responses. Nearly 6% of respondents were Hispanic/Latino (Table 6).

Table 6. Age, race and ethnicity profile of laboratory workers	
Age (n=1942)	**No. (%)**
25 years and less	61 (3%)
26-35 years	419 (22%)
36-45 years	379 (20%)
46-55 years	601 (31%)
56-65 years	428 (22%)
More than 65 years	54 (3%)
Race (n=1943)	
White	1387 (71%)
Asian	220 (11%)
Black/African American	154 (8%)
Native Hawaiian/Pacific Islander	11 (1%)
American Indian/Alaska Native	6 (<1%)
Multiracial	32 (2%)
Other/Don't Know	133 (7%)
Ethnicity (n=1943)	
Hispanic/Latino	107 (6%)

Job Classification and Function

Laboratory Type (n=1943 laboratorians)

In response to a "check all that apply" question, 68% (1320) of PHEAL workers identified their laboratory as being a public health laboratory, while 5% (103) worked in an environmental laboratory, and 1% (11) worked in an agricultural laboratory. Sixteen percent (311) of responding laboratorians worked in a public health and environmental laboratory and 1% (15) worked in a combined public health, environmental, and agricultural laboratory. Fewer than 1% identified their laboratory as public health and agricultural or environmental and agricultural. One-hundred eighty respondents did not identify their laboratory type.

Nearly 50% (47%; 920) of PHEAL respondents identified their laboratory as being a state public health laboratory; an additional 86 (4%) laboratorians work in state and university laboratories. Eighty-seven laboratorians worked in local public health laboratories. One percent or fewer of respondents worked identified their laboratory as federal, university, other, or a combination of all setting categories. Nearly 40% (758) of respondents did not identify their laboratory setting.

Job Classification (n=1886 laboratorians)

The survey provided 10 standardized job classifications defined by APHL (see Methods for job classification descriptions). Eight hundred-seventy (46%) PHEAL laboratorians identified themselves as Laboratory Scientists; 342 (18%) were Laboratory Scientist Supervisors; 229 (12%) were Laboratory Technicians; 209 (11%) were Laboratory Scientist-Managers; 103 (6%) were Laboratory Aide/Assistants; 55 respondents were Public Health Laboratory Directors (3%); 39 (2%) were Public Health Laboratory Assistant/Deputy Directors; 27 (1%) were Laboratory Developmental Scientists; 9 (<1%) were Agricultural or Environmental Laboratory Directors; and 3 (<1%) were Agricultural or Environmental Laboratory Assistant/Deputy Directors.

Job Function (n=1869 laboratorians)

When asked to identify the one program area that most closely matched their field of work, 246 (13%) PHEAL workers worked in environmental chemistry; 233 (12%) in bacteriology; 203 (10%) in laboratory administration/operation; 177 (9%) in newborn screening; 162 (8%) in molecular biology; 137 (7%) in virology; 121 (6%) in serology/immunology; 101 (5%) in environmental microbiology; 70 (4%) in laboratory quality assurance and/or continuous quality improvement; 69 (4%) in emergency preparedness and response; 48 (3%) in clinical chemistry/hematology; 35 (2%) in toxicology; and 34 (2%) in mycobacteriology. Fewer than 2% of laboratorians worked in the following program areas: education and training (26; 1%); parasitology (16; 1%); mycology (15; 1%); laboratory regulation and inspection (13; 1%); agricultural chemistry (11; 1%); cytology/cytogenetics (9; 1%); laboratory safety and security (8; <1%); microbiology (8; <1%); and agricultural microbiology (1; <1%). An additional 126 (7%) of PHEAL workers selected “other” program areas.

Education, Training, Competency Assessment and Experience

Job Experience

Over one-quarter of respondents (476/1732; 28%) reported having 5-10 years of work experience in a PHEAL; 365 (20%) had 11-20 years of PHEAL experience, 328 (19%) had 21-30 years of

experience and 137 (8%) had over 30 years of experience working in a PHEAL. Four hundred twenty-six (25%) workers had fewer than 5 years of PHEAL experience.

When asked about laboratory work experience other than their current position, 37% (721/1943) of respondents had a combined average of 4.6 years of prior work experience in a human clinical or hospital laboratory, 25% (481) had an average of 9.8 years of work experience in a university laboratory, 11% had an average of 4.1 years of previous experience in a pharmaceutical/industry laboratory, 10% (199) had an average of 3.8 years of prior work experience in a private research laboratory, and 4% (87) had an average of 3.8 years of work experience in a veterinary laboratory. As for previous PHEAL experience, 386 (20%) had prior experience in a public health laboratory, 15% in an environmental laboratory (293), and 4% (84) in an agricultural laboratory.

Educational Background (n=1865 laboratorians)

Nearly 60% (1147) of PHEAL respondents were trained at the bachelor's degree level; 359 (19%) held master's degrees; 147 (8%) held doctoral degrees; 99 (5%) were trained at the associate's degree level; and 96 (5%) held a high school diploma as their highest level of education. Seventeen workers (1%) held a professional degree such as MD, DVM, or DDS. Biology/zoology was the most common field of study reported for workers' highest degree (378; 20%), followed by microbiology (335; 17%), medical technology (318; 16%), analytical chemistry (180; 9%), public health (85; 4%); biochemistry/genetics (66; 3%), and molecular biology (59; 3%). An additional 372 workers (19%) were trained in an "other" field of study.

Licensure and Certification

Almost half of PHEAL respondents (873/1851) hold a professional license. National generalist certification such as Medical Laboratory Scientist, Medical Technologist, and/or Environmental Laboratory Technologist was held by 402 (22%) of respondents; national specialist certification was held by 146 (8%) laboratorians; state licensure to practice laboratory science was held by 368 (20%) of respondents; and 216 (12%) held "other" laboratory licenses or certifications. Two-hundred twenty-four workers held more than one licensure or certification. Over 30% (613/1859) of PHEAL

respondents reported that licensure was required for their jobs. Over three-quarters (661/873) of the workers who held licensure/certification reported that it had been valuable to them in their current or past laboratory position.

Professional Memberships (n=1845 laboratorians)

Seven hundred thirty-seven (40%) respondents reported holding at least one membership in a professional association, including 261 respondents who reported membership in the American Society for Clinical Pathology, 225 in the Association of Public Health Laboratories, 184 in the American Society for Microbiology, 56 in the American Society for Clinical Laboratory Science 55 in the American Chemical Society, 40 in the American Public Health Association, 36 in the American Association of Bioanalysts, and 36 in American Medical Technologists. One hundred seventy-two respondents held memberships in "other" associations. Two hundred thirty-two respondents held memberships in more than one association.

Academic Courses Taken (n=1800 laboratorians)

PHEAL workers reported whether they had taken formal academic or professional courses selecting from a list of 27 topical areas (Table 7). Half or more of respondents had taken courses in the following: biochemistry (1215; 68%), analytical chemistry (1220; 67%), bacteriology lab (1102; 61%), clinical, medical pathogenic bacteriology (947; 53%), laboratory safety and security (1004; 56%), and immunology (993; 55%).

Fewer than half had taken courses in the following areas: laboratory instrumentation/instrumental analysis (831; 46%), ethics (825; 46%), molecular biology and molecular diagnostics (757; 42%), lab quality assurance, mission evaluation, improvement & regulatory requirements (726; 40%), virology (709; 39%), public health emergency/disaster preparedness and response (679; 38%), environmental science/environmental health (659; 37%), leadership (658; 37%), biostatistics/public health statistics (556; 31%), virology lab (515; 29%), health behavior/health education (469; 26%), environmental/water microbiology (469; 26%), writing grant proposals/scientific publications (406; 23%), epidemiology (371; 21%), lab design workflow and operations (315; 18%), public health

administration, management theory and practice (237; 13%), public health information management systems for data handling/ communications handling/ communications (221; 12%), public health policy in state and federal government (178; 10%), public health laboratory management (175; 10%), design and evaluation of surveillance systems in public health (153; 9%), and public health law (126; 7%).

Self-assessed Competency Level (n=1737 laboratorians)

PHEAL workers were asked to assess their level of competency in the 27 topical areas on a 4-point scale: none, low, moderate, and high (Table 7). Forty percent or more of respondents reported no competence in the following areas: design and evaluation of public health surveillance systems (1086; 63%); public health law (922; 53%), public health administration (858; 49%), public health policy in state and federal government (803; 46%), writing (779; 45%), epidemiology (782; 45%), virology lab (768; 44%), public health information management systems for data handling/communications handling/communications (727; 42%), biostatistics/public health statistics (724; 4%), public health laboratory management (719; 41%), and health education and health behavior (701; 40%). Topical areas with at least one-quarter of respondents reporting high competence were: laboratory safety and security (673; 39%), laboratory instrumentation/instrumental analysis (521; 30%), bacteriology lab (464; 27%), and lab quality assurance, mission evaluation, improvement & regulatory requirements (451; 26%).

Table 7. Percent of PHEAL workers completing academic courses in topical areas and self-assessed competence

Area	Completed coursework (n=1800)	Competency Level (n=1737)			
		None No. (%)	Low No. (%)	Moderate No. (%)	High No. (%)
Analytical chemistry	67%	357 (21%)	458 (26%)	535 (30%)	387 (22%)
Bacteriology laboratory or practicum	61%	459 (26%)	301 (17%)	513 (30%)	464 (27%)
Biochemistry	68%	386 (22%)	544 (31%)	624 (36%)	183 (11%)
Biostatistics/public health statistics	31%	724 (42%)	529 (31%)	408 (24%)	76 (4%)
Clinical, medical, pathogenic bacteriology	53%	531 (30%)	345 (20%)	451 (26%)	410 (24%)
Design and evaluation of surveillance systems in public health	9%	1086 (63%)	426 (25%)	186 (11%)	39 (2%)
Environmental science/ health	37%	561 (32%)	486 (28%)	482 (28%)	208 (12%)
Environmental/water microbiology	26%	649 (37%)	491 (28%)	419 (24%)	178 (10%)
Epidemiology	21%	782 (45%)	539 (31%)	346 (20%)	70 (4%)
Ethics	46%	341 (20%)	356 (20%)	652 (38%)	38 (22%)
Health behavior/health education	26%	701 (40%)	538 (31%)	390 (23%)	108 (6%)
Immunology	55%	519 (30%)	392 (23%)	562 (33%)	264 (15%)
Lab quality assurance	40%	232 (13%)	298 (17%)	756 (44%)	451 (26%)
Lab design, workflow and operations	18%	428 (25%)	468 (27%)	590 (34%)	251 (15%)
Lab instrumentation/ instrumental analysis	46%	231 (13%)	294 (17%)	691 (40%)	521 (30%)
Laboratory safety and security	56%	100 (6%)	192 (11%)	772 (44%)	673 (39%)
Leadership	37%	234 (14%)	321 (19%)	791 (46%)	391 (23%)
Molecular biology and molecular diagnostics	42%	556 (32%)	426 (25%)	445 (26%)	310 (18%)

Public health administration	13%	858 (49%)	464 (27%)	310 (18%)	105 (6%)
Public health emergency/disaster preparedness and response	38%	434 (25%)	511 (29%)	581 (34%)	211 (12%)
Public health information management systems	12%	727 (42%)	547 (32%)	362 (21%)	101 (6%)
Public health laboratory management	10%	719 (41%)	454 (26%)	382 (22%)	182 (11%)
Public health law	7%	922 (53%)	545 (31%)	234 (14%)	36 (2%)
Public health policy in state and federal government	10%	803 (46%)	558 (32%)	323 (19%)	53 (3%)
Virology	39%	673 (39%)	436 (25%)	397 (23%)	231 (13%)
Virology laboratory or practicum	29%	768 (44%)	408 (24%)	349 (20%)	212 (12%)
Writing (grant proposals, scientific publications)	23%	779 (45%)	458 (26%)	369 (21%)	131 (8%)

PHEAL Worker Recruitment, Retention and Retirement

Recruitment Factors (n=1697 laboratorians)

Respondents rated a series of recruitment factors on a 5-point scale: unimportant/not applicable, of little importance, somewhat important, important, and very important. Job security was rated as important or very important by 1481 respondents (87%), followed by benefits packages (1391; 82%), appropriate work/life balance (1377; 81%), and safe/secure work environment (1339; 79%). Between 50-75% of respondents reported that the following recruitment factors were important or very important: providing public service (1339; 69%), competitive salary (1088; 64%), promotional opportunities/career paths (1079, 64%), flexible workdays/work times (1035; 61%), sufficient support staff to efficiently carry out responsibilities (989; 58%), cross-training opportunities (949; 56%), modern laboratory facilities/instrumentation (938; 55%), and opportunity to become a technical expert in a laboratory specialty field (912; 54%). Fewer than 50% of respondents cited the following factors as important or very important for recruitment: continuing education opportunities (833; 49%), limited on-call/weekend rotation (769; 45%), access to online resources (643; 38%), opportunities to participate in applied research or teaching (433; 26%), opportunity for

joint academic appointment at a local university (257; 15%), and onsite child care (141; 8%) (Table 8).

Over 1700 respondents reported source of information about PHEAL jobs, which included professional contacts (724), personal contacts (344), internet advertisements (270), newspaper advertisements (159), and college or professional career fairs (89). One hundred twenty-eight respondents reported "other" methods for learning about PHEAL jobs.

Retention Factors (n=1680 laboratorians)

The factors surveyed for recruitment were also rated by respondents, using the same scale, for worker retention (Table 8). Eighty percent or more of respondents reported job security (1563; 93%), benefits package (1554; 93%), competitive salary (1487; 89%), appropriate work/life balance (1428; 85%), and a safe/secure work environment (1391; 83%) as important or very important for retention. Between 50-75% of respondents reported the following retention factors as important/very important: promotional opportunities/career paths (1243; 74%), flexible workdays/work times (1240; 74%), sufficient support staff to carry out responsibilities (1210; 72%), providing public service (1196; 71%), modern laboratory facilities/instrumentation (1161; 69%), continuing education opportunities (1066; 63%), cross-training opportunities (1012; 60%), opportunity to become a technical expert in a laboratory specialty area (1001; 60%), and limited on-call/weekend rotation (886; 53%). Fewer than 50% of PHEAL workers reported the following retention factors as important or very important: access to online resources (814; 48%), opportunities to participate in applied research/teaching (537; 32%), opportunity for joint academic appointment at a local university (368; 22%), and onsite child care (224; 13%).

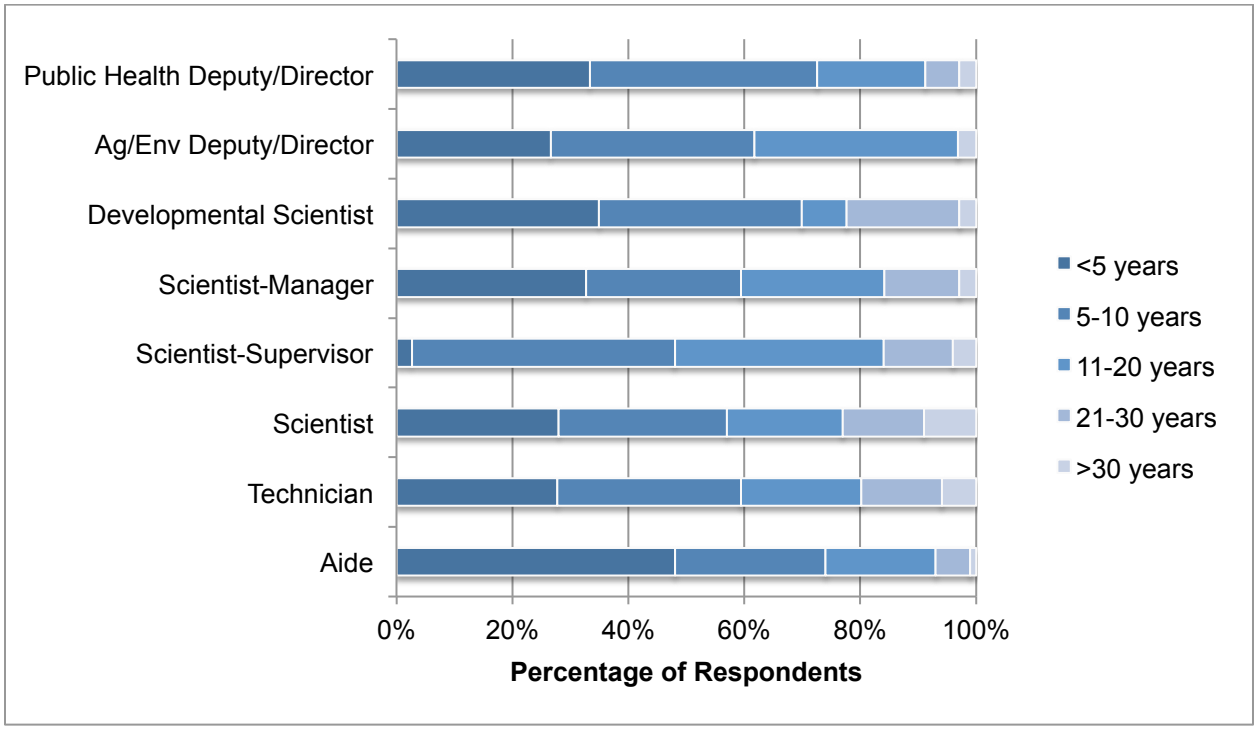
Table 8. Number (percent) of PHEAL workers reporting importance of recruitment and retention factors

Recruitment (n=1697)**/ Retention** (n=1680) **Factor**	**Unimportant/ Not Applicable**		**Of little importance**		**Somewhat important**		**Important**		**Very Important**	
	Rec	**Ret**	**Rec**	**Ret**	**Rec**	**Ret**	**Rec**	**Ret**	**Rec**	**Ret**
Job security	26 (2%)	17 (1%)	28 (2%)	11 (1%)	162 (10%)	89 (5%)	582 (34%)	492 (29%)	899 (53%)	1071 (64%)
Benefits package	44 (3%)	21 (1%)	43 (3%)	13 (1%)	219 (13%)	92 (6%)	582 (34%)	421 (25%)	809 (48%)	1133 (67%)
Appropriate work/life balance	48 (3%)	40 (2%)	54 (3%)	38 (2%)	218 (13%)	174 (10%)	636 (38%)	570 (34%)	741 (44%)	858 (51%)
Safe/secure work environment	46 (2%)	38 (2%)	64 (3%)	45 (3%)	248 (13%)	206 (12%)	680 (35%)	616 (37%)	659 (34%)	775 (46%)
Providing public service	72 (4%)	69 (4%)	136 (8%)	134 (8%)	316 (19%)	281 (17%)	656 (39%)	593 (35%)	517 (31%)	603 (36%)
Competitive salary	82 (5%)	26 (2%)	104 (6%)	36 (2%)	423 (25%)	131 (8%)	606 (36%)	543 (32%)	482 (28%)	944 (56%)
Promotional opportunities/career paths	118 (7%)	95 (6%)	140 (8%)	87 (5%)	360 (21%)	255 (15%)	632 (37%)	553 (33%)	447 (26%)	690 (41%)
Flexible workdays/times	131 (8%)	67 (4%)	196 (12%)	92 (6%)	335 (20%)	281 (17%)	576 (34%)	593 (35%)	459 (27%)	603 (36%)
Sufficient support staff	108 (6%)	54 (3%)	170 (10%)	95 (6%)	430 (25%)	321 (19%)	666 (39%)	687 (41%)	323 (19%)	523 (31%)
Cross-training opportunities	106 (6%)	95 (6%)	208 (12%)	160 (10%)	434 (26%)	413 (25%)	634 (37%)	579 (35%)	315 (19%)	433 (26%)
Modern laboratory facilities/instrumentation	95 (6%)	53 (3%)	191 (11%)	91 (5%)	473 (28%)	375 (22%)	649 (38%)	717 (43%)	289 (17%)	444 (26%)
Opportunity to become a technical expert in a laboratory specialty area	221 (13%)	160 (10%)	189 (11%)	151 (9%)	375 (22%)	368 (22%)	585 (35%)	549 (33%)	327 (19%)	452 (27%)
Continuing education opportunities	119 (7%)	94 (6%)	245 (14%)	150 (9%)	500 (30%)	370 (22%)	536 (32%)	569 (34%)	297 (18%)	497 (30%)
Limited on-call/weekend rotation responsibilities	259 (15%)	175 (10%)	321 (19%)	258 (15%)	348 (21%)	361 (22%)	417 (25%)	443 (26%)	352 (21%)	443 (26%)
Access to online resources	393 (23%)	257 (13%)	254 (15%)	190 (10%)	407 (24%)	419 (22%)	386 (23%)	462 (24%)	257 (15%)	352 (18%)
Opportunities to participate in applied research/teaching	492 (29%)	398 (24%)	394 (23%)	358 (21%)	378 (22%)	387 (23%)	288 (17%)	323 (19%)	145 (9%)	214 (13%)
Opportunity for a joint academic appointment	679 (40%)	572 (34%)	477 (28%)	420 (2%)	284 (17%)	320 (19%)	174 (10%)	216 (13%)	83 (5%)	152 (9%)
Onsite child care	1154 (68%)	1066 (64%)	241 (14%)	222 (13%)	161 (10%)	168 (10%)	74 (4%)	110 (7%)	67 (4%)	114 (7%)

Retirement (n=1730 laboratorians)

When asked how many more years they planned to work in a PHEAL, 100 respondents (6%) reported less than one year, while 185 (11%) reported planning to work 1-2 more years in a PHEAL, 230 (13%) plan 3-4 more years, 529 (31%) plan 5-10 more years, 375 (22%) plan 11-20 more years, 211 (12%) plan to work 21-30 more years and 100 (6%) plan to work more than 30 additional years in a PHEAL. By job classification, approximately 48% (39/81) of laboratory aide/assistant respondents plan to work less than 5 more years in a PHEAL, as are 28% (55/195) of laboratory technicians, 28% (226/815) of laboratory scientists, 28% (89/320) of laboratory scientist-supervisors, 33% of laboratory scientist- managers (63/192), and 36% (9/25) of laboratory developmental scientists. Approximately 33% (1/3) and 22% (2/9) of environmental and agricultural deputy laboratory directors and director respondents will work in a PHEAL for fewer than 5 more years, respectively. Thirty-two percent (12/37) of public health laboratory deputy directors will depart a PHEAL in less than 5 years, as will 36% (19/53) public health laboratory director respondents. Figure 4 shows the number of additional years respondents in each job category plan to work in a PHEAL by percentage.

Figure 4. Number of additional years respondents plan to work in a PHEAL by job category



Salary Ranges (n=1943 laboratorians)

Overall, the majority of PHEAL workers had annual salaries of between $25,000-$65,000. Sixty workers (3%) reported a salary of less than $25,000; 754 (38%) reported salaries between $25,000-$45,000; an additional 744 (38%) had salaries between $45,000-$65,000; 264 (14%) workers had salaries between $65,000-$85,000; and 121 (6%) had salaries above $85,000 (Table 9).

Table 9. Number and percent of workers in each salary range, by PHEAL job classification (n=1886)

	<$25,0000	**$25,000.01-$45,000**	**$45,000.01-$65,000**	**$65,000.01-$85,000**	**$85,000.01-$105,000**	**>$105,000**	**Total**
Aide/Assistant	24 (23%)	66 (64%)	11 (11%)	2 (2%)	0 (0%)	0 (0%)	103 (100%)
Technician	24 (11%)	139 (61%)	59 (26%)	6 (3%)	1 (<1%)	0 (%)	229 (100%)
Scientist	4 (1%)	445 (62%)	337 (39%)	74 (9%)	8 (1%)	1 (<1%)	870 (100%)
Scientist-Supervisor	0 (0%)	65 (19%)	185 (54%)	75 (22%)	17 (5%)	0 (0%)	342 (100%)
Scientist-Manager	0 (0%)	10 (5%)	111 (53%)	66 (32%)	17 (8%)	5(2%)	209 (100%)
Developmental Scientist	0 (0%)	5 (19%)	12 (44%)	6 (22%)	2 (7%)	2 (7%)	27 (100%)
Agricultural/ Environmental Deputy Director	0 (0%)	0 (0%)	0 (0%)	2 (67%)	1 (33%)	0 (0%)	3 (100%)
Agricultural/ Environmental Director	0 (0%)	1 (11%)	1 (11%)	3 (33%)	2 (22%)	2 (22%)	9 (100%)
Public Health Deputy Director	0 (0%)	2 (6%)	9 (23%)	13 (33%)	9 (23%)	6 (15%)	39 (100%)
Public Health Director	0 (0%)	1 (2%)	1 (2%)	10 (18%)	19 (35%)	24 (44%)	55 (100%)

Job and Workplace Satisfaction

Respondents (n=1717) were asked to rate their level of agreement with several statements related to their job and work environment (Table 10). Half or more of respondents agreed or strongly agreed with the following statements:

- Providing public service is an important reason why I continue to work in this career (1322; 77%).
- I am satisfied with my career working in PHEALs to date (1120; 65%)
- I am satisfied in my current laboratory position (1018; 59%)
- I support efforts to implement standardized PHEAL job titles, job descriptions, and career paths (1010; 59%)

Fewer than half of PHEAL respondents agreed or strongly agreed with the following statements;

- I would pursue an advanced degree in laboratory science if I could do so in my current employment (826; 48%)
- I have a desire to become a laboratory manager or director (596; 34%)
- My laboratory provides a sufficient number of technical and professional job classifications (534; 31%)
- My laboratory provides a sufficient number of pay grade levels within the job classifications (364; 21%)
- My laboratory's current technical and professional job classifications support employee retention and succession planning (286; 17%)
- There are sufficient opportunities for me to pursue higher education and progress to a Laboratory Director position (261; 15%)

Table 10. Job and workplace satisfaction ratings by PHEAL workers (n=1717)

Statement	Strongly Disagree/ Disagree	Neutral	Agree/ Strongly Agree	Not Applicable
I am satisfied in my current laboratory position	355 (21%)	339 (20%)	1018 (59%)	5 (<1%)
I am satisfied with my career working in PHEALs to date	260 (15%)	333 (19%)	1120 (65%)	4 (<1%)
Providing public service is an important reason why I continue to work in this career	98 (6%)	288 (17%)	1322 (77%)	9 (1%)
I have a desire to become a laboratory manager or director	596 (35%)	461 (27%)	586 (34%)	74 (4%)
There are sufficient opportunities for me to pursue higher education and progress to a Laboratory Director position	909 (53%)	482 (28%)	261 (15%)	65 (4%)
I would pursue an advanced degree in a laboratory science if I could do so in my current employment	394 (23%)	421 (25%)	826 (48%)	76 (4%)
My laboratory provides a sufficient number of technical and professional job classifications	731 (43%)	440 (26%)	534 (31%)	12 (1%)
My laboratory provides a sufficient number of pay grade levels within the job classifications	989 (58%)	353 (21%)	364 (21%)	11 (1%)
My laboratory's set of job classifications provide career advancement options, including supervisory and applied research/technology development paths	1013 (59%)	366 (21%)	323 (19%)	15 (1%)
My laboratory's current technical and professional job classifications support employee retention and succession planning	925 (54%)	489 (28%)	286 (17%)	17 (1%)
I support efforts to implement standardized PHEAL job titles, job descriptions, and career paths nationally	107 (6%)	569 (33%)	1010 (59%)	31 (2%)

CONCLUSIONS

I. National laboratory infrastructure is below optimal capacity in many areas.

- A significant portion of PHEALs reported low capacity (i.e., no, minimal or only partial capacity) to perform activities in the program areas of:
  - Agricultural microbiology (54% of labs reported low capacity)
  - Agricultural chemistry (50%)
  - Toxicology (45%)
- Fewer than 25% of laboratories reported high capacity (i.e., substantial or full capacity) to perform activities in agricultural chemistry (13%), agricultural microbiology (14%), clinical chemistry/hematology (19%), and toxicology (24%).
- Over half of responding laboratories (51%) report no, minimal or only partial capacity to provide education and training to their workers.
- Slightly over half of laboratories (51%) rated the overall quality of their equipment and instrumentation as “fair”.

II. The education and training of the PHEAL workforce needs to be strengthened.

- Only 1% of the laboratory workforce possesses a professional doctoral degree (e.g. MD, DVM, DDS), which is substantially lower than for most other occupational classifications in public health.
- Only one-quarter (26%) of the laboratorian workforce has a graduate (i.e. doctorate or masters) or professional doctoral degree.
- Approximately three-quarters (74%) of the laboratory workforce has a bachelors (60%), associate degree (6%) or high school equivalency (8%).
- Laboratorian respondents self-evaluated low competence (40% or more indicating “No Competence”) in many critical areas including:
  - Design/evaluation of surveillance systems (63% of respondents reported no competence)
  - Public health law (53%)

  - Public health administration (49%)
  - Public health policy in state and federal government (46%)
  - Writing (45%)
  - Epidemiology (45%)
  - Virology lab (44%)
  - Public health information management systems for data handling (42%)
  - Biostatistics (42%)
  - Public health laboratory management (41%)
  - Health education/health behavior (40%)
- In addition, at least 50% of the laboratorian respondents self-evaluated low or no competence in multiple areas including:
  - Environmental/water microbiology (65%)
  - Virology (64%)
  - Environmental health science (60%)
  - Molecular biology and diagnostics (57%)
  - Emergency preparedness (54%)
  - Lab design, workflow, operations (52%)
  - Biochemistry (53%)
  - Immunology (53%)
  - Clinical, medical, pathogenic bacteriology (50%)
- Lack of training opportunities was reported as a barrier to recruitment by 26% of laboratories and as a barrier to retention by 38% of laboratories.
- Availability of training opportunities was reported as important/very important to recruitment of well-qualified laboratorians by 54% of individual respondents and to retention of laboratorians by 64%.

III. Laboratories face significant challenges in maintaining and enhancing the workforce pipeline.

- 30% of individual laboratorian respondents plan to leave the workforce within the next 4 years.
- 25% of laboratory workers are older than 55 years.
- 10 labs reported losing more than 15% of their workforce in 2010; 38 labs anticipate losing more than 15% of their workforce in the next 5 years.
- The greatest recruitment/retention barriers according to laboratories are: lack of a career path (76% and 83% reported barrier for recruitment and retention, respectively), promotion opportunities (76% and 80%, respectively), and salary scale (74% and 73%, respectively).
- The greatest barriers to recruitment/retention according to workers were: lack of job security (87% and 93% reported important/very important for recruitment and retention, respectively), inadequate benefits package (82% and 93%, respectively), poor work/life balance (81% and 85%, respectively), and lack of safe/secure work environment (79% and 83%, respectively).
- Laboratories lack a standard set of commonly agreed upon job classifications to use when assessing the laboratory workforce.

IV. The national laboratory workforce lacks racial diversity, particularly in leadership positions.

- Less than 15% of the laboratory workforce self-identified as Black/African American, Native Hawaiian/Pacific Islander, or Hispanic/Latino.
- Over three-quarters (81%) of the laboratorian workforce self-identifies as either White or Asian.
- 90% of senior-level PHEAL administrators (Directors and Deputy Directors) are Non-Hispanic White.

DISCUSSION

In its 2002 report "The Future of the Public's Health in the 21st Century," the Institute of Medicine recommended that the federal government, "periodically assess the preparedness of the public health workforce, to document the training necessary to meet basic competency expectations, and to advise on the funding necessary to provide such training."[12] A necessary prerequisite for this undertaking is to enumerate and regularly monitor the size and composition of the U.S. public health workforce using methods that are repeatable, affordable, and consistent over time as part of a larger effort to assess the national health workforce overall.

Laboratorians, and the PHEAL network in which they serve, are a critical component of our national public health infrastructure. Despite this, a national enumeration has not been previously attempted for this segment of the public health workforce. This 2011 National Laboratory Workforce Capacity Assessment provides the first comprehensive summary of the size and composition of the national PHEAL workforce using data collected at both the organizational and individual worker levels. Because this is the initial attempt to characterize the PHEAL workforce, there are no trend data available from earlier surveys to use for comparison purposes. This highlights the importance of developing plans to regularly and systematically monitor the national laboratory workforce in order to assess the impact of investment and advocate for additional resources, identify gaps in the workforce pipeline, inform recruitment and retention efforts, guide competency compliance and credentialing initiatives, permit better alignment of academic resources with workforce needs, and allow for a better understanding between workforce infrastructure and specific health outcomes.

This assessment revealed national laboratory capacity is low in several areas but especially so in agricultural laboratory services, toxicology, and in the general area of laboratory worker education and training. APHL and key partners like the National Association of County and City Health Officials, Association of State and Territorial Health Officials, CDC, and others should work together to develop strategies to improve capacity in these areas specifically, and attain

optimal capacity in all program areas generally. Consideration should be given to the use of federal preparedness funding to address critical areas of program weakness in the national laboratory system since these relate directly to our nation's readiness to respond to emergencies and other public health threats. Importantly, the development of quantifiable goals against which national laboratory capacity can be assessed will also be essential to this effort. APHL and CDC previously developed the Laboratory Systems Improvement Program (LSIP) as a basis for evaluating performance and a section of the survey asked about their use in this survey. However, so few laboratories responded to this portion of the survey that the LSIP data is excluded from this report. This likely indicates that PHEALs are either not using the LSIP standards, aren't aware of them, or some combination thereof. If the intent is to encourage widespread implementation of LSIP standards, then much more needs to be done to market the standards and to educate laboratorians as to what they are and how they should be used to assess and improve laboratory performance. In order to visibly demonstrate the value of meeting LSIP standards and attaining full capacity in all laboratory program areas, consideration should be given to profiling model local and state laboratories or laboratory systems which have high-performing infrastructure based on LSIP standards and other standardized assessment tools.

The education and training of current lab workers was a notable area of weakness based on the findings of this survey. In order to improve core competencies for lab workers, the APHL, CDC, and state and local partners should encourage the continued development and implementation of competency-based learning models using nationally-accepted standards for applied laboratory training. These competencies should be integrated into the academic curriculum of schools and programs of public health through active engagement of the Association of Schools of Public Health (ASPH) in their development and to better insure their implementation. Any future assessment of the national laboratory workforce should include a thorough evaluation of worker skills and abilities employing a competency framework, similar to the methods used for assessing competency of epidemiologists in state health departments.[13] Directly related to the issue of laboratory worker education and training, is the need to increase the number and type

of laboratory science degree offerings in schools and programs of public health. For example, there is currently no academic doctoral program in public health laboratory science and practice at any school of public health nationwide. Strategies need to be developed by APHL in collaboration with key partners like ASPH and CDC to both sustain existing programs and to envision ways to create new ones. One method for accomplishing this could involve the formation of educational consortiums across states, universities or schools to share responsibility and resources for maintaining laboratory science training programs. Alternatives to formal degree programs for providing laboratory training should be also explored including reduced-credit certificate programs which could be offered through use of distance technologies and the development of more training and educational opportunities offered through community colleges at the associate degree level. Given the survey's finding indicating dearth of laboratorians with doctoral level training, many of whom occupy positions of leadership in laboratories, special focus should be placed on preserving and expanding doctoral programs in laboratory science augmented by enhanced marketing and recruitment efforts to increase student enrollment in these programs. Finally, CDC may wish to consider increasing the number of positions available through the highly-regarded CDC Emerging Infectious Disease Fellowship program for both master's and doctoral level trainees, accompanied by an expansion in the number of trainee placements in state and local government laboratories to help address pipeline issues.

The assessment findings revealed a pronounced lack of diversity of the national laboratory workforce, with relatively few underrepresented minorities, especially in positions of laboratory leadership. Strategies should be developed collaboratively among APHL, CDC, NACCHO, ASTHO, and ASPH to increase the diversity of the laboratory workforce. An important first step might entail convening a minority recruitment task force comprising individuals from all these organizations focused on attracting underrepresented minorities to the field of laboratory science. This could be coordinated with special outreach activities at schools and programs of public health to recruit minorities to enroll in public health graduate programs generally, and graduate laboratory science programs, specifically. APHL may wish to consider the designation

of a staff person to concentrate their efforts on assisting state and local PHEALs with minority recruitment, retention, and promotion planning.

The findings provided in this report are subject to several limitations. The information on reported capacity, strengths and barriers is self-assessed data and subject to all the biases known to accompany therewith. The methods employed by organizational-level survey respondents to calculate this information likely varied. The response rate to the organizational-level survey of PHEALs was 76% and it is possible that responding laboratories differed in a systematic way from non-responding laboratories, which would impact the generalizability of survey results and their interpretation. The same limitation exists for the individual-level survey, which garnered a 35% response rate. Finally, survey administration was limited to public health, environmental, and agricultural laboratories which were organizational members of APHL at the time of the survey. There are other PHEAL laboratories which were not members and therefore not surveyed, although this number is estimated to be small relative to the number of PHEALs which are APHL members at the time of this assessment.

RECOMMENDATIONS

1) Develop strategies to attain full capacity in all laboratory program areas.
    - The US Centers for Disease Control and Prevention (CDC) and the APHL should use findings of this assessment to develop quantifiable goals for improving laboratory infrastructure and capacity.
    - APHL should enhance marketing efforts to further awareness and encourage use of Laboratory System Improvement Plan (LSIP) standards by all public health laboratories as a means for assessing laboratory performance and capacity needs.
    - Through public health preparedness funding, CDC and other federal agencies should support states in attaining full capacity in the following areas of need: agricultural chemistry, agricultural microbiology, education and training, and toxicology.
    - In order to demonstrate the value of optimal laboratory capacity, CDC and APHL should profile model states with high-level laboratory infrastructure that employ a well-integrated PHEAL system.
    - Local, state and federal agencies responsible for insuring adequate laboratory capacity should engage in ongoing discussions to develop methodologies for addressing structural deficiencies in the PHEAL network.

2) Develop training and educational opportunities to improve core competencies for current lab workers.
    - APHL, CDC, and state and local partners should encourage development and implementation of competency-based learning models using nationally accepted standards for applied laboratory training.
    - Work should continue, with input from APHL, CDC, and the Association of Schools of Public Health (ASPH), to establish competencies with applicability in public health practice and academic public health.
    - Future national laboratory capacity assessments should incorporate an evaluation of worker competency using a standardized framework.

3) Increase the number of laboratory science degree programs in schools and programs of public health.
    - APHL should partner with ASPH to develop strategies to prevent further erosion of laboratory training programs while also focusing on sustaining existing programs.
    - APHL should encourage universities and states to form educational consortiums to share responsibility and resource commitment to support laboratory training programs.
    - Schools and programs of public health should be encouraged to consider developing reduced-credit certificate programs in laboratory science to increase training opportunities for laboratory workers.
    - APHL should explore opportunities for community colleges to provide laboratory training at the associate's degree level.
    - Special focus should be placed on preserving and expanding existing doctoral programs for laboratorians, including the development of innovative recruitment strategies to increase student enrollment.
    - CDC should consider expanding the Emerging Infectious Disease (EID) program for masters and doctoral trainees, accompanied by a significant expansion of training placements in state and local governmental PHEALs.

4) Conduct regular monitoring of the size and composition of the national public health laboratory workforce.
    - APHL, CDC, and other responsible federal entities should commit to the conduct of future periodic assessments of the national PHEAL workforce using a methodology that is repeatable, affordable, and consistent over time.
    - Future assessments of the national PHEAL workforce should be refined to include evaluation of worker competency and collect additional information related to job functions performed by laboratory workers, in addition to measures of program area, information technology, and automated surveillance capacity at the organizational level.

- APHL should support and participate in efforts being led by the University of Michigan Center of Excellence in Public Health Workforce Studies to standardize methods for continuous monitoring of the size and composition of the national public health workforce.

5) Devise strategies to increase the diversity of the laboratory workforce, especially in leadership positions.
    - APHL should consider convening a minority task force to specifically focus on development of strategies to increase the diversity of the national laboratory workforce.
    - Schools and programs of public health should be strongly encouraged to develop special outreach efforts to recruit underrepresented minorities to graduate degree programs, especially doctoral degree programs, in laboratory science.
    - APHL should consider designating a staff person to focus specifically on assisting PHEALs with minority recruitment, retention, and promotion.

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APPENDIX 1: ORGANIZATIONAL-LEVEL SURVEY TOOL

National Laboratory Workforce Capacity Assessment

Survey of Laboratory Directors

Developed by the Association of Public Health Laboratories in partnership with the University of Michigan Center of Excellence in Public Health Workforce Studies

Frequently Asked Questions

National Laboratory Workforce Capacity Assessment

What is the purpose of this study?
The University of Michigan School of Public Health (UM SPH) will assist the Association of Public Health Laboratories (APHL) in the development and distribution of a survey to Laboratory Directors and other scientific laboratory staff in public health, environmental and agricultural laboratories in the United States as part of a research study to enumerate, characterize and assess capacity of the national public health laboratory workforce. The APHL Workforce Development Committee, consisting of APHL staff and public health laboratory officials, will provide oversight and guidance to the project. The results of this survey will help inform APHL member agencies, public health officials and policymakers about national public health laboratory workforce capacity.

What will I be asked to do?
You will be asked questions about organizational information about the laboratory; assess program area capacity, capacity to perform public health laboratory services, and performance measurement; provide an enumeration and characterization of the laboratory's employees; identify factors in recruiting and retaining scientific laboratory staff; and determine whether the laboratory supports continuing education and professional development opportunities for staff.

You will be asked to complete this survey anonymously using multiple choice and fill in the blank questions about the following topics: demographics, salary, education and training, perceived competences; and recruitment and retention information. You will complete the survey through the secure MRInterview system.

If you have any questions regarding the survey, please contact:

Deborah Kim, MPH
Association of Public Health Laboratories
Survey and Research Manager
240-485-2742
Deborah.kim@ahpl.org

Thanks in advance for completing the survey!

Definitions

The following terms will be used in this survey. Please read the definitions below.

PHEAL – Public Health, Environmental, or Agricultural Laboratory
PH – Public Health

Job Category
Scientific staff: all staff who perform laboratory services and procedures and can be categorized into one of the following job classifications:

PHEAL Aide/Assistant:

- High school diploma or equivalent
- Entry level position, no prior experience required
- Responsibilities include routine tasks and laboratory procedures
- Grade level equivalent to the complexity of work and level of supervision required

PHEAL Technician:
- Associate degree in a laboratory science or medical laboratory technology from an accredited institution
- Entry level position, no prior experience required
- Responsibilities include processing specimens/samples, performing moderate to high complexity testing, and reporting test results
- Grade level equivalent to the complexity of work and level of supervision required

PHEAL Scientist:
- Bachelors degree in a laboratory science or medical technology from an accredited institution
- Entry level position, no prior experience required
- Responsibilities include those of PHEAL technician in addition to other higher level laboratory duties
- Grade level equivalent to the complexity of work and level of supervision required

PHEAL Scientist-Supervisor:
- Bachelors degree in a laboratory science or medical technology from an accredited institution or equivalent years of experience
- Position attained through hiring or promotions; prior laboratory experience required
- Responsibilities include scientific, supervisory and administrative duties
- Grade level equivalent to track record and time in grade

PHEAL Scientist-Manager:
- Masters or doctoral degree from an accredited institution or equivalent years of experience
- Prior scientific and supervisory work experience required in a PHEAL or research laboratory
- Responsibilities include developing, overseeing, and consulting on a full range of tests, services, and operations related to a particular field of public health laboratory practice
- Grade level equivalent to track record, years of experience in the job, and laboratory-wide managerial responsibilities

PHEAL Developmental Scientist:
- Masters or doctoral degree in an appropriate laboratory science from an accredited institution or equivalent years of experience
- Prior scientific knowledge, skills, and applied or basic research experience required
- Responsibilities include developing new diagnostic assays and technologies, researching and validating new analytical procedures, preparing grant proposals and writing scientific publications as well as providing technical oversight of lower-level developmental scientists
- Grade level equivalent to level of supervision, track record, and years experience in the job

Environmental or Agricultural Laboratory Assistant Director, Deputy Director or Director:

- Masters or doctoral degree in an appropriate laboratory science from an accredited institution
- Six or more years work experience in an environmental or agricultural laboratory
- Responsibilities include laboratory-wide scientific, supervisory, and/or managerial duties

Public Health Laboratory Assistant Director or Deputy Director

- Masters or doctoral degree in an appropriate laboratory science from an accredited institution
- Six or more years work experience in an environmental or agricultural laboratory
- Responsibilities include laboratory-wide scientific, supervisory, and/or managerial duties

Public Health Laboratory Director

- Doctoral degree in an appropriate laboratory science from an accredited institution
- Eight years experience working in an appropriate laboratory
- National certification and sufficient experience to meet pertinent federal and state qualifications to direct a medical laboratory in one or more laboratory specialties
- Responsibilities include laboratory-wide scientific, supervisory, and/or managerial duties

I. Organizational Information

1. What type of laboratory do you direct? Please check all that apply.
   - ○ Agricultural
   - ○ Environmental
   - ○ Federal
   - ○ Local
   - ○ Public health
   - ○ State
   - ○ University
   - ○ Other

2. What percentage of your scientific laboratory employees are funded by the following funding sources? (Responses should add to 100%.)

   _____ Federal
   _____ State (including Medicaid)
   _____ Local/County/City
   _____ Fee for Service
   _____ Other

3. Overall, how would you rate the quality of the instrumentation and equipment in your laboratory?

   ○Very Poor ○Poor ○Fair ○Good ○Very Good

II. Capacity Assessment and Performance Measurement

4. What is your laboratory's in-house capacity to perform necessary activities and services in the following program areas? Please use this scale to assess capacity:

   None: 0% capacity to perform
   Minimal Capacity: 1%-24% capacity to perform
   Partial Capacity: 25%-49% capacity to perform
   Substantial Capacity: 50%-74% capacity to perform
   Almost Full Capacity: 75%-99% capacity to perform
   Full Capacity: 100% capacity to perform
   N/A: program area is not applicable to our laboratory

Program Area	Capacity Level
Agricultural chemistry (e.g., feeds, pesticides, foods)	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A
Agricultural microbiology (e.g., foods and feeds, animal diagnostic testing)	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A
Bacteriology	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A
Clinical chemistry/hematology	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A
Education and training (e.g. lab-conducted workshops; post-	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A

doc/fellowship rotations)	
Emergency preparedness and response	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A
Environmental microbiology (e.g., food, dairy, shellfish, water)	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A
Environmental chemistry (inorganics, organics, radiation, trace metals, air quality)	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A
Laboratory administration/ operation	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A
Laboratory quality assurance and/or continuing quality improvement	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A
Laboratory regulation and inspection	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A
Laboratory safety and/or security	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A
Molecular biology	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A
Mycology	
Newborn screening	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A
Parasitology	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A
Serology/immunology	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A
Toxicology	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A
Virology	○None ○Minimal ○Partial ○Substantial ○Almost Full ○Full ○N/A

5. Please provide an overall summary rating of your laboratory's capacity to perform necessary activities and services in all program areas.

   None: 0% capacity to perform
   Minimal Capacity: 1%-24% capacity to perform
   Partial Capacity: 25%-49% capacity to perform
   Substantial Capacity: 50%-74% capacity to perform
   Almost Full Capacity: 75%-99% capacity to perform
   Full Capacity: 100% capacity to perform

6. Has your laboratory participated in the Laboratory System Improvement Plan (LSIP) assessment?
   - Yes
   - No (skip to question 8)

   6.a. Is your laboratory using the LSIP indicators?
   - Yes
   - No (skip to question 8)

7. Please rate the capacity to perform or address each of the following Laboratory System Improvement Plan (LSIP) indicators in your laboratory. Please use this scale to assess capacity:

None: no capacity to perform

Minimal Capacity: 1%-24% capacity to perform
Partial Capacity: 25%-49% capacity to perform
Substantial Capacity: 50%-74% capacity to perform
Almost Full Capacity: 75%-99% capacity to perform
Full Capacity: 100% capacity to perform
N/A: activity is not applicable to our laboratory

LSIP Indicator	Capacity Level						
Surveillance Systems and Data Management							
Identify sentinel health events and trends through interoperable laboratory information systems	○None	○Minimal	○Partial	○Substantial	○Almost Full	○Full	○N/A
Utilize a comprehensive system of gathering data, organisms and samples to support evaluating community and environmental health	○None	○Minimal	○Partial	○Substantial	○Almost Full	○Full	○N/A
Contribute data on identified/detected infectious diseases to a statewide surveillance system	○None	○Minimal	○Partial	○Substantial	○Almost Full	○Full	○N/A
Monitoring Community Health Status							
Support monitoring of congenital, inherited and metabolic diseases of PH significance	○None	○Minimal	○Partial	○Substantial	○Almost Full	○Full	○N/A
Generate reliable information about chronic diseases of PH significance	○None	○Minimal	○Partial	○Substantial	○Almost Full	○Full	○N/A
Disseminate reliable information about chronic diseases of PH significance	○None	○Minimal	○Partial	○Substantial	○Almost Full	○Full	○N/A
Provide high quality services to diagnose, investigate, and monitor health problems and hazards	○None	○Minimal	○Partial	○Substantial	○Almost Full	○Full	○N/A
Collaboration and Communication							
Participate in national surveillance systems for state and national linkage	○None	○Minimal	○Partial	○Substantial	○Almost Full	○Full	○N/A
Engage in networks that collaborate in the epidemiological investigation of and response to natural and man-made disasters	○None	○Minimal	○Partial	○Substantial	○Almost Full	○Full	○N/A
Have an identified system of outreach and communication to inform professional networks about relevant health issues	○None	○Minimal	○Partial	○Substantial	○Almost Full	○Full	○N/A
Workforce Development							
Assess competencies of the workforce	○None	○Minimal	○Partial	○Substantial	○Almost Full	○Full	○N/A
Identify staff development needs	○None	○Minimal	○Partial	○Substantial	○Almost Full	○Full	○N/A
Address workforce shortage issues	○None	○Minimal	○Partial	○Substantial	○Almost Full	○Full	○N/A
Research							
Engage in research activities	○None	○Minimal	○Partial	○Substantial	○Almost Full	○Full	○N/A
Evaluate research to foster improvement and innovation	○None	○Minimal	○Partial	○Substantial	○Almost Full	○Full	○N/A
Disseminate research outcomes and best practices	○None	○Minimal	○Partial	○Substantial	○Almost Full	○Full	○N/A

8. In 2010, how many total tests, excluding newborn screenings, were performed by your laboratory?

9. The following questions relate to the number of newborn tests that were conducted by your laboratory.
    a. In 2010, how many newborn samples did your laboratory receive for screening?
    b. In 2010, how many confirmed disorders were reported by your laboratory?
    c. How many dedicated FTEs (including technical and clerical staff) are employed in your newborn screening laboratory?

10. In 2010, how many pulsed-field gel electrophoresis (PFGE) patterns did your laboratory upload to PulseNet?

11. How many dedicated technical staff FTEs worked in your PFGE laboratory in 2010?

12. In 2010, how many formal laboratory-based publications were authored by one or more of your laboratory staff?
    - Peer-reviewed publications
    - Technical reports
    - Posters
    - Abstracts
    - Scientific presentations
    - Other – please specify:

III. Workforce Enumeration and Characteristics

13. Please provide the number of scientific laboratory staff in each job category based on the highest-level degree they have attained.

	Laboratory Aide/Assistant	Laboratory Technician	Laboratory Scientist	Laboratory Scientist-Supervisor	Laboratory Scientist Manager	Laboratory Developmental Scientist	Assistant or Deputy Director	Director	Total
A) PhD, DrPH, DSc, ScD, or other doctoral degree									
B) Professional degree (MD, DVM, DDS)									
C) MS, MPH, MBA, MPA, MPP or other master's degree									
D) BS, BA or other bachelor's degree									
E) Associate's degree									
F) High school or equivalent									
G) Total									

14. Please provide the number of scientific laboratory staff holding a Bachelors, Masters, or Doctoral Degree as their highest degree in the following fields.

	Bachelors	**Masters**	**Doctoral/Professional**	**Total**
A) Biology or zoology				
B) Molecular biology				
C) Microbiology				
D) Biochemistry/genetics				
E) Analytical chemistry				
F) Public health				
G) Medical Technology/ Medical Laboratory Science				
H) Other				
I) Total	(Equal to Q13 Row D total)	(Equal to Q13 Row C total)	(Equal to Q13 Rows A&B total)	

15. Of the scientific staff in your laboratory, how many FTEs work in the following program areas? (Can break down to 0.25 FTE)
    _____ Agricultural chemistry (e.g., feeds, pesticides, foods)
    _____ Agricultural microbiology (e.g., foods and feeds, animal diagnostic testing)
    _____ Bacteriology
    _____ Clinical chemistry/hematology
    _____ Education and training (e.g., lab-conducted workshops; post-doc/fellowship ' rotations)
    _____ Emergency preparedness and response
    _____ Environmental microbiology (e.g., food, dairy, shellfish, water)
    _____ Environmental chemistry (inorganics, organics, radiation, trace metals, air quality)
    _____ Laboratory administration/operation
    _____ Laboratory quality assurance and/or continuing quality improvement
    _____ Laboratory regulation and inspection
    _____ Laboratory safety and/or security
    _____ Molecular biology
    _____ Mycology
    _____ Newborn screening
    _____ Parasitology
    _____ Serology/immunology
    _____ Toxicology
    _____ Virology
    _____ Other
    _____ Total (should equal Q13 Row G total)

16. How many **administrative support** employees work in your laboratory?

17. How many **Information Technology/Informatics** staff work in your laboratory?

18. How many **total employees**, including administrative support, Information Technology/Informatics, and scientific staff, work in your laboratory?

19. Do you require a minimum level of laboratory experience for entry-level laboratory scientists?
    - o Yes
    - o No- please skip to #20

    19.a. How many years?
    - o Less than 1
    - o 1-2
    - o Greater than 2

20. Does your lab require **individual-level certification** as a condition of employment for any scientific staff classification?
    - o Yes
    - o No

21. Does your lab require **individual-level licensure** as a condition of employment for any scientific staff classification?
    - o Yes

- No

22. What proportion of doctoral-level laboratory staff has general or specialty certification?

23. What proportion of master's or bachelor's-level laboratory staff has general or specialty certification?

IV. Recruitment and Retention of Staff

24. How many laboratory staff were released (e.g., terminated, RIF), retired, or resigned in 2010 (provide nearest whole number of FTE staff)?

25. What proportion of your laboratory workforce was released (e.g., terminated, RIF), retired, or resigned in 2010?
    - 15% or less
    - 16-25%
    - 26-50%
    - 51- 75%
    - Over 75%

26. What proportion of your laboratory workforce do you anticipate retiring in the next 5 years?
    - 15% or less
    - 16-25%
    - 26-50%
    - 51- 75%
    - Over 75%

27. How much do you agree or disagree with the following barriers to **recruitment of scientific staff to your laboratory**?

Policies and procedures for hiring personnel are a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
The salary scale for employees is a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
The job benefits offered to employees are a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
Job security is a barrier (e.g. potential for layoffs)	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
Complexity of administrative bureaucracy	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
Job location is a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree

The travel required of staff is a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
The travel permitted by staff is a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
The frequency of opportunities for training and professional development is a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
The availability of opportunities for promotion is a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
The lack of a career path for employee growth is a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
Lack of succession planning is a barrier (e.g. planning future leadership changes)	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree

28. How much do you agree or disagree with the following statements regarding barriers to **retention of scientific staff in your laboratory**?

Personnel policies and procedures are a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
The salary scale for employees is a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
The job benefits offered to employees are a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
Job security is a barrier (e.g. potential for layoffs)	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
Complexity of administrative bureaucracy	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
Job location is a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
The travel required of staff is a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
The travel permitted by staff is a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
The frequency of opportunities for training and professional development is a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
The availability of opportunities for promotion is a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree

The lack of a career path for employee growth is a barrier	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree
Lack of succession planning is a barrier (e.g. planning future leadership changes)	○Strongly Disagree ○Disagree ○Neutral ○Agree ○Strongly Agree

V. Continuing Education and Professional Development

29. Does your laboratory make any of the following provisions to support continuing education or professional development for your employees?

Financial support for courses (registration fees, travel to courses, etc.)	○Yes ○No
Internal training opportunities offered to staff	○Yes ○No
Provide training for local public health laboratory or clinical laboratory partners	○Yes ○No
Reimburse dues or professional society memberships for your staff	○Yes ○No
Support staff positions responsible for monitoring, developing or providing internal training	○Yes ○No
Time away from job to attend classes	○Yes ○No
Time off to attend external trainings or participate in distance learning trainings	○Yes ○No
Tuition reimbursement	○Yes ○No

Thank you for completing the survey!

APPENDIX 2: INDIVIDUAL-LEVEL SURVEY TOOL

National Laboratory Workforce Capacity Assessment

Survey of Laboratorians

Developed by the Association of Public Health Laboratories in partnership with the University of Michigan Center of Excellence in Public Health Workforce Studies

Frequently Asked Questions

National Laboratory Workforce Capacity Assessment

What is the purpose of this study?
The first step in meeting challenges to recruiting, retaining, and adequately compensating current and future public health, environmental, and agricultural laboratory staff is to characterize the existing workforce in these laboratories. The University of Michigan School of Public Health and the Association of Public Health Laboratories (APHL's) Workforce development Committee have developed a survey to help carry out this characterization. This survey is directed to you as an employee of one of these laboratories. Your input, along with that of your peers, will be the basis for analysis and publications to help inform and direct APHL, APHL members, public health officials and policymakers as they identify and implement solutions to the challenges facing our laboratory workforce.

What will I be asked to do?
You will be asked to complete this survey anonymously using multiple choice and fill in the blank questions about the following topics: demographics, salary, education and training, perceived competences; and recruitment and retention information. You will complete the survey through the secure MRInterview system.

If you have any questions regarding the survey, please contact:

Deborah Kim, MPH
Association of Public Health Laboratories
Survey and Research Manager
240-485-2742
Deborah.kim@ahpl.org

Thanks in advance for completing the survey!

Definitions

The following terms will be used in this survey. Please read the definitions below.

PHEAL – Public Health, Environmental, or Agricultural Laboratory
PH – Public Health

Job Category
Scientific staff: all staff who perform laboratory services and procedures and can be categorized into one of the following job classifications:

PHEAL Aide/Assistant:
- High school diploma or equivalent
- Entry level position, no prior experience required
- Responsibilities include routine tasks and laboratory procedures
- Grade level equivalent to the complexity of work and level of supervision required

PHEAL Technician:
- Associate degree in a laboratory science or medical laboratory technology from an accredited institution
- Entry level position, no prior experience required
- Responsibilities include processing specimens/samples, performing moderate to high complexity testing, and reporting test results
- Grade level equivalent to the complexity of work and level of supervision required

PHEAL Scientist:
- Bachelors degree in a laboratory science or medical technology from an accredited institution
- Entry level position, no prior experience required
- Responsibilities include those of PHEAL technician in addition to other higher level laboratory duties
- Grade level equivalent to the complexity of work and level of supervision required

PHEAL Scientist-Supervisor:
- Bachelors degree in a laboratory science or medical technology from an accredited institution or equivalent years of experience
- Position attained through hiring or promotions; prior laboratory experience required
- Responsibilities include scientific, supervisory and administrative duties
- Grade level equivalent to track record and time in grade

PHEAL Scientist-Manager:
- Masters or doctoral degree from an accredited institution or equivalent years of experience
- Prior scientific and supervisory work experience required in a PHEAL or research laboratory
- Responsibilities include developing, overseeing, and consulting on a full range of tests, services, and operations related to a particular field of public health laboratory practice
- Grade level equivalent to track record, years of experience in the job, and laboratory-wide managerial responsibilities

PHEAL Developmental Scientist:
- Masters or doctoral degree in an appropriate laboratory science from an accredited institution or equivalent years of experience
- Prior scientific knowledge, skills, and applied or basic research experience required
- Responsibilities include developing new diagnostic assays and technologies, researching and validating new analytical procedures, preparing grant proposals and writing scientific publications as well as providing technical oversight of lower-level developmental scientists
- Grade level equivalent to level of supervision, track record, and years experience in the job

Environmental or Agricultural Laboratory Assistant Director, Deputy Director or Director:
- Masters or doctoral degree in an appropriate laboratory science from an accredited institution
- Six or more years work experience in an environmental or agricultural laboratory

- Responsibilities include laboratory-wide scientific, supervisory, and/or managerial duties

Public Health Laboratory Assistant Director or Deputy Director

- Masters or doctoral degree in an appropriate laboratory science from an accredited institution
- Six or more years work experience in an environmental or agricultural laboratory
- Responsibilities include laboratory-wide scientific, supervisory, and/or managerial duties

Public Health Laboratory Director

- Doctoral degree in an appropriate laboratory science from an accredited institution
- Eight years experience working in an appropriate laboratory
- National certification and sufficient experience to meet pertinent federal and state qualifications to direct a medical laboratory in one or more laboratory specialties
- Responsibilities include laboratory-wide scientific, supervisory, and/or managerial duties

I. Demographic Information

30. What is your current age in years?

31. What is your race/ethnicity? Please check all that apply.
- American Indian or Alaska Native
- Asian
- Black or African American
- Native Hawaiian or Other Pacific Islander
- White
- Hispanic or Latino
- Other- please specify:

32. Are you?
- Male
- Female

33. In your current PHEAL position, what is your annual salary?
- <$25,000
- $25,000 - $35,000
- $35,000.01 - $45,000
- $45,000.01 - $55,000
- $55,000.01 - $65,000
- $65,000.01 - $75,000
- $75,000.01 - $85,000
- $85,000.01 - $95,000
- $95,000.01- $105,000
- $105,000.01 - $115,000
- $115,000.01 - $125,000
- $125,000.01 - $135,000
- $135,000.01-$145,000
- >$145,000

II. Employment Information

34. In what state is your laboratory located?

35. What is the name of the laboratory in which you work?

36. In which type of laboratory are you currently employed? Please check all that apply.

- Public health
- Environmental
- Agricultural
- Federal
- State
- Local
- University
- Other

37. Other than your current place of employment, have you worked in any of the following types of laboratories throughout your career? Please check all that apply.

    - o Human clinical or hospital laboratory→ How many years have you worked there?
    - o Public health laboratory
    - o Environmental laboratory
    - o Agricultural laboratory
    - o Veterinary laboratory → How many years have you worked there?
    - o Private research laboratory → How many years have you worked there?
    - o Pharmaceutical/Industry laboratory →How many years have you worked there?
    - o University research laboratory →How many years have you worked there?

38. What is your current job classification: Please use the glossary for definitions of the job classifications. Please choose ONE that most closely matches your current position.

    - o Laboratory Aide/Assistant
    - o Laboratory Technician
    - o Laboratory Scientist
    - o Laboratory Scientist-Supervisor
    - o Laboratory Scientist- Manager
    - o Laboratory Developmental Scientist
    - o Agricultural or Environment Assistant/Deputy Director
    - o Public Health Assistant/Deputy Director
    - o Agricultural/Environmental Director
    - o Public Health Director

39. In which area do you spend the majority of your time? Please choose ONE that most closely matches your field of work.

    - o Agricultural chemistry (e.g., feeds, pesticides, foods)
    - o Agricultural microbiology (e.g., foods and feeds, animal diagnostic testing)
    - o Bacteriology
    - o Clinical chemistry/hematology
    - o Education and training (e.g., lab-conducted workshops; post-doc/fellowship rotations)
    - o Emergency preparedness and response
    - o Environmental microbiology (e.g., food, dairy, shellfish, water)
    - o Environmental chemistry (e.g., inorganics, organics, radiation, trace metals, air quality)
    - o Laboratory administration/operation
    - o Laboratory quality assurance and/or continuing quality improvement
    - o Laboratory regulation and inspection
    - o Laboratory safety and/or security
    - o Molecular biology
    - o Mycology
    - o Newborn screening
    - o Parasitology
    - o Serology/immunology
    - o Toxicology
    - o Virology
    - o Other-please specify:

III. Education/Training/Certification

40. Please check your **highest level of education.** Please choose one.
    - o High school diploma/GED
    - o Associate's degree
    - o BS, BA, or other bachelor's degree
    - o MS, MPH, MBA, MPA, MPP or other master's degree
    - o PhD, DrPH, DSc, ScD
    - o Professional degree (MD, DVM, DDS)

    11.a. In what **field of study** is your highest degree?. Please choose one.
        - o Biology/ zoology
        - o Molecular biology
        - o Microbiology
        - o Biochemistry/ genetics
        - o Analytical chemistry
        - o Public Health
        - o Medical Technology
        - o Other – please specify:
        - o Not applicable

41. Are you required to hold licensure or certification for your current position?
    - o Yes
    - o No

42. Which of the following licenses/certifications do you currently hold? Please check all that apply.
    - o National generalist certification such as Medical Laboratory Scientist, Medical Technologist, Environmental Laboratory Technologist (ASCP BOC, AMT, AAB, ISCLT, NREP)
    - o National specialist certification, such as Microbiology, Molecular Biology or Analytical Chemistry (ABMM, ABMLI, NRCM, AAB, ASCP BOC)
    - o Licensure by a state entity to practice laboratory science
    - o Other lab licenses or certifications
    - o I do not currently hold any licenses or certifications

43. Has certification proven valuable to you in your current or past lab employment (i.e. hiring, enhanced pay, promotion)?
    - o Yes
    - o No
    - o I have never held any certifications

44. In which of the following professional societies do you hold a current membership? Please check all that apply.
    - o American Association for Clinical Chemistry
    - o American Association of Bioanalysts
    - o American Chemical Society
    - o American Medical Technologists
    - o American Public Health Association
    - o American Society for Clinical Laboratory Science
    - o American Society for Clinical Pathology

- American Society for Microbiology
- Association for Molecular Pathology
- Association of Public Health Laboratories
- Other
- I do not currently hold any professional society membership

45. Which of the following **formal academic or professional courses** have you taken?

Courses	Course Taken
Analytical chemistry	○ Yes ○No
Bacteriology laboratory or practicum	○ Yes ○No
Biochemistry	○ Yes ○No
Biostatistics/public health statistics	○ Yes ○No
Clinical, medical, pathogenic bacteriology	○ Yes ○No
Design and evaluation of surveillance systems in public health	○ Yes ○No
Environmental science/environmental health	○ Yes ○No
Environmental/water microbiology	○ Yes ○No
Epidemiology	○ Yes ○No
Ethics	○ Yes ○No
Health behavior/health education	○ Yes ○No
Immunology	○ Yes ○No
Lab quality assurance, mission evaluation, improvement & regulatory requirements	○ Yes ○No
Laboratory design, workflow and operations	○ Yes ○No
Laboratory instrumentation/instrumental analysis	○ Yes ○No
Laboratory safety and security	○ Yes ○No
Leadership	○ Yes ○No
Molecular biology and molecular diagnostics	○ Yes ○No
Public health administration, management theory and practice	○ Yes ○No
Public health emergency/disaster preparedness and response	○ Yes ○No
Public health information management systems for data handling/communications	○ Yes ○No
Public health laboratory management	○ Yes ○No
Public health law	○ Yes ○No
Public health policy in state and federal government	○ Yes ○No
Virology	○ Yes ○No
Virology laboratory or practicum	○ Yes ○No
Writing (grant proposals, scientific publications)	○ Yes ○No

46. Please rate your level of competence in the following areas.

Areas	Competence Level
Analytical chemistry	○None ○Low ○Moderate ○High
Bacteriology laboratory or practicum	○None ○Low ○Moderate ○High
Biochemistry	○None ○Low ○Moderate ○High
Biostatistics/public health statistics	○None ○Low ○Moderate ○High
Clinical, medical, pathogenic bacteriology	○None ○Low ○Moderate ○High
Design and evaluation of surveillance systems in public health	○None ○Low ○Moderate ○High
Environmental science/environmental health	○None ○Low ○Moderate ○High
Environmental/water microbiology	○None ○Low ○Moderate ○High
Epidemiology	○None ○Low ○Moderate ○High
Ethics	○None ○Low ○Moderate ○High
Health behavior/health education	○None ○Low ○Moderate ○High
Immunology	○None ○Low ○Moderate ○High
Lab quality assurance, mission evaluation, improvement & regulatory requirements	○None ○Low ○Moderate ○High
Laboratory design, workflow and operations	○None ○Low ○Moderate ○High
Laboratory instrumentation/instrumental analysis	○None ○Low ○Moderate ○High
Laboratory safety and security	○None ○Low ○Moderate ○High
Leadership	○None ○Low ○Moderate ○High
Molecular biology and molecular diagnostics	○None ○Low ○Moderate ○High
Public health administration, management theory and practice	○None ○Low ○Moderate ○High
Public health emergency/disaster preparedness and response	○None ○Low ○Moderate ○High
Public health information management systems for data handling/communications	○None ○Low ○Moderate ○High
Public health laboratory management	○None ○Low ○Moderate ○High
Public health law	○None ○Low ○Moderate ○High
Public health policy in state and federal government	○None ○Low ○Moderate ○High
Virology	○None ○Low ○Moderate ○High
Virology laboratory or practicum	○None ○Low ○Moderate ○High
Writing (grant proposals, scientific publications)	○None ○Low ○Moderate ○High

IV. Recruitment and Retention

47. How many years of experience do you have working in one or more PHEAL?
    - ○ <1 year
    - ○ 1-2 years
    - ○ 3-4 years
    - ○ 5-10 years
    - ○ 11-20 years
    - ○ 21-30 years
    - ○ >30 years

48. Approximately how many more years do you plan to work in a PHEAL?
    - ○ <1 year
    - ○ 1-2 years
    - ○ 3-4 years
    - ○ 5-10 years
    - ○ 11-20 years
    - ○ 21-30 years
    - ○ >30 years

49. How much do you agree or disagree with the following statements?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Applicable
I am satisfied in my current laboratory position	○	○	○	○	○	○
I am satisfied with my career working in PHEALs to date	○	○	○	○	○	○
Providing public service is an important reason why I continue to work in this career	○	○	○	○	○	○
I have a desire to become a laboratory manager or director	○	○	○	○	○	○
There are sufficient opportunities for me to pursue higher education and progress to a Laboratory Director position	○	○	○	○	○	○
I would pursue an advanced degree in a laboratory science if I could do so in my current employment	○	○	○	○	○	○
My laboratory provides a sufficient number of technical and professional job classifications	○	○	○	○	○	○
My laboratory provides a sufficient number of pay grade levels within the job classifications	○	○	○	○	○	○
My laboratory's set of job classifications provide career advancement options, including supervisory and applied	○	○	○	○	○	○

research/technology development paths						
My laboratory's current technical and professional job classifications support employee retention and succession planning	○	○	○	○	○	○
I support efforts to implement standardized PHEAL job titles, job descriptions, and career paths nationally	○	○	○	○	○	○

50. I learned about PHEAL jobs from: Please check all that apply.
    - ○ Professional contact
    - ○ Personal contact
    - ○ Newspaper advertisement
    - ○ Internet advertisement
    - ○ College or professional career fair
    - ○ Other

51. **RECRUITMENT:** How important were the following items when you were **recruited** as a PHEAL employee?

	Unimportant/ Not applicable	Of Little Importance	Somewhat Important	Important	Very Important
Benefits package – govt. pension, paid holidays, parking, medical/dental plans etc.	○	○	○	○	○
Competitive salary	○	○	○	○	○
Continuing education opportunities	○	○	○	○	○
Cross-training opportunities	○	○	○	○	○
Flexible workdays/work times	○	○	○	○	○
Job security	○	○	○	○	○
Sufficient support staff to efficiently carry out responsibilities	○	○	○	○	○
Modern laboratory facilities/instrumentation	○	○	○	○	○
Opportunity for a joint academic appointment at a local university	○	○	○	○	○
Limited on-call/weekend rotation responsibilities	○	○	○	○	○
Opportunities to participate in applied	○	○	○	○	○

research/teaching					
Opportunity to become a technical expert in a laboratory specialty area	○	○	○	○	○
Promotional opportunities/career paths	○	○	○	○	○
Providing public service	○	○	○	○	○
Safe/secure work environment	○	○	○	○	○
Appropriate life/work balance	○	○	○	○	○
Onsite child care	○	○	○	○	○
Access to online resources	○	○	○	○	○

52. **RETENTION:** How important are the following items when choosing whether to **remain** in a PHEAL career? Please do not base your answers on what your laboratory currently provides.

	Unimportant	Of Little Importance	Somewhat Important	Important	Very Important
Benefits package – govt. pension, paid holidays, parking, medical/dental plans etc.	○	○	○	○	○
Competitive salary	○	○	○	○	○
Continuing education opportunities	○	○	○	○	○
Cross-training opportunities	○	○	○	○	○
Flexible workdays/work times	○	○	○	○	○
Job security	○	○	○	○	○
Sufficient support staff to efficiently carry out responsibilities	○	○	○	○	○
Modern laboratory facilities/instrumentation	○	○	○	○	○
Opportunity for a joint academic appointment at a local university	○	○	○	○	○
Limited on-call/weekend rotation responsibilities	○	○	○	○	○
Opportunities to participate in applied	○	○	○	○	○

research/teaching					
Opportunity to become a technical expert in a laboratory specialty area	○	○	○	○	○
Promotional opportunities/career paths	○	○	○	○	○
Providing public service	○	○	○	○	○
Safe/secure work environment	○	○	○	○	○
Appropriate life/work balance	○	○	○	○	○
Onsite child care	○	○	○	○	○
Access to online resources	○	○	○	○	○

Thank you for completing the survey!