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Developing and Fostering a Dynamic Program for Training in Veterinary Pathology and Clinical Pathology: Veterinary Students to Post-graduate Education

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Abstract

Recent reports project a deficiency of veterinary pathologists, indicating a need to train highly qualified veterinary pathologists, particularly in academic veterinary medicine. The need to provide high-quality research training for veterinary pathologists has been recognized by the veterinary pathology training program of the Ohio State University (OSU) since its inception. The OSU program incorporates elements of both residency training and graduate education into a unified program. This review illustrates the components and structure of the training program and reflects on future challenges in training veterinary pathologists. Key elements of the OSU program include an experienced faculty, dedicated staff, and high-quality students who have a sense of common mission. The program is supported through cultural and infrastructure support. Financial

compensation, limited research funding, and attractive work environments, including work–life balance, will undoubtedly continue to be forces in the marketplace for veterinary pathologists. To remain competitive and to expand the ability to train veterinary pathologists with research skills, programs must support strong faculty members, provide appropriate infrastructure support, and seek active partnerships with private industry to expand program opportunities. Shortages of trained faculty may be partially resolved by regional cooperation to share faculty expertise or through the use of communications technology to bridge distances between programs. To foster continued interest in academic careers, training programs will need to continue to evolve and respond to trainees' needs while maintaining strong allegiances to high-quality pathology training. Work–life balance, collegial environments that foster a culture of respect for veterinary pathology, and continued efforts to reach out to veterinary students to provide opportunities to learn about the diverse careers offered in veterinary pathology will pay long-term dividends for the future of the profession.

Keywords

pathology; training; education; veterinary; program

Introduction and Background

A recent report prepared for the Recruitment Committee of the American College of Veterinary Pathologists (ACVP) and the Society of Toxicologic Pathology¹ projected a deficiency of more than 200 veterinary pathologists in multiple job settings by 2007. This projection, coupled with a relatively small cohort of board-certified veterinary pathologists (~1,500), indicates a dramatic need to train highly qualified veterinary pathologists. This need is particularly acute in colleges of veterinary medicine and other academic settings, which have recently had difficulty in attracting and retaining veterinary pathologists. As indicated in the ACVP report,¹ veterinary pathologists who will fill leadership roles in the job market will require training in scientific research methods in addition to traditional pathology knowledge and skills. This research focus in veterinary pathology training is especially critical in the “translational,” setting in which discovery is clearly linked to treatment of human or animal patients. Similarly, a recent report from the National Academy of Sciences indicates that Colleges of veterinary medicine must lead an effort to develop a national animal health education plan to educate and train individuals from all sectors (from animal handlers to pathologists) in disease prevention and early detection and to recruit veterinary students into careers in public health, food systems, biomedical research, diagnostic laboratory investigation, pathology, epidemiology, ecosystem health, and food-animal practice.²

Further illustration of the importance of training veterinary pathologists in research can be found in a separate report of the National Academy of Sciences,³ which states that “the capacity of veterinary research depends on the availability of human and financial resources, research facilities, and infrastructure.” The veterinary pathology training program of the Ohio State University (OSU) has recognized the need to provide high-quality research training for veterinary pathologists since its inception more than 50 years ago. This requirement has been a common theme and has formed the foundation of the environment and mission of the program from the beginning. The OSU training program has a long and successful track record of training research pathologists, incorporating elements of both residency training and graduate education into a unified program. This review illustrates the components and structure of the training program and reflects upon future challenges in training veterinary pathologists focused on research careers. The program components and characteristics outlined below are written to document common characteristics of a

particular program and are not meant to represent the only formula for success in training research-intensive veterinary pathologists. It is our hope that the common traits and features illustrated here will serve as a useful guide in developing successful training programs in veterinary pathology and clinical pathology (see Table 1). The term “veterinary pathology,” as used throughout the review, includes both veterinary anatomic pathology and veterinary clinical pathology.

Overview of Program Components

The OSU Veterinary Pathology Training Program's structure and philosophy, from veterinary student electives to instruction for residents/graduate students, is faculty intensive. Faculty members strongly encourage veterinary pathology trainees to be independent and self-directed learners at every stage of the program. The training program provides experienced faculty trainers who are prepared to guide students and help evaluate their progress (see Table 2). The program emphasizes one-on-one mentoring and promotes interactions in small-group settings in a variety of ways to promote self-exploratory patterns of learning. The overall objectives of the OSU training program in veterinary pathology include (1) providing a learning environment in which the resident or graduate student will become competent in diagnostic veterinary pathology, principles of pathobiology, and complete training for certification by the ACVP; (2) developing and promoting an academic environment in which the resident or graduate student can be introduced to skills in experimental design, research methods, and scientific writing to fulfill requirements for an MS or PhD degree; (3) providing opportunities for residents or graduate students to gain teaching experience by assisting departmental faculty in instruction; and (4) providing opportunities for students to develop and perfect their oral and written communication skills through proposal and report writing as well as through numerous informal seminar and formal PowerPoint presentations in public forums. The training program, coordinated through the OSU Department of Veterinary Biosciences, is run within the College of Veterinary Medicine (CVM) and is an important component of the one of the most comprehensive health sciences centers in the United States. This feature places the training program in the context of a larger biomedical enterprise and provides a strong culture for research for trainees in the program. The Department of Veterinary Biosciences combines the disciplines of veterinary anatomy, immunology, microbiology, pathology, pharmacology, and physiology into a single academic unit. The breadth of the faculty's expertise offers opportunities for research; interdisciplinary teaching in the veterinary medical, post-DVM, and graduate programs; and state-of-the-art clinical laboratory services. There are currently 29 primary departmental faculty members involved in research, education, and service activities. Among them are a critical mass of 12 board-certified by the ACVP (nine in anatomic veterinary pathology and three in veterinary clinical pathology). The department supports strong interdisciplinary research programs in the areas of cancer, endocrinology, rickettsiology, and retrovirology and runs a graduate program with approximately 75 students (approximately 50% of them veterinarians) pursuing MS and PhD degrees in experimental pathobiology, molecular biology, biochemistry, microbiology, molecular virology, and physiology. Typically, the program maintains approximately 20 veterinarians seeking training in veterinary pathology as residents/graduate students or post-doctoral instructors; it is thus among the largest programs in the United States in terms of the number of active trainees.

Program Elements: Emphasis on People

Essential to any high-quality educational program are well-qualified teachers, dedicated support staff, and academically qualified students. The same is true for successful veterinary pathology training programs. Graduate training faculty members at OSU include those from

the department and from other allied biomedical-related units within the university, as well as key adjunct faculty members outside the university. By expanding the number of available research mentors in the program, OSU offers trainees access to a highly qualified and diverse group of mentors. This has strengthened the recruitment efforts of the OSU training program, as applicants are encouraged by the breadth of expertise available to assist in their research training. In a time when qualified veterinary pathology trainees are in high demand, students' attitude is much like that of savvy consumers, well aware of the marketplace and of the skills needed to work in a research setting. In this environment, it is highly desirable for programs to be able to offer students more choices in the selection of a research mentor.

While the number of qualified faculty mentors is important for both the veterinary pathology training and the research experiences of the students, a cultural component is an important unifying theme. While harder to define, the culture of the training program needs to stress a positive attitude toward veterinary pathology training and encourage a team approach that includes a positive reward structure. The accomplishments of veterinary pathologists, such as election to national office positions in the ACVP or national scientific awards, should be emphasized and promoted in program communications and beyond. This reward system may take many forms, from announcements in newsletters to submitting veterinary pathologists for national awards, but it needs to be ongoing and ingrained in the culture of the program to sustain a sense of common purpose, respect for the discipline, and excellence. The overall structure of the program, including infrastructure support (e.g., well-equipped seminar rooms for conferences), must be congruent with program goals and aspirations. If administrative support is misaligned with program goals, morale will suffer. What has sustained OSU's veterinary pathology training program over time is a strong administrative support structure that includes veterinary pathologists as leaders in the CVM.

Structure of the Training Program

Specialty training at OSU is offered in veterinary clinical and anatomic pathology; the two courses of study are similarly structured. In the first year, the program is pathology intensive; instruction is based on service activities, didactic coursework, and participation in regular seminar series. Anatomic veterinary pathology trainees participate in hospital necropsy duty and assist in diagnostic services and in the instruction of veterinary students. Veterinary clinical pathology trainees are incorporated into cytology service duty and review all cytology cases and selected hemograms. During this time, all first-year pathology trainees complete preliminary write-ups on cases, which are then reviewed by faculty members. In this first year, approximately 10% of trainees' time is devoted to identifying laboratories in which to pursue graduate education leading to the PhD degree. Informal rotations of trainees in prospective research mentor laboratories are encouraged, to allow trainees to make an informed decision in selecting a mentor for their research training at the beginning of year 2. Years 2 through 5 are research intensive. Students engage in dissertation research and participate in scientific meetings, workshops, and seminar series that hone their skills as investigators in biomedical research. Success in this arena is measured by the quantity and quality of students' first-authored publications and extramurally funded fellowships (see Table 2).

Pathology training continues from year 1 in the form of less time-demanding service-related activities (e.g., reading surgical biopsies in lieu of participation in necropsy rotations), continued enrolment in didactic courses, and participation in a great variety of regularly scheduled pathology seminars. System- or discipline-specific pathology seminars (e.g., renal, cardiovascular, laboratory animal) represent an important component of this training period. These system- or discipline-specific seminars offer a unique format for clinicians to

interact directly with pathology trainees, thus broadening their training experiences. Clinical pathology trainees who are second- and third-year residents are assigned cytology duty based on discussions with faculty and research advisors to manage their available time effectively.

Preparation for the ACVP board certification examination begins indirectly in the first year of the program, through informal preparations in histopathology and clinical pathology seminar courses and one-on-one interactions with training faculty, but intensifies in the fifth year of the program, as the dissertation draws to completion. Preparation follows a carefully structured regimen that takes advantage of the expertise of other trainees in the program, as well as of dedicated pathology faculty who have developed an organized template approach to preparation for the exam. Typically, individuals begin more intense preparations approximately 12 months in advance of the exam, with the organization of study groups and individual sessions with training pathologists to maximize economy of effort on the part of both students and faculty mentors (see Table 3).

A unique key to the success of the program is the flexibility that permits it to be tailored to individuals who have already achieved a strong background in research. For these individuals, the program may be shorter and may remain pathology intensive for the duration of the study period. Other trainees may already have begun pathology training at another institution, coming to OSU in order to strengthen their research skills while continuing to develop their pathology expertise. Programs for these individuals are therefore more research intensive. Some of these trainees may function as senior pathology residents, and in this role they can also mentor other students. The result is a dynamic environment, highly supportive of dual research and pathology education, that embraces individuals of diverse backgrounds.

In the second year of the program, the trainee's PhD Advisory Committee is selected by mutual agreement between the trainee and his or her advisor. The inclusion of veterinary pathologists or clinical pathologists in the Advisory Committee promotes the discipline in the context of the thesis research project. The responsibilities of the Advisory Committee are to provide advice regarding the student's overall academic and research program and to assist in the evaluation of progress in both these aspects of the total graduate program. Trainees and advisors must plan a program of study toward an advanced degree and submit it to the Advisory Committee for approval. Each trainee is evaluated in a yearly meeting with the Advisory Committee and by pathology and clinical pathology mentors on a regular basis throughout the academic program. A completed annual review form is an important evaluation tool for the department's Graduate Studies Committee, which reviews the information to ensure that both the department and the student are fulfilling their responsibilities in their research program. These processes are vital in ensuring that trainees receive support and that trainees' requirements of the graduate program are clearly outlined, thus ensuring timely completion of each trainee's PhD program.

Additional interactions between trainees that promote the incorporation of veterinary pathology in context to biomedical research are achieved through research seminar series in the department and throughout the university. Specific invited speakers who are leaders in veterinary pathology and research scientists are encouraged. Students are often included in informal interactions with biomedical scientists, to encourage career exploration and scientific exchange. Trainees in the program are required to present their research on a regular basis to refine their communication and presentation skills. Annual research seminar and publication awards have been established and provide financial and peer recognition of high-quality scientific communications.

Veterinary Students: Attracting the Next Generation of Veterinary Pathologists

The exposure of professional veterinary students to careers in veterinary pathology—including academic veterinary pathology—can be incorporated into the curriculum to encourage recruitment. The OSU CVM offers required and elective courses in veterinary pathology to promote the discipline, beginning with basic veterinary pathology courses in the first year of the curriculum, taught by engaged and interactive faculty members. Electives in basic pathology and the pathogenesis of disease are recognized by faculty members as critical in attracting veterinary students into the discipline of pathology. Recruitment is further supported by active support of a veterinary pathology club sanctioned by the ACVP. Elective courses in both basic and clinical veterinary pathology are offered to veterinary students; these courses emphasize basic macroscopic or microscopic changes in tissue or cells in the context of disease. These basic electives are designed to attract those students seriously interested in pathology as well as those who understand that interpreting gross lesions or cytology is important in clinical practice. Veterinary students are also offered opportunities to interpret macroscopic tissue changes in diseases of domestic and exotic animal species, with correlation to pathogenesis. Individual-study courses in veterinary pathology are offered to single students or groups of students and range from using histopathology or cytology slide-based case material to more in-depth veterinary pathology techniques such as immunohistochemistry or *in situ* hybridization. In addition, some veterinary students interested in veterinary pathology choose to join a more structured dual-degree program, earning their DVM and MS degrees and participating in a Summer Research Program supported by the CVM. Collectively, these efforts provide early and diverse exposure to veterinary pathology for interested students.

Core Curriculum Components

A well-structured didactic curriculum offered to residents and graduate students seeking training as research-focused veterinary pathologists is common to most successful training programs. A key to the success of a veterinary pathology curriculum is the combination of specific veterinary pathology courses and graduate courses related to the trainee's research. This type of curriculum builds the basic concepts allowing veterinary pathologists to incorporate their knowledge and skills in the context of biomedically important questions. The core curriculum of the OSU training program consists of specific veterinary pathology courses taught in the department and selected courses offered throughout the university. The overall philosophy of the program is to provide selective didactic coursework to complement the educational backgrounds of trainees and to individualize coursework for each trainee's needs. This flexibility allows a tailored approach rather than relying on a rigid and time-consuming list of required didactic courses. Course plans for veterinary pathology trainees includes courses that emphasize principles of general pathology or clinical pathology and gross, microscopic, and ultrastructural pathology of domestic animals. These are supplemented by comparative pathology courses on naturally occurring diseases of humans, exotic animals, and laboratory animals, given as either didactic or seminar course series.

Anatomic veterinary pathology trainees are required to take a series of didactic courses, which are a foundation for systems-based discussions on mechanisms of disease at the biochemical, cellular, tissue, and organism level. Emphasis in this course series is on naturally occurring diseases, but experimentally induced disease is presented when it serves to elucidate relevant mechanisms. The approach is based in comparative medicine, focusing on diseases of mammals. The course of study spans three quarters per year, for a total of two years, and is team taught. Faculty participation is based on either general or organ-system-

specific pathology expertise. Additional expertise is provided by veterinary pathologists from regional universities and from industry. Lectures are supplemented by faculty-mentored reviews of histopathology and ultrastructural pathology study sets. In addition to the systems-based didactic lectures, instructional blocks are provided in specialty areas such as the pathology of fish, reptiles, and amphibians; the pathology of laboratory animals; and basic principles in toxicological pathology. Content in these specialty topics provides sufficient background so that the student can effectively engage the scientific literature or participate in service areas requiring these backgrounds.

Regular weekly seminars in veterinary pathology use case-based materials in histopathology (both light microscopic and ultrastructural) or clinical pathology to discuss mechanisms of disease or patterns of disease expression. Faculty, students, and pathologists from outside the university may rotate as conveners for this course. The seminar is considered a staple of training; students' participation continues from the beginning of the training program through to the end. Monthly seminars in diagnostic veterinary pathology include ophthalmic pathology, neuropathology (brain trim), cardiac pathology, laboratory-animal pathology, exotic-animal pathology (in collaboration with the Columbus Zoo), dermatopathology, and renal pathology. The program structure benefits from a large and diverse case load (see Box 1). Conferences are multidisciplinary in nature; participants include clinical faculty, clinical residents, and veterinary students in addition to pathology faculty members and residents or graduate students. Pathology residents and graduate students work with senior pathologists to prepare case presentations, with the goal of integrating clinical findings (e.g., magnetic resonance imaging, cytology results) with gross and microscopic post-mortem findings. Students coordinate their participation in specific seminars for the duration of their training. Three additional courses use a case-based approach to instruction in gross post-mortem findings, histological findings, and cytological interpretation of clinical specimens. Instruction is linked to necropsy, surgical biopsy, or cytology services. Residents are responsible for generating final written reports under the guidance of a senior pathology resident and a faculty board-certified pathologist.

A graduate-level course in statistics is required of all residents and graduate students, representing a minimum of three credit hours. Students may select from a number of courses offered by the OSU Department of Statistics, the choice being determined by the student's background. Individuals with a statistics background from their undergraduate or prior graduate curriculum can also fulfill the requirement by enrolling in one of a number of summer programs in applied statistical methods.

Additional coursework for each trainee is defined following formation of and consultation with a specific Graduate Advisory Committee. All laboratories supporting dissertation research are extramurally funded; the majority of this funding comes from the National Institutes of Health (NIH), including a training grant in mouse pathobiology. Research projects performed in these environments necessarily embrace state-of-the-art technologies in genomics and proteomics, development and use of genetically modified animals, and development and use of tissue-culture systems.

To develop skills in scientific writing, many trainees are expected to submit training fellowships to the NIH (e.g., K08, Mentored Clinical Scientist Development Awards; K01, Special Emphasis Research Career Awards) (Table 4). In addition, some advisors teach grant-writing skills to their students by allowing them to participate in preparing extramural grant applications. All trainees are offered multiple grant-writing workshops, including grant-writing seminars offered each year by the OSU Research Foundation.

The PhD candidacy examination typically consists of a four-day closed-book written exam and a two-hour oral examination given two weeks after the written exam. The PhD candidacy exam committee consists of four faculty members and may include the same faculty as the Advisory Committee of the trainee or different faculty. Each chapter of the dissertation is considered a publishable unit (manuscript), and chapters are submitted for peer review and publication as completed, which may be prior to thesis defense. The average number of peer-reviewed publications resulting from a dissertation is typically four and has ranged from three to seven in the recent past.

Recruitment of Trainees

Devoted recruitment efforts are increasingly important to a successful veterinary pathology training program. Recruitment of trainees to the OSU training program is accomplished through established procedures used successfully by the OSU Graduate School and the Department of Veterinary Biosciences. These procedures employ selective advertisements at a national level in scientific journals such as *Veterinary Pathology*; they also include the development of professionally designed recruitment posters and brochures used in mailings. Mailing lists for targeted institutions in the United States include all deans and appropriate department chairs or Graduate Studies Committee chairs of North American colleges of veterinary medicine. Additional lists have been developed that target peer institutions, veterinary medical student honor societies (e.g., Phi Zeta), and institutions that train minorities underrepresented in the United States (e.g., Howard University in Washington, DC.) The department has redirected a secretarial staff position to support the graduate program. The graduate records of the department have been centralized, and an inquiry system has been established to provide information to prospective graduate students. To provide immediate feedback for prospective applicants to the program, inquiries from potential trainees are answered by phone, e-mail, and mailings of brochures and applications. A Web site was created to facilitate recruitment of graduate students. The Web site includes faculty profiles, general community information, admissions and financial information, and recent fellowship announcements. The department has developed a Graduate Program Handbook for all entering graduate students. Trainees are given a list of currently available research laboratories, along with descriptions of the field of research. Dedicated staff members offering help with residency or visa applications, grant applications, necropsy records (including image collections), and occupational-health requirements are important additional sources of support.

Veterinary pathology trainees are recruited either from existing pools of graduate students or directly through focused national recruitment efforts, as outlined above. Typically, trainees have a minimum GPA of 3.6 (on a 4-point scale) in all previous undergraduate and professional coursework and a minimum composite Graduate Record Exam score of 1,800 or better. An additional factor in the selection of trainees is an area of research interest congruent with those currently offered by the department. The most competitive applicants have had previous research exposure or experience in veterinary school or elsewhere.

Competing for Trainee Support

A significant challenge for any veterinary training program is to maintain funding for stipends and training costs. In the national competition for highly qualified veterinarians seeking advanced graduate training, veterinary pathology training programs find themselves competing directly with programs in other veterinary medical specialties. A competitive advantage for veterinary pathology programs is the NIH's increased willingness to offer funding programs for physician-scientists, including veterinary pathologists. The OSU training program has emphasized this opportunity by supporting mentors and trainees

seeking NIH fellowships. As a result, over the past 10 to 15 years trainees in the program have successfully competed for these highly prestigious graduate-student fellowships (Table 2). These awards have directly enhanced these students' ability to obtain employment following completion of their degree, in part because the awards are transferable during the postdoctoral period.

Our program has found from experience that fellowship offers in the first year of the program are critical to enhance the “package” offered to the top students seeking training in veterinary pathology. To ensure our success in recruiting these individuals, we have applied for and received university fellowships and program support grants. The availability of this type of university support has improved our departmental recruitment efforts, shortened the time required for these students to complete their degree, and provided the transitional support necessary to allow them to be competitive for extramural research awards. Department and university resources provide additional funds for on-campus visits by qualified students, including students in their second or third year of veterinary school. The department also supplies funds to send qualified students to conferences and workshops during their final years of graduate training, which increases their competitive advantage in the job market. Based on our experience, we have targeted selected high-quality conferences (e.g., Cold Spring Harbor Laboratories) and workshops (e.g., NIH-sponsored workshops in mouse pathobiology) that offer advanced training for those students nearing the completion of their thesis research. These funds are awarded to students, and matching funds are sought from faculty mentors to extend the use of the funds. The department also supports a biannual career day organized by graduate students in the program to bring in speakers from a variety of job settings, including veterinary pathology.

Interactions with Other Training Environments

To provide research training for veterinary pathologists, many programs make use of their local biomedical communities. Similarly, the OSU training program exists within a larger biomedical center that includes the Colleges of Medicine, Veterinary Medicine, Pharmacy, Dentistry, Nursing, Optometry, and Allied Medical Professions, and has utilized other units to supplement the training of veterinary pathologists. A clear geographical advantage is that all components of the center are on the same campus and within walking distance of the department. This environment is key to our training, providing a diverse source of graduate faculty, faculty collaborations, seminar series, and core research-support facilities. The latter support technologies including whole-animal imaging, confocal microscopy, genomics and proteomics, and generation of genetically modified mice. In recent years, the training program in veterinary pathology has interacted directly with the Animal Diagnostic Disease Laboratories of the Ohio Department of Agriculture, located approximately 20 minutes from the department, to support rotations of first-year pathology residents on the necropsy floor and interpretation of “mail-in” cases. These rotations expose residents to the pathology of production animals as well as to diagnostic support services, including toxicology and microbiology. The university is adjacent to the headquarters of the Battelle Memorial Institute, one the largest non-profit research organizations in the world, and Battelle staff toxicologists have served as both instructors and consultants for training activities within the Department of Veterinary Biosciences at OSU. Collectively, this group of resources provides a rich environment for veterinary pathology trainees and their mentors.

Concluding Remarks: Opportunities and Challenges

At the national level, the shortage of appropriately trained veterinary pathologists is a significant challenge to training programs. At OSU, the 31 trainees who have completed the Veterinary Pathology Training Program in the past decade have chosen employment

positions evenly divided between academia (9), industry (9), and diagnostic laboratories (8); slightly fewer (5) have chosen to work in government and private research institutes (see Figure 1). Financial compensation and attractive work environments, including appropriate work–life balance, will undoubtedly continue to be forces in the marketplace for veterinary pathologists. Programs seeking to train research-intensive veterinary pathologists will also be faced with the challenge of limited research funding as government sponsorship of research declines and competition increases for grant dollars.³ To remain competitive, and to expand their ability to train veterinary pathologists with research skills, programs must provide a comprehensive curriculum that emphasizes strong faculty members who are well supported by their institution. Additional support mechanisms, including active partnerships with private industry (e.g., pharmaceutical companies), can play a vital role in program support.⁴ Shortages of trained faculty members may be partially resolved by regional cooperation to share faculty expertise or through the use of technology (e.g., digital microscopy) to bridge communication gaps between programs. To foster continuing interest in academic careers, training programs will need to continue to evolve and respond to trainees' needs while maintaining a strong allegiance to high-quality pathology training, which forms the foundation of the discipline. A healthy work–life balance and collegial environments that foster a culture of respect for veterinary pathology will help new generations of veterinarians to find career opportunities in pathology. Continuing efforts to reach out to veterinary students, offering opportunities to learn more about the diverse careers available in veterinary pathology, will pay long-term dividends for the future of the profession. In the words of former US president John F. Kennedy, “There are risks and costs to a program of action. But they are far less than the long-range risks and costs of comfortable inaction.”⁵ Similarly, the time for investing in the training of veterinary pathologists is here; it will not be without risk, but the risk of inaction is far greater.

Box 1: OSU Pathology Case Load and Species Distribution

Cases submitted to the diagnostic laboratories of the Department of Veterinary Biosciences can be subdivided as follows:

Necropsies: average 20 cases per week

Submissions from the Department of Veterinary Clinical Sciences:

70% dog and cat

10% equine

10% camelid

5% bovine

2% small ruminant

2% exotic (avian, reptiles)

1% pocket pet (rabbit, ferret, gerbils, hamsters, etc.)

Submissions from the Columbus Zoo average one to two per week. Species transported to the department for post-mortem examination have included fish, reptiles, amphibians, birds, primates, zebras, moose, cheetahs, bears, giraffes, and rhinoceros. Elephants are necropsied on zoo premises by response teams from the department.

Surgical biopsies average 25 cases per week:

70% dog and cat

15% equine

15% camelid, bovine

Laboratory-animal submissions average 10 cases per week:

90% mice and rats (includes mouse phenotyping service)

9% raccoon, opossum, chinchilla

1% primate

Cytology service: average 34 cases per week

Hematology/Biochemistry service: average 100 cases per week

Cases submitted to the Animal Diagnostic Disease Laboratories, Ohio Department of Agriculture (first-year anatomic pathology trainees on three- to six-week rotation) can be subdivided as follows:

Necropsies: 10 cases per week

Mail-in histology: 8 cases per week:

70% cattle (beef and dairy), small ruminants (sheep and goats), pigs, chickens

10% equine

10% camelids

10% wildlife (birds, deer, raccoons, etc.)

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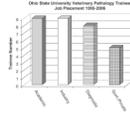


Figure 1. Graphic illustration of initial job placement of veterinary pathologists (31 total trainees, anatomic and clinical pathology) from the Ohio State University from 1995 through 2006

Table 1
Components of an effective veterinary pathology program with emphasis on research training

Component	Strength	Limitation	Comment
Strong group of highly qualified veterinary pathologists	Critical mass with well-recognized standards of excellence	Shortage of qualified faculty in academic settings	Becoming more difficult with shortage of qualified veterinary pathologists
Diverse group of research mentors with sponsored research	Provides recruitment advantages and choices for students	May not be available without a strong biomedical environment	Flexible and cooperative policies on mentoring across units facilitate this component.
Positive culture	Creates sense of common mission and promotes work-life balance	Challenging with high case loads or a reduced workforce	Ongoing efforts to improve the culture are required.
Infrastructure support	Provides necessary tools to conduct diagnostics and research	Resources may be limited by factors beyond the program.	Differs depending on unit, but basic support for pathology education is central to success
Reward systems	Nurtures respect and positive attitude for veterinary pathologists, staff, and students	May be perceived as unequal unless criteria are clear and consistent	Rewards may come in variety of forms and may not always be financial.
Graduate Research Advisory Committees that include veterinary pathologists	Involves veterinary pathologist as advocate for trainee and emphasizes pathogenesis	Requires a veterinary pathologist who understands research and is supportive of laboratory research	Local graduate programs may differ in policies for graduate faculty involvement.
Strong biomedical research environment	Promotes interdisciplinary research and sponsored research	College or training unit may be geographically unable to provide	Important for translational research and recruitment
Regular and structured evaluation of trainees	Provides direct feedback to trainee and allows corrective action to improve pathology skills and conceptual knowledge on a daily basis	If performed in a punitive manner or inconsistently, may create a sense of unequal evaluation on the part of trainees	May involve course work, quality of work-ups on cases and presentations, annual research progress updates and final research report, or defense of thesis
Flexible and high-quality curriculum	Adjusts for background of recruited trainees and allows an individually designed program	Requires committed mentor and advisory committees and clear guidelines	A functional advisory committee is a key element of quality control to maintain standards.
Inclusion of veterinary students through a broad array of elective courses and interactions with faculty	Early involvement stimulates long-term interest in veterinary pathology.	Availability of faculty to teach courses may limit offerings or limit the number who can be constructive mentors.	Veterinary students are often most interested in year 1 of curriculum and may be more difficult to involve in subsequent years.

Table 2
OSU Veterinary Pathology Training Program: Outline of training with research emphasis

Immersion in Pathology: Early Experiences	Refinement of Proficiency in Diagnostic Pathology and Research Training: Years 2-5
<ul style="list-style-type: none"> • There is a heavy emphasis on diagnostic training in the first year, with necropsy floor duty (average approximately 2 days/week) or clinical pathology service duty (average approximately 2-3 days/week). • First-year anatomic pathology students are required to present selected cases from databases (e.g., Armed Forces Institute of Pathology) at monthly conference • Students attend systems-based pathology conferences with clinical specialists (dermatopathology, neuropathology, cardiac pathology, etc.). • Weekly histopathology or clinical pathology seminars (3-5 presentations) and research seminar attendance are required. • Students participate in informal rotations with potential faculty mentors for PhD training to gain exposure to research. 	<ul style="list-style-type: none"> • Diminished time is spent on anatomic pathology necropsy or clinical pathology services. • Anatomic pathology trainees switch to surgical biopsy service; clinical pathology trainees have reduced clinical pathology service. • Students rotate on weekend necropsy (anatomic pathology). • Weekly histopathology or clinical pathology seminars (2-3 presentations) and research seminar (one presentation annually) are required. • A formal 6-quarter course in systems-based diagnostic pathology is offered continuously over a 2-year period; this course is required for anatomic pathology trainees. • Students attend systems-based pathology conferences with clinical specialists (e.g., dermatopathology, neuropathology, cardiac pathology, renal pathology, ophthalmic pathology, laboratory-animal pathology). • Students carry out independent study of literature. • Students carry out independent study of histopathology or clinical pathology study sets maintained by an educational resource staff. • Students undertake independent and faculty-supervised study of gross pathology study slides. • Students are offered opportunities in lecture and laboratory teaching experience. • Completion of PhD is expected in years 4-5. • Intensive preparation for ACVP Certifying Exam takes place in year 5.

Table 3
Preparation for ACVP certifying examination: A 12-month plan for success

Board Preparation Timeline and Milestones	Organization of Final 12-Month Course of Preparation
<ul style="list-style-type: none"> • Individual 12-month preparation plans with goals for didactic reading, review of clinical materials, mock histopathology and clinical pathology exams, and intensive one-on-one instruction • Training supplemented with seminars and intensive student–faculty interactions in necropsy, surgical pathology, clinical chemistry, cytology, and hematology 	<ul style="list-style-type: none"> • References, organization, a study plan, short-term goals • Periodic meetings to assess and teach how to triage articles • Biweekly meetings to review gross pathology photos for 12-month period; weekly meetings for last 2–3 months • Private meetings to discuss individual issues • Starting on July 1, weekly 2-hour, 10-slide histopathology exam for 10 weeks • Exams graded with comments and reviewed • Each student to describe 100 slides during 2–3 months • Orientation about Ames, IA (site of exam); travel plans

Table 4
Research Fellowships for Veterinary Pathologists at OSU, 1992–2007

Number	Award Mechanism
9	NIH K08 (Mentored Clinical Scientist Development Award)
5	NIH K01 (Special Emphasis Research Career Award)
10	NIH F32 (Individual National Research Service Award)
3	NIH T32 (Institutional National Research Service Award)
1	National Multiple Sclerosis Society
1	US Army Postdoctoral Research Fellowship