Careers in Veterinary Pathology
General Facts

- First veterinary board-specialty organization recognized by AVMA
- Established in 1949
- Roughly 2,000 members
- Earn $70,000 to > $250,000 annually
What is Veterinary Pathology?

• The study of animal disease in a variety of species, often with human implications
What is Veterinary Pathology?

• Pathology provides the scientific foundation for the practice of medicine by studying the etiology and pathogenesis of disease at all levels
• Crucial in determining cause of animal disease and its risk to human health (at forefront of the One Health concept)
What is Veterinary Pathology?

• Studies range from live animals to specific proteins involved in disease
Subsections of Pathology

- **Clinical**: Body fluid and cell analysis
  - Biochemistry, hematology, cytology, urinalysis, microbiology
- **Anatomic**: Necropsies and surgical biopsies
  - Postmortem examination of animal carcasses & microscopic evaluation of tissues, e.g. immunohistochemistry
  - Microscopic examination of masses and tissues removed from living animals
  - Phenotyping of laboratory animals
- Separate specialties, each requiring a different training and board certification
An Integrative Science

- Pathology encompasses multiple disciplines that enables a broad approach to problem-solving

- The ability to investigate hypotheses from a broad knowledge base makes pathologists valuable members of research teams
Cytology

• Cells from tissue or body fluid fixed and stained for microscopic examination

Fine needle aspirate: Cells from a cancerous lymph node

Blood smear: Cancerous cells from the lymph node also present in the blood stream (leukemia)
Hematology

- Blood cell analysis
  - Cell counts & percentages
  - Cell size & distribution
  - Hemoglobin concentration
Histology

- Fixed, embedded tissues sectioned and stained for microscopic examination

- Hematoxylin & Eosin
- Sevier Munger
- GMS
- PAS
- Toluidine Blue
Special Staining Techniques

- Antibodies paired with a marker are used to identify cells & tissues

Immunocytochemistry

Immunohistochemistry

Immunofluorescence
Flow Cytometry

- Count and sort cells by size & fluorescent biomarkers
- Uses include
  - Hematology
  - Cancer detection
  - Immune function assays
  - Stem cell isolation
Microbiology

- Bacteriology
- Mycology
- Parasitology
- Virology
Clinical Chemistry

• Analysis of body fluids including plasma, serum or urine to examine
  – Liver & kidney function
  – Cardiac markers
  – Electrolytes & minerals
  – Enzymes & hormones
  – Drug or chemical levels
  – Other proteins or nutrients
Transmission Electron Microscopy

• Highly detailed images at higher magnification
Digital Image Capture & Analysis

- Slides digitized
  - Photographed
  - Scanned
- Image analyzed
  - Cell proliferation counts
  - Measurements
  - Immunohistochemical quantification
  - Histomorphometry
Necropsy

- Gross inspection of a deceased animal
- Fluid & tissue collection for analysis
Diagnostic Laboratories

- In large diagnostic laboratories, the workload is shared and it’s easy to consult with others before releasing results.
Careers in Veterinary Pathology

• Major Industries
  – Academic
  – Governmental
  – Private

• Possible Roles
  – Diagnostician
  – Researcher
  – Lecturer & Mentor
  – Public Outreach & Education
  – Contracted Expert or Consultant
Pathology Subspecialties

- Diagnostic
- Investigative
- Molecular
- Toxicological
- Translational
- Drug Discovery & Safety
- Phenotyping & Characterization
- Electron microscopy
How do I become a Pathologist?

• Bachelor’s degree or equivalent
• DVM or equivalent
• Residency or postdoctoral training in veterinary pathology
• ACVP Board Certification
  – Anatomic and/or Clinical
• 50% also obtain a PhD
  – Consider combined programs
Specific Cases

• Canine pemphigus foliaceus

- Presentation
- Histopathological Diagnosis
- Post-treatment
Specific Cases

- Melamine toxicity
  - Canine kidney histopathology

Light microscopy

Polarizing lens: Melamine crystals

[ACVP Fact Sheet]
[USA Today, 2008]
Specific Cases

• West Nile Virus

—Bronx Zoo discovered N. American invasion

Tracking down a killer virus

20 day odyssey from St. Louis to West Nile

PHILIP KORN

Theodore Rush Laboratory for Animal Infectious Disease

The first case of West Nile Virus was reported in 1999 in the United States. Since then, outbreaks have been reported in Africa and Europe, most recently in Europe in 2002.

Scientists believe that the virus is transmitted by mosquitoes to birds and other animals. The virus then spreads to humans and animals through mosquito bites.

In the U.S., the first case was reported in New York City in 1999. Since then, the virus has spread to other states, including Louisiana, Florida, and Texas.

Scientists have been working to develop ways to prevent the spread of the virus, including the use of mosquito control programs and the development of vaccines.

[Ref: CDC, 1999]
Meet the Pathologist

Mark J. Hoenerhoff, DVM, PhD, DACVP
National Toxicology Program, National Institute of Environmental Health Sciences
Deciphering the molecular and epigenetic mechanisms of carcinogenesis (2009)
Two patterns of T-cell epitheliotropism were encountered: that arose in the IEC and the LPC. Arose in the diffuse MALT of the intestine. T-cell lymphomas characteristic morphological features (see below) and initially mucosal architecture in T-cell lymphoma small intestine from midjejunum to the ileum. Pylorus. B-cell lymphomas occurred in the distal half of the duodenum except in 1 instance (cat No. 114) in which there was direct extension from lymphoma infiltrating the gastric antrum and pylorus (Fig. 6). We did not encounter B-cell lymphomas that involved the duodenum except in 1 instance (cat No. 114) in which there was direct extension from lymphoma infiltrating the gastric antrum and pylorus (Fig. 6). We did not encounter B-cell lymphomas that involved the duodenum except in 1 instance (cat No. 114) in which there was direct extension from lymphoma infiltrating the gastric antrum and pylorus (Fig. 6).

Transmural T-cell lymphoma only occurred in the small intestine. Endoscopic biopsies were excluded from transmural lesions (Fig. 12). In more advanced lesions, dense lymphocytic infil-tration occurred as a band of increased lymphocyte density that spanned the crypt–villous junction (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 14). In the latter instances, marked mucosal changes, such as villous blunting, fusion, as well as crypt effacement, were evident (Fig. 14). In the latter instances, marked mucosal changes, such as villous blunting, fusion, as well as crypt effacement, were evident (Fig. 14).

Figure 3. Kaplan-Meier plot of survival comparing cats with T-cell lymphoma, large-cell type (median survival 1.5 months) with cats with T-cell lymphoma, large-cell type (median survival 1.5 months).

Figure 3. Kaplan-Meier plot of survival comparing cats with T-cell lymphoma, large-cell type (median survival 1.5 months) with cats with T-cell lymphoma, large-cell type (median survival 1.5 months).

Figure 4. Kaplan-Meier plot of survival comparing cats with mucosal T-cell lymphoma and in 11 of the 19 cats (58% of cats) were T-cell lymphoma (median survival 1.5 months). Alternatively, infiltration occurred as a band of increased lymphocyte density occurred within the villous lamina propria; adjacent villi were often uninvolved (Fig. 11). Of the 11 cats with transmural lymphoma, 8 had diffuse lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13). The most severe lesions were associated with complete lymphocytic infiltration of the villous and crypt lamina propria with the formation of a lymphocytic band beneath the crypt epithelium (Fig. 13).

Figure 2. Kaplan-Meier plot of survival comparing cats with mucosal T-cell lymphoma (median survival 29 months) with cats with transmural T-cell lymphoma (median survival 1.5 months).

Figure 2. Kaplan-Meier plot of survival comparing cats with mucosal T-cell lymphoma (median survival 29 months) with cats with transmural T-cell lymphoma (median survival 1.5 months).
Piper M. Treuting, DVM, MS, DACVP
Assoc. Professor, University of Washington Department of Comparative Medicine
Mouse models in translational study of human disease
Meet the Pathologist

Ken Frazier, DVM, PhD, DACVP, DABT, FIATP
Safety Assessment, GlaxoSmithKline

Toxicologic pathology of the kidney in drug development

Basophilic granules in rat renal tubules due to administration of an antisense aptamer

In situ hybridization for Heme Oxygenase 1 mRNA (blue) demonstrating on target pharmacology in collecting ducts associated with a Locked Nucleic Acid (LNA) antisense oligonucleotide drug indicated for kidney disease

Hyaline glomerulopathy in mice as an example of a preclinical toxicity when given an antisense oligonucleotide drug

Electron microscopic view of subepithelial dense deposits in monkey glomeruli ultrastructure due to immune-mediated reaction to a new generation drug
Meet the Pathologist

Lila Ramaiah, DVM, PhD, DACVP
Safety Assessment, Huntingdon Life Sciences
Assessing the toxicity of new drugs using clinical pathology endpoints
Meet the Pathologist

Scott P. Terrell, DVM, DACVP
Disney’s Animal Programs, Walt Disney Parks and Resorts USA
Zoo and wildlife pathology; Corporate leadership

Cape buffalo with bovine tuberculosis in Kruger National Park, South Africa
Meet the Pathologist

Corrie Brown, DVM, PhD, DACVP
Professor, University of Georgia College of Veterinary Medicine
Global diseases of livestock and building animal health infrastructure

Learning to bleed a chicken in Liberia

Necropsy training course in Kabul, Afghanistan

Learning to read an impression smear in Ghana
Meet the Pathologist

Brett H. Saladino, DVM, DACVP
Calvert Laboratories, Contract Research Organization
GLP Biomedical Safety Assessment, Comparative Pathology, Toxicology

Cynomolgus: Tripanosomiasis

Rat: Hyaline droplet nephrosis
Additional Information

- Visit [http://www.acvp.org](http://www.acvp.org)
- Join our open Facebook group *Student Chapters of the ACVP*
- Find our *ACVP Forum* on LinkedIn
- Follow us on Twitter [@ACVP](https://twitter.com/ACVP)
- Email us at *info@acvp.org*
Disclaimer

To the best of our knowledge, all information included in this presentation falls under the fair use or public domain guidelines of copyright law in the United States. We strive for accuracy but cannot be held responsible for any errors in information featured in the slides or incorrect attributions. ACVP does not represent or warrant that the information in the presentation is complete or current and while ACVP uses reasonable efforts to include accurate and up to date information in the presentation, ACVP makes no warranties or representations as to its accuracy. ACVP assumes no liability or responsibility for any errors or omissions in the content.

Many of the images that have been used in the presentation are Royalty Free images that ACVP is fully permitted to use. Other images have been sourced directly from the Public domain, from where in most cases it is unclear whether copyright has been explicitly claimed. Our intention is not to infringe any artist’s copyright, whether written or visual. We do not claim ownership of any image that has been freely obtained from the public domain. In the event that we have freely obtained an image or quotation that has been placed in the public domain and in doing so have inadvertently used a copyrighted image without the copyright holder’s express permission we ask that the copyright holder writes to us directly at (INCLUDE ACVP Contact information) upon which we will contact the copyright holder to request full written permission to use the quote or images. The collection, arrangement and assembly of content in the presentation are the exclusive property of ACVP and are likewise protected by copyright and other intellectual property laws.

This presentation and its contents are Copyright © ACVP 2013. ALL RIGHTS RESERVED.