

# Evolution of the Pathology Residency Curriculum: Preparing for a Positive Future

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## Abstract

The required medical knowledge and skill set for the pathologist of 2020 are different than in 2005. Pathology residency training curriculum must accordingly change to fulfill the needs of these ever-changing requirements. In order to make rational curricular adjustments, it is important for us to know the current trajectory of resident training in pathology—where we have been, what our actual current training curriculum is now—to understand how that might change in anticipation of meeting the needs of a changing patient and provider population and to fit within the evolving future biomedical and socioeconomic health-care setting. In 2013, there were 143 Accreditation Council for Graduate Medical Education-accredited pathology residency training programs in the United States, with approximately 2400 residents. There is diversity among residency training programs not only with respect to the number of residents but also in training venue(s). To characterize this diversity among pathology residency training programs, a curriculum survey was conducted of pathology residency program directors in 2013 and compared with a similar survey taken almost 9 years previously in 2005 to identify trends in pathology residency curriculum. Clinical pathology has not changed significantly in the number of rotations over 9 years; however, anatomic pathology has changed dramatically, with an increase in the number of surgical pathology rotations coupled with a decline in stand-alone autopsy rotations. With ever-expanding medical knowledge that the graduating pathology resident must know, it is necessary to (1) reflect upon what are the critical need subjects, (2) identify areas that have become of lesser importance, and then (3) prioritize training accordingly.

## Keywords

changes, curriculum, future needs, pathology, pathology residency programs

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## Introduction

On July 1, 2014, the Accreditation Council for Graduate Medical Education (ACGME) began phase II of the Milestones Project, which included anatomic pathology and clinical pathology (AP/CP) residency training programs. The pathology milestones include 27 milestone progressions or sets along which each graduating pathology resident is expected to achieve substantial compliant advanced level ratings by their program's Clinical Competency Committee, thereby assuring that pathology residency training programs are graduating residents with a standardized competency skill set at the expected level of a new practitioner pathologist.<sup>1</sup> The question is: how is

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this achieved among the 143 ACGME-accredited pathology residency training programs, with their considerable variation in size with respect to the number of resident full-time equivalents (range in 2013 survey sample of 76 AP/CP programs being from 8 to 38, with a mean of 17.7, median 16, and mode 12); faculty members' skill set in providing specialized education (eg, in laboratory management, clinical informatics, and genomics); the presence or not of subspecialty fellowship training programs within pathology; the presence or not of residency and fellowship training programs outside of pathology; regional diversity of patient population; variations in facilities infrastructure (eg, research core facility); and the presence or not of an academic medical center with medical school affiliation?

In the early 2000s, the resident groups within the College of American Pathologists (CAP) and American Society for Clinical Pathology expressed their desire for program directors to strive toward uniformity of pathology residency curriculum among the 143 residency training programs. The ACGME pathology residency program training requirements for AP/CP, however, are not highly prescriptive as to what should be included in the curriculum, for example, not listing prescribed lecture topics as has been done in the past by other specialties, notably infectious diseases.<sup>2</sup> The training requirements also do not specify how educational sessions are structured, scheduled, and held, as they are in obstetrics (OB) and gynecology (GYN),<sup>3</sup> although the most recent pathology program requirements do include specific reference to additional areas of education, such as in renal pathology and electron microscopy.<sup>4</sup>

How do pathology residency programs train their residents in such diverse settings and still achieve a national average of 90% first time pass rate in the primary board certification in AP/CP?<sup>5</sup> Are new diplomates of the American Board of Pathology (ABP) prepared with the proper medical knowledge and skill set to practice pathology in their first job following AP/CP residency training, including areas in which they have not had additional training as fellows? We sought to gain insight into these questions through a comprehensive survey submitted to pathology residency programs.

### *Preparation for Change*

Biomedical science is advancing, and health-care organization is changing, both rapidly. These changes alone would suffice to drive change in pathology practice and training; however, patient and pathologist demographics are also changing at the same time. These factors challenge educators to rethink how we are training the next generation of pathologists.

Concurrently, there are limitations of resources. For example, there is scant likelihood of developing more funded positions for training pathologists, with the emphasis nationally directed at increasing training positions for primary care providers.<sup>6</sup> However, we still have opportunities to improve the alignment of our trainees with their practices. The "average" pathology trainee adds 1.4 years of subspecialization (ie, fellowship) following his or her residency. So, we have funded

positions for residency plus 1 or more years of additional training with which to work.<sup>7</sup>

Program accreditation and board certification standards have been more eminence than evidence based, and the attempt at dual use of fellowships, which are designed as training for subspecialty practice, to supplement general residency training, fails to adapt training precisely to individual practice needs of future employers in many instances.<sup>8</sup> Taylor suggested that evidence-based education should drive the changes in undergraduate medical education that the Liaison Committee for Medical Education (LCME) mandated in the early 1990s.<sup>9</sup> If educators overall were better able to determine what the trainees' actual pathology practice would require, preparation to anticipate and configure training to match it could be achieved. To better confront this future, we are now and will continue to gather more and better data on actual pathology practice requirements and use this information to modify future training. However, to determine the changes required, we need a baseline knowledge of how training is done at present, as we seek to align it with what it needs to be in the future.

Horowitz conducted 3 different surveys of numerous community pathologists over a period of 9 years to identify what skills and knowledge a resident should have to succeed in practice, and the results of these surveys were discussed at the Association of Pathology Chairs (APC) in 1996, the Association of Directors of Anatomic and Surgical Pathology in 2003, and the APC again in 2005.<sup>8</sup> There were obvious trends and changes in the skill set and knowledge that community pathologists seek in graduating residents and fellows who evolved over the near decade. Diagnostic competency in surgical pathology, frozen section diagnosis, and gross dissection remained a high priority; however, new skills such as laboratory management (quality assurance procedures) and molecular techniques emerged as new expectations in community practice. Using molecular pathology as an example, in the 1996 survey, immunohistochemistry was useful, but other techniques were not considered important. In the 2003 survey, immunohistochemistry was considered essential, flow cytometry was useful, and other techniques were not valued as important. In the subsequent 2005 survey, it was found that many community practices routinely relied upon immunohistochemistry, tumor markers, flow cytometry, polymerase chain reactions, fluorescence in situ hybridization, and cytogenetics, whereas a few laboratories were using tissue microarrays.<sup>8</sup> Kass et al provided additional evidence for the need to respond to downstream employers in the design of training objectives for pathology residency training programs.<sup>10</sup>

This progression of observations illustrates how our practice of pathology is in evolution, changing with new technology and diagnostic innovation; education of pathologists must likewise evolve. The following results of our survey represent a step forward in defining our baseline mode of training as of 2013. Our look back at how our training has already evolved over nearly a decade also helps to establish the trajectory of change.

## Methods

To begin to understand the intricacies of the process of training and educating a pathologist, the Program Directors Section (PRODS) of the APC conducted a survey of the curriculum and practices at the 143 programs that were accredited in 2013. An online survey was conducted on the PRODS listserv in 2013 and was open for several weeks with multiple invitations by the authors of the survey to participate. Of the 143 AP/CP programs, 80 programs responded to the survey (56% response rate): 76 responses described AP/CP programs and 2 each described AP-only and CP-only programs. If responses were unclear or ambiguous, the program directors were contacted by e-mail for clarification when the survey closed. In 2005, a similar survey had been conducted on the PRODS listserv, by 1 author (W.Y.N.), was open for 1 week, and received 38 responses (~ 25% response rate among the approximately 150 programs at that time). The identity of the programs was protected in the 2005 survey; therefore, direct comparison of curricular changes for a particular program with the 2013 survey was not possible.

The data from the 2013 survey were further subdivided to see whether there were trends identified in the curriculum when comparing small residency programs (defined as those programs with 16 or fewer residents—16 being the median number of residents) versus large residency programs (defined as those programs with more than 16 residents). Specific practices were also queried, such as residents' performance of fine needle aspiration (FNA) biopsies, bone marrow biopsies, presence of subspecialty sign-outs, fellowships, and so on.

## Results

Although the survey gathered a wealth of information on pathology curriculum, the purpose of this article is to highlight trends in the major areas of pathology training. For AP, the areas of surgical pathology, autopsy, and cytopathology were studied. For CP, the areas of hematology, transfusion medicine/blood banking, chemistry, and microbiology were considered. There were several areas that bridge AP and CP, being relevant to both curricular tracks; these included hematopathology (including flow cytometry), laboratory management, and molecular pathology.

### *Variations Between the 2 Surveys*

There are limitations to this study due to the different designs of the surveys in 2005 and 2013. In 2005, the survey asked for responses in terms of months, whereas the 2013 survey asked for responses in terms of weeks. Within both surveys, there were interprogram differences that made comparison of results challenging. At some institutions, the Gregorian calendar's months were used, whereby there would be 12 rotations in an academic year, with slight variation in the rotation length depending upon the calendar month. Other programs utilized the lunar month of 4 weeks to a rotation block and 13 rotations

to the academic year, with some programs using 1- or 2-week increments for some rotations. In the following discussion, the term "rotation" is used for both a calendar month-long experience in the 2005 survey and a 4-week experience in the 2013 survey, but for purposes of tabular comparison between these surveys by weeks, multiple calendar month rotations were for computational purposes treated as though each calendar month was 4 $\frac{1}{3}$  weeks long.

Another variable that made comparison of curricula difficult was that some programs scheduled dedicated vacation time in their curriculum, whereas other programs allowed residents discretionary use of vacation time out of their scheduled rotations. In the latter situation, the curriculum would have more nominal rotation time than in programs that have scheduled vacation time.

Qualitative differences that made comparison challenging between the 2005 and the 2013 survey included that, in 2005, "hematopathology" was queried as a single entity. In the 2013 survey, separate questions were asked about hematology (CP) and hematopathology (AP/CP). Likewise, 3 other rotation areas were separately queried only in 1 of the 2 surveys: immunopathology only in 2005 and informatics and flow cytometry only in 2013. Finally, each of the various commonly identified surgical pathology subspecialties was individually queried in the 2013 survey, in addition to the aggregate major rotation area of surgical pathology. A comparison of the findings of the 2005 and 2013 surveys is found in Table 1 and Figure 1.

### *Curricular Changes in Anatomic Pathology*

Surgical pathology was the subject area with the most variability among programs in both the 2005 and the 2013 surveys. In 2005, the modal number of surgical pathology weeks (converted at 4 $\frac{1}{3}$  weeks per calendar month) was 61 with a mean of 54.6 weeks and a range of 35 to 104 weeks of a 208-week curriculum. In 2013, the mode had increased to 64 weeks with a mean of 58.7 and a range of 18 to 108. Large programs had a mean of 56.5 weeks and a mode of 36 weeks in surgical pathology, with a range of 18 to 108 weeks. Small programs had a mean of 60.5 weeks, mode of 64 weeks, and a range of 24 to 92 weeks.

Additionally in 2013, 12 weeks of hematopathology were reported as well as 16 weeks of "hematology," whereas in 2005, only 17 weeks of hematopathology rotation time was reported (all modal times). Since both diagnostic hematopathology and laboratory hematology are required elements of AP/CP training in pathology, the 17 weeks of reported hematopathology in 2005 presumably correspond to the 16 weeks of reported hematology in 2013, with the 12 weeks reported as hematopathology in 2013 corresponding to diagnostic hematopathology. If these modal 12 weeks of hematopathology are then added to the reported modal 64 weeks of surgical pathology, the effective weeks of residency rotation in surgical pathology (including diagnostic hematopathology) rise to 76.

Cytopathology has shown a slight decrease in assigned weeks, from a mean and mode of 15.6 and 13 weeks in 2005

**Table 1.** Comparison of Modal Distribution of Rotations Among Pathology Residency Programs, 2005 Versus 2013.

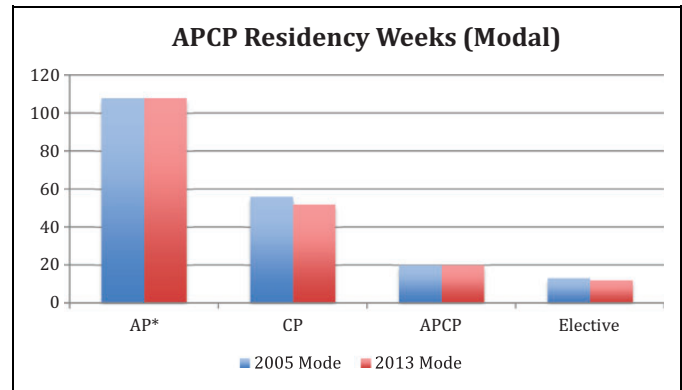
	2005 Mode* (in weeks)	2013 Mode (in weeks)	2013 Program Count
<b>Anatomic pathology rotations</b>			
Surgical pathology	61	64	75
Hematopathology		12	63
Autopsy	26	12	53
Cytopathology	13	12	76
Forensic pathology	4	4	70
Anatomic pathology, other	4	4	10
Total anatomic pathology	108	108	
<b>Clinical pathology rotations</b>			
Clinical chemistry	13	12	76
Hematology	17	16	37
Microbiology	13	12	76
Transfusion medicine/blood bank	13	12	75
Total clinical pathology	56	52	
<b>Anatomic/clinical pathology rotations</b>			
Molecular pathology and genomics	4	4	72
Cytogenetics	4	4	57
Laboratory management	4	4	49
Anatomic pathology/clinical pathology, other <sup>†</sup>	8	8	25
Total anatomic pathology/clinical pathology	20	20	
<b>Elective rotations</b>			
Elective	13	12	75
Total elective	13	12	
<b>Anatomic/clinical pathology residency totals</b>			
Residency total	197	192	

\*As above, the conversion of multi-month rotations reported in the 2005 survey on the basis of 1 calendar month = 4½ weeks may artificially lengthen reported duration of 3 or more months by a week, corresponding to the appearance of 5 more weeks in the 2005 curriculum than in the 2013 curriculum.

<sup>†</sup>Anatomic and clinical pathology (AP/CP) other: the modal 8 weeks reported in 2005 included 4 weeks of immunopathology plus 4 unspecified weeks; the 8 weeks reported in 2013 are unspecified.

(range: 4-43) to a mean and mode of 12.6 and 12 in 2013 (range: 4-24). In 2013, large programs assigned slightly fewer weeks (mean and mode) than small programs: 11.3 and 12 (range: 4-16) versus 13.7 and 12 (range: 8-24).

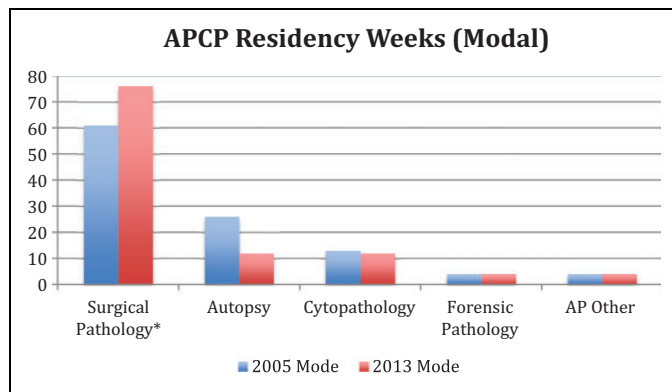
Autopsy rotations reported the greatest change: in 2005, the mode was 26 weeks with a mean of 18.2 weeks and a range of 4 to 43 assigned weeks. In 2013, although the mean number of assigned weeks had decreased by only 3 weeks to 15.2, the mode had decreased by 14 weeks to 12, with a range of 4 to 32 weeks. Although this represents a marked decrease in the modal number of weeks assigned to autopsy rotations, equally significant is that only 60 of the 76 programs reporting AP/CP curricula in 2013 assigned any autopsy rotation weeks. The requirement for autopsy training being universal among AP/CP

**Figure 1.** Comparison of modal distribution of anatomic pathology (AP), clinical pathology (CP), AP/CP, and elective rotations, 2005 versus 2013.

programs, 16 programs (21% of all survey respondents) provided autopsy training other than by assigned weeks (1 program had both a free-standing autopsy rotation and additional autopsy training integrated in another rotation). The mean and modal numbers of assigned autopsy weeks for large programs were 15.0 and 12, respectively, with 6 of these 34 programs (18%) no longer having stand-alone autopsy weeks. The range of assigned autopsy weeks among large programs was 6 to 24. For small programs, autopsy had a mean of 15.4 and a mode of 16 assigned weeks, with a range of 4 to 32 weeks; 10 (23.8%) of these 42 programs no longer had stand-alone autopsy rotations.

Ten programs combine autopsy with surgical pathology. Of these 10 programs, 6 programs did not specify how this is done, and 2 programs have autopsy coverage for 1 day of a 4-day rotation. In the latter instance, day 1 = cover frozen sections + gross, day 2 = sign-out surgical grossed on day 1, day 3 = sign-out small biopsies, and day 4 = autopsy. One program does the following: day 1 = gross + cover frozen sections and day 2 = preview and sign-out biopsies; however, if an autopsy happens, the resident does the autopsy rather than preview and sign-out biopsies; then afternoon, preview big surgical specimens, day 3 = sign-out big surgical specimens. One program uses a “standby” system: if an autopsy happens, the Pathologists’ Assistant (PA) grosses the surgical specimens for the resident.

Other programs combine autopsy with other rotations: 2 programs combine with pediatric pathology; 1 program combines with surgical pathology and pediatric pathology; 1 program combines adult autopsies with surgical pathology and pediatric autopsies with pediatric pathology; 1 program combines autopsy with surgical pathology and cytopathology; 1 program combines autopsy with cytopathology and CP; 1 program combines autopsy with 12 weeks of general surgical pathology and 12 weeks of subspecialty surgical pathology sign-out; 1 program has autopsy “integrated with AP”; and 1 program has autopsy “integrated with all rotations, rotating schedule.” Finally, 1 program has 8 weeks of a free-standing autopsy rotation, then 24 weeks combined with



**Figure 2.** Comparison of modal distribution of anatomic pathology rotations, 2005 versus 2013.

cytopathology. With elimination of dedicated autopsy rotations as above, surgical pathology rotations have picked up the newly available time.

Forensic pathology showed a consistent finding of 4 weeks across all programs surveyed in 2005. In 2013, the mode remained 4 weeks and the mean a nearly identical 3.9 weeks, with a reported range of forensic pathology of 2 to 8 (plus 1 program that reported 12 weeks, “for forensic cases deferred to hospital”).

Finally, a similar number of miscellaneous other weeks of assigned AP rotations were reported both in 2005 and in 2013: in 2005, the mean and mode were 10.4 and 4, with a range from 4 to 17; in 2013, the mean and mode were 8.4 and 4, with a range from 2 to 24.

Overall, in AP, subspecialty surgical pathology “carve outs” have become far more common in large programs, and “stand-alone” autopsy rotations are fewer in both large and small programs. Many programs reported they have incorporated/integrated autopsy pathology into surgical pathology rotations. Figure 2 details the modal differences in AP rotations between 2005 and 2013.

### Curricular Changes in Clinical Pathology

Clinical pathology rotations as reported between 2005 and 2013 have changed very little, perhaps because they were already at a minimum: the “big 4” rotations (clinical chemistry, hematology, microbiology, and transfusion medicine/blood banking) all remained essentially the same (and perhaps exactly the same, allowing for the  $4\frac{1}{3}$  week per calendar month conversion). A comparison of CP rotations from 2005 to 2013 is summarized in Table 2 and Figure 3.

In this context, it is worthy of note that the  $4\frac{1}{3}$ :1 conversion from calendar month rotations to rotation weeks makes an assumption that these assigned monthly rotations were inclusive of vacation weeks; if they were not, then the appropriate conversion factor would instead be 4:1, and the modal numbers of weeks for each of the big 4 CP rotations would be precisely unchanged between the 2005 and 2013 surveys. The utilization of weeks rather than calendar months has allowed many

programs to expand rotations from 12 calendar months to 13 4-week blocks, effectively adding 4 additional rotations to the training paradigm.

The rotations common to AP and CP sampled in both surveys were also unchanged in their modal number of weeks, with 4 weeks each for molecular/genomic pathology, laboratory management, and cytogenetics. In 2013, 72 of the 76 programs reported assigned rotations in molecular/genomic pathology, with a range of 2 to 18 weeks and a mean of 5.8 weeks; this represents only a slight increase from the 2005 range of 2 to 13 weeks with a mean of 5.2. Laboratory management showed an unchanged range of 2 to 9 weeks in both surveys and a small decrease in the mean from 5.2 in 2005 to 4 in 2013. Cytogenetics similarly showed a range and mean of 2 to 9 and 3.9 in 2005 and of 1 to 8 and 3.1 in 2013.

Both surveys reported “other” assigned rotation common to AP and CP; the modal number of such weeks increased from 4 in 2005 to 8 in 2013, but a specific reporting option was offered for immunopathology in 2005 that was not offered in 2013. If the modal 4 weeks reported for immunopathology in 2005 is combined with the 4 weeks of other rotations, then the modal number of such weeks was unchanged. A comparison of the 2005 and 2013 surveys for rotations common to AP and CP is found in Figure 4.

Although the mode remained the same for molecular pathology, the mean number of rotation weeks increased slightly (from 5.2 to 5.8 weeks), reflecting an increase in longer rotation assignments. Although this raises questions about the uniformity of teaching across residency programs, it is encouraging given the increasing importance of molecular pathology in practice. According to a survey of private practice pathologists that Dr Richard Horowitz performed in 2005, community practice hospitals are utilizing more and more molecular tools in their daily practice, and the senior pathologists “depend on young pathologists to bring these techniques with them from the university.”<sup>8</sup> Interestingly, although there is a weak trend toward more weeks of molecular pathology in larger programs, there is a wide range in weeks assigned across all program sizes. The number of weeks of molecular pathology by program size is graphically depicted in Figure 5.

Last among the major curricular elements sampled in both surveys is elective time: in 2005, the mean and mode were 29.9 and 13, with a range of 9 to 52 weeks; in 2013, the mean and modal weeks were 21.0 and 12, respectively, with a range of 2 to 52. The 2013 survey requested more specificity, with a breakdown of elective weeks as flexible between AP and CP or dedicated either to AP or to CP. For most programs, all elective weeks were flexible between AP and CP; a minority of programs designated some weeks specifically for AP or for CP, the balance being flexible, as shown in Table 3.

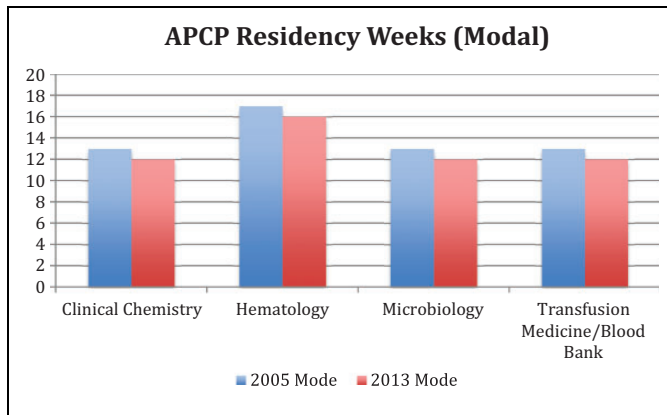
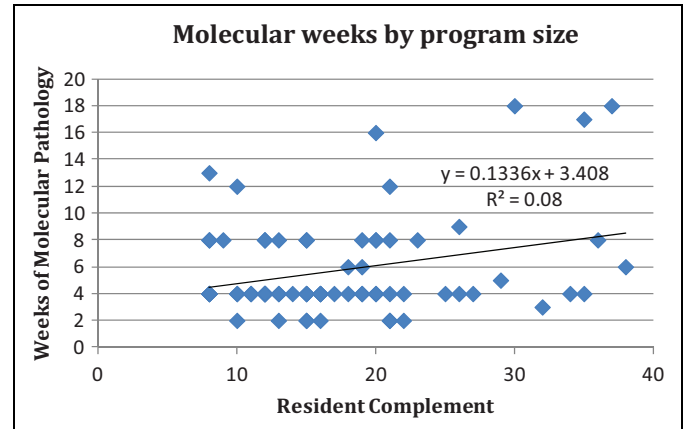
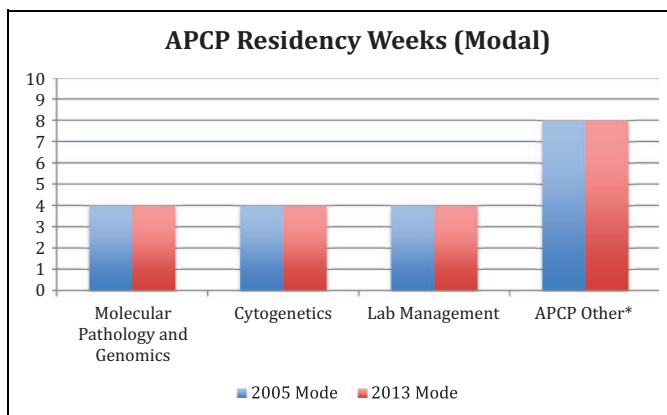
### Subspecialty Education Rotations

The 2013 survey also delved into subspecialization in resident rotations. This is a relatively difficult area to succinctly

**Table 2.** Comparison of Mean, Modal, and Minimum and Maximum Number of Weeks of Clinical Pathology Rotations, 2005 Versus 2013.

	2005 Mean*	2005 Mode*	2005 Minimum*	2005 Maximum*	2013 Mean	2013 Mode	2013 Minimum	2013 Maximum
Clinical chemistry	12.6	13	4	22	12.6	12	4	22
Hematology	20.8	17	9	35	13.6	16	4	30
Microbiology	13.0	13	7	22	12.7	12	8	22
Transfusion medicine/blood bank	13.4	13	9	22	13.8	12	8	20

\*As above, the conversion of multi-month rotations reported in the 2005 survey on the basis of 1 calendar month = 4½ weeks may artificially lengthen reported duration of 3 or more months by a week.

**Figure 3.** Comparison of modal distribution of clinical pathology rotations, 2005 versus 2013.**Figure 5.** Number of weeks of molecular pathology by program size.**Figure 4.** Comparison of modal distribution of anatomic and clinical pathology rotations, 2005 versus 2013.

summarize, due to the wide variety of modes of introducing residents to subspecialized practice. In some instances, various recognized subspecialties were combined in rotations, either for conceptual or practical reasons, so designated weeks were not always additive. The most general way to consider the survey findings is as they represent the emphasis in training, with the number of programs devoting time to the individual subspecialties being more clearly interpretable than the numbers of weeks for each subspecialty. The time allocated to specific subspecialty sign-outs is shown in Table 4.

**Table 3.** Weeks Designated by Programs for Elective Time From 2013 Survey.

2013 Electives	Mean	Mode	Minimum Number of Weeks	Maximum Number of Weeks	Program Count
Total weeks	21.0	12	2	52	75
Flexible weeks*	18.2	12	2	48	70
Clinical pathology weeks	7.6	8	1	24	15
Anatomic pathology weeks	7.2	8	2	18	13

\*"Flexible weeks" are elective weeks that can be used as anatomic and clinical pathology or dedicated to anatomic or clinical pathology.

The subspecialties taught most commonly as specific rotations are clearly neuropathology, dermatopathology, and pediatric pathology, with approximately 60% of AP/CP programs having them as subspecialized rotations, presumably reflecting their prevalence as separate sign-out services; this is most likely true of medical renal as well, with the generally lower case volume and prevalence of medical renal sign-out plausibly corresponding to the step-off down to its 37% rate of subspecialized sign-out.

The next most prevalent group of subspecialty teaching services are gastrointestinal (GI), GYN, genitourinary (GU), and breast and pulmonary pathology, on which residents rotate as

**Table 4.** Weeks Allocated by Programs for Subspecialty Teaching From 2013 Survey.

AP/CP Training Track-2013	Mean	Mode	Minimum	Maximum	Count
AP subspecialty: neuropathology	4.8	4	1	12	46
AP subspecialty: pediatric pathology	5.1	4	2	16	45
AP subspecialty: dermatopathology	4.6	4	1	12	45
AP subspecialty: medical renal pathology	3.6	4	1	8	28
AP subspecialty: gastrointestinal pathology	7.3	4	3	12	19
AP subspecialty: gynecologic pathology	9.5	4	4	30	17
AP subspecialty: breast pathology	6.3	4	2	12	15
AP subspecialty: genitourinary pathology	5.5	6	2	10	15
AP subspecialty: pulmonary pathology	5.1	4	2	8	13
AP subspecialty: head and neck pathology	5.3	6	3	8	10
AP subspecialty: transplant pathology	5.7	4	2	24	9
AP subspecialty: liver pathology*	7.0	12	2	12	9
AP subspecialty: bone and soft tissue pathology	4.5	6	2	6	8
AP subspecialty: cardiac pathology†	5.7	8	2	8	6
AP subspecialty: obstetric pathology‡	9.3	6	4	20	4
AP subspecialty: consults	4.0	4	2	6	4

Abbreviation: AP/CP, anatomic and clinical pathology.

\*Liver pathology often included in/counted with gastrointestinal pathology.

†Cardiac pathology often included in/counted with pulmonary pathology.

‡Obstetric pathology often included in/counted with gynecologic pathology.

subspecialties in from 25% to 17% of AP/CP programs; as referenced in the tabular footnotes above, GI, GYN, and pulmonary pathology each often has an associated subspecialty rotation of liver, OB, and cardiac pathology, respectively.

Finally, head and neck (ENT), transplant, and bone and soft tissue pathology are taught as subspecialty rotations in 13%, 12%, and 11% of programs, respectively. Five percent of programs organize their consultation service as a separate rotation; however, the substantive content of a consultation rotation will vary depending on the nature of that institution's actual referral case mix and volume.

This is an area in which the relationship of program size with program structure was marked; as can be seen in Table 5

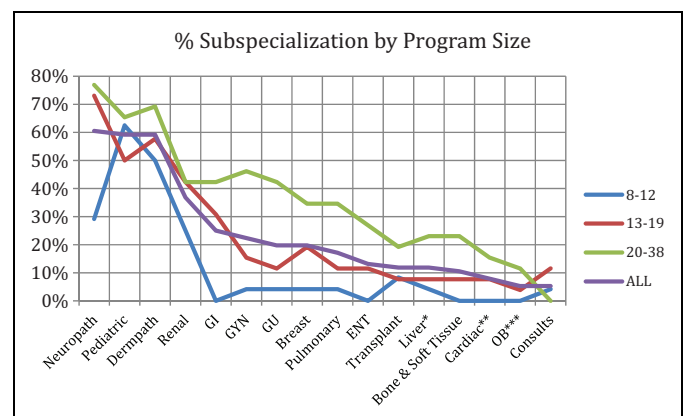
**Table 5.** Distribution of Subspecialty Teaching by Program Size From the 2013 Survey.

Subspecialty Sign-Outs	8-12 Residents	13-19 Residents	20-38 Residents	All Programs
Neuropathology	29%	73%	77%	61%
Pediatric pathology	63%	50%	65%	59%
Dermatopathology	50%	58%	69%	59%
Renal pathology	25%	42%	42%	37%
Gastrointestinal pathology	0%	31%	42%	25%
Gynecologic pathology	4%	15%	46%	22%
Genitourinary pathology	4%	12%	42%	20%
Breast pathology	4%	19%	35%	20%
Pulmonary pathology	4%	12%	35%	17%
Head and neck pathology	0%	12%	27%	13%
Transplant pathology	8%	8%	19%	12%
Liver pathology*	4%	8%	23%	12%
Bone and soft tissue pathology	0%	8%	23%	11%
Cardiac pathology†	0%	8%	15%	8%
Obstetrics pathology‡	0%	4%	12%	5%
Consults	4%	12%	0%	5%

\*Liver pathology often included in/counted with gastrointestinal pathology.

†Cardiac pathology often included in/counted with pulmonary pathology.

‡Obstetric pathology often included in/counted with gynecologic pathology.

**Figure 6.** Distribution of subspecialty teaching by program size from the 2013 Survey.

and Figure 6, there was an increase in subspecialization across the range of AP subspecialties with increasing filled program size with 3 exceptions. The first exception was pediatric pathology, where the middle third of programs had a lower reported rate of this subspecialization than either the smaller or larger third. The second exception was medical renal pathology, in which a threshold effect was seen, whereby programs in the middle and larger thirds were equally likely to teach medical renal pathology as a subspecialty and more likely to do so than the smaller third. The third exception, consultation cases, showed reported subspecialization only for programs in the smaller and middle

**Table 6.** Mean, Modal, and Minimum and Maximum Number of Weeks of Subspecialty Clinical Pathology (CP) and Anatomic and Clinical Pathology (AP/CP) Rotations.

2013 CP and AP/CP Rotations	Mean	Mode	Minimum	Maximum	Count
Coagulation and hemostasis	5.2	4	2	17	35
Human leukocyte antigen (HLA)	2.5	2	1	8	27
Flow cytometry	5.6	4	2	17	20
Informatics	2.9	2	1	8	19

thirds, with none in the larger third, presumably because consultation cases would go to subspecialty sign-out services in larger programs.

There were also 4 named CP or common AP/CP subspecialty rotations on which survey data were collected in 2013: coagulation and hemostasis, human leukocyte antigen (HLA), flow cytometry, and informatics. Again, some reported weeks would appear to coincide with hematology (coagulation and hemostasis), hematopathology (flow cytometry), or transfusion medicine/blood banking, so the significance of this information lies predominantly in their prevalence of being taught as subspecialties. Forty-six percent of AP/CP programs have subspecialty-specific rotations in coagulation and hemostasis, and 36% in HLA; flow cytometry and informatics are both less often presented in this fashion, at 26% and 25%. This is summarized in Table 6.

### Practices

Additional information was captured during the 2013 Curriculum Survey that was not queried in 2005. This included practices at the various training programs such as participation in FNA and the variations of this technique including the availability of ultrasound-guidance training, fellowships in surgical pathology, and subspecialties of surgical pathology, and so on. Not all programs responded to all questions.

In AP, 70 (87.5%) of the 80 programs that responded train residents in the performance of FNA biopsies. Twenty-one (26.9%) of 78 programs also train residents in ultrasound-guided FNA biopsies. Only 3 (3.8%) of 79 programs train their residents in the performance of core needle biopsies or ultrasound-guided core needle biopsies. Forty-eight (60.8%) of the 79 programs rely upon sharing hospital autopsies or counting forensic autopsies to achieve the 50 autopsies required for board qualification and compliance with ACGME accreditation.

Forty-three (53.8%) of the 80 programs offer a surgical pathology fellowship. Thirty-two (69.5%) programs offer purely general surgical pathology fellowship training, whereas 14 (30.5%) have hybrid general/subspecialty surgical pathology fellowship programs in which a portion of the training is devoted to subspecialty areas such as breast, GI, GU, and so on. Twenty-nine (43.3%) of 67 programs offer purely subspecialty

surgical pathology fellowship training. Eleven (36.7%) of the 29 programs that offer purely subspecialty surgical pathology fellowship training are ACGME accredited as selective pathology fellowship programs.

Within CP, 41.8% of the 79 programs have residents performing trephine bone marrow biopsies. Residents are involved in performing apheresis consults in 67% of the 79 programs, whereas only 49.4% of programs have their residents involved with writing orders and providing direct patient care to apheresis patients. A total of 42.5% of the 80 programs provide formal instruction in laboratory leadership to their residents.

### Discussion

The ACGME Common Program Requirements mandate an annual program evaluation to be performed by the Program Evaluation Committee.<sup>4</sup> Through this requirement, each and every pathology program's curriculum is dynamic and ever changing, driven by resident performance, faculty development, and graduate performance outcome data to improve the program's quality. Other factors that drive curriculum change are compliance with ACGME Pathology Program Requirements, such as the need for each resident to perform at least 50 autopsies, 200 intraoperative consultations, examine at least 1500 cytologic specimens, and examine and assess 2000 surgical pathology specimens, essential for maintaining ongoing accreditation of the program.<sup>4</sup> Of these ACGME index case requirements, the 50 autopsies completed by each resident by the time the application for certification is submitted are the only requirement by the ABP.<sup>11</sup> The other factor that should shape curricular changes is the needs and demands of the future pathology workforce. Sometimes, the factors that influence change in the pathology curriculum are not equally aligned, and at some points, they appear to be diametrically opposed to one another. When the LCME mandated change of the medical school curriculum at the Keck School of Medicine of the University of Southern California because the school had not "significantly updated the curriculum in 22 years," Taylor offered an argument for evidence-based curriculum reform.<sup>9</sup> The current article is intended to provide information to begin an evidence-based curriculum reform at the postgraduate medical education level in pathology.

Through the course of 2 surveys spread by 8 to 9 years, we have taken a "snapshot" of pathology curricula at 2 points in time and compared the similarities and differences. Cytopathology, forensic pathology, and the 4 major areas of CP have not seen significant change over this period of time. However, the number of months in surgical pathology have increased concomitantly with a decrease in the number of hospital-based autopsy months, with a few programs eliminating a dedicated rotation for autopsy altogether. The reason for this may have resulted from the diametrically opposed forces that drive curriculum change.

In another article by Taylor, he discusses how the massive proliferation of medical knowledge in the past 40 years that a medical student must know has put an unrealistic burden on



them in terms of the amount of reading of required and recommended textbooks.<sup>12</sup> In that paper, he describes how medical students use handouts and “note clubs” to forego the mandatory reading. The medical knowledge that our residents need to know has continued to exponentially explode in the past decade, when compared to when Taylor’s paper was written nearly a quarter century ago. Although our AP/CP residents and straight AP residents are still required to have completed a minimum of 50 autopsies in order to qualify for the primary certification boards, the amount of medical knowledge that continues to grow daily has driven many programs to hire faculty members with subspecialty fellowship training and expertise to teach their subspecialty in a dedicated rotation. Although this practice was around in 2005 at a few institutions, there has been an increase in the number of medium- and large-size programs using the subspecialty education approach to teach surgical pathology. One study showed that subspecialty education is uncommon to nonexistent in programs with 10 residents or less.<sup>13</sup> In order to “create time” for these additional subspecialty education rotations, time had to be “borrowed” or taken from existing rotations. Program directors have recognized that autopsy is important from the standpoint of providing residents with a foundation of AP and the residents needing 50 cases to sit for boards. However, the diminished numbers of autopsies that occur at irregular intervals do not support a dedicated, freestanding autopsy rotation.

The ABP has performed exit surveys of practicing pathologists following their Maintenance of Certification (MOC) examination and found that around 41% of pathologists do not perform autopsies in their practice.<sup>5</sup> Provided with this information, some programs have eliminated free-standing autopsy rotations, combined with other rotations, and have utilized this time to increase the number of rotations in surgical pathology. This begins to address the extra time needed to train residents in surgical pathology; however, molecular pathology, laboratory administration, and clinical informatics are also areas that have an increasing importance in the future needs of the fledgling pathologist and have a notable presence in the pathology milestones.<sup>1,4</sup> The question remains: where will the time for these disciplines come from?

Although it is not the purpose of this study to answer the question immediately above, we observe that opportunities are coming into view. Black-Schaffer and colleagues have examined the relationship between the time-based structure of existing Graduate Medical Education (GME) programming in pathology residency training programs and competency-based milestones, which might accelerate the GME training process.<sup>14</sup> A logical outcome of competency-based milestones is that additional training time might become available for enhanced skill set development during the mandatory postgraduate year 1 (PGY1) through PGY4 years. Hébert et al describe programming for accelerated “onboarding” of pathology residents, including reaching into the closing year of undergraduate medical education.<sup>15</sup> This might again create potential opportunities for extended training during the PGY1 through PGY4 years. In a similar vein, Rishi et al describe successful

insertion of a full-time month dedicated to laboratory management, during the PGY3 year of pathology residency training.<sup>16</sup> Hence, we are optimistic that our discipline can respond to the need to use evidence coming from our current study and other sources to evolve successfully in our future GME training efforts.

## Summary

Pathology program directors need feedback from community practice groups, academic medical centers, and industry to understand and identify gaps in training programs’ preparation of pathologists for their future practice. Ongoing data collection by the ABP from pathologists taking their MOC examination will be helpful as these data accrue. A manuscript coauthored by members of APC and CAP providing such feedback from pathologists that are new in practice and from employers of recent graduates is forthcoming.

Although these findings will greatly expand our understanding of the relationship of the present state of training to its application in practice, any conclusions that may be drawn from these surveys about the alignment of training with practice will only be directional, in the sense of indicating areas of increased need for training and areas of decreased need. For an accrediting or credentialing agency to determine from these national indicators what would be constructive to change, that agency will need to know how its existing curricular requirements compare with the existing curricular elements nationally. Similarly for any particular residency program, if the national survey findings suggest, for example, that more training in laboratory management is needed, the implications for a particular program that is already above the 90th percentile in laboratory management training would be different than for a program below the 10th percentile; likewise, if the suggestion is that less autopsy training is indicated, a program would need to consider not only the then current ABP and ACGME requirements but also how its present training in autopsy compares with such training nationally.

The intent of this article is therefore to provide some of the core information for a productive national reconsideration of the future design of residency training in pathology, by providing baseline perspective on the essential structural elements of the national pathology residency curriculum where they remain the same and understanding of their present trajectory as they are changing.

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