Developing a Doctoral Program in Public Health Laboratory Science and Practice

Workforce Development Committee

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In this document, the term "public health laboratory" encompasses all governmental health laboratories that protect the public's health including state and local public health laboratories, environmental laboratories, and agricultural laboratories.

Workforce Shortage

Public health laboratorians serve on the front line of defense against infectious disease outbreaks, foodborne illness, chemical exposures, hereditary disorders, terrorist threats, environmental hazards and natural disasters. Although these scientists make up only about 1% (5,555)[1] of the total public health workforce (448,254),[2] their work is critical to everyone's health.

Until recently, a scientific or professional doctoral degree was the accepted credential for a leadership position in a public health laboratory. These degrees conferred the basic scientific knowledge needed to direct specialty areas in a research or clinical laboratory. However, over time the responsibilities of public health laboratory directors have broadened to the point where a doctoral degree in a scientific discipline is no longer adequate preparation. Public health laboratory scientist-managers and directors now require a broad education to carry out a range of complex professional duties that include disease surveillance, prevention and control; integrated data management; environmental health and protection; food safety; laboratory law and regulations development; public policy development; public health emergency preparedness and response; training and educating the next generation of public health laboratory scientists; and developing and maintaining partnerships and communications.[2]

Despite increasing demand for qualified public health laboratory leaders, a shortage of American laboratory professionals (i.e., scientists, scientist-supervisors, scientist-managers, and directors) has persisted for more than a decade.[3-7] As of October 24, 2012, 11 of the 50 state public health laboratory directorships were vacant.

Unlike nursing and epidemiology, there is no doctoral-level degree program in public health laboratory science and practice. Recent Association of Public Health Laboratories (APHL) research[8] indicates that current and future public health laboratory leaders lack the academic training—and presumably the related workplace competencies—necessary to ensure success in their profession. This is especially notable in the areas of leadership and management. A dedicated doctoral program is urgently needed to ensure a future workforce of capable public health laboratory leaders.

Background

From the 1960s through the mid-1980s, the School of Public Health at the University of North Carolina (UNC) in Chapel Hill and the Centers for Disease Control and Prevention (CDC) in Atlanta jointly operated a program that produced Doctors of Public Health in public health laboratory science and practice.[9] Academic courses were conducted at UNC and doctoral research in Atlanta. The cost of this three- to four-year, full-time, on-campus doctoral program eventually led to its demise. Since then, the US has lacked an academic program to prepare public health laboratory leaders.

The UNC-CDC program trained two generations of public health laboratory directors, some of whom are still working. Yet, by 2005, APHL identified an alarming reality: the loss of a formal academic pipeline was contributing to a shortage of qualified public health laboratory scientists, supervisors, scientist-managers and directors. In response, APHL elevated *workforce development* to the top objective of its strategic plan, a position it still retains.

As a result of APHL's increased emphasis on workforce development, a team of senior public health laboratory scientists and managers participated in the National Public Health Leadership Institute at UNC. Starting in 2005, this yearlong program allowed each team to identify and conduct in-depth research on an aspect of laboratory practice. In 2006, the APHL team's research project identified the academic courses essential for sitting public health laboratory directors to succeed.[10] This work began a multi-component APHL research program that supports the development of data and products needed to expand the public health laboratory workforce pipeline, with a goal of reducing the chronic shortage of qualified laboratory leaders.

In 2007, APHL re-activated its Workforce Development Committee, which developed a mission focused upon: 1) workforce development and research; 2) training, consulting and partnerships; and 3) professional development. A new subcommittee, the Workforce Research and Pipeline Subcommittee (WRAPS), was given primary responsibility for establishing a multi-component workforce research program that includes: workforce characterization; personnel standards and career paths; competitive compensation; core competencies; core education and training requirements; professional certification; recruitment and retention; mentoring and succession planning; and marketing the profession.

For the past five years, WRAPS and its partners have researched and published (or have in press) a half-dozen papers and reports covering personnel standards,[11] workforce characterization,[1,12] compensation,[13,14] and educational requirements.[8,10] These studies are the groundwork for the future objectives of the public health laboratory workforce pipeline expansion.

Next, a set of workplace competencies for scientific and technical employees of public health laboratories will be developed and vetted nationally. In 2011, WRAPS developed a preliminary draft of core competencies and with it, gained the interest and support of CDC. In September and October of 2012, APHL and CDC convened joint meetings to develop a full set of public health laboratory workplace competencies and initiate the national vetting process. These competencies are a foundation for academic institutions and training entities to develop didactic courses and curricula in public health laboratory science and practice.

Also during 2011-2012, APHL's executive director, Scott Becker, and the Workforce Development Committee authorized Dr. David Smalley, a committee member, to contact several academic institutions to gauge their interest in establishing a doctoral program in public health laboratory science and practice. With workforce characterization and core-course research findings in hand, and core competencies under development, APHL members believe it is time to move forward and develop this needed doctoral program.

Avoiding Pitfalls by Applying the New Research on Education

Based on lessons learned from the UNC-CDC's old public health doctoral program and from APHL's recent research, it is clear that the success of a new degree program hinges upon its cost-effectiveness. APHL believes that a practical way to restructure the UNC-CDC doctoral program model is to remove the on-campus component completely.

As studies have shown, the steep cost of higher education has placed it in crisis, causing potential students to question the value.

> "According to a survey sponsored by *Time Magazine* and the Carnegie Corporation of New York, 89% of [1,000] US adults and 96% of [540] senior administrators at colleges and universities said higher education is in crisis, and nearly 4 in 10 in both groups considered the crisis to be 'severe.' . . . Likewise, members of the general population were twice as likely as college leaders to say that college isn't worth the price: 80% of US adults agreed that at many colleges, the education that students receive is not worth what they pay for it." (Sanburn, J. Higher-Education Poll. 2012. *Time Magazine*, Oct. 18, 2012.)

This is particularly true for potential students with full-time positions and families, who need to worry about the loss of income and the effects of uprooting their families. However, fortunately, as a result of improved teaching methods and technology, there are now avenues for economical, effective higher education.

> "More and more, higher education is transforming from closed, instructor-led classrooms to open, student-directed communities of learning. College-level content is accessible anywhere and anytime. ... Learning will be augmented through new technologies to create and simulate the real world." (Chang, A.L. Higher Education: the Future. 2011. *Microbe*, 6(6):256-257.)

Research suggests and experience shows that students are capable of completing high quality coursework through modern distance learning programs; and, in the case of this proposed degree program, can readily conduct doctoral research within existing, well-equipped public health laboratories. This design will eliminate a large portion of the cost to a university, and bring many benefits to the students and laboratories.

1. Public health laboratories as doctoral research sites

Maintaining modern laboratory facilities and laboratory-based faculty-scientists is one of the most expensive aspects of providing a graduate education in a scientific field. For the last 30 years, this steep cost has caused undergraduate and graduate schools to reduce or eliminate laboratory-based courses. It is essential for a student in a public health laboratory science and practice doctoral program to conduct research in a modern facility. Fortunately, the availability of fully functioning federal, state and local public health laboratories throughout the nation makes it unnecessary for an academic partner to establish or expand laboratories on a university campus.

Public health laboratories are multi-million-dollar operations containing many specialty laboratories. Since a student's doctoral research will require access to a wide range of specialty public health laboratories, as well as the scientists trained in these specialized, high-tech areas, it makes sense to partner with the nation's public health laboratories. Not requiring students to conduct research on a university campus will also help employees return to graduate school more easily, as they will be able to maintain their current employment and housing.

Having graduate students onsite provides many advantages to federal (e.g., CDC, EPA, FDA, USDA), state, and local public health laboratories and their employees. CDC and a number of state laboratories have expressed informal interest in opening their facilities to doctoral students in a public health laboratory science and practice program. Some of the advantages to these facilities include increased opportunities for employee professional development (e.g., as students, trainers, mentors, researchers, adjunct faculty), academic-practice partnerships, higher employee morale and retention rates, applied public health research findings, research publications, and grant proposal justifications and resources.

An academic institution's cost for using a public health laboratory as a student research site would be minimal and probably limited to the costs of a possible accrediting inspection and/or credentialing laboratory staff as adjunct faculty and/or student mentors. The costs to a public health laboratory would also be minimal and may include allowing an employee to spend some percentage of his or her workweek as a student, providing student access to existing equipment and reagents, and allowing a number of employees to serve as adjunct faculty and student mentors. Over time the laboratory would make up these costs by not losing an experienced employee to graduate school, by lower employee turnover, and by improved employee expertise and organizational succession planning.

2. Distance learning as a major program strategy

The Workforce Development Committee believes that, to justify distance learning on the scale envisioned here, there must first be clearly stated goals and outcomes, and data about the intended students. The focus cannot be on technology or hardware, but on effective, high-quality distance learning. Quality distance courses also require strong instructional design and appropriate teaching.

> ". . . simply porting existing content over the Internet for delivery as an on-line course will not give a quality course. Nor will your students learn much from the experience. However, if you pay attention to the process of course design, you can create and offer a course via distance learning that will actively engage your students and will produce results as good as or better than found in a traditional on-campus course."[15]

Once good course design is present, there are many benefits of distance learning. Some basic benefits include:

- Course design can be carried out online by faculty living in different geographic areas.
- Broader student access to the program and its courses.
- Increased academic independence and self-regulation among students.
- More active involvement of students making use of self-learning processes.
- More immediate feedback to students using self-learning modules.
- Enhanced communication via the Internet provides greater access and reduced turn-around times among faculty and students.
- A shift from instructor-centered to student-centered and team-based learning.

Diamond[16] states that some students may experience difficulties in distance learning courses, especially when instructional design involves problem-based learning. Younger students may be challenged by working in groups to solve real problems, but the students in a public health laboratory science and practice doctoral program are likely to be older than the typical student and will have already gained problem solving and teamwork skills from previous laboratory work experience. Public health laboratory science and practice students should not flounder in a distance learning course that requires self-management and direction.

One advantage of distance learning programs is that students can move through the material at their own pace. However, if the pacing is left entirely to the student-employees, it is natural that assignments will be neglected in order to meet the daily deadlines in their jobs. Posting a list of due dates at the beginning of the semester will help students prioritize appropriately. Asking students to submit weekly assignments will also help.

Over the past year, a number of national projects have extended distance learning to ever-broader populations.

> "Johns Hopkins is among 12 top-ranked universities that partnered in July [2012] with Coursera to make high-quality education available worldwide. The School [Bloomberg School of Public Health] is the first Hopkins division to offer classes through Coursera, founded a year ago by two Stanford University professors with four university partners. 'It's part of our mission to disseminate our knowledge,' says James Yager, PhD, senior associate dean for Academic Affairs and the Edyth H. Schoenrich Professor in Preventive Medicine. 'We felt that this level of visibility, particularly with these other institutions, was the right thing to do at the right time.'
>
> The collaboration augments the School's Internet-based offerings, which includes 106 online credit courses and OpenCourseWare (OCW), a web resource that makes the content from 107 [sic] courses accessible at no cost to users worldwide on a noncredit basis. OCW does not offer assignments or exams.
>
> Yager says that Coursera's approach to open learning differs from the OCW model in that it offers 'mini-courses' that may include quizzes and assignments. Students can complete class evaluations and may post questions to faculty via an online bulletin board. They can also answer each other's questions and create their own social networks of learners with shared interests." (Source: *The MAGAZINE of the Johns Hopkins Bloomberg School of Public Health*, Fall 2012, www.jhsph.edu)

Online interactive teaching modules would allow a university to recruit the nation's best public health laboratory scientists and directors to serve as part-time, adjunct course developers and faculty, as well as field-based mentors and research advisors for students. After some time, the program could expand globally to admit qualified foreign students and overseas laboratories.

3. Drawing on the experience of APHL and its membership

Because there is no existing doctoral program in public health laboratory science and practice, an academic institution will need to develop a new program, courses and curriculum. A potential complicating factor is that an institution may not have faculty with working experience in the field.

It is probable that a university will not have funds to recruit and hire new faculty immediately. Faculty union and university policy may limit the use of adjunct faculty. However, if such a program is to provide a quality and cost-effective education to its students, some consultants from APHL and faculty in public health laboratory science and practice disciplines will be needed at all stages of program development, implementation, maintenance, evaluation and assessment.

APHL will work closely with an institution by appointing one or more APHL volunteers to learn and understand the university's academic model and timeframes and to serve as initial project liaisons during the early planning and development of the doctoral program.

APHL and its members will strongly support an academic institution willing to undertake the development of a doctoral program in public health laboratory science and practice. In most cases this support can and will be provided on a volunteer basis as typical of a non-profit professional association. The association and its members can be expected to work closely with the program's developers.

Academic Justification for a Doctoral Program in Public Health Laboratory Science and Practice

Before an institution develops a doctoral program and its curriculum, two major questions must be answered satisfactorily. First: is there a need? Second, if the need is identified, are there sufficient resources available to an academic partner to ensure the program's success?[17]

1. Available APHL support

In the end, academic partners must find these answers through their own methods. However, APHL would be willing and able to play a role in:

(1) Helping identify students, prerequisites and adjunct faculty;

(2) Supporting curriculum policies, curriculum components, course syllabi, course unit development and sequencing;

(3) Identifying and supporting laboratory-based doctoral research sites;

(4) Helping develop educational processes such as distance learning; and

(5) Helping set workplace competencies and defining program outcome statements, assessment and evaluation, faculty orientation and student mentoring.

The needs of the students, the academic institution, the profession and APHL are deeply related. APHL and it members can offer significant assistance during the development and maintenance of a doctoral program, in the belief that their efforts will have a direct effect on the program's quality and relevancy to the workplace, as well as the university's ability to offer it at a lower cost.

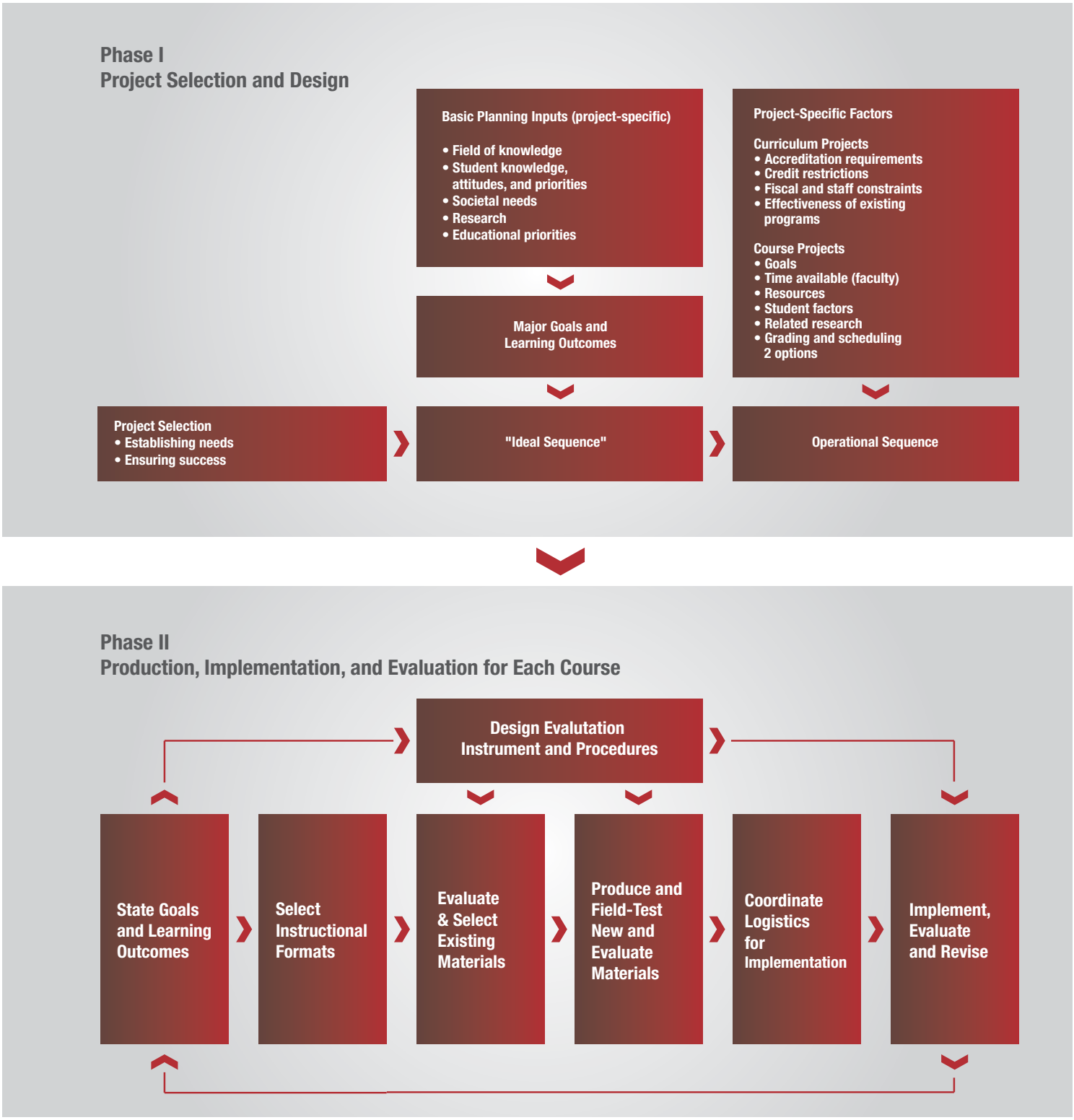
2. Educational program model

APHL and it members understand that developing and implementing a new academic program is a complex undertaking. They also understand that although primarily the responsibility of the academic institution, the process requires that all participants:

- Be sensitive to the academic setting, culture and processes;
- Be aware of the capabilities, interests and priorities of the targeted students;
- Have knowledge and appreciation of the discipline;
- Understand the resources and options available;
- Articulate instructional goals that all students must meet;
- Have a working knowledge of successful teaching, learning and assessment methods.

APHL is aware the process will follow a model similar to Figure 1, under which there are two basic phases: 1) project selection and design; and 2) production, implementation and evaluation. To support the academic partner, APHL and WRAPS could help develop an outline and critical path that incorporates the university's program development model. WRAPS would need access to the institution's list of steps and timeframes that are required to obtain final approval for new courses, curriculum and academic program. An APHL workgroup could then work closely with the academic partner to provide or help identify local and national experts willing to support program development and implementation, as well as public health laboratories willing to serve as student research sites.

Figure 1. Process for the development of educational programs. (Source: R.M. Diamond. Designing and Assessing Courses and Curricula: A Practical Guide, 3rd ed. 2008. Jossey-Bass, San Francisco)



Developing a High-Quality, Cost-Effective Doctoral Program

The right university can create a unique national public health resource. A single well-crafted doctoral program in public health laboratory science and practice could resolve the American shortage of qualified laboratory leaders. Scientist-leaders could acquire the broad qualifications needed to direct the public health laboratories throughout the country.

1. Student Pools and Class Sizes

The approximately 5,000 scientific and technical US public health laboratory employees without doctoral degrees are a primary pool of potential students for a public health laboratory science and practice degree program. A second and possibly larger group of potential students would be the many who pursue PhDs in the biological and chemical sciences to attain positions in private and academic research and teaching. These PhDs have had a hard time finding these jobs since the economic downturn beginning in 2008. A third pool of potential students includes several thousand military and academic medical technology graduates who aim to grow professionally in a laboratory career.

A doctoral program in public health laboratory science and practice should enroll five or more new students from the US each academic year. This number is based on a total of 529 public health laboratorians (bench scientists, supervisors, developmental scientists, scientist-managers and directors) possessing doctoral degrees (PhD, DrPH, DSc, ScD) in 2011[18] and applying a conservative loss/retirement rate of 4% per year to show 21 (= 529 X 0.04) new doctoral graduates will be needed each year to ensure a minimum workforce pipeline. The proposed program may eventually be able to educate a majority of these 21 needed students each year.

While it is difficult to predict to what extent foreign students would seek to enroll, there is a large and growing number of public health laboratories in developing countries in Asia, Africa and the Middle East that must employ qualified scientist-managers and directors. In the past, those public health laboratories have employed physicians to oversee their laboratory operations.

Unfortunately, those physician-directors are difficult to recruit and retain as many immigrate to higher paying positions in Europe and the US. For 10 years, APHL has provided consultants to help upgrade public health laboratories in developing countries and, through this important role, has first-hand knowledge of international staffing problems.

In addition there may be a growing need for hospitals in the US and overseas to hire graduates of the proposed doctoral program as laboratory managers and directors, in place of pathologists. This would allow hospitals to lower costs, provide expanded career paths, and support employee recruitment and retention.

2. Needed Courses and Curriculum

APHL surveys conducted in 2006[10] and 2011[8] identified 31 course topics that public health laboratory directors believed were "core" to functioning effectively in their positions. Since a public health laboratory scientist-manager or director must be both a scientist and leader, this proposed doctoral program must offer training in both areas.

> "Scientist-managers and directors are scientists, leaders, and managers, who spend much of their time planning mission objectives, evaluating programs, preparing budgets and grant proposals, maintaining partnerships, overseeing organizational ethics, testifying at hearings, and ensuring workplace safety and security. They must lead scientists and others through public health emergencies and resource shortages, and deal with the politics of large governmental bureaucracies, including the demands of county councils and state legislatures. These varied demands are fully reflected in the 31 core coursework subjects."[8]

A list of these 31 core course topics is available in Table 1. In the 2006 APHL survey, public health laboratory directors placed more importance on course topics, skills and experience related to leadership and management than on scientific knowledge and experience. The typical director of a state laboratory spends most of his or her time leading and managing, rather than acting as a laboratory scientist. This is especially true in large public health laboratories where leadership and managerial responsibilities are most important to a director's professional success, and where other doctoral scientists answering to the director serve as chief scientists in various scientific specialties (e.g., environmental chemistry, newborn screening, and public health microbiology).

However, this survey also showed that laboratory directors must have a strong background in laboratory science. Most directors advanced their careers by being good scientists and believe this experience is essential to earn the respect of employees and the public; without scientific training and practice, it would be difficult to manage a complex, public, scientific organization. Survey responses emphasized a need to offer such subjects as molecular biology, epidemiology, bacteriology and virology.

APHL's 2011 workforce survey showed that most public health laboratory leaders had not completed a majority of courses covering 25 subjects they rated "core" to their positions. APHL believes this dissonance between course importance and course completion is due to lack of availability and access. Scientific doctoral degree programs emphasize science, but provide little or no exposure to public health laboratory core subjects such as public health law, surveillance systems in public health, or laboratory management. This is why current doctoral programs in basic science are inadequate to prepare a future workforce of public health laboratory leaders. Only a doctoral program in public health laboratory science and practice can provide a curriculum with the right mix of courses in science and management. Such a program would also provide current directors with access to core courses they need or want.

TABLE 1: **Thirty-one course subjects identified by 40 sitting public health laboratory directors as "core" to their effectiveness as directors. (Adapted from: Reference 10)**

Course Ranking (by Importance)	Percentages of Directors Listing Subjects as Core Subjects	Core Course Subjects
1	95	Lab QA, mission evaluation, regulatory requirements
2	93	Public health laboratory management
3	85	Laboratory safety and security
4	80	Writing grant proposals and scientific publications
5	80	Molecular biology and molecular diagnostics
6	78	Leadership
7	75	Principles of management
8	75	Epidemiology
9	74	Clinical/medical/pathogenic microbiology
10	73	Immunology
11	73	Virology
12	70	Ethics
13	70	Emergency/disaster preparedness and response
14	68	Surveillance systems in public health
15	65	Medical virology
16	64	Environmental and water microbiology
17	63	Laboratory design, workflow, and operations
18	60	Politics, partners, and public relations in government
19	57	Information management systems/communications
20	55	Epidemiology of infectious diseases
21	55	Writing for scientific publication
22	55	Public health administration
23	53	Doctoral-level basic or applied research
24	51	Environmental science/environmental health
25	51	Biochemistry
26	50	Epidemiology of food/waterborne diseases
27	50	Statistics/biostatistics
28	48	Public health law
29	45	Lab instrumentation/instrumental analysis
30	45	Bacteriology laboratory
31	45	Virology laboratory

Conclusions

1. The field of public health laboratory science and practice is essential for the defense of the public's health and safety from infectious disease, chemical hazards and treatable hereditary disorders.
2. There is a continuing shortage of individuals pursuing professional careers in public health laboratory science and practice.
3. An important component of any workforce pipeline for future leaders in public health laboratory science and practice is a specialized doctoral program.
4. Public health laboratory workforce research is providing the data needed to support the development of a doctoral program in public health laboratory science and practice.
5. A cost-effective and sustainable doctoral program in public health laboratory science and practice is one that will employ distance learning and public health laboratories as sites for student doctoral research.
6. There is an annual pool of more than 10,000 potential students in the US for a doctoral program in public health laboratory science and practice.
7. A doctoral program in public health laboratory science and practice should plan to enroll at least five new US students each academic year.
8. The first university that implements a doctoral program in public health laboratory science and practice is likely to be the sole entity in the US offering such a program.
9. A doctoral program in public health laboratory science and practice could expand enrollment by marketing to and enrolling international students from public health laboratories in both developed and developing countries.
10. APHL and its membership, having a range of interests aligned with any doctoral program in public health laboratory science and practice, can and will work closely with an academic institution to help develop, implement, maintain and otherwise support the program and its students.

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16. Diamond, p. 425.

17. Diamond, p. 61.

18. The Univ. of MI, p. 20 (Table 2).

Appendix 1: Purpose

The purpose of this white paper is to draw the interest of an academic institution in developing and implementing a cost-effective doctoral program in public health laboratory science and practice that will provide a continuing workforce pipeline of scientist-managers, directors, and leaders in the discipline.

Appendix 2: Scope

The scope of this white paper is to inform academic institutions of:

1. The continuing shortage of public health laboratory scientist-managers and directors;
2. The need for a doctoral program in public health laboratory science and practice;
3. Mechanisms that will ensure a cost-effective doctoral program;
4. Core-courses needed by students in the discipline and program; and
5. Types of expertise and support APHL can provide to an academic partner interested in developing this doctoral program.

Appendix 3: Definitions

Association of Public Health Laboratories (APHL) is the national, non-profit organization, located in Silver Spring, MD, dedicated to working with members to strengthen governmental laboratories that perform testing of public health significance, and to providing member laboratories with the resources and infrastructure needed to protect the health of US residents and visitors, and to protect and control disease globally.

Director is a scientist-manager with sufficient experience and professional certification required to meet federal and state qualifications to direct a medical, environmental, or agricultural laboratory.[1]

Distance learning is a type of education where students work on their own at home or in a laboratory or office and communicate with faculty and other students via e-mail, electronic forums, videoconferencing, chat rooms, bulletin boards, instant messaging and other forms of computer-based communication.

Doctoral research is laboratory research performed to meet certain requirements for a doctoral degree in public health laboratory science and practice.

Public health laboratory is a governmental public health, environmental, or agricultural laboratory that performs biological and chemical testing and provides testing-related services to protect human populations against infectious diseases, food and waterborne diseases, environmental hazards, treatable hereditary disorders, and other natural and man-made public health emergencies.

Scientist-manager is a laboratory scientist, usually possessing an earned doctoral degree, with scientific and supervisory work experience who develops, oversees, and consults on a wide range of laboratory testing and services in a particular field (e.g., environmental chemistry, microbiology, newborn screening).[1]

Appendix 4: Acronyms

APHL	Association of Public Health Laboratories
CDC	US Centers for Disease Control and Prevention
EPA	US Environmental Protection Agency
FDA	US Food and Drug Administration
OCW	OpenCourseWare
USDA	US Department of Agriculture
WDC	APHL's Workforce Development Committee
WRAPS	WDC's Workforce Research and Pipeline Subcommittee

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