Porcine Respiratory Pathology and Laboratory Diagnosis of Disease

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Professor, Diagnostic Pathologist, Pathology Section Leader

Iowa State University Veterinary Diagnostic Laboratory

Professional Background:

- Worked in mixed animal veterinary practice for 3 years prior to returning to academia.

- On staff at the Iowa State University Veterinary Diagnostic Laboratory in Ames, IA
  - Anatomic pathologist, pathology section leader
    - Section has 10 diagnostic pathologists, 6 ACVP diplomates

  - The ISU VDL handles >125,000 accessions/yr with ~80% caseload originating from swine
    - Approximately 20% of cases involve necropsy/histopathology
    - If a disease issue is occurring in US swine, we are likely involved/aware

- Professor of veterinary diagnostic and production animal medicine at ISU.
  - Research focus on *Brachyspira* spp. infections and nutritional impacts on enteric disease

- Current past-president of American Assoc of Veterinary Laboratory Diagnosticians (AAVLD)

ISU Veterinary Diagnostic Laboratory

Veterinary Diagnostic Laboratory

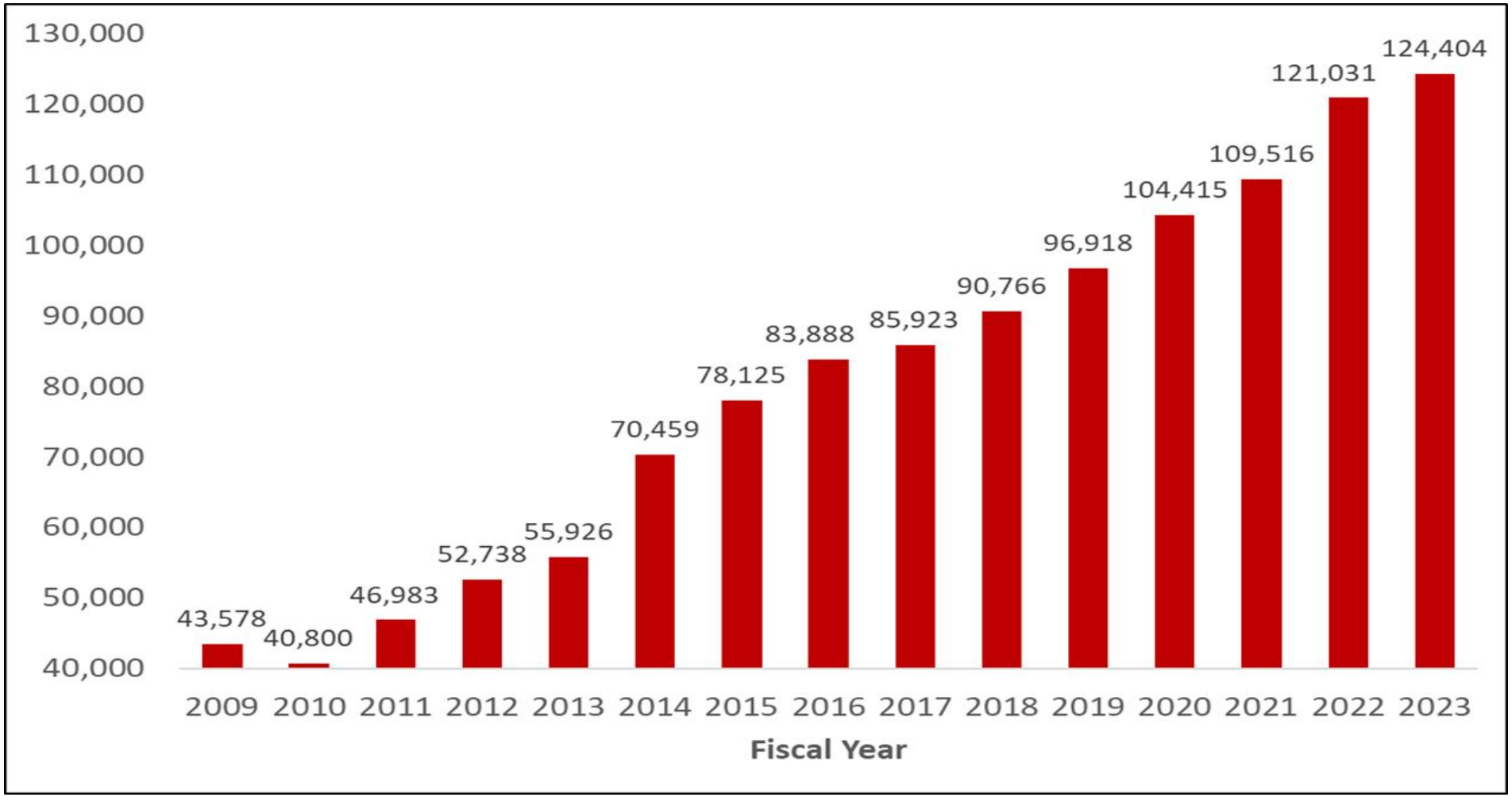
ISU VDL Faculty & Staff

~30 faculty & 150 staff
~125,000 cases/yr
>1.5 M tests/yr

LARGEST FOOD ANIMAL CASELOAD IN NORTH AMERICA

Veterinary Diagnostic Laboratory

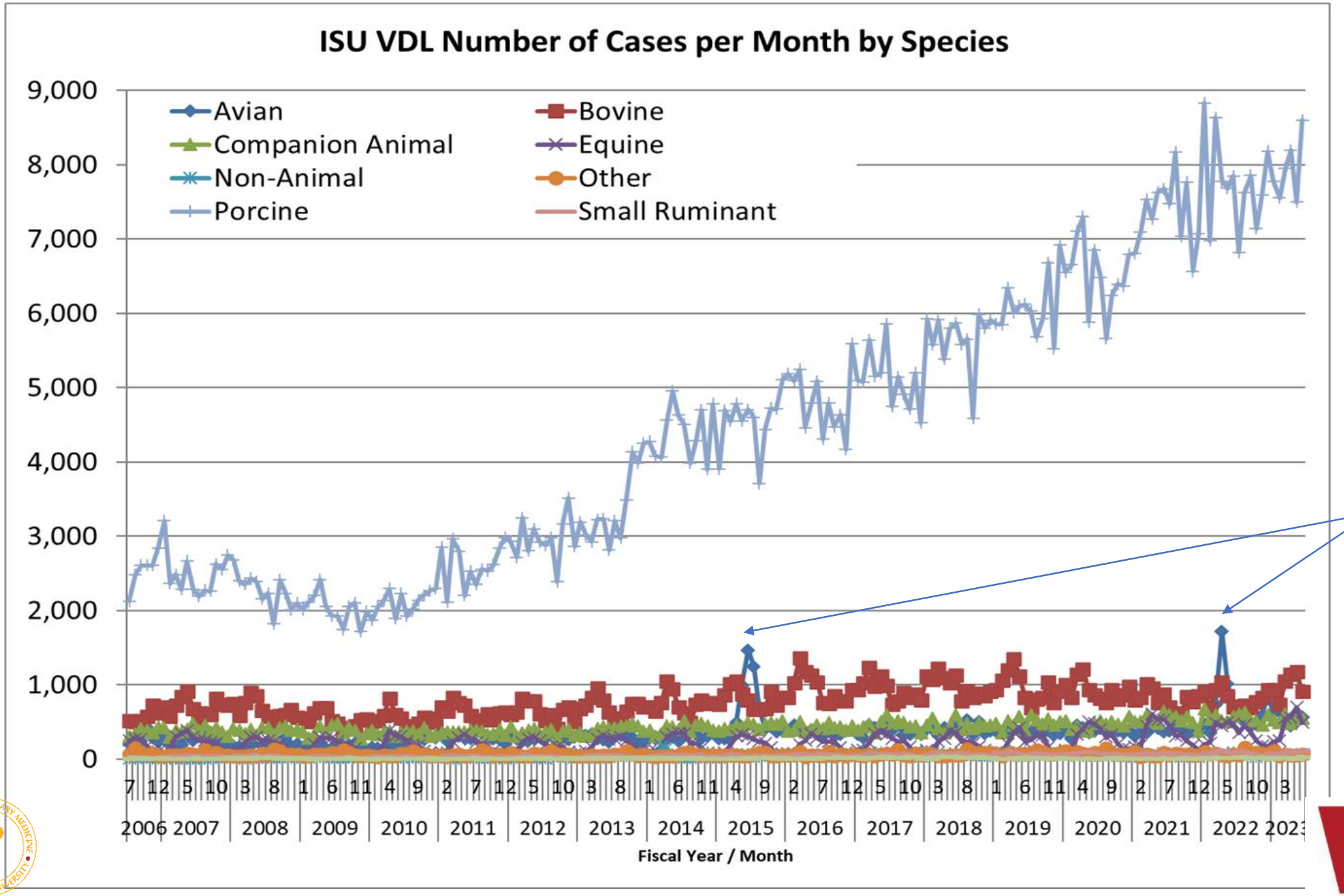
Number of Case Accessions by Fiscal Year

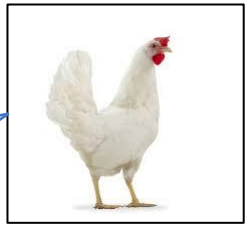


Providing <u>Full-Service</u> Precision Diagnostic Medicine Services to the Most Progressive Animal Agriculture Industry in the World

Veterinary Diagnostic Laboratory

ISU VDL Number of Cases per Month by Species





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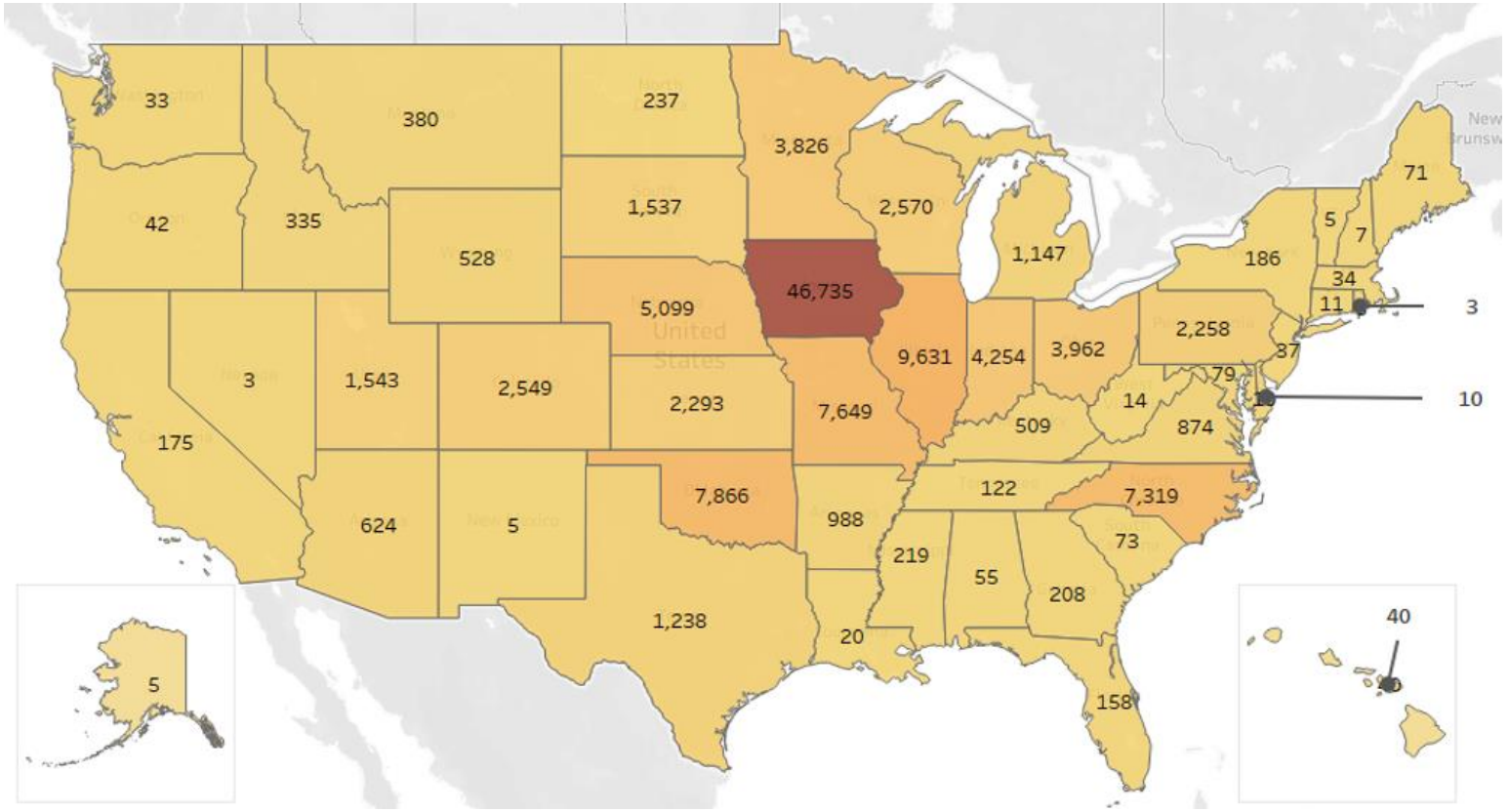
Distribution of ISU VDL's ≈ 125,000 Cases Accessions in 2023



95% of Diagnostic Services → Food Animal Agriculture

Scope of Services are National in Scope (Most Notably For Swine)

- Goals for today's talk:
  - Present common infectious diseases of pigs
    - Diseases that are particularly relevant for Australian pigs
  - Utilize case material from recent diagnostic cases in the US
    - Over 90% of the materials used are from personal cases received since 2023
    - Demonstrate commonly used ancillary diagnostic tools in the US
  - Provide visual examples of common lesions
    - Quality examples of classic lesions
    - Align gross features with histologic lesions
    - Review common histology terms in pathology reports
      - *What phrases suggest different disease processes?*

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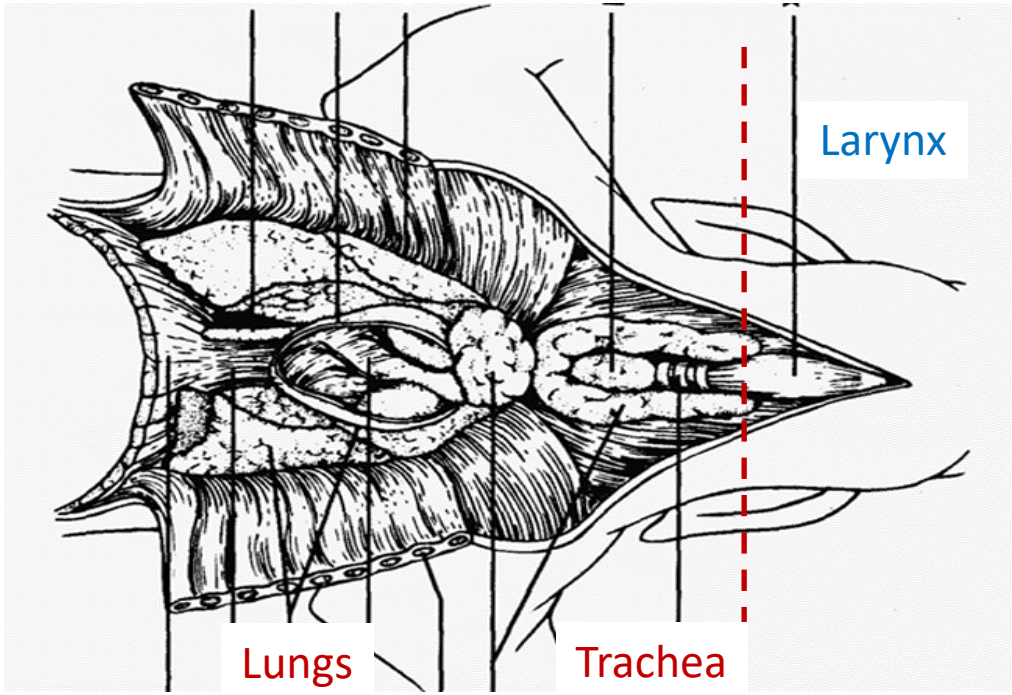
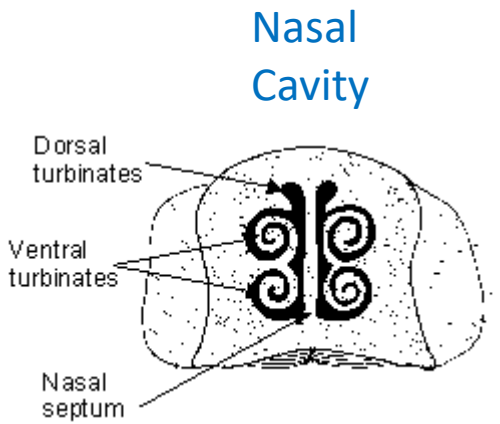
- Health challenges in commercial pigs can be a diagnostic dilemma:
  - Many common pathogens are endemic on commercial farms
    - **Detection may or may not = disease**
  - Available diagnostic tests may not differentiate pathogens / non-pathogens / vaccines
    - PCR, culture, ELISA, even IHC
    - MLV vaccines are common in swine production (PRRSV, *Lawsonia*, *Salmonella*)
  - Disease expression is variable within and among farms
    - On-farm management factors impact disease expression
  - Mixed infections are common (if not the norm)

- Anatomy





- Lower Respiratory Tract
  - Conducting airways
    - Transfer air to and from alveoli
    - Trap and remove particulate antigen
    - Mucosal immunity: secretory IgA + phagocytes
  - Alveoli
    - Functionally sterile
    - Oxygenate blood
    - Alveolar macrophages
    - Serum IgG (via inflammation)

- Upper Respiratory Tract
  - Filter and humidify air
  - Sample particulate antigens
  - Colonized by commensal bacteria*
    - Respiratory epithelium
    - Tonsillar crypts

* Key understanding in differentiating detection vs disease

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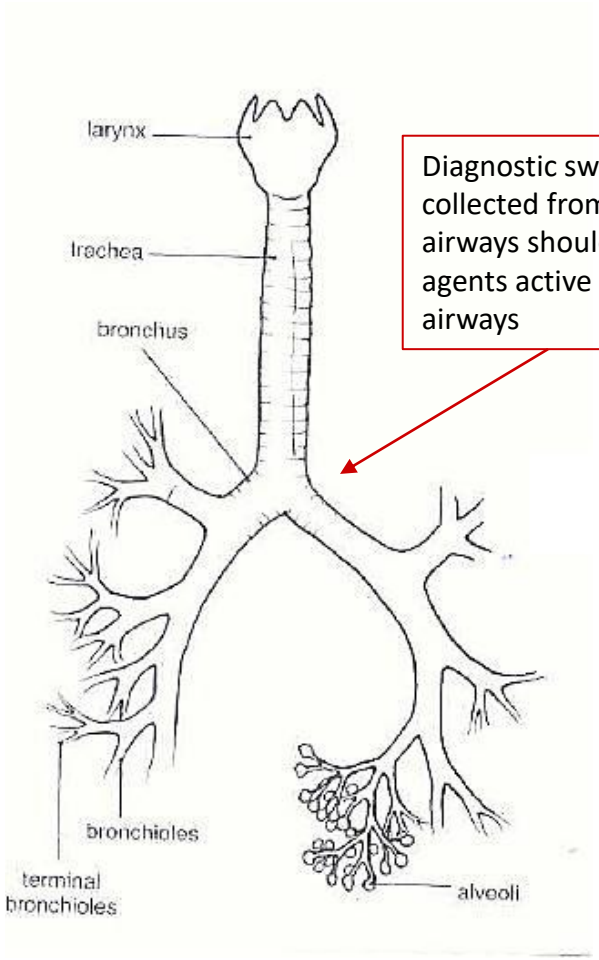
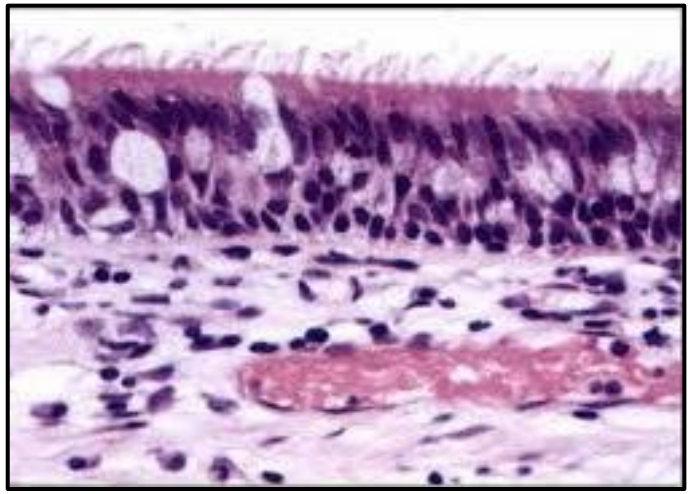
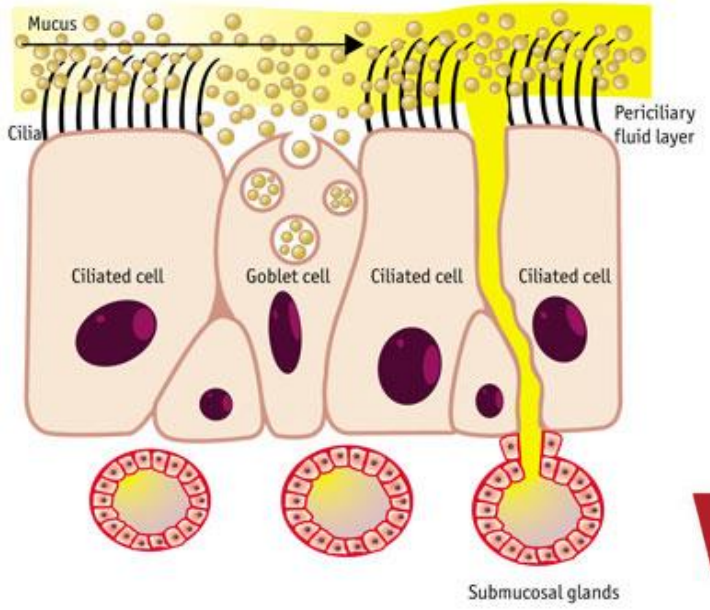
- Anatomy
  - Conducting Airways
    - Mucociliary apparatus: Mechanical clearance of particles and spent cells



Diagnostic swabs collected from the 1° airways should detect agents active in lower airways





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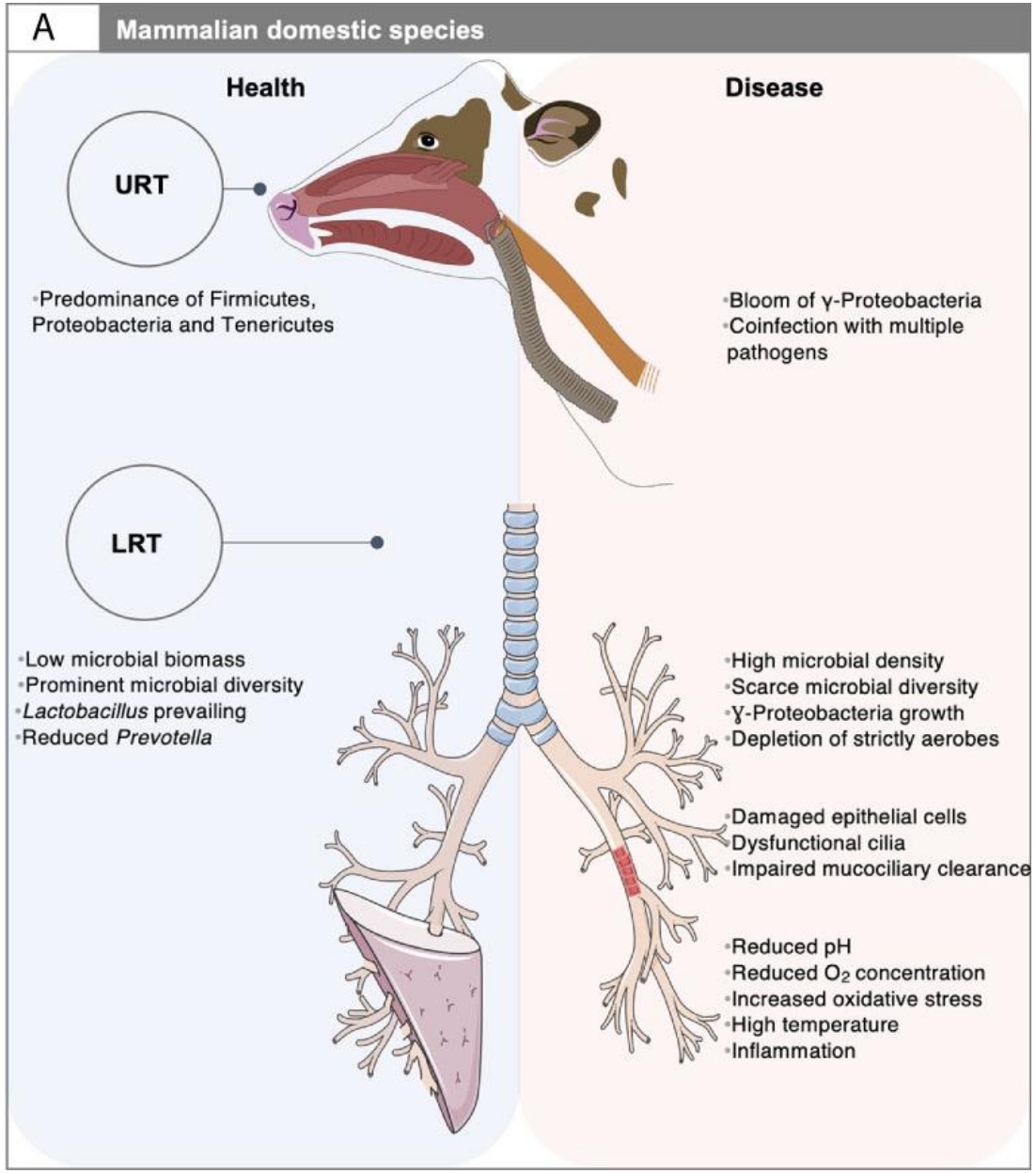
- Anatomy
  - Microbiome



Mach N, Baranowski E, Nouvel LX and Citti C (2021) The Airway Pathobiome in Complex Respiratory Diseases: A Perspective in Domestic Animals. *Front. Cell. Infect. Microbiol.* 11:583600.

A Intrinsic host factors

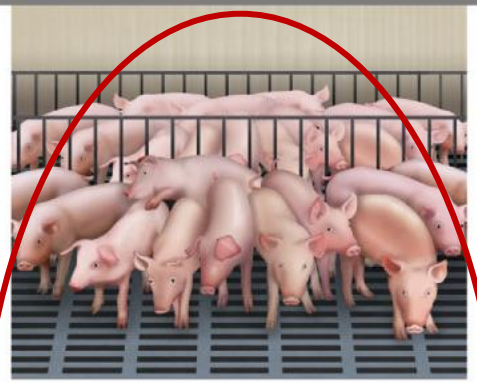
- **Age**
- **Breed**
- Genetics and epigenetics
- Gut microbiome

B Intrinsic airway factors

- Mucus secretion
- Surfactant secretion
- Gas concentration
- Temperature
- pH
- Osmolality
- Nutrients availability
- Blood flow
- Secretion of IgA
- Innate and adaptative immune recognition
- Thickness of the mucus layer

C Extrinsic environmental factors

- **Maternal microbiome**
- **Housing management**
- **Dietary changes**
- **Antibiotics**
- **Pathogen exposure**
- **Weaning**
- **Commingling**
- **Transportation**
- **Vaccination**
- Biosecurity level



- **Maternal microbiome**
- **Delivery mode**
- **Housing management**
- **Dietary changes**
- **Antibiotics**
- **Pathogen exposure**
- **Weaning**
- **Type of floor**
- **Ammonia concentration**
- Transportation
- Vaccination
- Biosecurity level

- **Hatchery environment**
- **Transportation**
- **Farm stage**
- **Heat stress**
- **Ammonia concentration**
- **Performance stress**
- Antibiotics
- Production system
- Vaccination
- Dietary changes
- Biosecurity level
- Litter and floor type
- Pathogen exposure

- **Housing management**
- **Dietary changes**
- **Exposure to other animals and people**
- Maternal microbiome
- Delivery mode
- Antibiotics
- Performance and specialty
- Event shows
- Weaning
- Pathogen exposure
- Vaccination

- **Residential environment**
- **Family lifestyle**
- **Climate change / air quality**
- Maternal microbiome
- Delivery mode
- Weaning
- Antibiotics
- Pathogen exposure
- Vaccination

Mach N, Baranowski E, Nouvel LX and Citti C (2021) The Airway Pathobiome in Complex Respiratory Diseases: A Perspective in Domestic Animals. *Front. Cell. Infect. Microbiol.* 11:583600.

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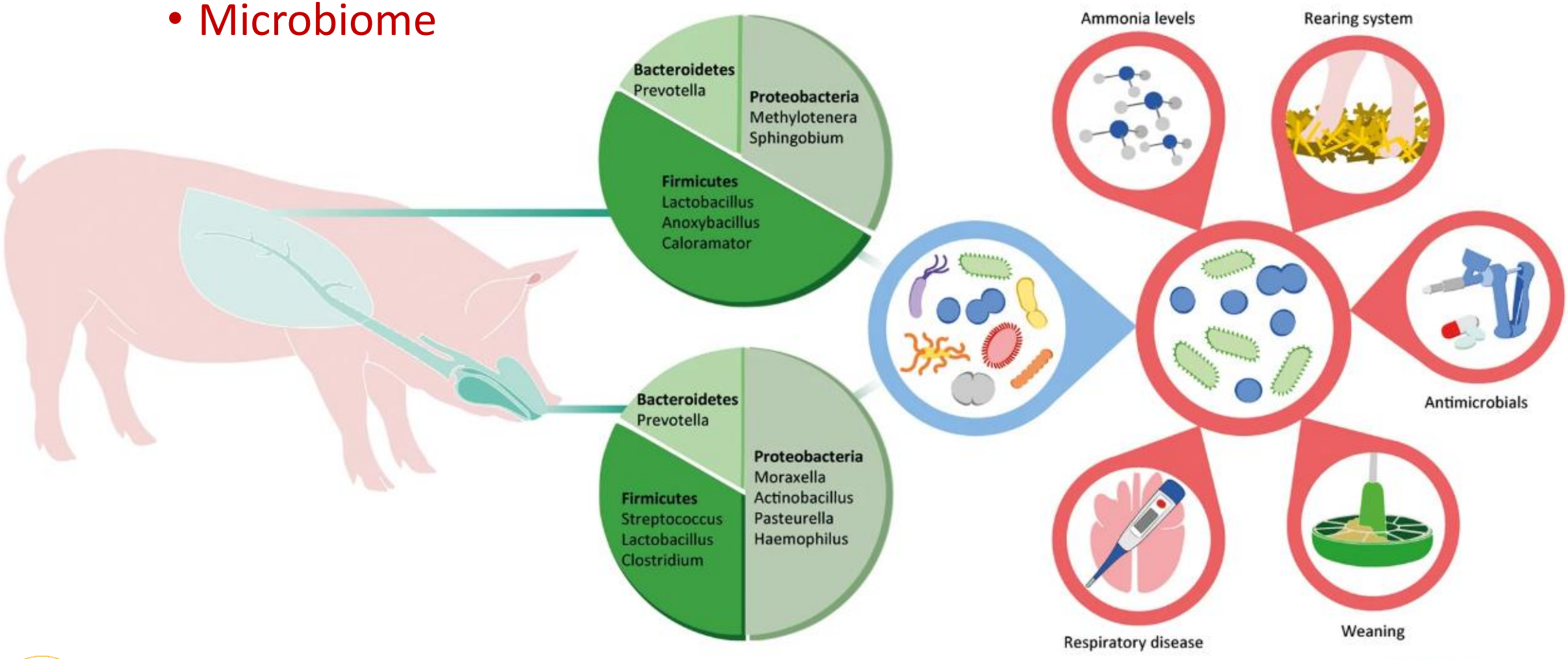
- Anatomy
  - Microbiome



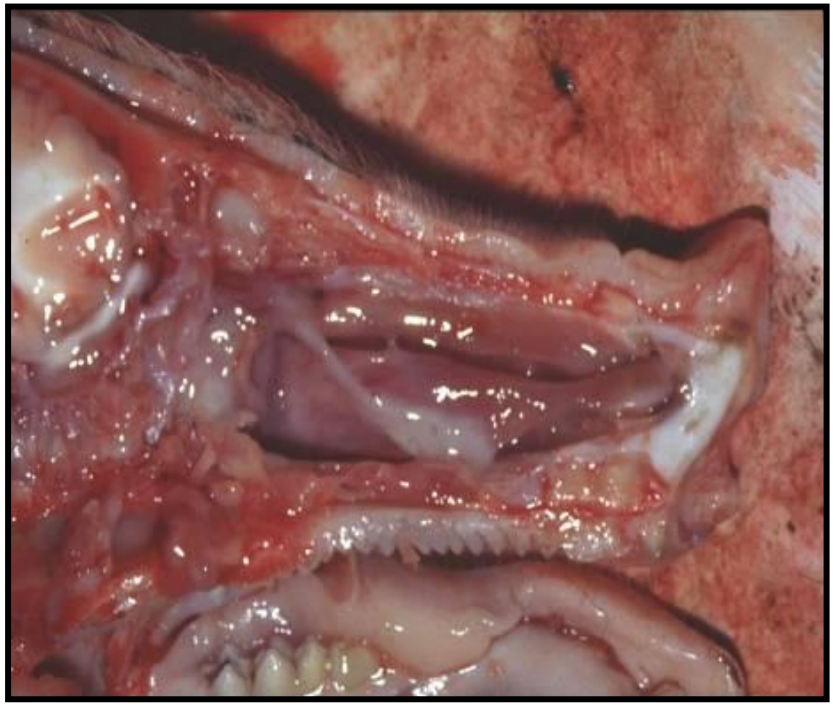
Pirolo, M., Espinosa-Gongora, C., Bogaert, D. *et al.* The porcine respiratory microbiome: recent insights and future challenges. *Anim Microbiome* **3**, 9 (2021).

Veterinary Diagnostic Laboratory

Common endemic infectious diseases in US swine

Etiologic agent	Age often affected	Clinical signs	Microscopic lesions
Respiratory pathogens			
Influenza A virus	After 2 weeks	Abrupt onset of fever, sneeze, cough; high morbidity; lethargy; oculonasal discharge	Necrotizing bronchitis and bronchiolitis; necrotic, suppurative plugs in terminal airways; peribronchiolar lymphocytic cuffing with chronicity
Mycoplasma hyopneumoniae	After 3 weeks	Cough, especially on arousal; escalates over time	Suppurative and histiocytic bronchopneumonia with BALT hyperplasia
Actinobacillus spp.	After 2 weeks	Dyspnea, acute, rapid prostration and death; epistaxis	Necrosis, hemorrhage, suppuration, streaming leukocytes and pleuritis
Secondary bacterial pneumonia *(Bordetella, Glaesserella, Pasteurella, Streptococcus, Trueperella)*	After 2 weeks	Cough, fever, expiratory dyspnea, lethargy; pneumonia of variable duration	Suppurative bronchopneumonia; abscesses and pleuritis possible
Systemic pathogens			
Porcine reproductive and respiratory syndrome virus	All ages	Dyspnea, anorexia, fever, anorexia, poor growth	Lymphohistiocytic interstitial pneumonia; necrotic macrophages; occasionally nephritis, myocarditis, encephalitis
Systemic bacterial infection (e.g. Streptococcus suis, Glaesserella, A. suis, Mycoplasma hyorhinis)	After 2 weeks	Acute, subacute, chronic multisystemic disease; paddling leg movements; found dead	Fibrinopurulent serositis, septic thrombi, lesions in other tissue localizations
Porcine circovirus type 2	After 4 weeks	Acute, subacute, or chronic dyspnea; diarrhea; wasting; uremia, icterus, rapid deaths	Lymphoid depletion, granulomatous inflammation (lymph node, lung, intestine, kidney, liver)
Porcine circovirus type 3	After 6 weeks	Ill thrift, non-specific, may be subclinical	Lymphoplasmacytic periarteritis in heart, kidney, and mesentery

- Conducting Airway Diseases
  - Atrophic Rhinitis
    - Non-progressive form (NPAR)
      - *Bordetella bronchiseptica* alone
        - Dermonecrotic toxin (DNT)
    - Clinical signs
      - Sneezing, oculonasal discharge, dry cough
    - Gross lesions
      - Nasal exudate



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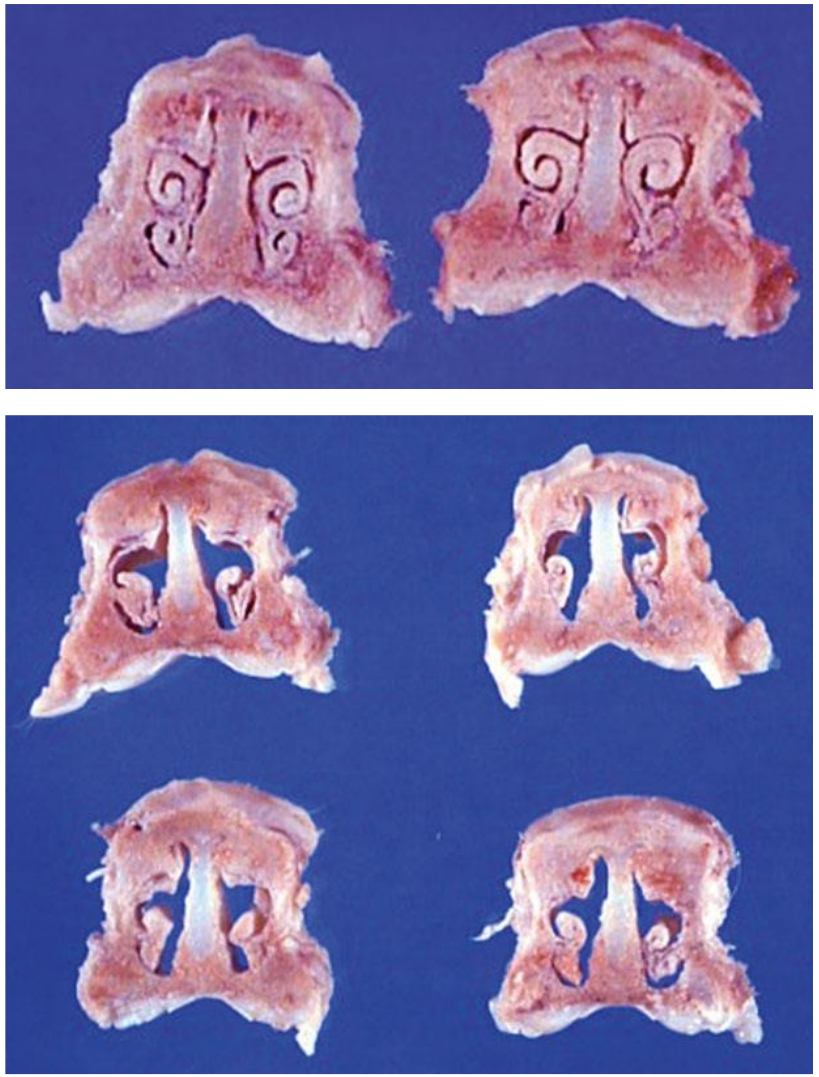
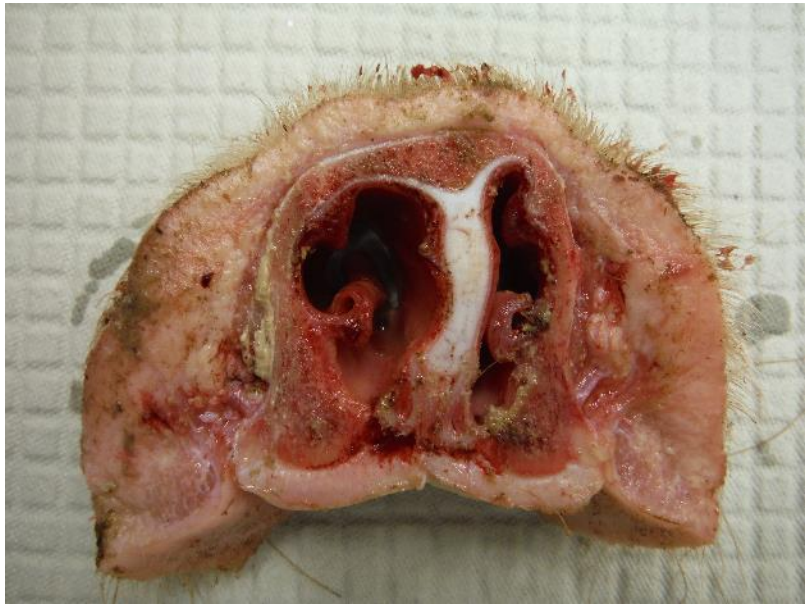
        - Dermonecrotic toxin (DNT)
    - Clinical signs
      - Sneezing, oculonasal discharge, dry cough
    - Gross lesions
      - Nasal exudate
      - Mild to moderate turbinate atrophy
      - Reversible condition



From Diseases of Swine 11th ed.

- Conducting Airway Diseases
  - Atrophic Rhinitis
    - Progressive form (PAR)
      - *Bordetella bronchiseptica* +
      - *Pasteurella multocida* (toxigenic; mostly type D strains)
    - Gross lesions
      - Lateral deviation of the snout
      - Brachygnathia superior
      - Severe turbinate atrophy often with septal deviation
      - Irreversible condition
        - PMT impairs bony remodeling
    - Predisposing factors
      - Intensive indoor production systems
        - high stocking density
        - poor hygiene
        - poor ventilation (dust and ammonia)



- Conducting Airway Diseases
  - Atrophic Rhinitis
    - Diagnostics
      - Bacterial culture
      - PCR for detection of PMT toxin gene

Bacteriology
Culture Summary

Animal ID	Specimen	Enrichment	Growth	Organism	Comment
B, 7908	Swab		High	Pasteurella multocida D	
B, 7908	Swab		Few	Streptococcus suis	
1N5423, SID #4	Nasal swab		Few	Pasteurella multocida D	
9N8139, SID #16	Nasal swab		Low	Pasteurella multocida D	
9N4536, SID #20	Nasal swab		Low	Bordetella bronchiseptica	
6N4143, SID #27	Nasal swab		Moderate	Bordetella bronchiseptica	
6N4235, SID #28	Nasal swab		Moderate	Pasteurella multocida D	

Molecular Diagnostic
PCR - P. multocida toxin

Animal ID	Specimen	Result	Comment
B, 7908	Culture	Negative	
1N5423, SID #4	Culture	Negative	
9N8139, SID #16	Culture	Negative	
6N4235, SID #28	Culture	Positive	

Veterinary Diagnostic Laboratory

- Conducting Airway Diseases
  - Epitheliotropic viruses
    - Influenza A virus (IAV)
      - Orthomyxovirus
      - High morbidity, low mortality when uncomplicated
    - Clinical Signs
      - Epidemic “acute” flu
        - High morbidity, low mortality, rapid recovery
        - Barking cough, fever, lethargy
      - Endemic “chronic” flu
        - Less severe, less consistent cough
        - Common with varying passive immunity levels
    - Gross lesions
      - Checkerboard to coalescing consolidation
        - Centered on large conducting airways
      - Mucoid exudate in conducting airways

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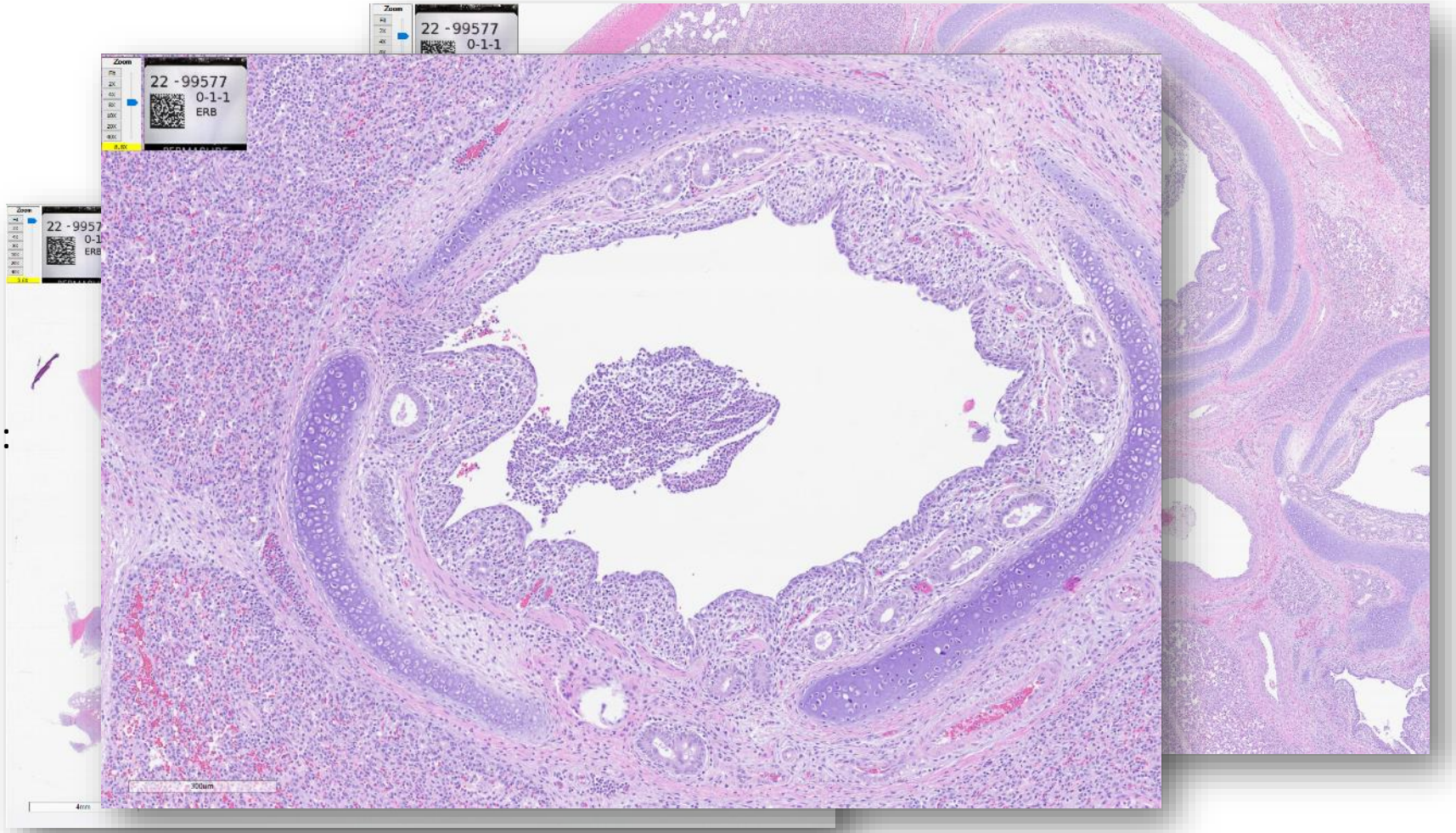
- Conducting Airway Diseases
  - Epitheliotropic viruses
    - Influenza A virus (IAV)

Histology (acute):



Necrosuppurative bronchitis and bronchiolitis; proprial infiltrates of lymphocytes and plasma cells with time

- Conducting Airway Diseases
  - Epitheliotropic viruses
    - Influenza A virus (IAV)
      - Diagnostics
        - PCR
          - Subtyping
            - Hemagglutinins (1-16)
            - Neuraminidases (1-9)
            - H1N1, H1N2, H3N2 common in swine
        - VI
        - IHC
          - Typically directed at nucleoprotein
          - Will see nuclear and cytoplasmic labeling

Molecular Diagnostic

PCR - Influenza A

Animal ID	Specimen	Target	Ct / Result
1, SID #1	Lung	Influenza general	17.7 / Positive
2, SID #2	Lung	Influenza general	20.2 / Positive
3, SID #3	Lung	Influenza general	22.4 / Positive

PCR - Influenza A subtype Applied Biosystems

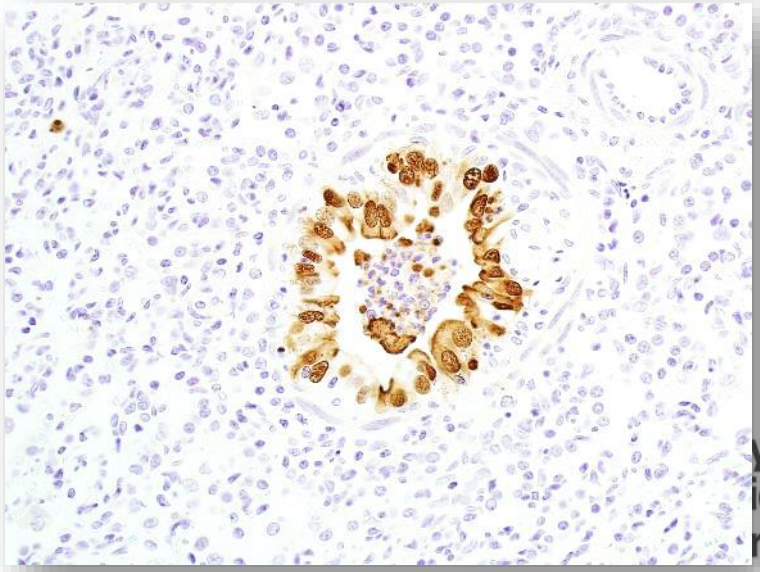
Animal ID	Specimen	Target	Ct / Result
1, SID #1	Lung	Influenza H1	19.3 / Positive
		Influenza H3	>=40 / Negative
		Influenza N1	21.4 / Positive
		Influenza N2	>=40 / Negative

PCR - Influenza A subtype Applied Biosystems

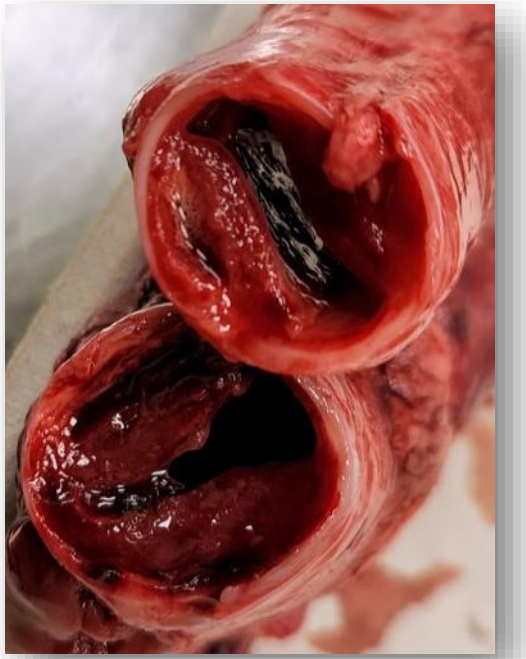
Animal ID	Specimen	Target	Ct / Result
2, SID #2	Lung	Influenza H1	22.2 / Positive
		Influenza H3	>=40 / Negative
		Influenza N1	24.2 / Positive
		Influenza N2	>=40 / Negative

PCR - Influenza A subtype Applied Biosystems

Animal ID	Specimen	Target	Ct / Result
3, SID #3	Lung	Influenza H1	25.0 / Positive
		Influenza H3	>=40 / Negative
		Influenza N1	26.2 / Positive
		Influenza N2	>=40 / Negative

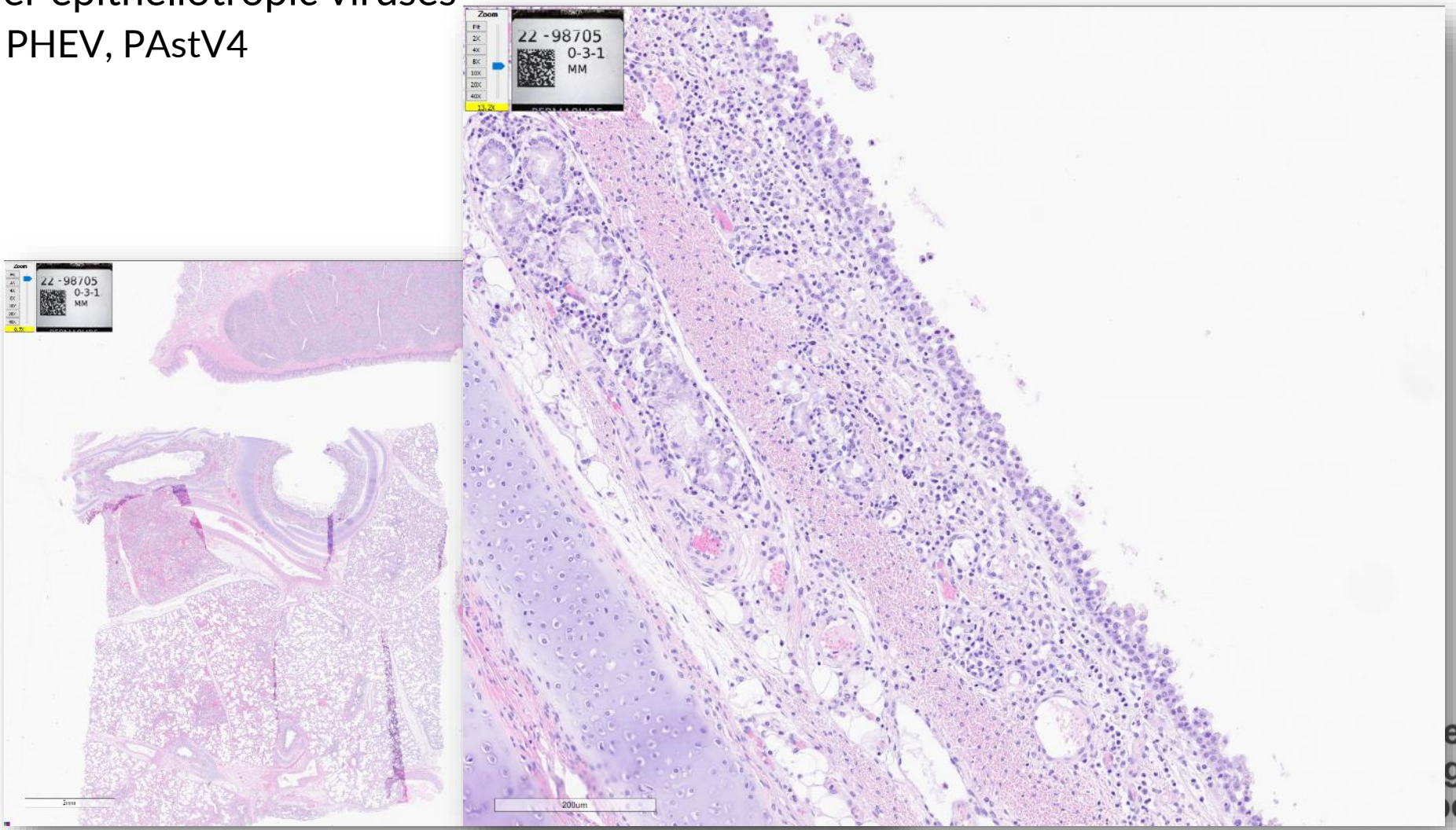


- Conducting Airway Diseases
  - Epitheliotropic viruses
    - Porcine hemagglutinating encephalomyelitis virus (PHEV)
      - betacoronavirus
    - Porcine astrovirus type 4 (PAstV4)
      - porcine astroviruses have 5 lineages with great genetic variability
    - Clinical signs
      - Coughing similar to IAV
    - Gross lesions
      - Lung lesions are similar to IAV
        - Centered on large conducting airways
      - Tracheal involvement is common and often considerable



- Conducting Airway Diseases
  - Epitheliotropic viruses
    - Other epitheliotropic viruses
      - PHEV, PAstV4

Histology (acute):



- Conducting Airway Diseases
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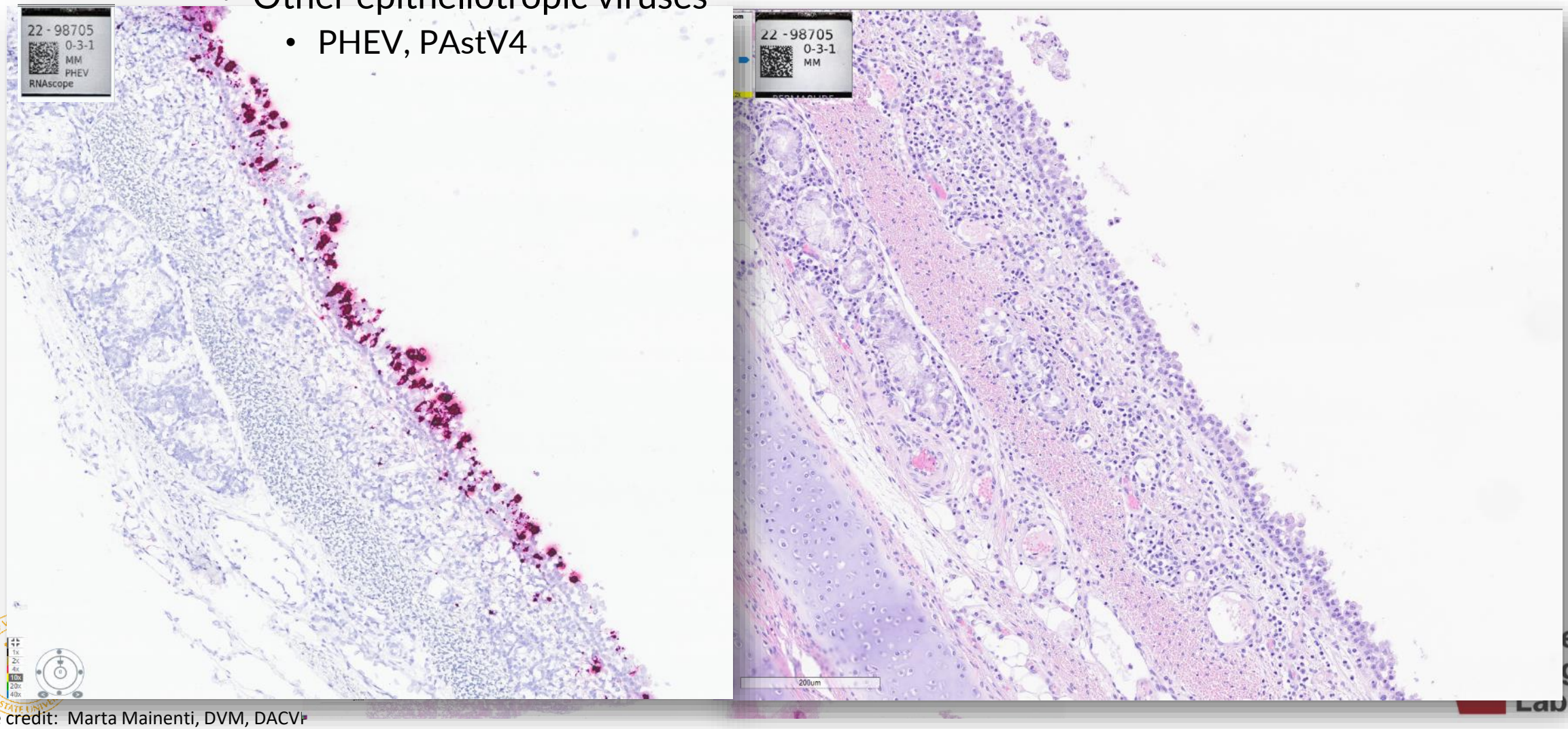
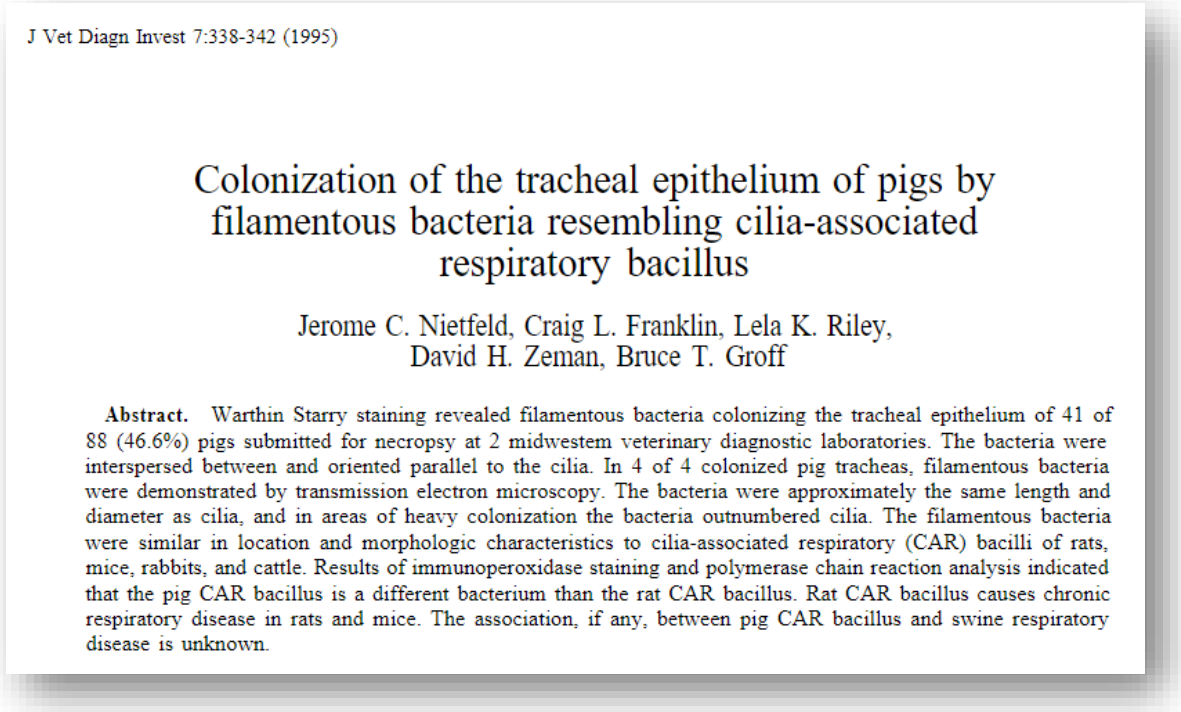


Case credit: Marta Mainenti, DVM, DACVP

- Conducting Airway Diseases
  - Bacteria
    - Cilia-Associated Respiratory Bacilli
      - *Filobacterium rodentium*
      - Gram-negative, non-spore-forming
      - Observed occasionally in both healthy and diseased pigs
      - Experimental inoculations have not reproduced disease



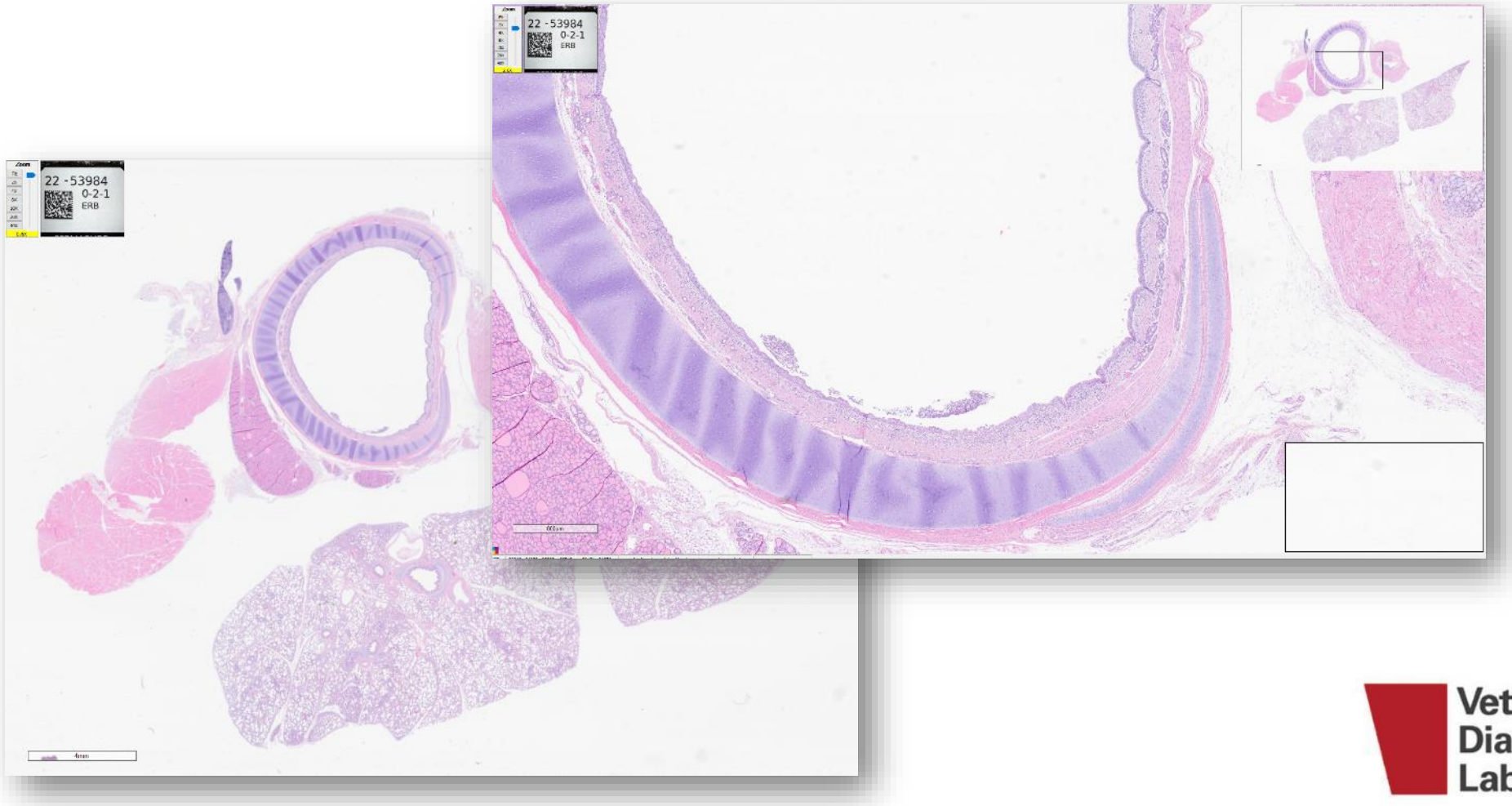
J Vet Diagn Invest 7:338-342 (1995)

Colonization of the tracheal epithelium of pigs by filamentous bacteria resembling cilia-associated respiratory bacillus

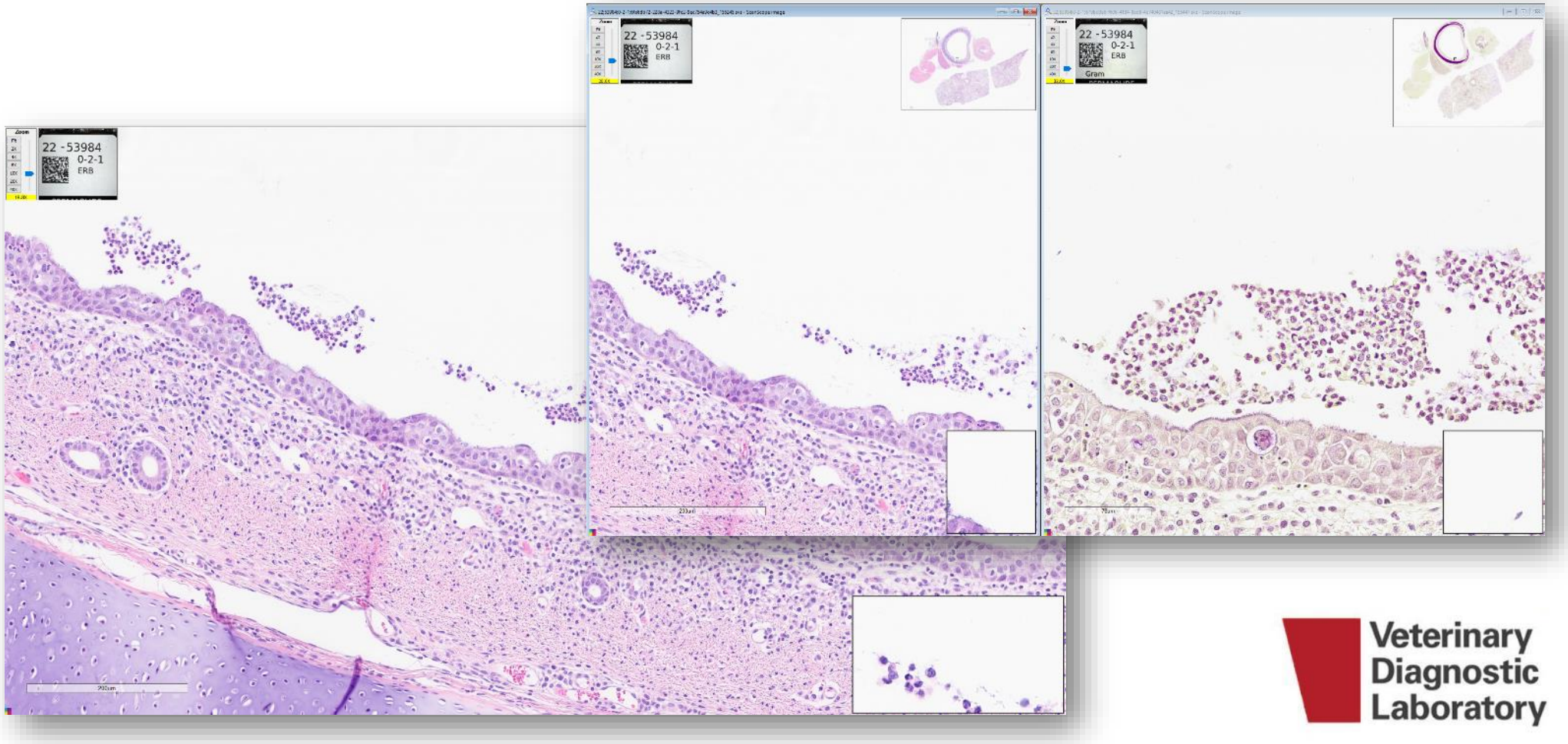
Jerome C. Nietfeld, Craig L. Franklin, Lela K. Riley, David H. Zeman, Bruce T. Groff

Abstract. Warthin Starry staining revealed filamentous bacteria colonizing the tracheal epithelium of 41 of 88 (46.6%) pigs submitted for necropsy at 2 midwestern veterinary diagnostic laboratories. The bacteria were interspersed between and oriented parallel to the cilia. In 4 of 4 colonized pig tracheas, filamentous bacteria were demonstrated by transmission electron microscopy. The bacteria were approximately the same length and diameter as cilia, and in areas of heavy colonization the bacteria outnumbered cilia. The filamentous bacteria were similar in location and morphologic characteristics to cilia-associated respiratory (CAR) bacilli of rats, mice, rabbits, and cattle. Results of immunoperoxidase staining and polymerase chain reaction analysis indicated that the pig CAR bacillus is a different bacterium than the rat CAR bacillus. Rat CAR bacillus causes chronic respiratory disease in rats and mice. The association, if any, between pig CAR bacillus and swine respiratory disease is unknown.

- Conducting Airway Diseases
  - Bacteria
    - Cilia-Associated Respiratory Bacilli



- Conducting Airway Diseases
  - Bacteria
    - Cilia-Associated Respiratory Bacilli



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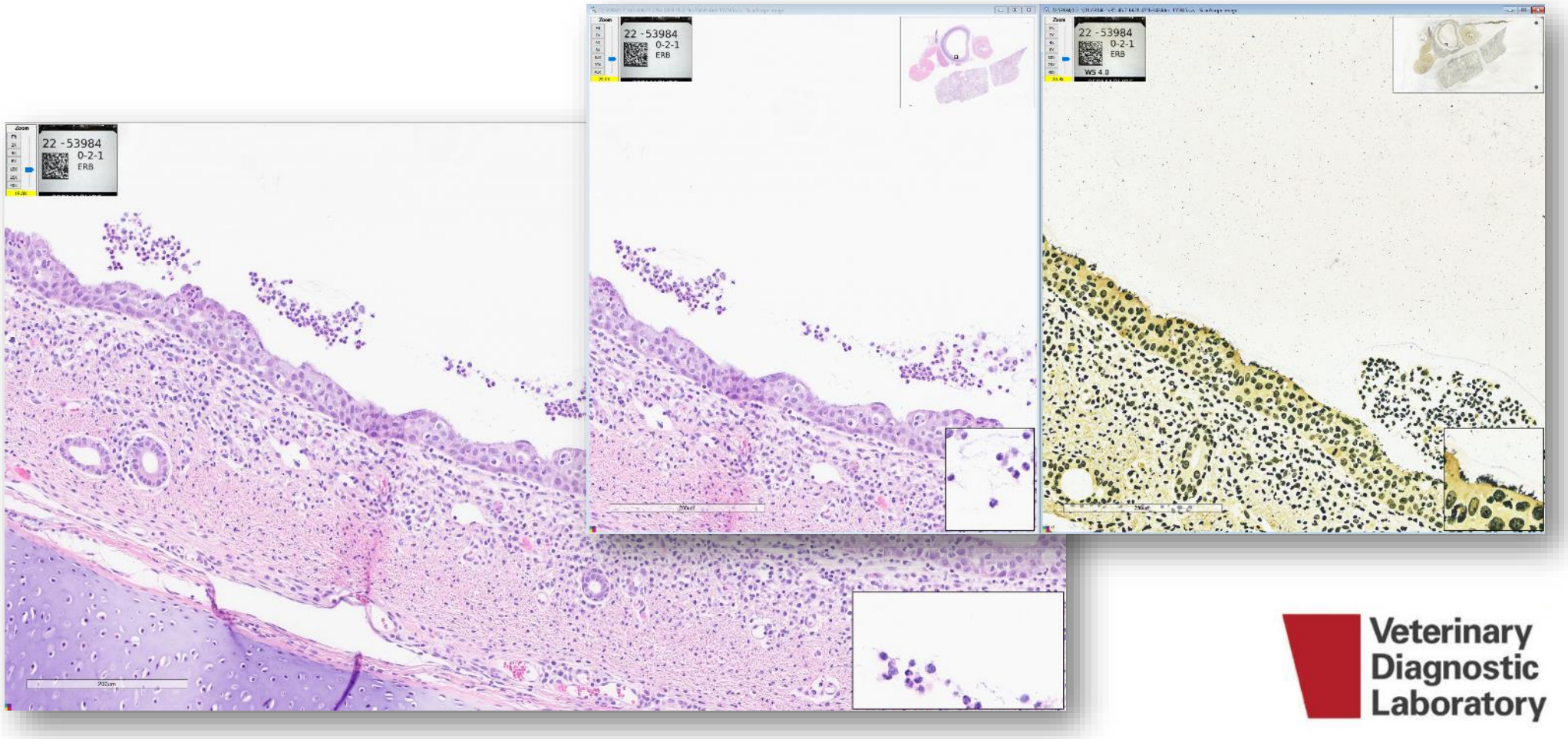
- Conducting Airway Diseases
  - Bacteria
    - Cilia-Associated Respiratory Bacilli



Veterinary Diagnostic Laboratory

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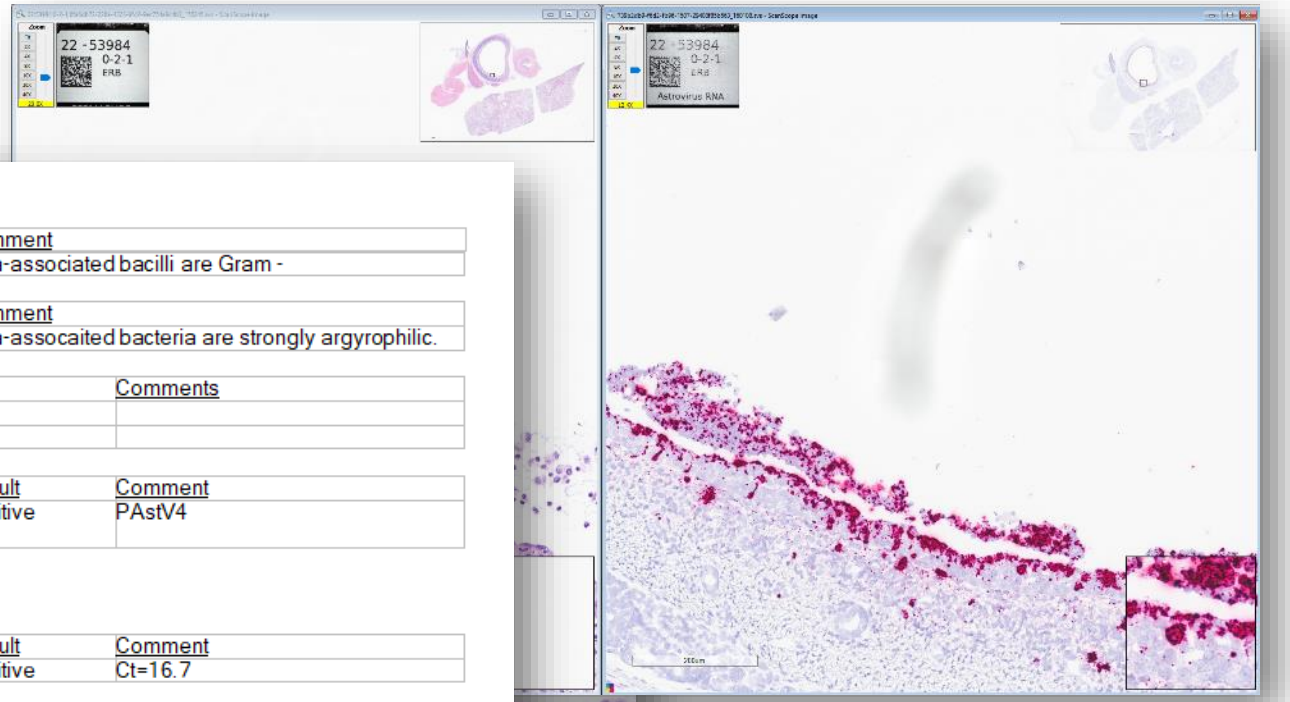


Histopathology

Bacteria, Gram SS (Vet Path)

Animal ID	Specimen	Result	Comment
2	Assorted	Other	Cilia-associated bacilli are Gram -

Bacteria, W. S. 4.0 SS (Vet Path)

Animal ID	Specimen	Result	Comment
2	Assorted	Positive	Cilia-assocaited bacteria are strongly argyrophilic.

Histopathology - With Interpretation

Animal ID	Specimen	Slides	Comments
1	Assorted	1	
2	Assorted	1	

Porcine Astrovirus Type 3 RNAscope

Animal ID	Specimen	Target	Result	Comment
2	Assorted	Research and Development	Positive	PAstV4

Molecular Diagnostic

PCR - based detection - R&D

Animal ID	Specimen	Target Agent	Result	Comment
GA [1-2]	Bronchial swab	PoAstV4	Positive	Ct=16.7

PCR - Influenza A

Animal ID	Specimen	Target	Ct / Result	Comment
GA [1-2]	Bronchial swab	Influenza general	>=38 / Negative	

PCR - Mycoplasma hyorhinis

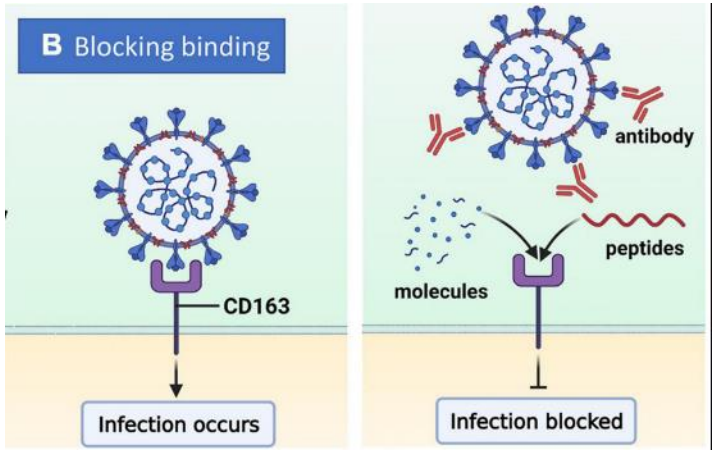
Animal ID	Specimen	Ct / Result	Comment
GA [1-2]	Bronchial swab	>=35 / Negative	

PCR - Porcine parainfluenza virus type 1

Animal ID	Specimen	Ct/Result	Comment
GA [1-2]	Bronchial swab	>=38 / Negative	

Veterinary Diagnostic Laboratory

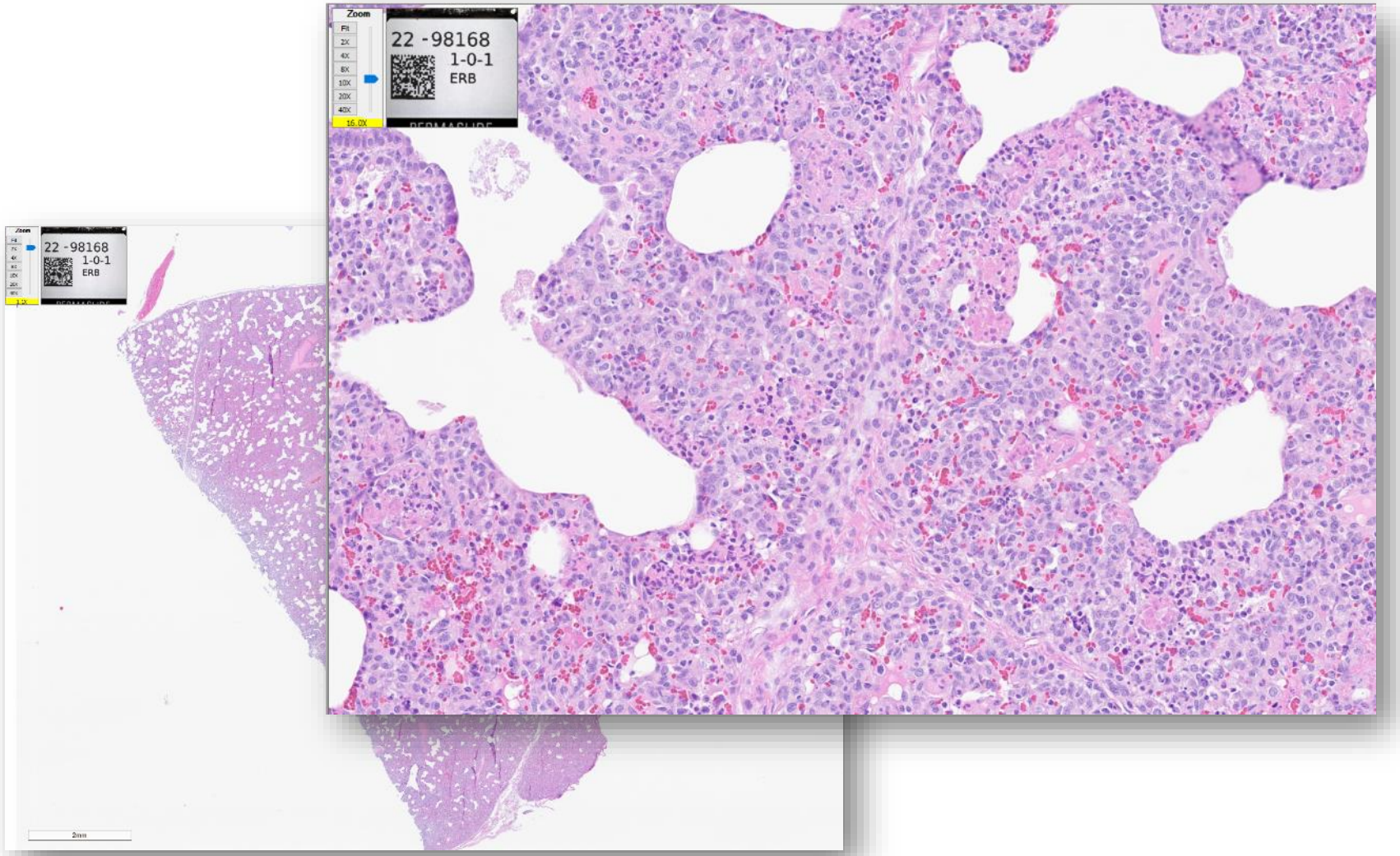
- Pneumonias
  - Viral
    - Porcine Reproductive and Respiratory Syndrome Virus (PRRSV)
      - Arterivirus; near worldwide distribution
        - CD163 is the essential receptor
          - Scavenger for hemoglobin-haptoglobin complex
          - Expressed on macrophages
        - Type I (EU), Type II (US)
        - A majority of domestic herds are positive
      - Clinical Signs
        - Respiratory Disease
          - Fever, anorexia
          - Respiratory distress, thumping
        - Reproductive Disease
          - Abortion, stillbirths, mummification
          - Depends upon prior immunity



- Pneumonias
  - Viral
    - Porcine Reproductive and Respiratory Syndrome Virus (PRRSV)
      - Clinical Signs
        - Respiratory Disease
          - Fever, anorexia
          - Respiratory distress, thumping
        - Reproductive Disease
          - Abortion, stillbirths, mummification
          - Depends upon prior immunity
      - Gross lesions
        - Non-collapsing lungs with interlobular edema
          - Mottled tan appearance, varying consolidation
        - Severe disease will have rib impressions

- Pneumonias
  - Viral
    - PRRSV

Histology (acute):

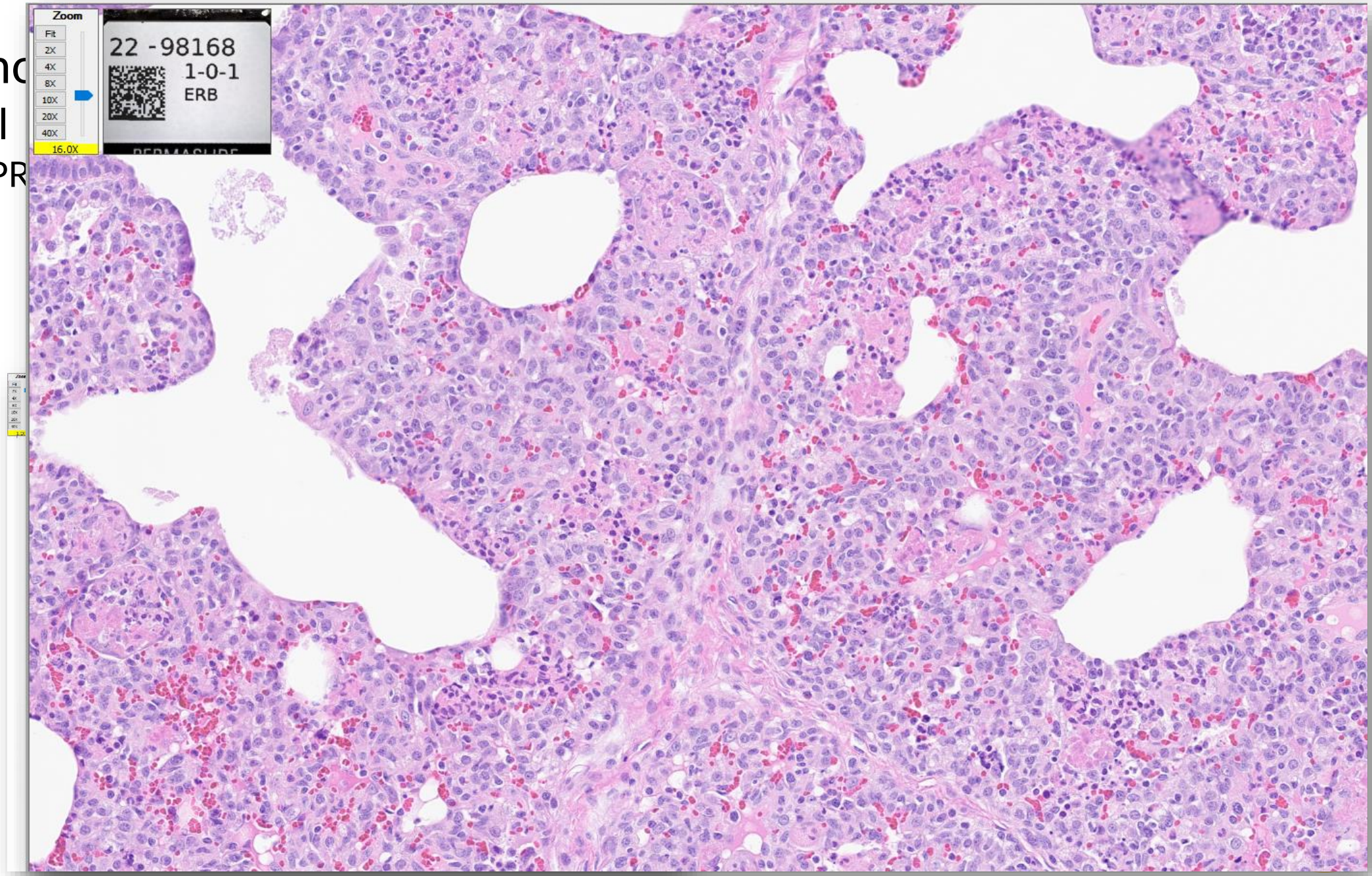


Lymphohistiocytic interstitial pneumonia with aggregates of necrotic PAMs

Veterinary Diagnostic Laboratory

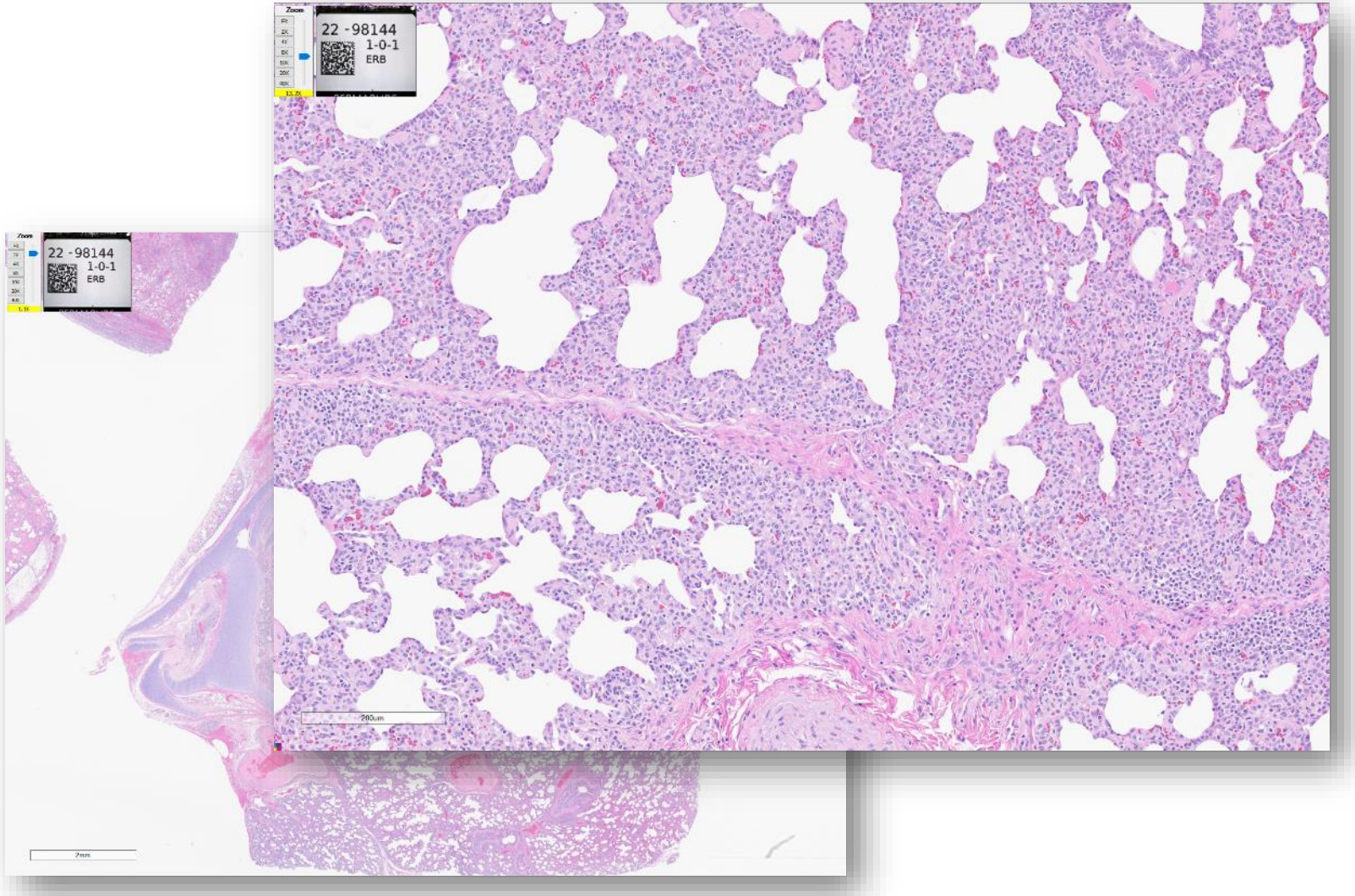
- Pneumo
  - Viral
    - PR

Histology (acute):



- Pneumonias
  - Viral
    - PRRSV

Histology (subacute):



Lymphohistiocytic interstitial pneumonia with variable type II pneumocyte hyperplasia

- Pneumonias
  - Viral
    - PRRSV
      - Diagnostics
        - PCR
          - Lung, serum
          - Oral fluids
        - Sequencing
          - Compare historic vs MLV strains
        - VI
        - Serology
        - IHC

PCR - PRRSV Applied Biosystems

Animal ID	Specimen	PRRSV-2 (NA) Ct/Result	PRRSV-1 (EU) Ct/Result	Comment
GA [1-3]	Lung	17.9 / Positive	>=37 / Negative	

Bioinformatics

PCR - PRRSV ORF5 Type 2 (NA)

Animal ID	Specimen	Result	Comment
GA [1-3]	Lung	Positive	

Sequencing and Analysis - PRRSV Type 2 (NA)

Please note the RFLP, genetic lineage and any comments that have been included for this PRRSV sequence. Please contact the laboratory if you would like any further interpretation or have other sequences for comparison to this one.

Animal ID	Specimen	Target Gene	RFLP	Lineage
GA [1-3]	Lung	ORF5	1-4-4	L1C-unclade

Comment:	Wild type

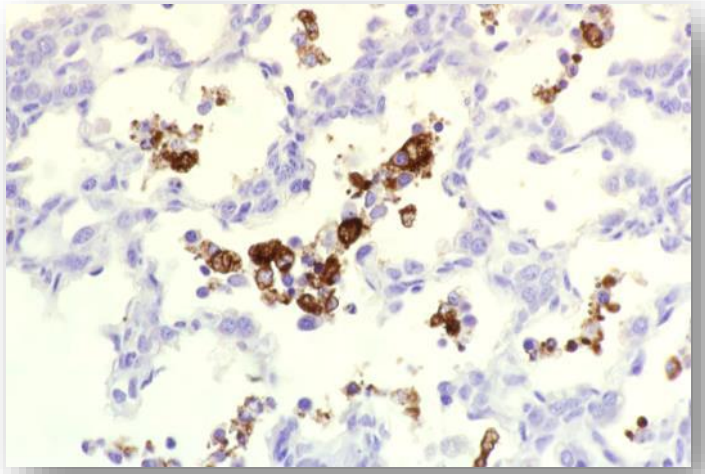
Sequence Homology

Reference Virus	Ingelvac ATP	PRRSGard	Prime Pac
Percent Identity	82.6%	87.2%	82.9%

Reference Virus	Ingelvac MLV	Fostera	Prevacent
Percent Identity	82.3%	82.8%	85.8%

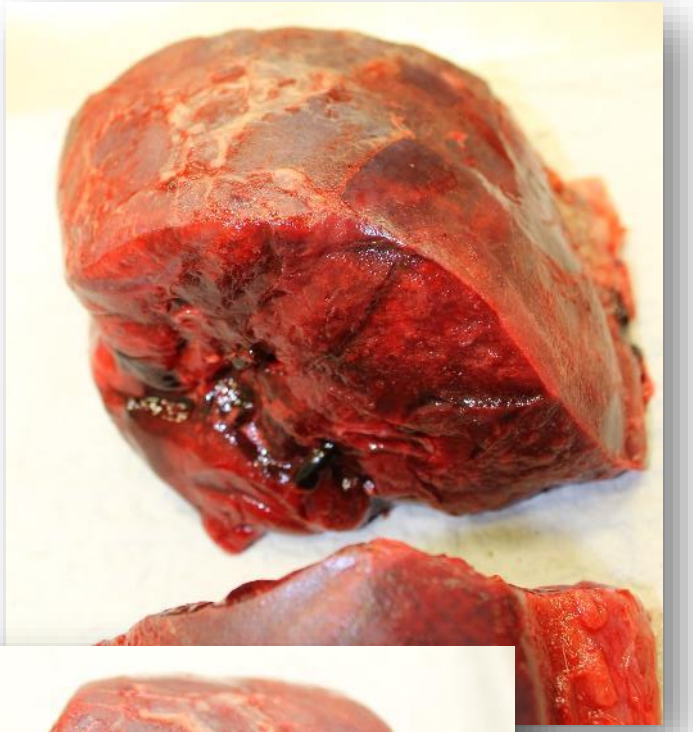
Nucleotide

ATGTTGGGGAAATGCTTGACCGCGGGTTGTTGCTCGCAATCGCTTTTTTTGTGGTGTATCGTGC
CATTTTGTCTTGCTGCGCTCGTCAACGCCAGCTACGGCAACAGCTCCCATTTACAGTCGATTTAT
AACCTGACGATATGCGAGCTGAACGGCACCGAATGGCTTAACAGGCATTTTGGCTGGGCAGTAGA
GACTTTCGTTATTTTTCCAGCGTTGACTCATATTGTCTCTTACGGCGCCCTTACCACCAGCCATT
TCCTTGACACGGTCGGCCTGATCACTGTGTCCACCGCCGGATACTATCACAGGCGGTATGTATTG

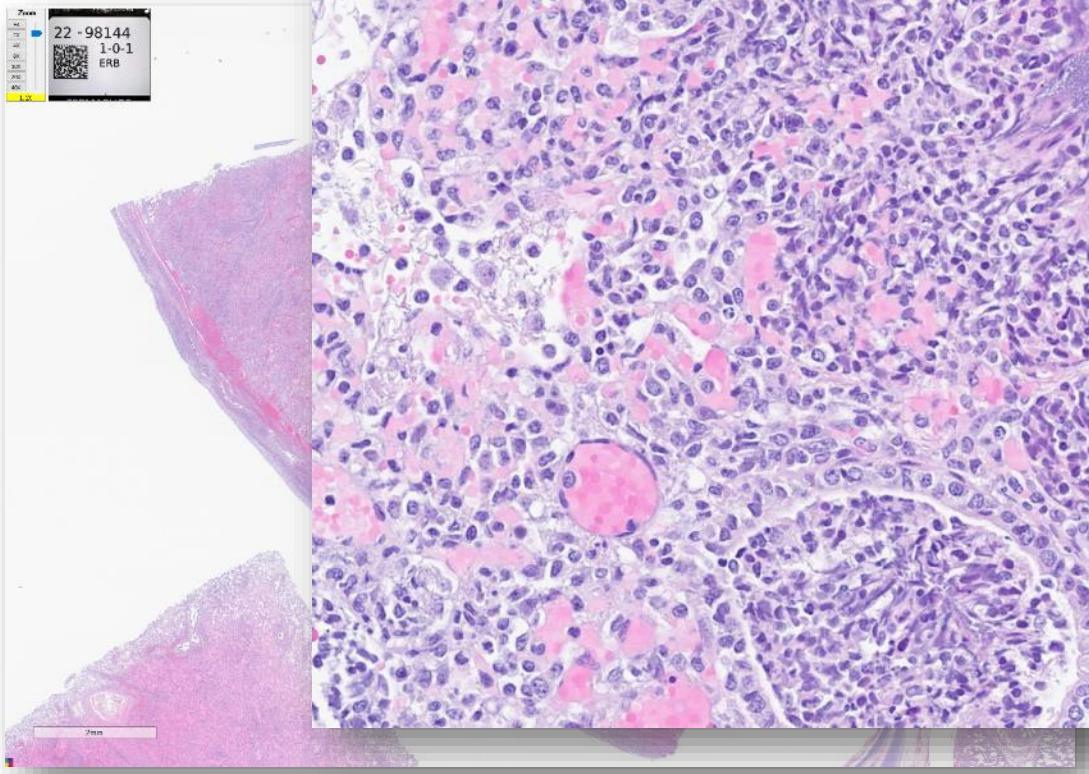


Veterinary Diagnostic Laboratory

- Pneumonias
  - Bacterial
    - *Actinobacillus* spp.
      - ***Actinobacillus pleuropneumoniae*** (APP); 16 serotypes
        - Many herds have eliminated highly virulent serotypes
          - 1, 5, 7, 9, 11, 15 often considered highly virulent
        - Recent serotype 15 outbreak in Iowa
          - Epidemiology traced back to rendering truck
        - All produce cytotoxins (some combination of ApxI - IV)
          - Antiphagocytic and hemolytic activity
      - ***Actinobacillus suis***
        - Has genes coding for toxins similar to Apx I & II
      - Gross lesions
        - APP typically limited to lung, may be unilateral
          - Epistaxis is common
        - *A. suis* may also have lesions of septicemia



- Pneumonias
  - Bacterial
    - *Actinobacillus s*



emorrhagic
uppurative
neumonia

Histology:

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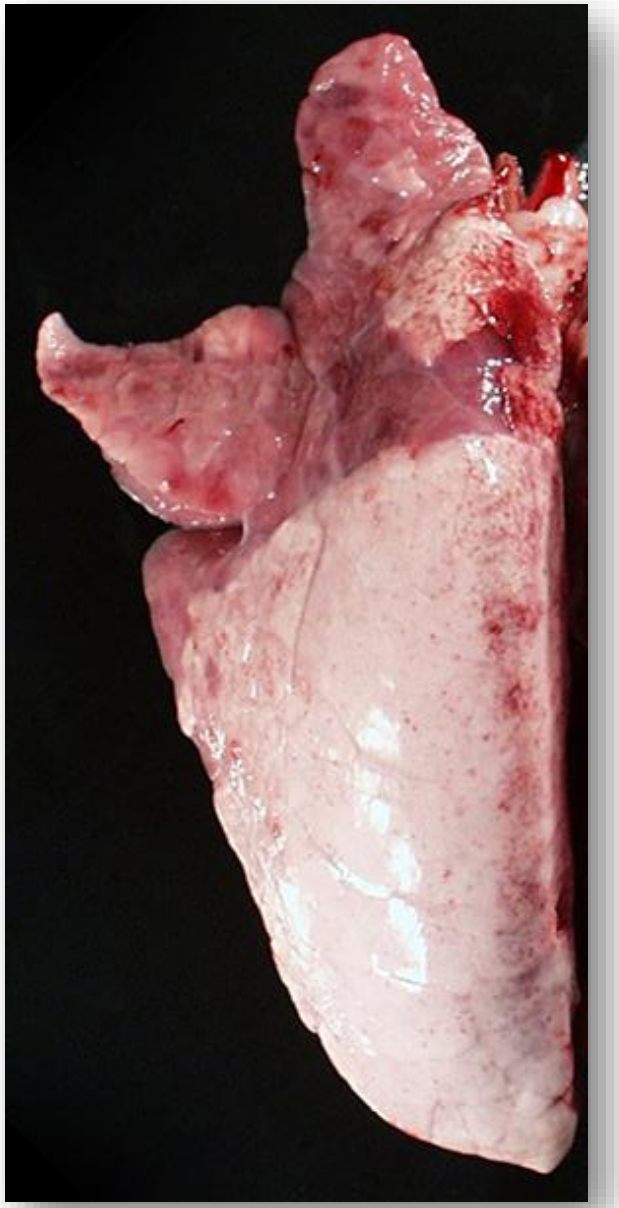
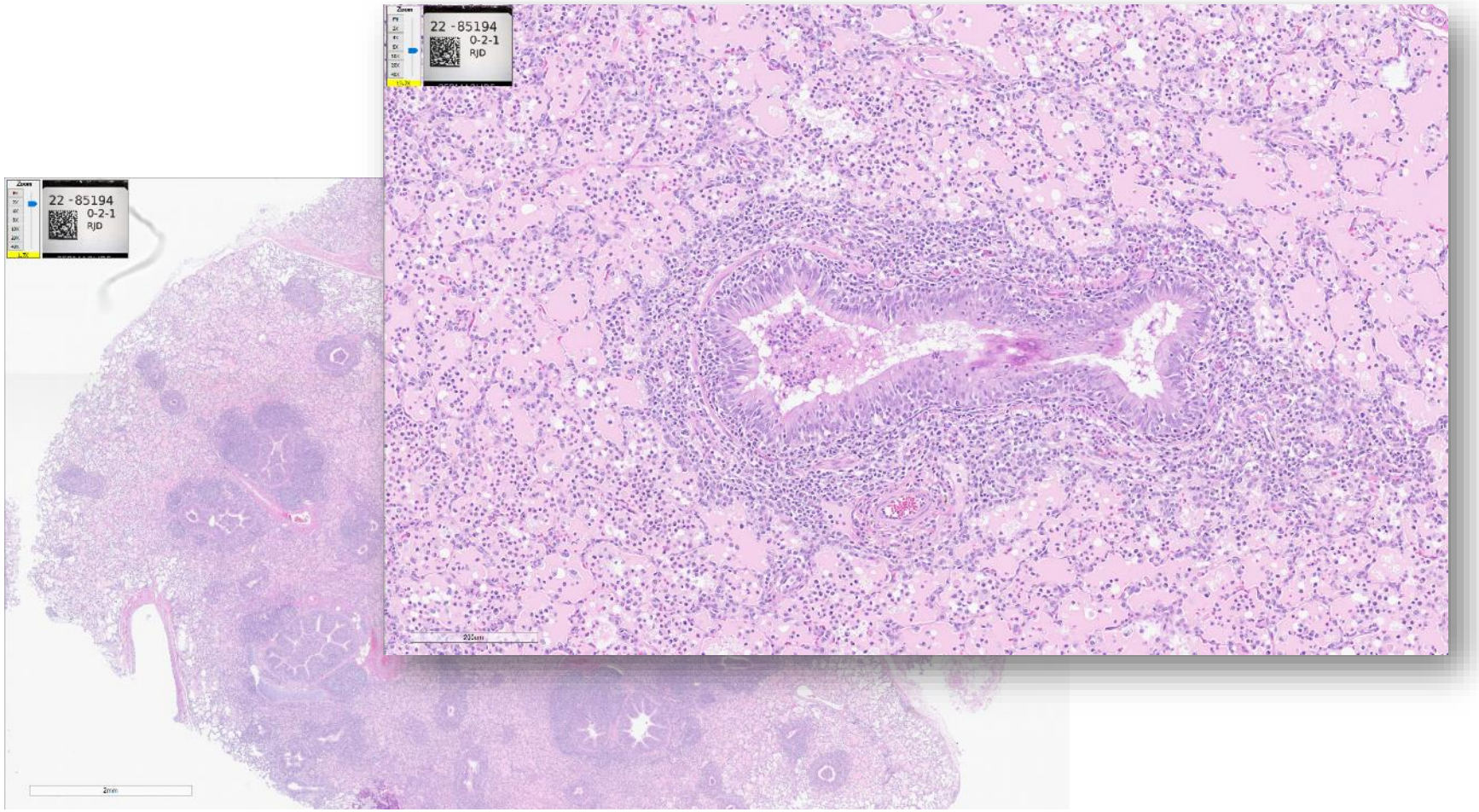
Laboratory

- Pneumonias
  - Bacterial
    - *Mycoplasma hyopneumoniae* (MHP)
      - Colonizes ciliated respiratory epithelial cells
        - Leads to reduced clearance and 2° bacterial pneumonia
          - Enzootic form with *P. multocida*
        - May potentiate disease with PRRSV and PCV2
      - Most commercial pigs are vaccinated; many herds are free
      - Disease spreads slowly through herds
        - Subclinical infection is common
        - Chronic, non-productive cough
        - Often observed in late finishing as immunity wanes
      - Gross lesions
        - Well-demarcated cranioventral consolidation



- Pneumonias
  - Bacterial
    - MHP

Histology:



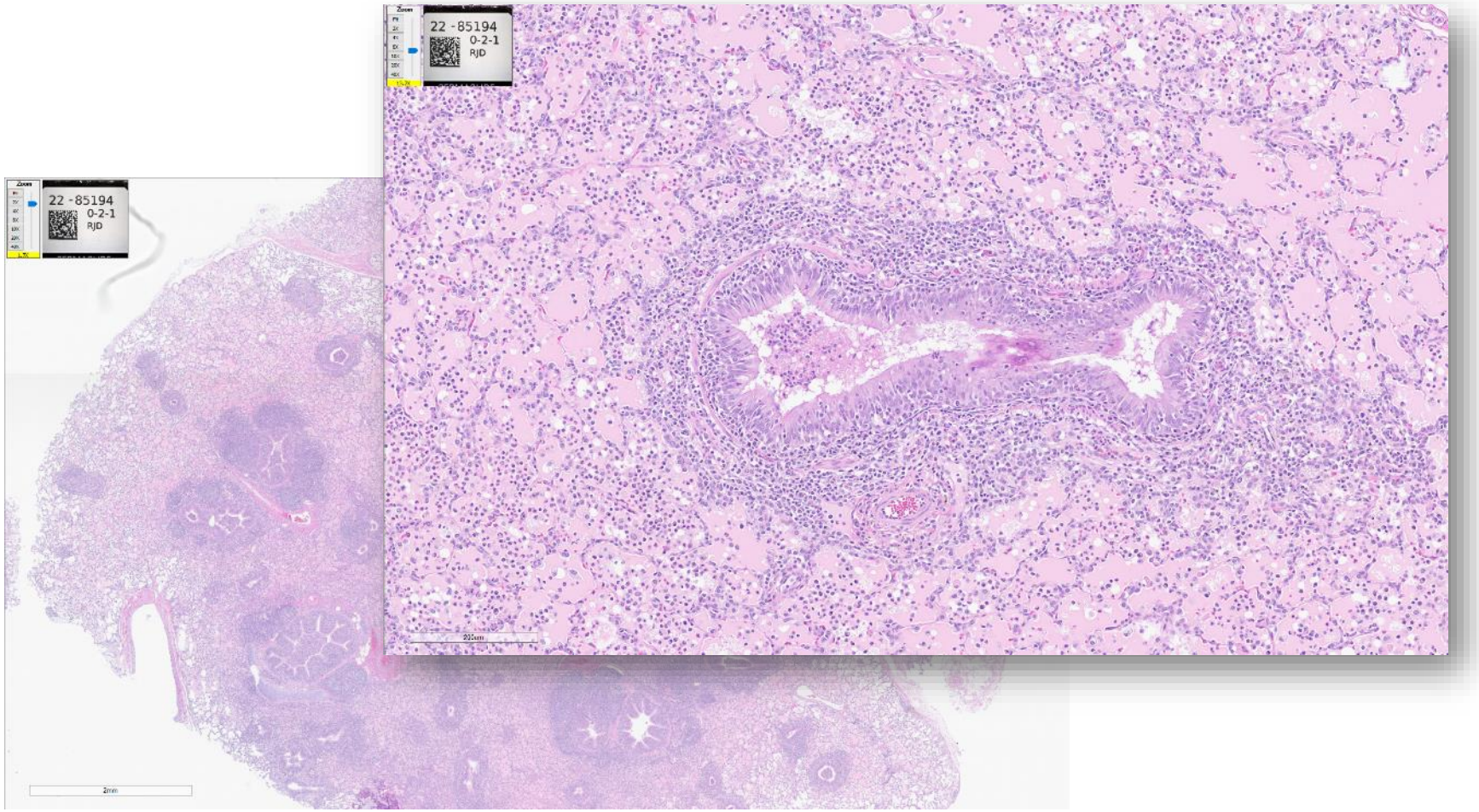
Lymphocytic infiltrates around conducting airways

Alveoli flooded with edema, neutrophils, and macrophages.

Veterinary Diagnostic Laboratory

- Pneumonias
  - Bacterial
    - MHP

Histology:

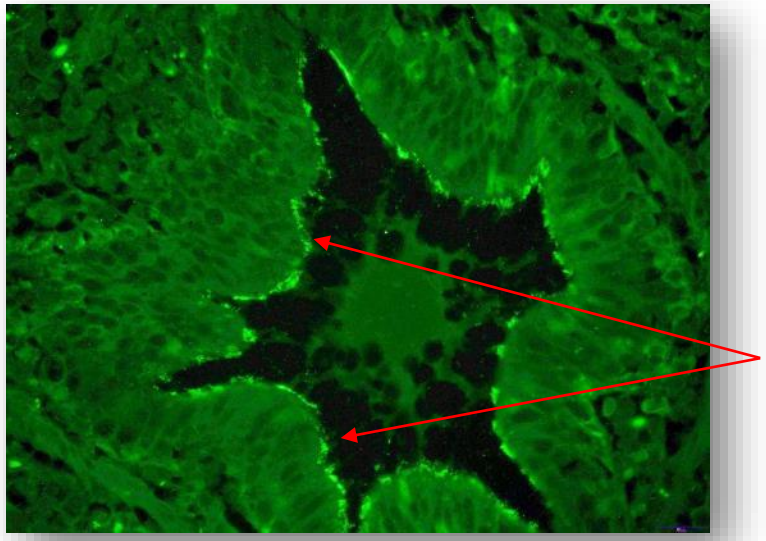


Lymphocytic infiltrates around conducting airways

Alveoli flooded with edema, neutrophils, and macrophages.

Veterinary Diagnostic Laboratory

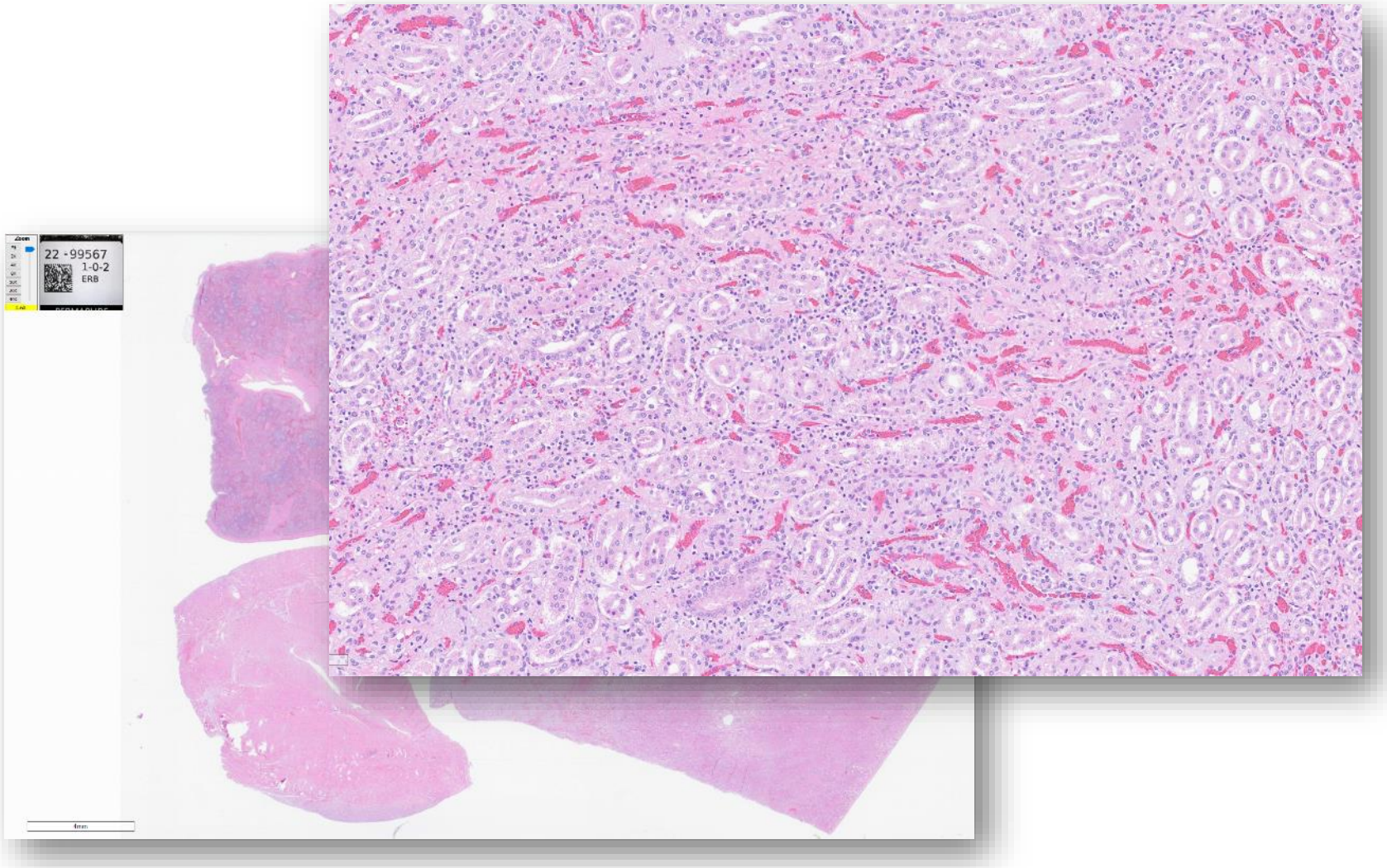
- Pneumonias
  - Bacterial
    - MHP
      - Diagnostics
        - Culture (very difficult, requires Friis media)
        - PCR
        - Serology
          - Common for population monitoring (ELISA)
          - Not as useful for disease diagnosis
            - Does not differentiate between maternal, vaccine-induced, or infection
        - IHC/ISH



Common infectious systemic diseases of pigs

Veterinary Diagnostic Laboratory

- Common Systemic Infections
  - Viral
    - Porcine reproductive and respiratory syndrome virus (PRRSV)



Lymphoplasmacytic interstitial nephritis, myocarditis, and encephalitis

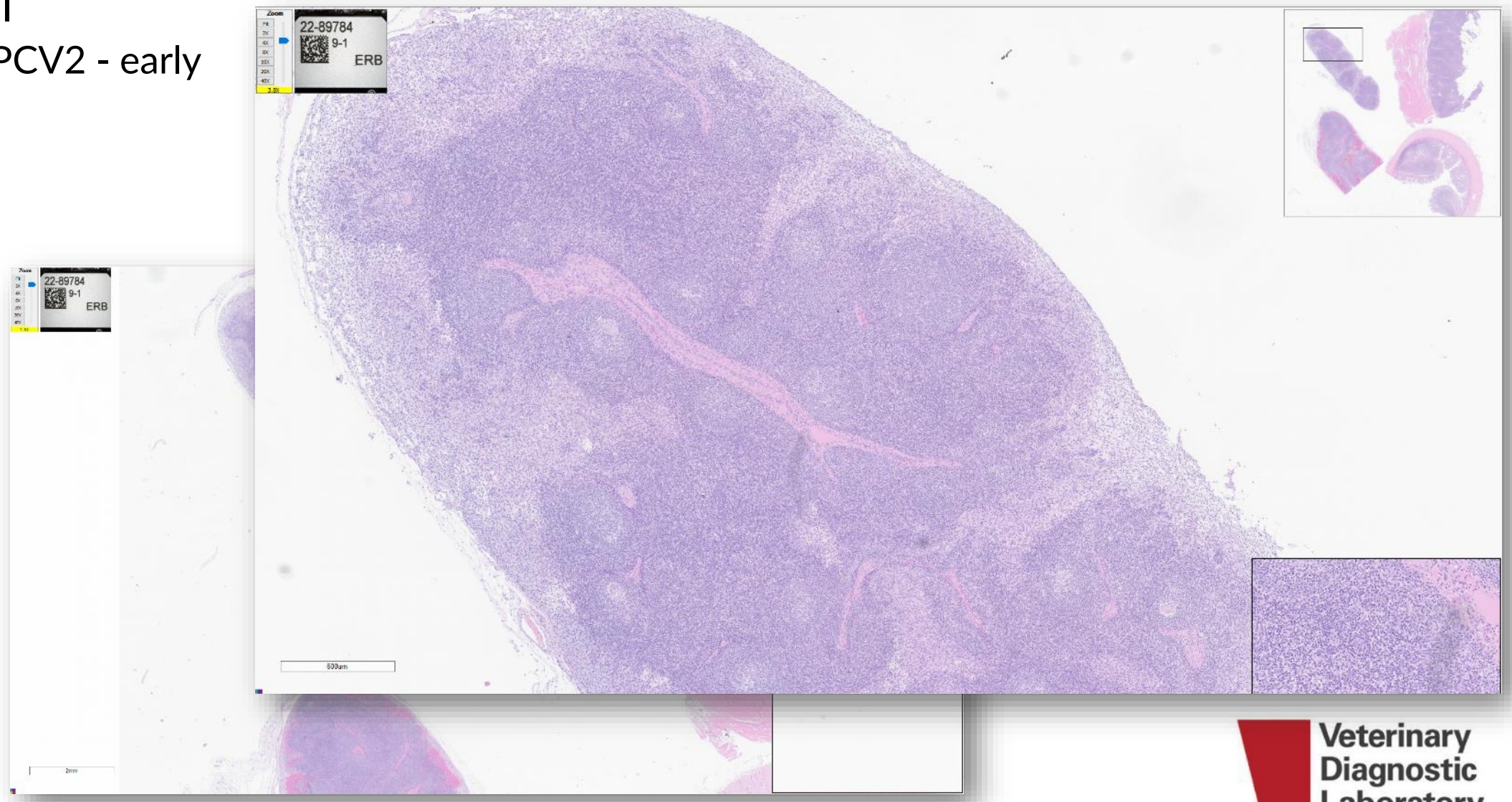
- Common Systemic Infections
  - Viral
    - Porcine circoviruses
      - DNA viruses with a circular genome
      - Three types have been well-described PCV1-3; PCV4 has recently been described

      - PCV2 is the best characterized and has multiple genotypes (2a, 2b, 2c, 2d, 2e)
        - Associated with reproductive failure, pneumonia, lymphoid depletion, and **wasting**
        - Most commercial pigs are vaccinated; highly effective
          - Disease is often a measure of vaccination compliance

      - PCV3 is becoming better understood
        - Associated with reproductive failure and poor growth in weaned pigs

      - Diagnostics
        - PCR, sequencing
        - Direct detection

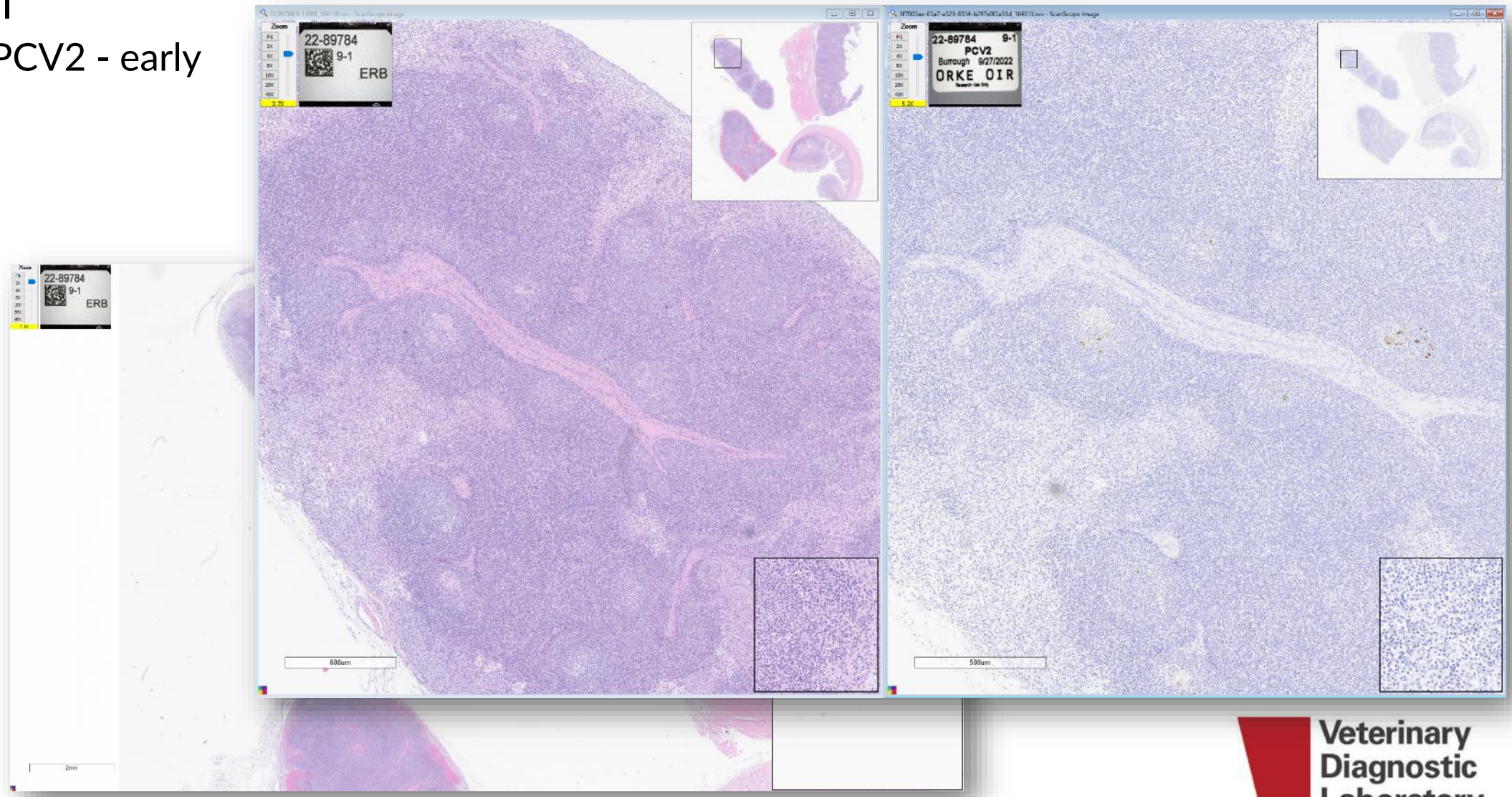
- Common Systemic Infections
  - Viral
    - PCV2 - early



Mild lymphoid depletion with central accumulations of macrophages

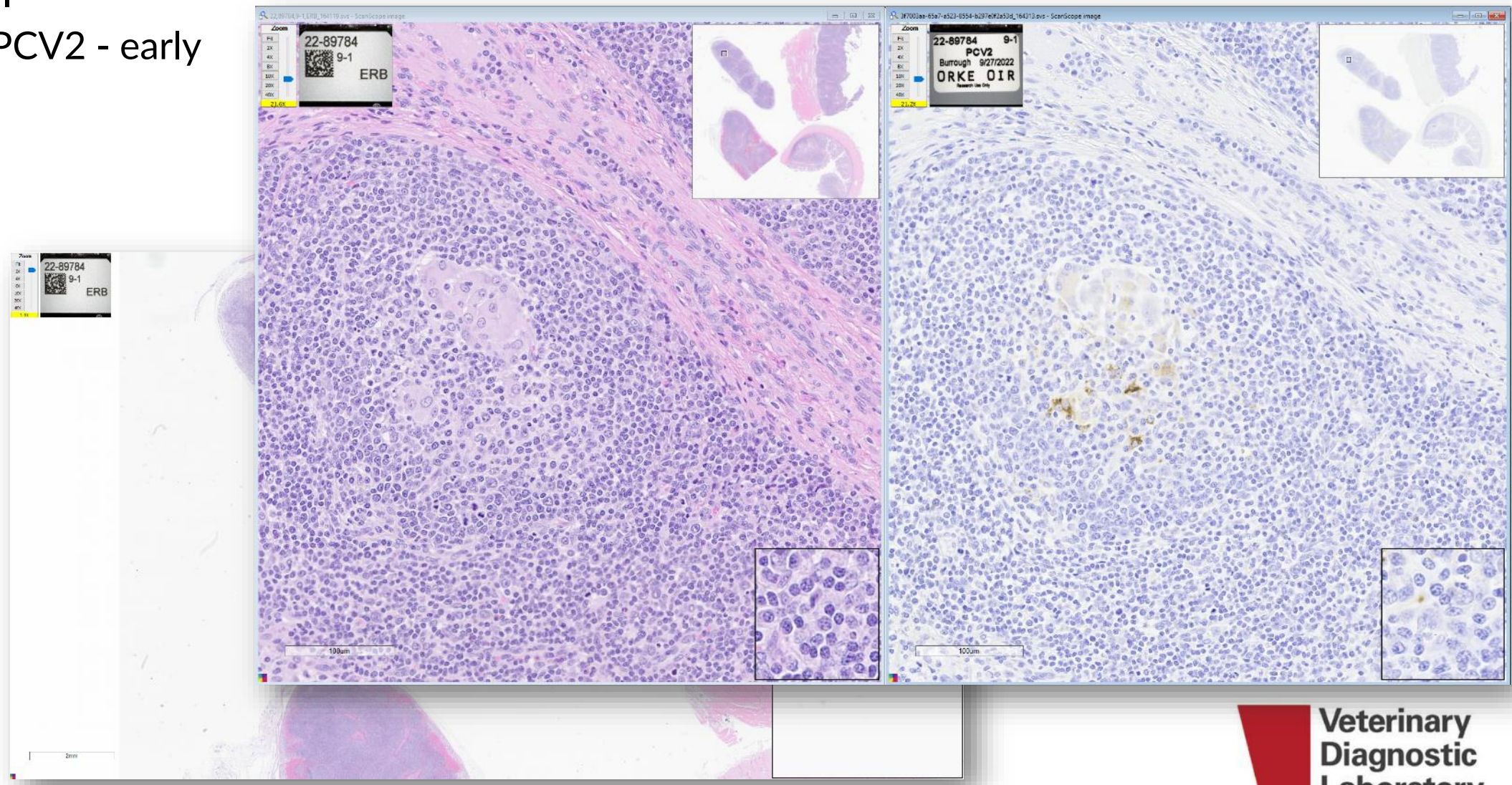
Veterinary Diagnostic Laboratory

- Common Systemic Infections
  - Viral
    - PCV2 - early



Viral antigen limited to germinal centers

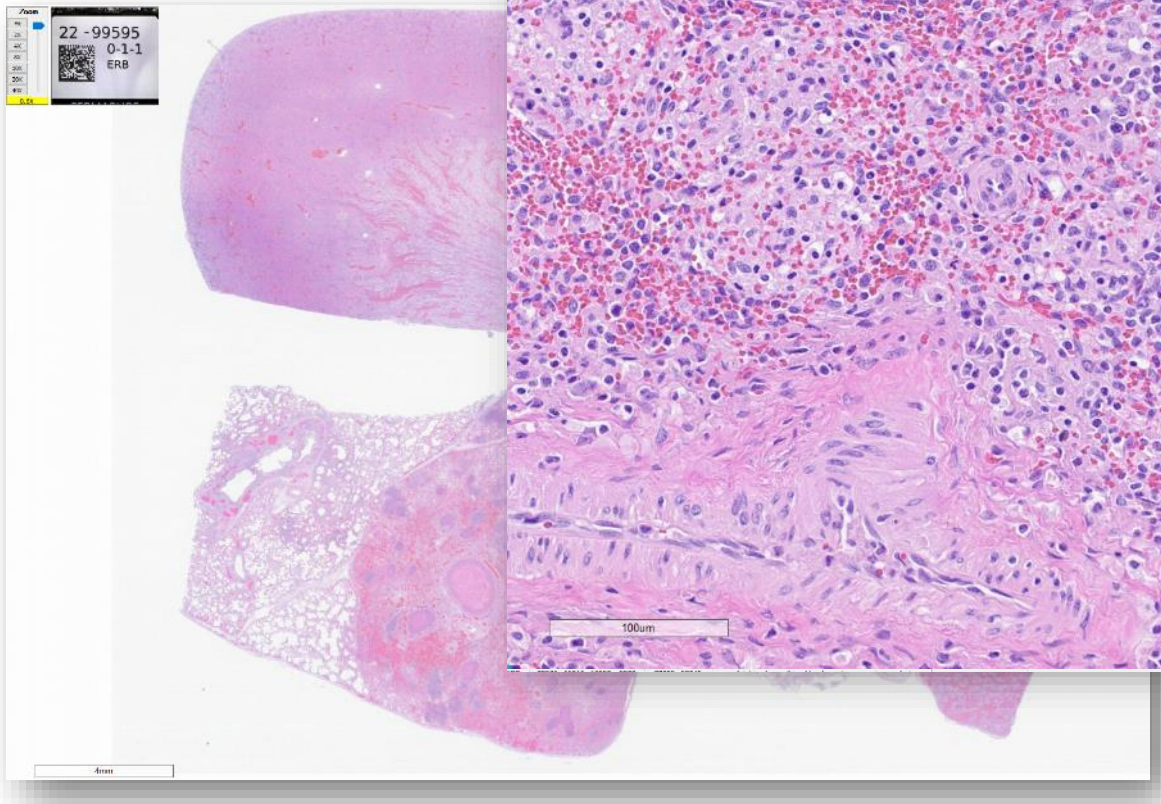
- Common Systemic Infections
  - Viral
    - PCV2 - early

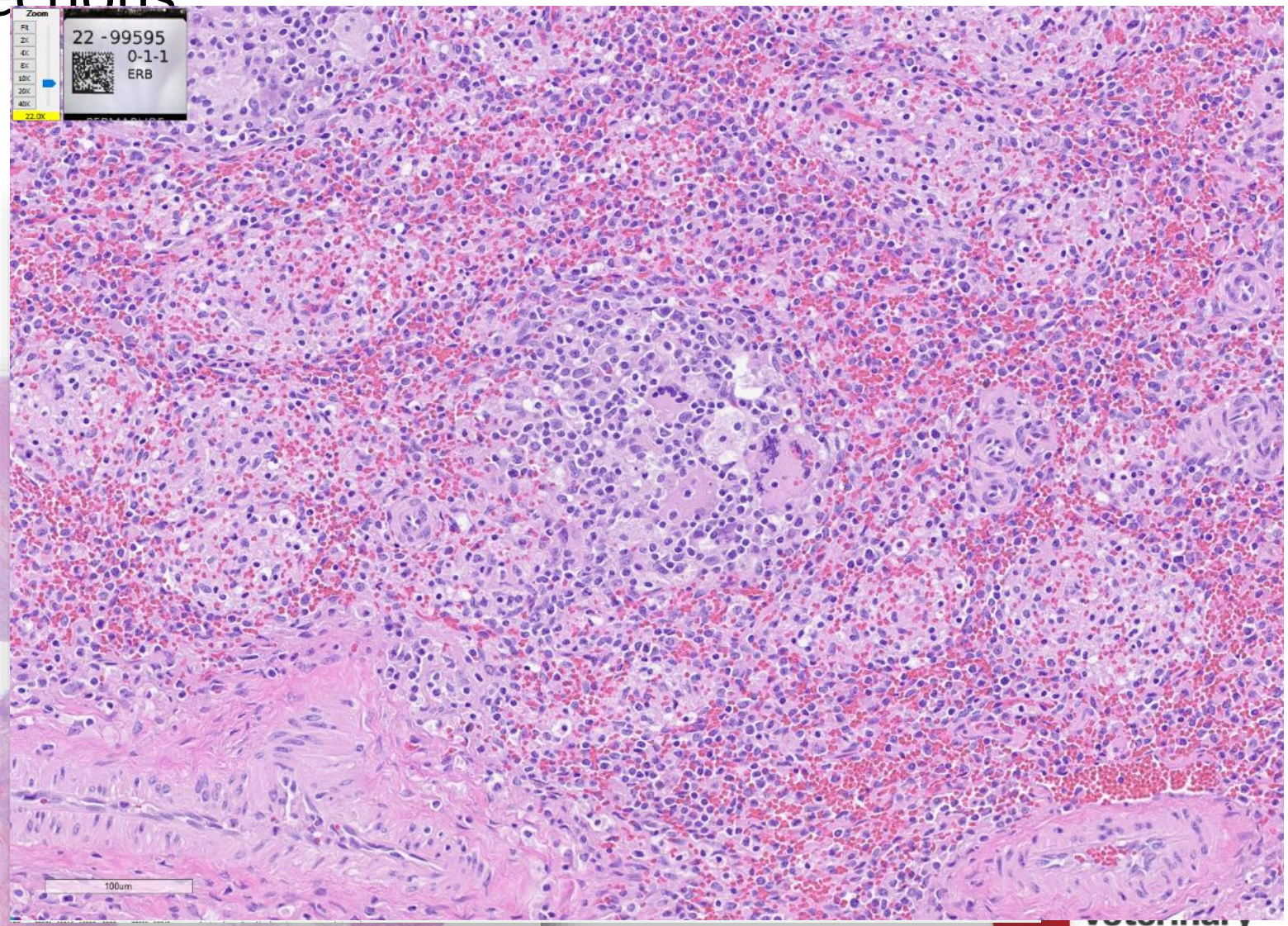


Viral antigen limited to germinal centers

Veterinary Diagnostic Laboratory

- Common Systemic Infections
  - Viral
    - PCV2 - intermediate

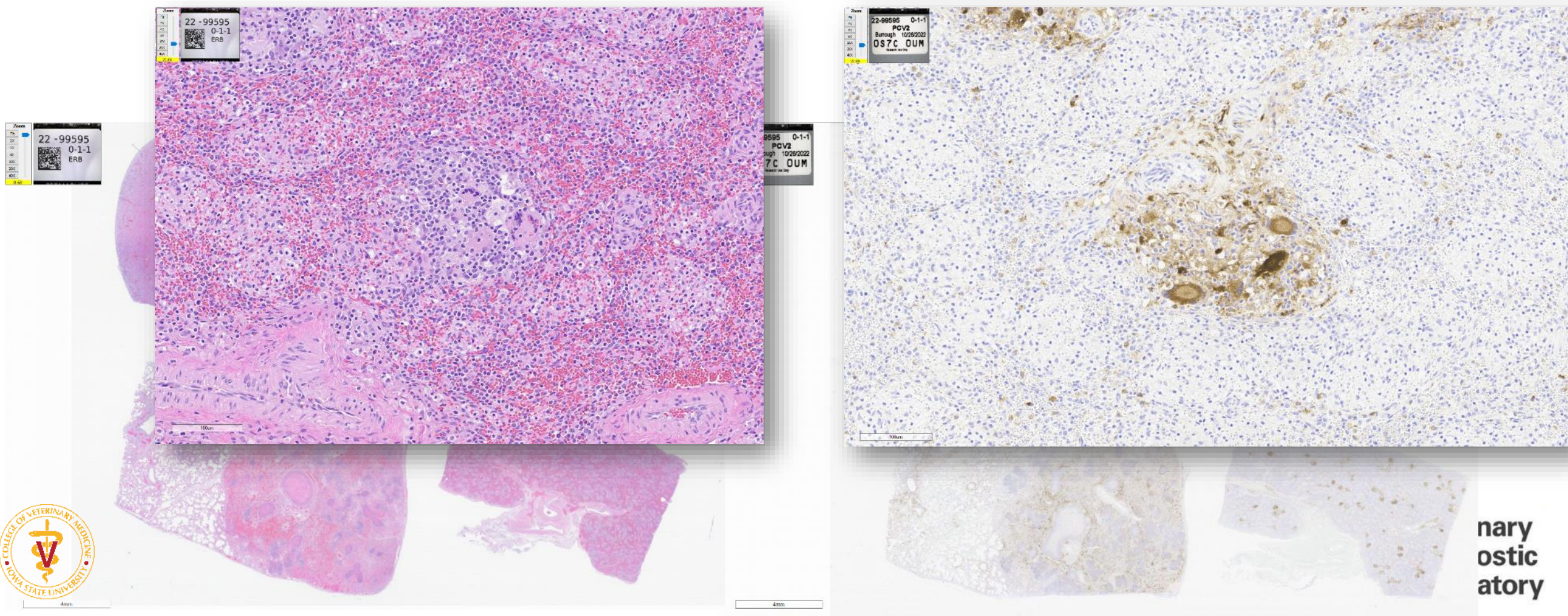




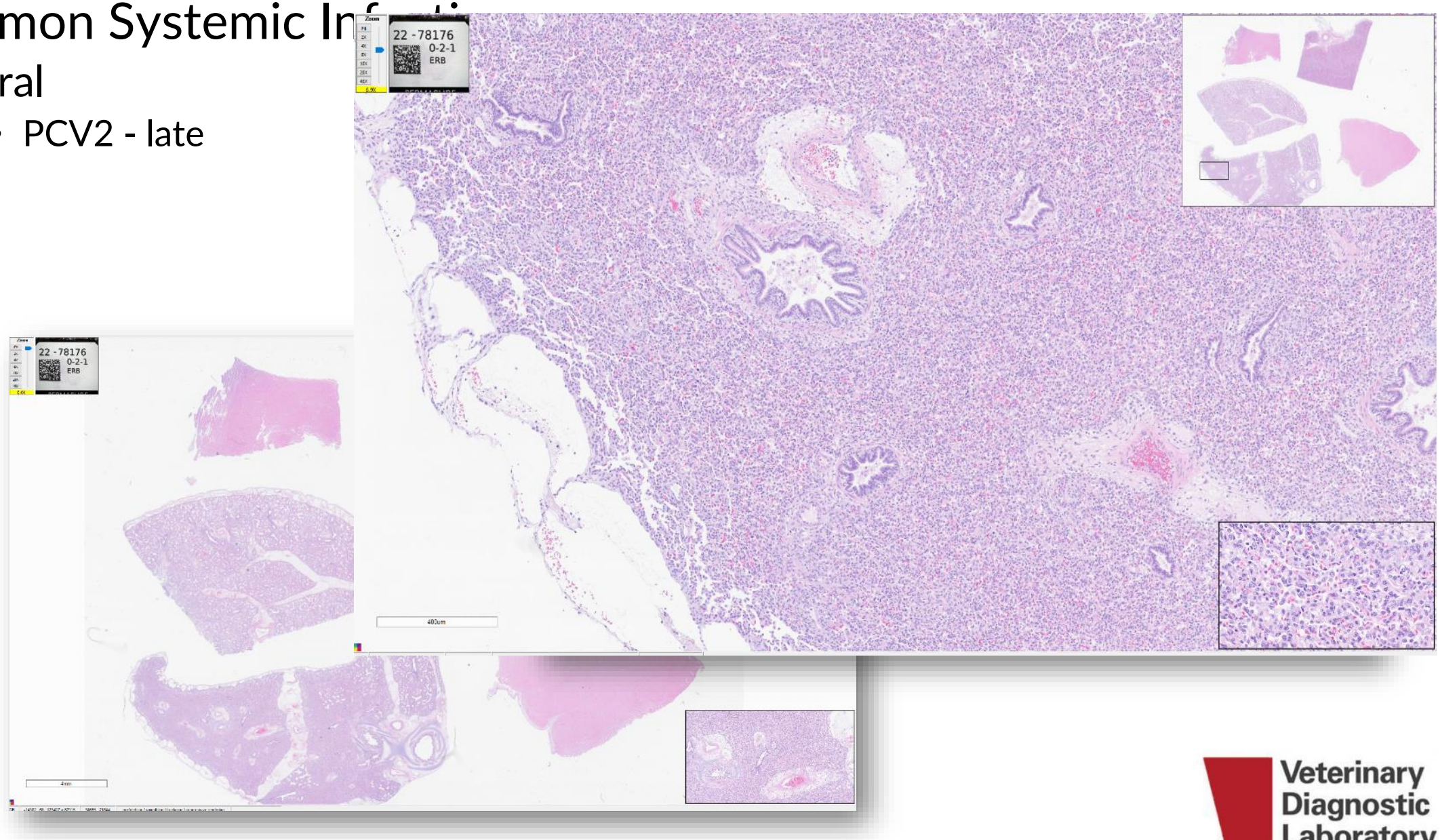
Moderate lymphoid depletion with central accumulations of macrophages and giant cells

Veterinary Diagnostic Laboratory

- Common Systemic Infections
  - Viral
    - PCV2 - intermediate



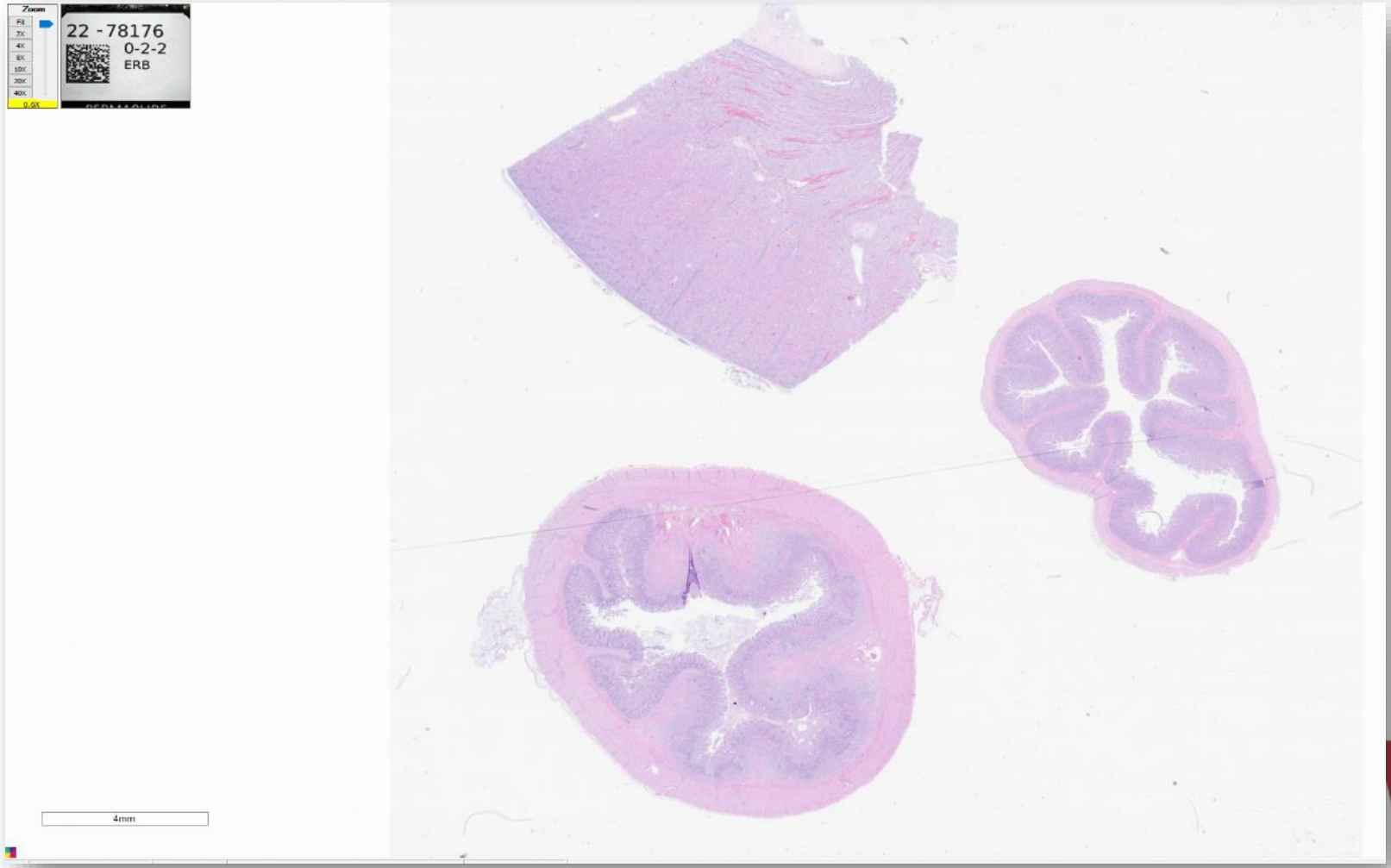
- Common Systemic Infectious
  - Viral
    - PCV2 - late



Severe lymphoid depletion and histiocytic interstitial pneumonia

Veterinary Diagnostic Laboratory

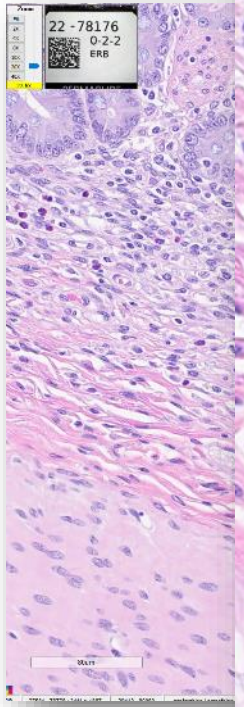
- Common Systemic Infections
  - Viral
    - PCV2 - late

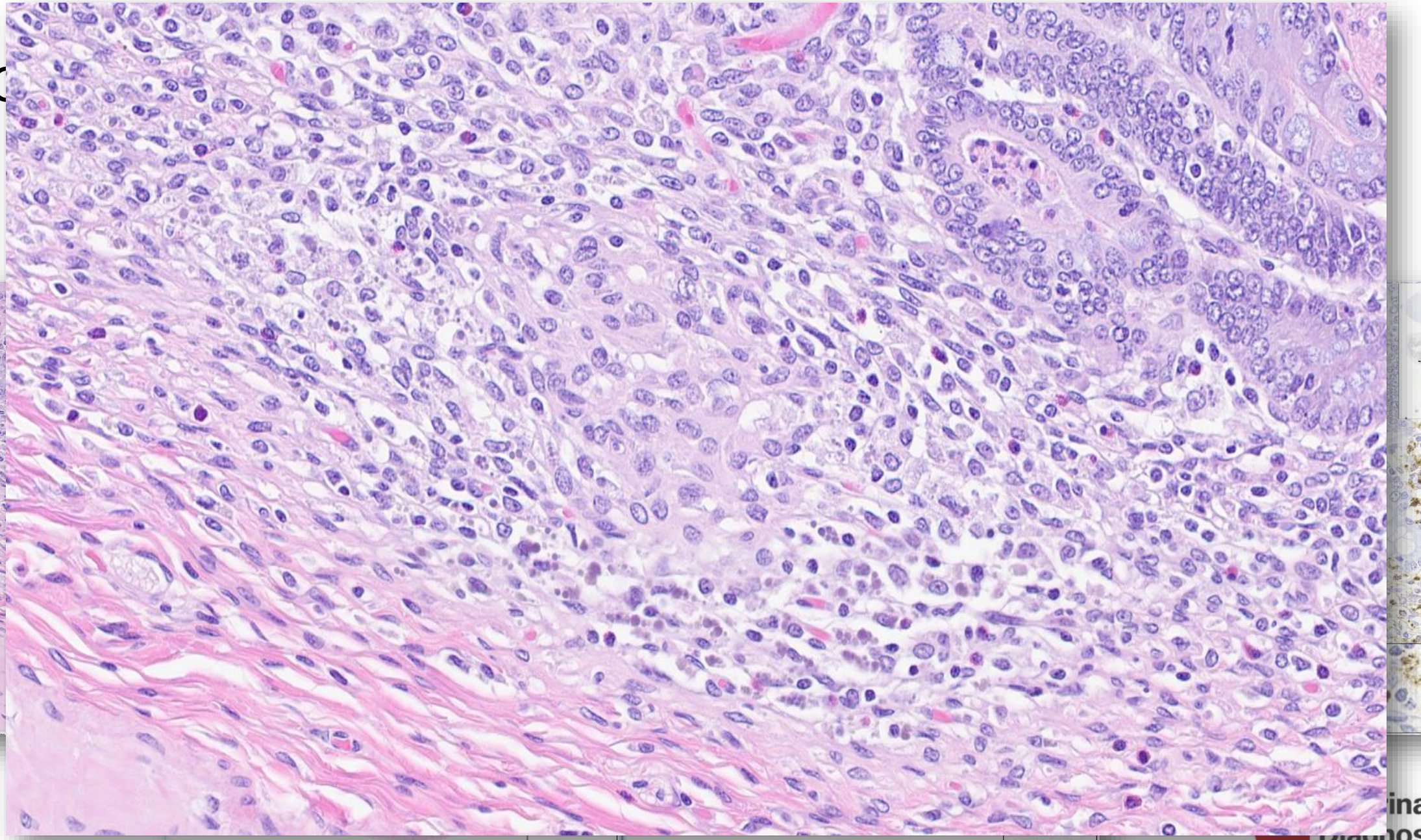


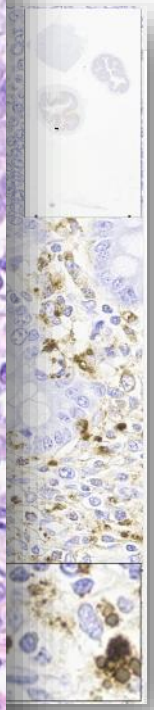
Severe lymphoid depletion, granulomatous inflammation, +/- botryoid inclusions

Veterinary Diagnostic Laboratory

- C







- Common Systemic Infections
  - Viral
    - PCV2 - late

Viral loads are extreme, often with single digit PCR Ct values

Histopathology

Histopathology - With Interpretation

Animal ID	Specimen	Slides	Comments
House 2	Assorted	1	
House 4	Assorted	1	

Porcine Circovirus Type 2 IHC

Animal ID	Specimen	Result	Comment
House 2	Assorted	Positive	
House 4	Assorted	Positive	

Molecular Diagnostic

PCR - African Swine Fever - USDA program

Animal ID	Specimen	ct / Result	Comment
House 2, SID #1	Spleen	>=45 / Negative	
House 4, SID #2	Spleen	>=45 / Negative	

PCR - Classical Swine Fever - USDA program

Animal ID	Specimen	ct / Result	Comment
House 2, SID #1	Spleen	>=45 / Negative	
House 4, SID #2	Spleen	>=45 / Negative	

PCR - Influenza A

Animal ID	Specimen	Target	Ct / Result	Comment
House 2, SID #1	Lung	Influenza general	>=38 / Negative	
House 4, SID #2	Lung	Influenza general	>=38 / Negative	

PCR - M. hyopneumoniae

Animal ID	Specimen	Ct / Result	Comment
House 2, SID #1	Lung	>=37 / Negative	
House 4, SID #2	Lung	>=37 / Negative	

PCR - Porcine Circovirus 2

Animal ID	Specimen	PCV2 ct / Result	Comment
House 2, SID #1	Lung	8.5 / Positive	
House 4, SID #2	Lung	6.9 / Positive	

Veterinary Diagnostic Laboratory

- Common Systemic Infections
  - Viral
    - PCV3

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PCV3-associated disease in the United States swine herd

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[a]Department of Veterinary Diagnostic and Production Animal Medicine, Iowa State University, Ames, IA, USA; [b]Cambridge Technologies, Worthington, MN, USA; [c]Prestage Farms, Inc, Clinton, NC, USA; [d]The Hanor Company of Wisconsin, LLC, Enid, OK, USA; [e]Swine Health Care, Mexico, IN, USA; [f]Swine Vet Center, St Peter, MN, USA; [g]Pipestone Veterinary Service, Ottumwa, IA, USA

ABSTRACT

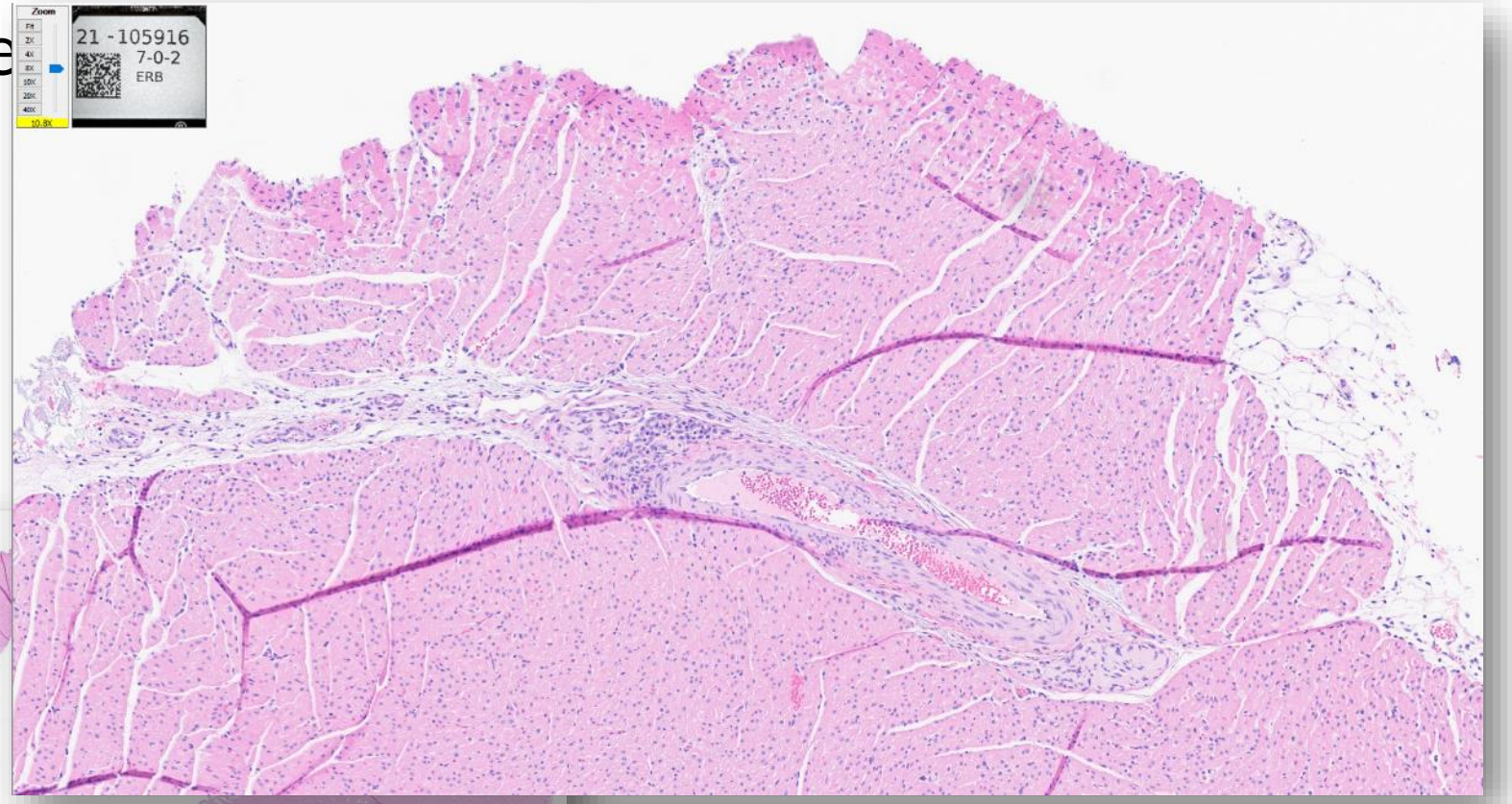
Porcine circovirus-associated disease encompasses multiple disease syndromes including porcine circovirus 2 systemic diseases, reproductive failure, and porcine dermatitis and nephropathy syndrome. Until recently, porcine circovirus 2 was the only species associated with the porcine circovirus-associated disease. In this report, diagnostic investigations of thirty-six field cases submitted from multiple production systems, numerous sites and varied geographic locations demonstrated porcine circovirus 3 within lesions by *in situ* hybridization including fetuses with myocarditis, weak-born neonatal piglets with encephalitis and myocarditis, from cases of porcine dermatitis and nephropathy syndrome, and in weaned pigs with systemic periarteritis. Porcine circovirus 3 was detected by PCR in numerous fetuses and perinatal piglets at high viral loads (trillions of genome copies per mL of tissue homogenate). Samples from all cases in this study were assayed and found negative for porcine circovirus 2 by PCR. Metagenomic sequencing was performed on a subset of reproductive cases, consisting of sixteen fetuses/fetal sample pools. PCV3 was identified in all pools and the only virus identified in fourteen pools. Based on these data, porcine circovirus 3 is considered a putative cause of reproductive failure, encephalitis and myocarditis in perinatal piglets, porcine dermatitis and nephropathy syndrome, and periarteritis in swine in the United States.

ARTICLE HISTORY Received 1 February 2019; Revised 15 April 2019; Accepted 20 April 2019

KEYWORDS Porcine circovirus; reproductive failure; porcine dermatitis and nephropathy syndrome; myocarditis; encephalitis

Veterinary Diagnostic Laboratory

- Common Systemic Infe
  - Viral
    - PCV3 - perivasculitis



Vessels in the epicardium / external myocardium are commonly affected

Molecular Diagnostic

PCR - Influenza A

Animal ID	Specimen	Target	Ct / Result	Comment
GB [1-5]	Bronchial swab	Influenza general	>=38 / Negative	

PCR - Mycoplasma hyorhinis

Animal ID	Specimen	Ct / Result	Comment
GA [1, 3-4, 6-7]	Joint fluid	>=35 / Negative	

PCR - Porcine Circovirus 2 and 3

Animal ID	Specimen	PCV2 ct/ Result	PCV3 ct / Result	Comment
GB [1-5]	Spleen	>=37 / Negative	20.2 / Positive	

PCR - Porcine parainfluenza virus type 1

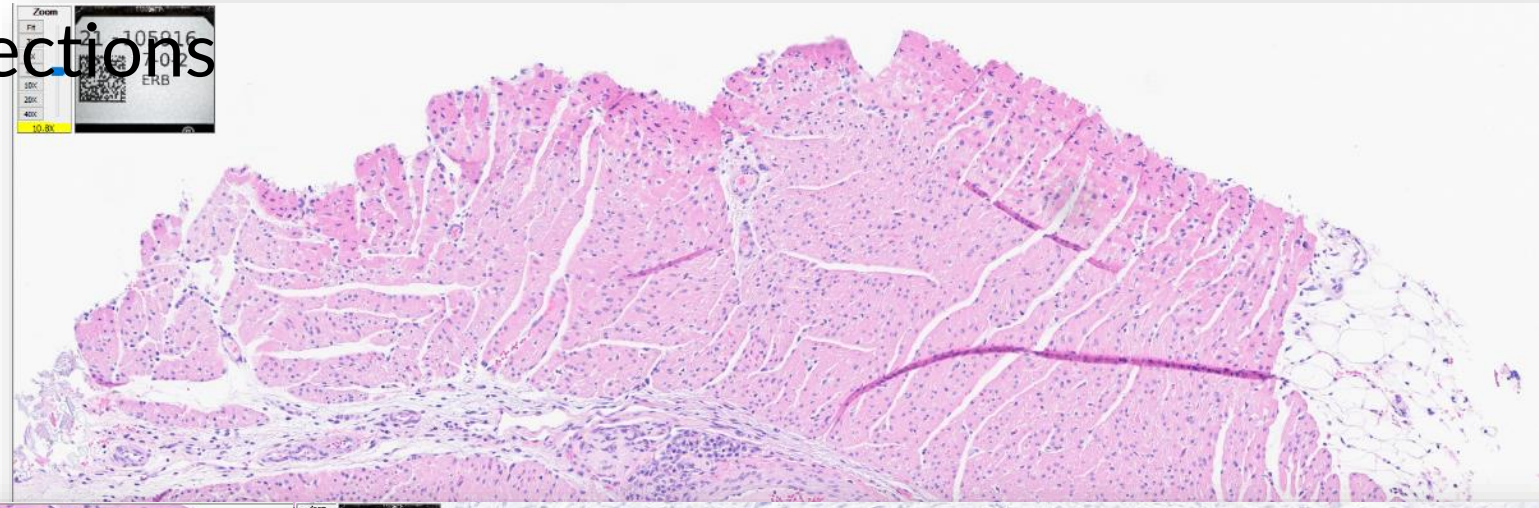
Animal ID	Specimen	Ct/Result	Comment
GB [1-5]	Bronchial swab	>=38 / Negative	

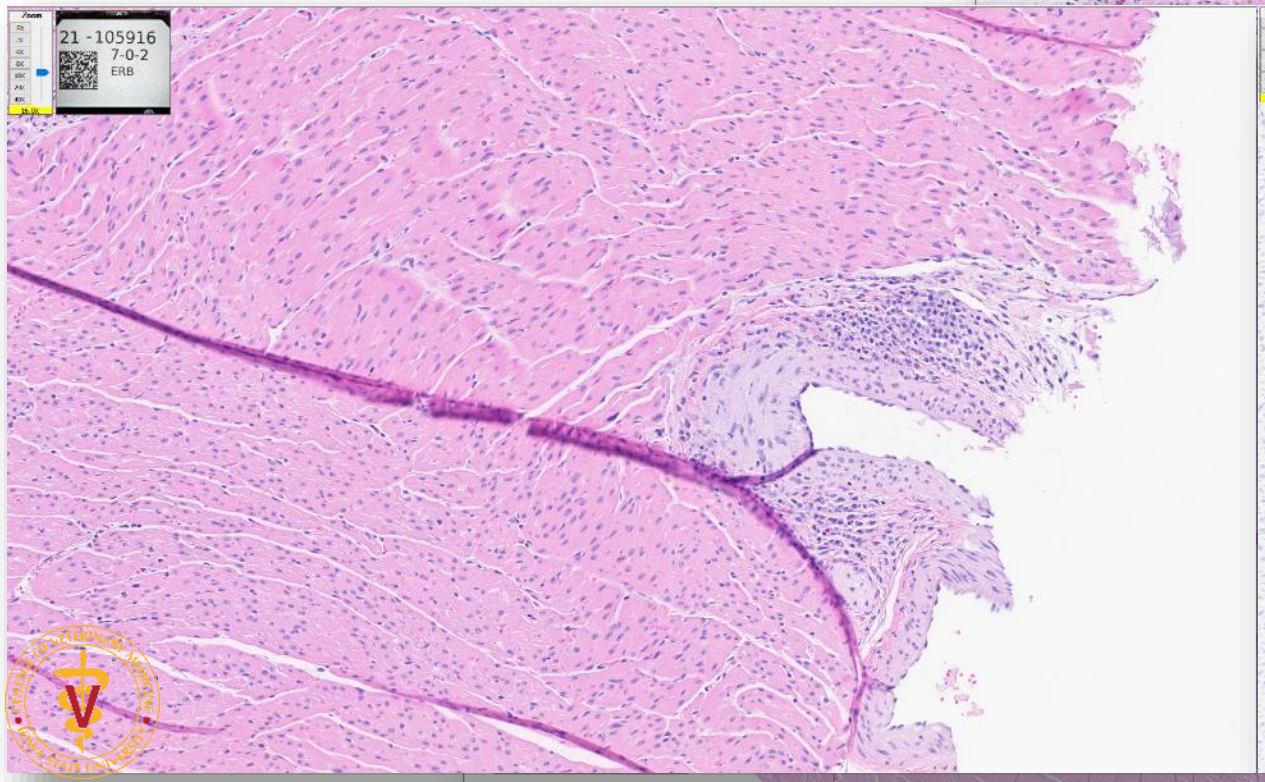
PCR - PRRSV Applied Biosystems

Animal ID	Specimen	PRRSV-2 (NA) Ct/Result	PRRSV-1 (EU) Ct/Result	Comment
GB [1-5]	Bronchial swab	>=37 / Negative	>=37 / Negative	

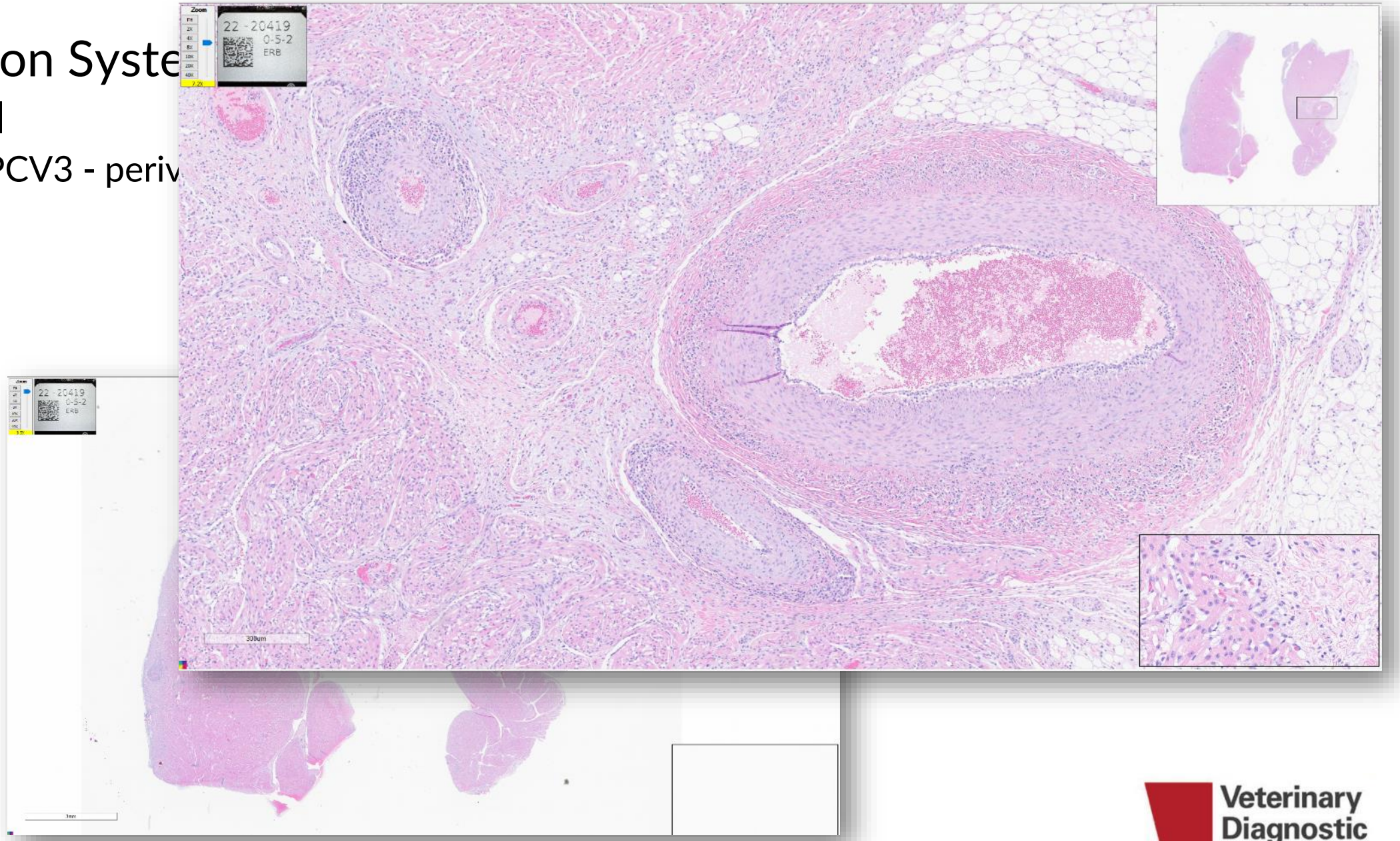
Veterinary Diagnostic Laboratory

- Common Systemic Infections
  - Viral
    - PCV3 - perivasculitis



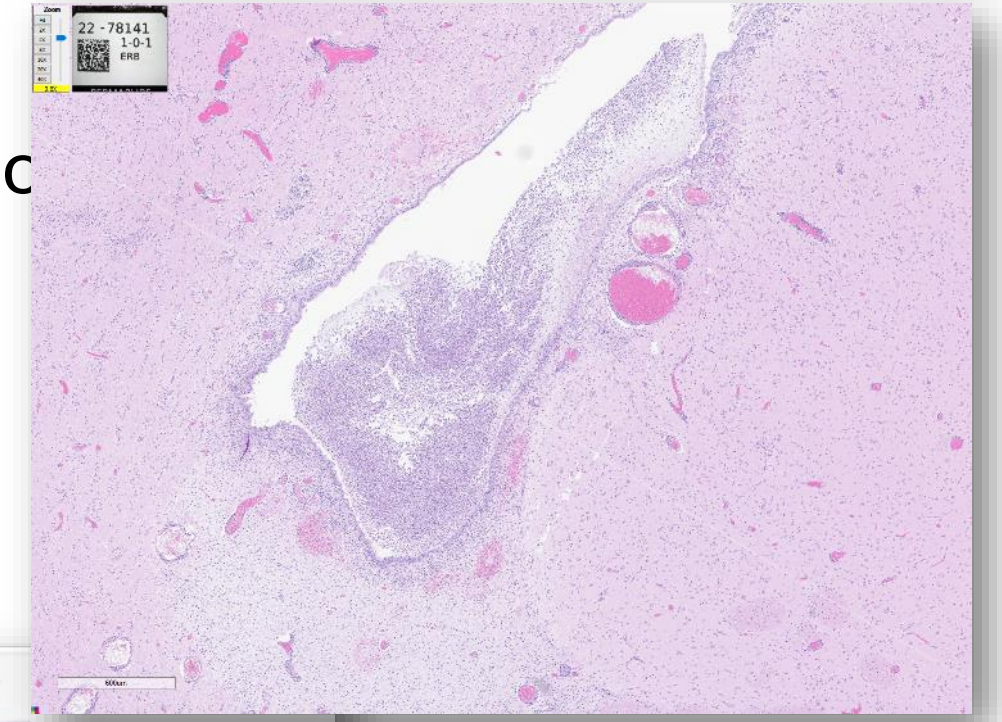


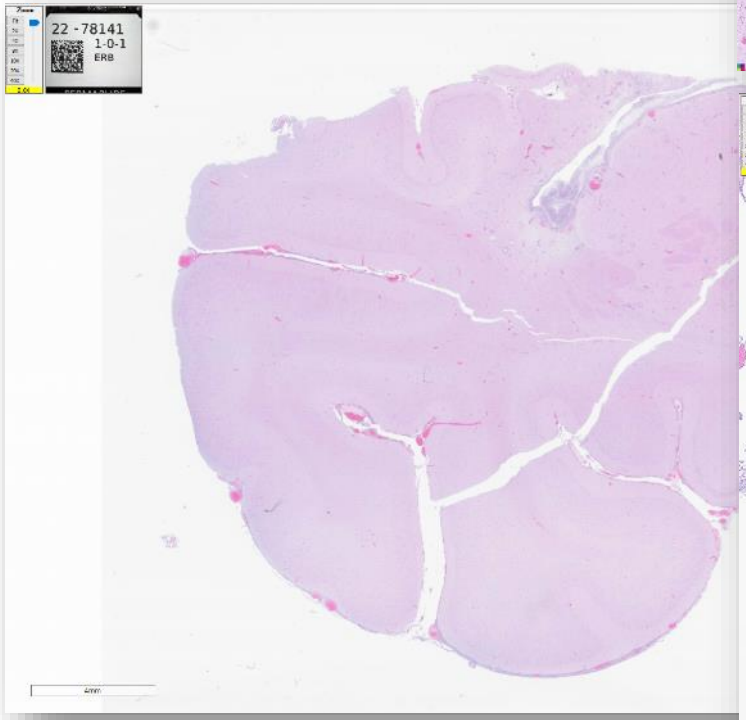
- Common Syste
  - Viral
    - PCV3 - periv

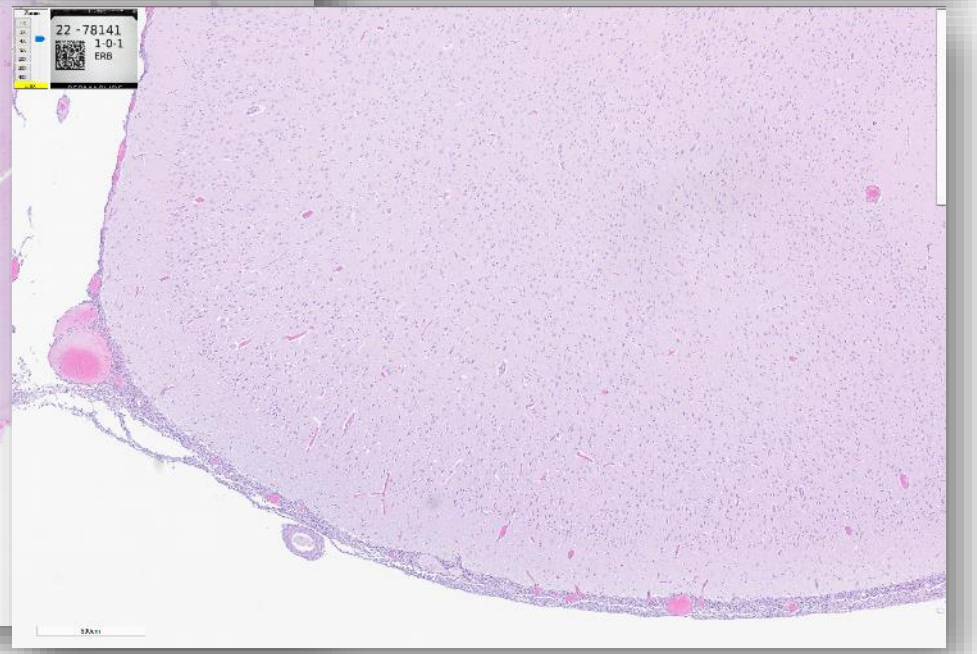


- Common Systemic Infections
  - Bacterial
    - **The suis-cides + MHR**
      - *Streptococcus suis*
      - *Glaesserella parasuis*
      - *Actinobacillus suis*
      - *Mycoplasma hyorrhinis*
    - Gross lesions
      - Fibrinopurulent polyserositis, meningitis, synovitis, and VVE
      - Can't consistently differentiate grossly
    - Diagnostics
      - Culture
      - PCR for fastidious organisms

- Common Systemic Infectic
  - Bacterial
    - Meningitis +/- polyserositis

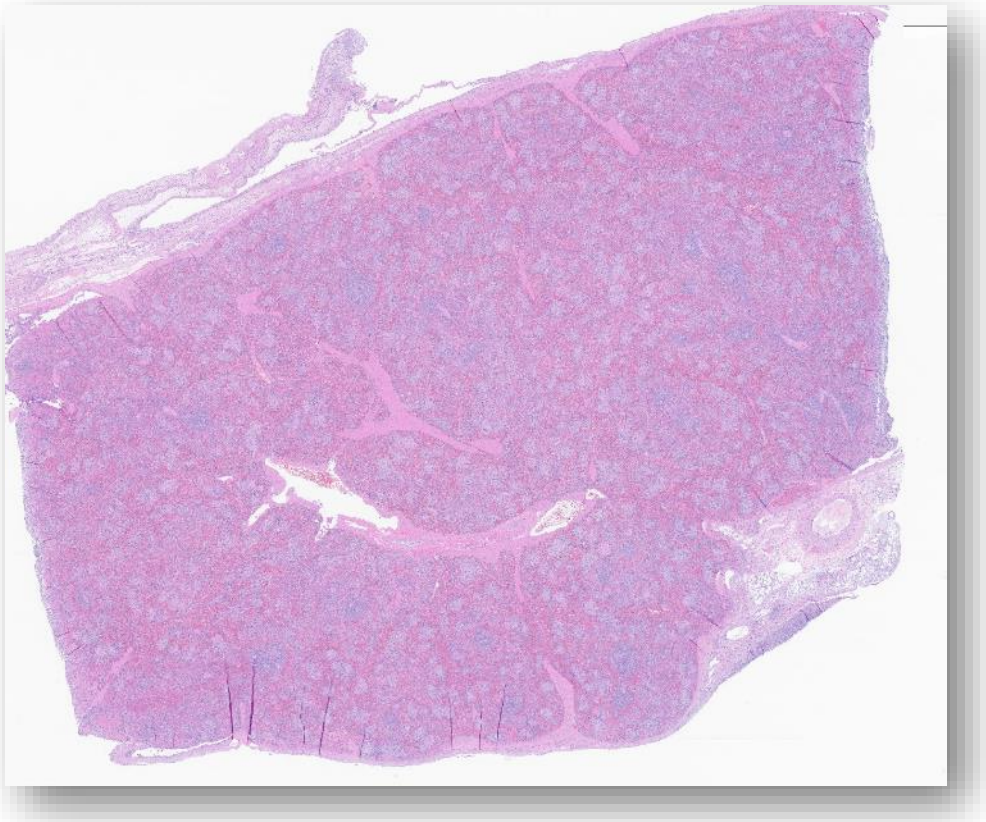






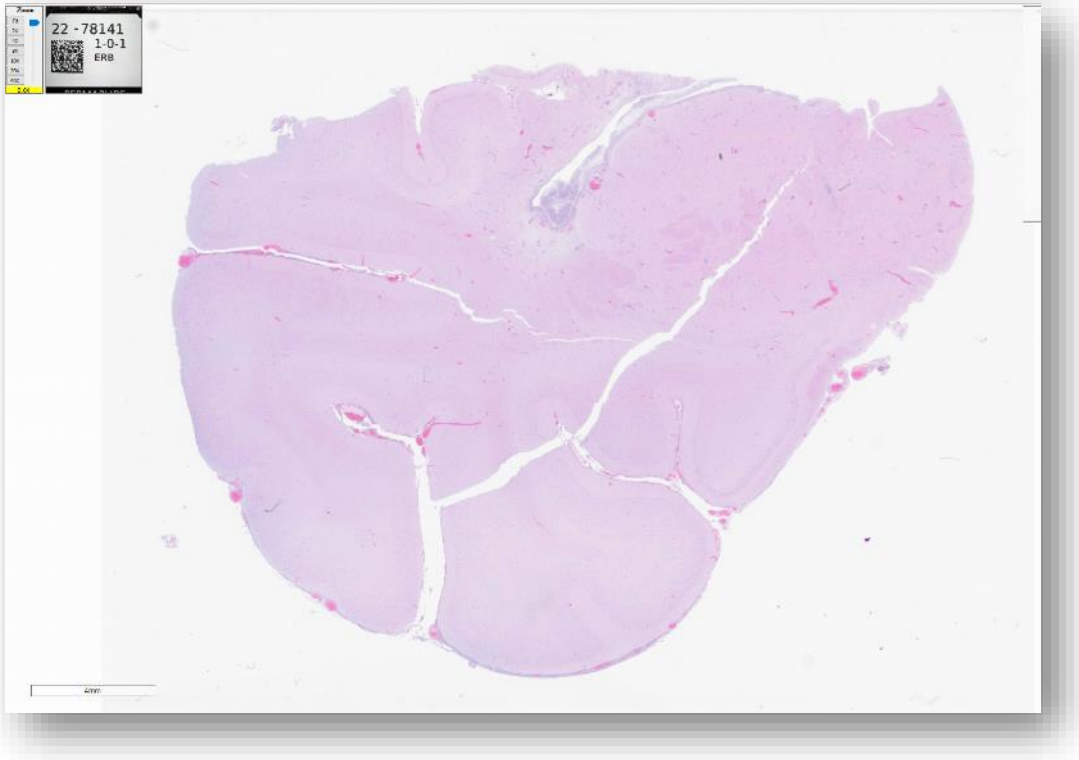
Fibrinosuppurative exudate expands the meninges and may fill ventricles

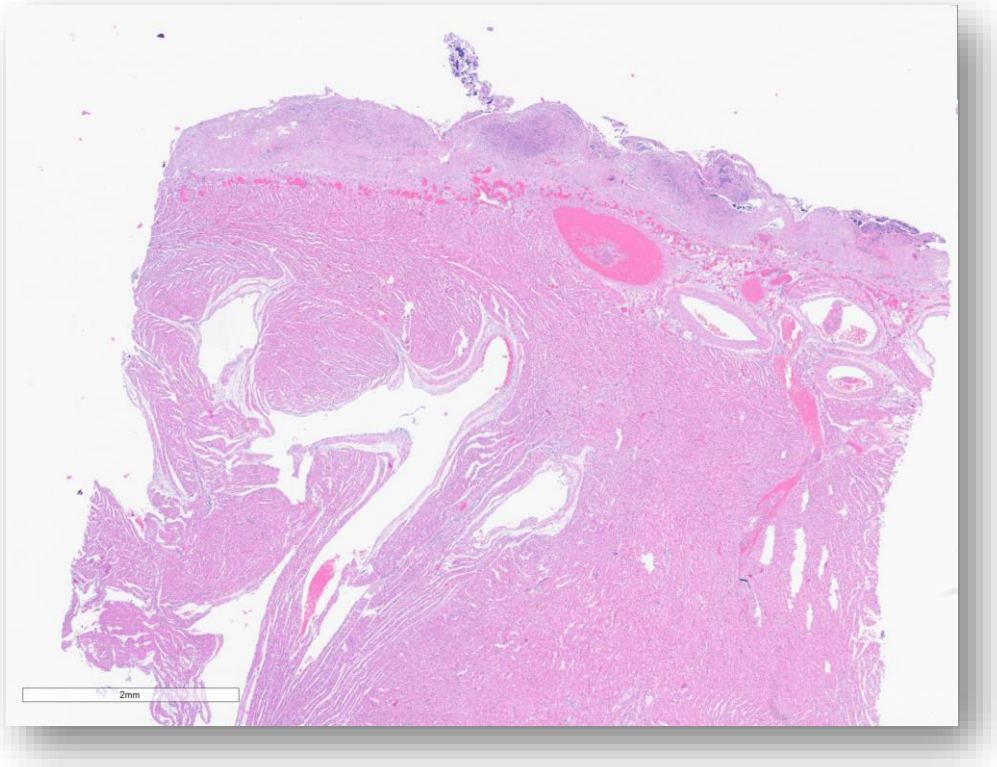
- Common Systemic Infections
  - Bacterial
    - Meningitis +/- polyserositis



Multiple serosal surfaces are often involved

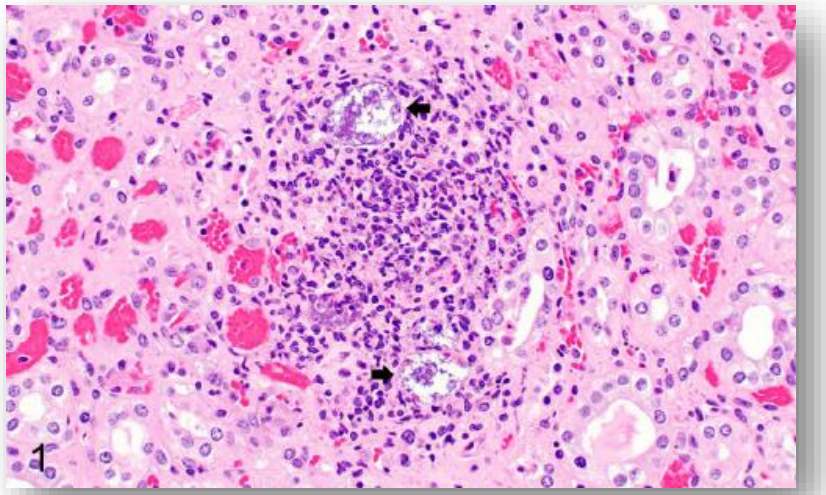
- Common Systemic Infections
  - Bacterial
    - Meningitis +/- polyserositis

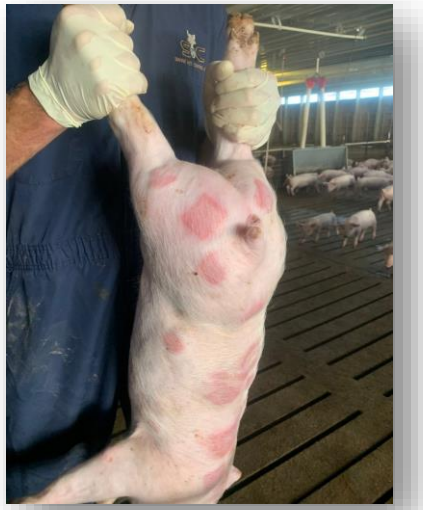




Multiple serosal surfaces are often involved

- Less Common Systemic Infections
  - Bacterial
    - *Streptococcus dysgalactiae* subsp. *equisimilis*
      - Similar disease as *S. suis*
    - *Streptococcus equi* subsp. *zooepidemicus*
      - Rapidly fatal septicemia
        - Severe splenomegaly
      - Often occurs in regional outbreaks
    - *Streptococcus gallolyticus*
      - Increasingly recognized cause of endocarditis in pigs and people
    - *Erysipelothrix rhusiopathiae*
      - Epidermal infarcts
      - VVE
      - Synovitis





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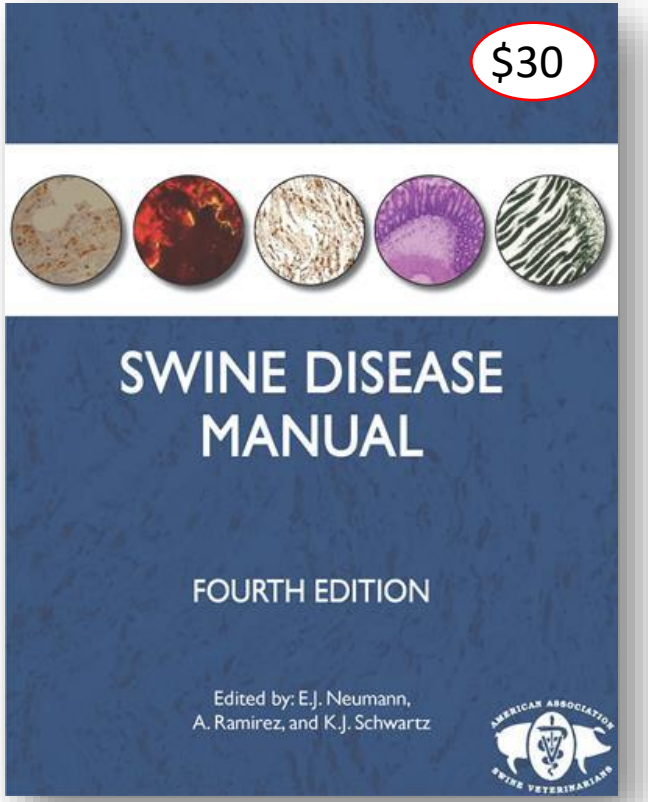
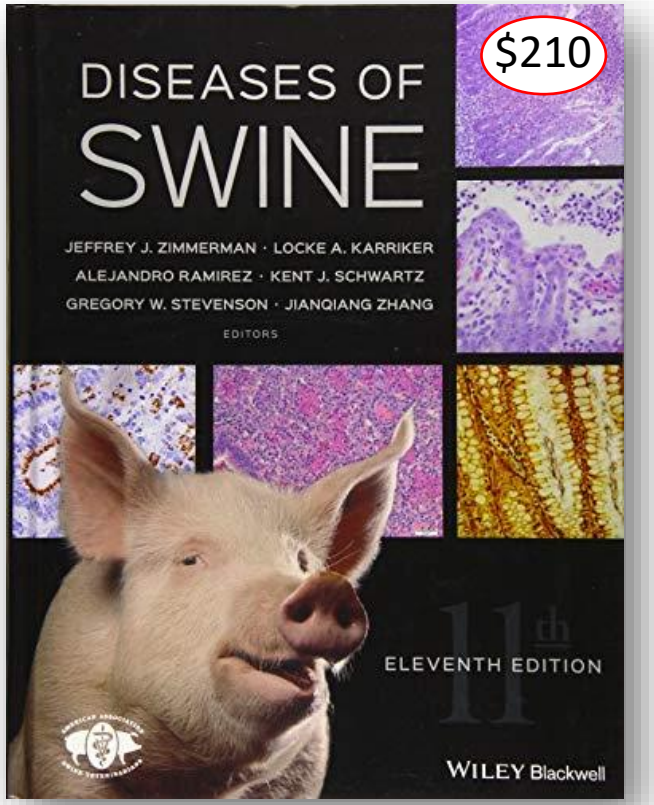
- Summary
  - Health challenges in commercial pigs often present a diagnostic dilemma
    - Many potential pathogens are endemic in populations and disease expression is variable
    - Subclinical disease is common and can impact interpretation of treatment responses
  - **Very few lesions are pathognomonic**
    - New agents/diseases/syndromes are being discovered every year in swine
      - *In large part due to the increasing availability of NGS + ISH*
      - PCV3, PAstV4, PHEV, etc. are examples **since 2012**
    - Direct detection assays are available at ISU VDL for most of the agents discussed
  - Consistent microscopic evaluation of a full set of tissues can help detect unexpected infectious diseases in swine but still need to focus on ***lesions***.
    - Brain, heart, lung, liver, lymph node, kidney, spleen, small intestine, and colon

Textbooks:





Web resources:

https://www.aasv.org/swine-information/ (member only)
https://vetmed.iastate.edu/vdpam/FSVD/swine/index-diseases/
https://www.swinehealth.org/fact-sheets/

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Questions?

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