Porcine Gastrointestinal Pathology and Laboratory Diagnosis of Disease

Eric R. Burrough, DVM, PhD, DACVP

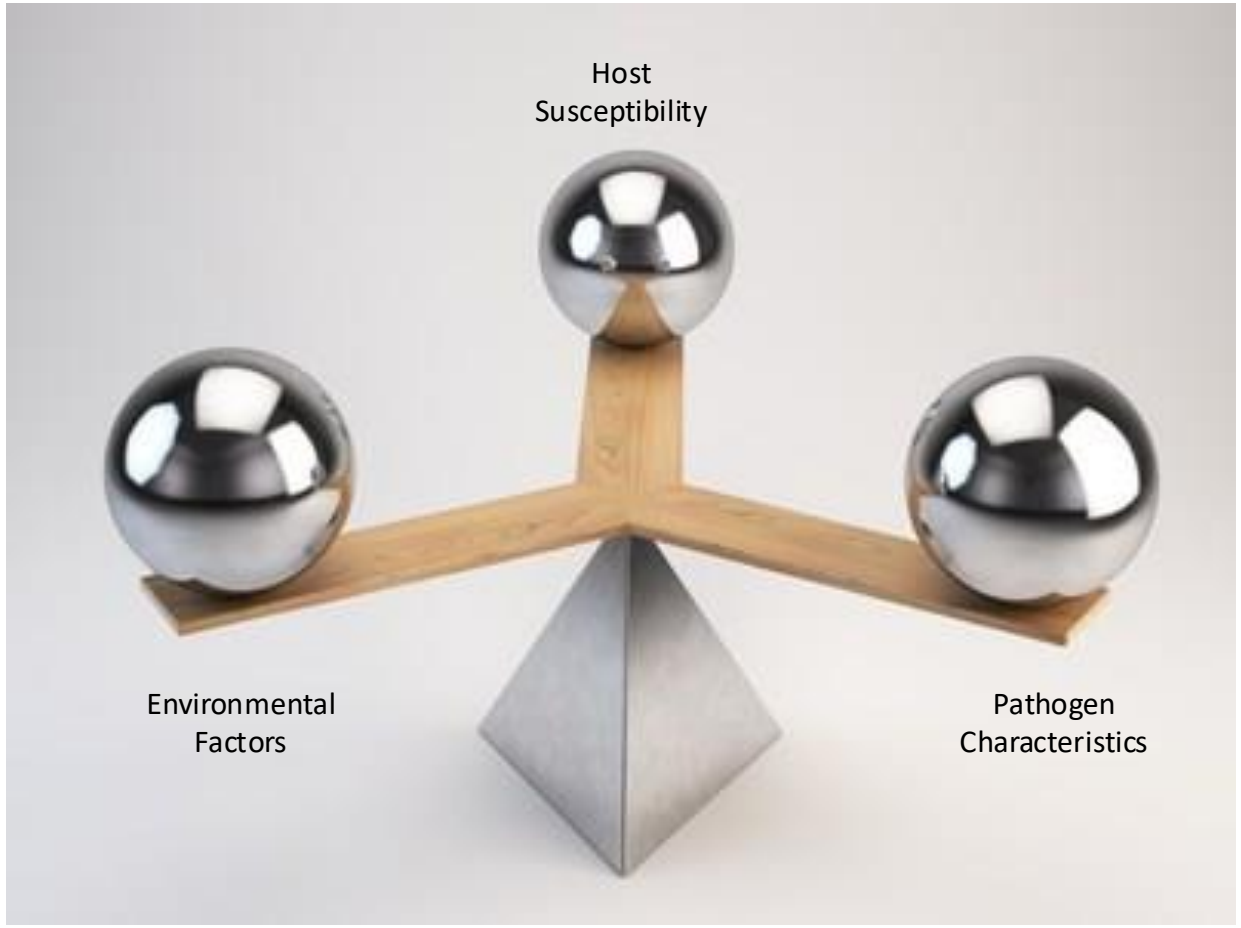
Professor, Diagnostic Pathologist, Pathology Section Leader

Iowa State University Veterinary Diagnostic Laboratory

- 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?*

Veterinary Diagnostic Laboratory

- Health challenges in commercial pigs can be a diagnostic dilemma:
  - Many common enteric pathogens are endemic on affected farms
    - **Detection may or may not = disease**



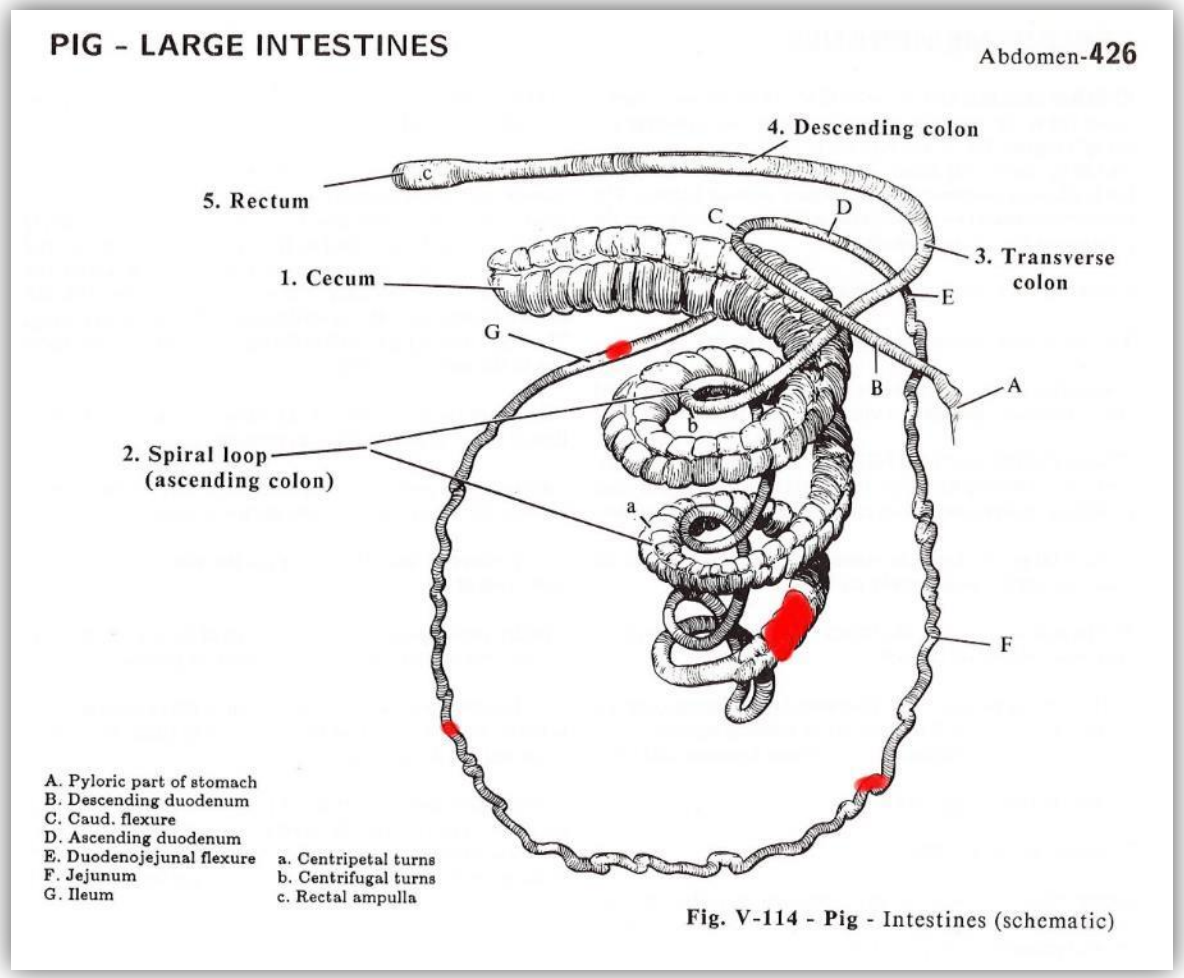
- Health challenges in commercial pigs can be a diagnostic dilemma:
  - Many common enteric pathogens are endemic on affected farms
    - **Detection may or may not = disease**
  - Available diagnostic tests may not differentiate pathogens / non-pathogens / vaccines
    - PCR, culture, ELISA, even IHC
    - 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)
  - *The key to diagnostic accuracy is the **right sample** from the **right animal** at the **right time***

- Health challenges in commercial pigs can be a diagnostic dilemma:
  - What is wrong with this diagnostic submission for enteric disease?

Veterinary Diagnostic Laboratory

- Health challenges in commercial pigs can be a diagnostic dilemma:
  - What is wrong with this diagnostic submission for enteric disease?
    - *Looks SOP driven:*
      - Sacrifice 3 pigs
      - Collect fresh and fixed samples of all major internal 'clean' organs
      - Collect fresh and fixed small and large intestine
        - *2 – 3 sections (approx. 1") of small intestine in formalin; the rest fresh*
        - *1 small random section of colon fixed; the rest fresh*
      - Put it all in a box and send to the diagnostic laboratory
    - All major systems were sampled; however, if the diagnostic question is causes of enteric disease, why not focus more on the intestines?
      - *Histopathology has high diagnostic specificity but relatively poor diagnostic sensitivity*
      - There are many feet of intestine and only 3 inches were fixed for evaluation
        - Enteric diseases are often multifocal or segmental in nature

- Health challenges in commercial pigs can be a diagnostic dilemma:
  - What is wrong with this diagnostic submission for enteric disease?



Pasquini and Spurgeon, *Anatomy of Domestic Animals*, 5th ed.

- Health challenges in commercial pigs can be a diagnostic dilemma:

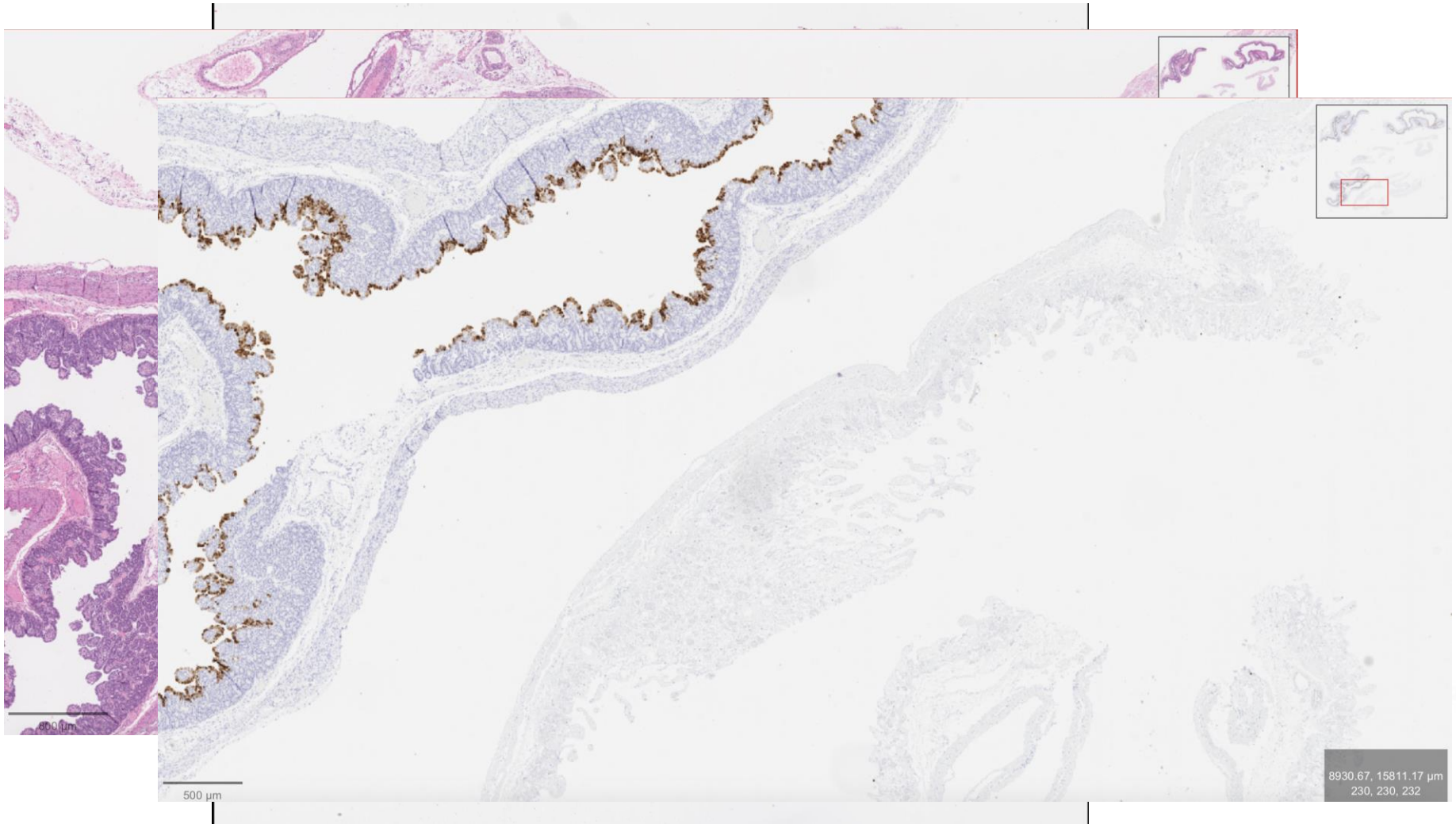
  - How can we improve this submission for enteric disease?
    - *Refine the SOP for enteric disease:*
      - *Sacrifice 2-3 pigs with active clinical disease consistent with the issue*
      - ~~*Collect fresh and fixed samples of all major internal 'clean' organs*~~
      - *Collect fresh and fixed samples of internal 'clean' organs that look abnormal*
      - *Collect fresh and fixed small and large intestine*
        - ***5 – 6 sections (approx. 1") of intestine in formalin, especially any that look abnormal; some fresh***
        - ***2 – 3 sections of colon fixed, especially abnormal regions; some fresh (can separate some content)***
      - *Put it all in a box and send to the VDL*

    - Different diseases affect different segments:
      - Whipworms are commonly observed in the cecum
      - Dysentery is most often found in the spiral colon (apex)
      - *Salmonella* lesions are more commonly observed in the centripetal spiral than SI
      - Enteric viruses commonly impact the aboral jejunum and ileum more then other segments
      - Coccidia are commonly observed in the ileum
      - *Lawsonia* lesions can occur from jejunum through the spiral colon

- Health challenges in commercial pigs can be a diagnostic dilemma:
  - What about autolyzed intestinal tissue?
    - PCR
      - Minimal to no impact on direct sample PCR
      - Would not be ideal for NGS or microbiome evaluation
    - Culture
      - In most cases is still okay,
      - Will have some overgrowth of some bacteria, may lose fastidious organisms
    - Histopathology
      - Can often still see villus length and assess villus:crypt ratio
      - Typically lose the mucosa:
        - No way to confirm ETEC or coccidia
        - IHC for viral agents may be falsely negative

Veterinary Diagnostic Laboratory

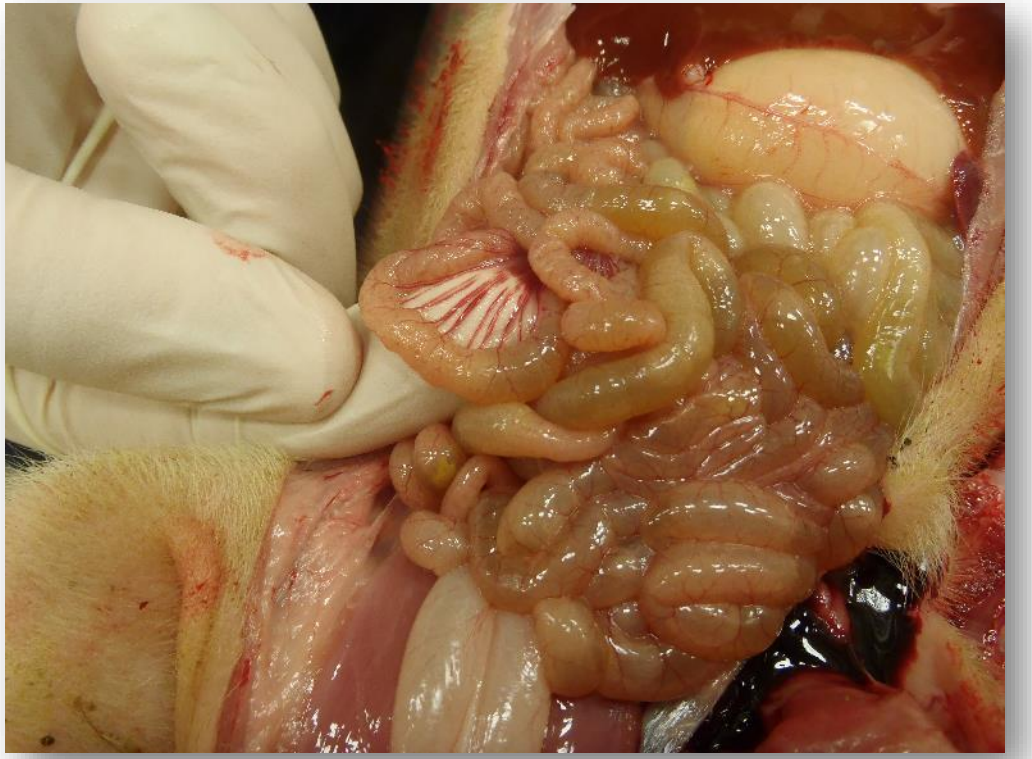
- Health challenges in commercial pigs can be a diagnostic dilemma:
  - What about autolyzed intestinal tissue?



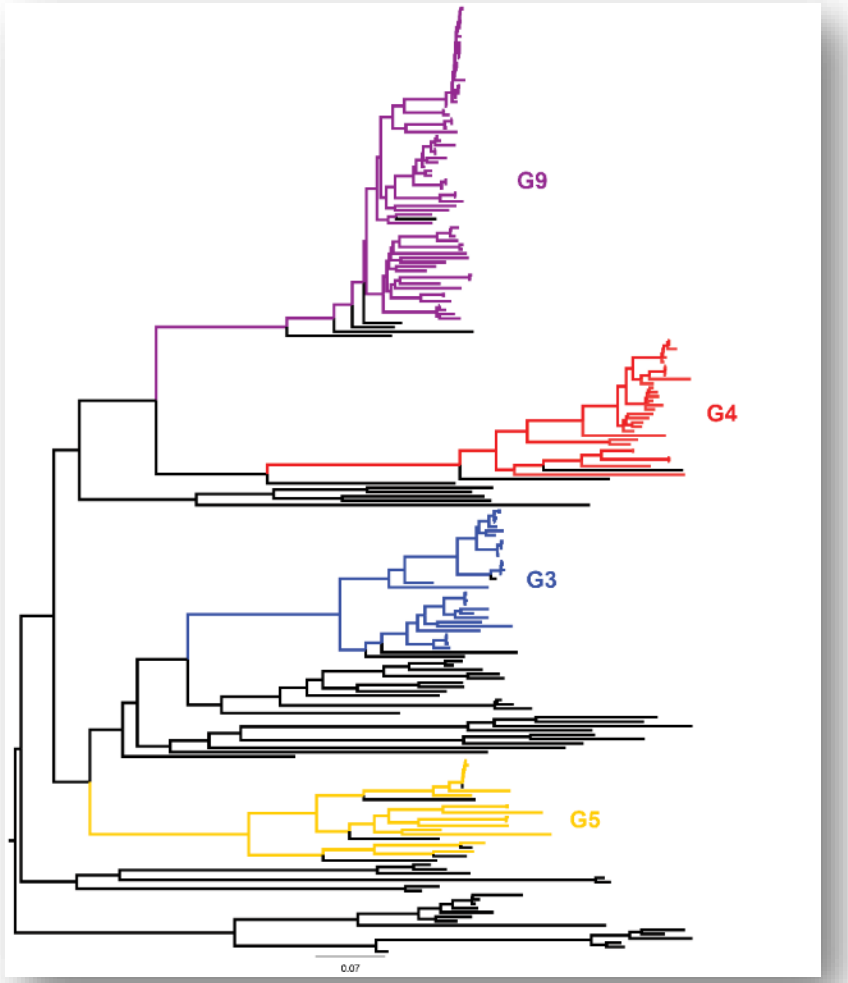
Veterinary Diagnostic Laboratory

Common endemic infectious diseases in US swine			
Etiologic agent	Age often affected	Clinical signs	Microscopic lesions
Enteric pathogens			
Coronaviruses	All ages	Acute watery diarrhea, can be severe in neonates	Segmental villus blunting and fusion that can be severe; epithelial necrosis; mild inflammation
Clostridium perfringens type C	Birth to 7 days	Hemorrhagic diarrhea; rapid death often of an entire litter	Mucosal necrosis, suppuration, hemorrhage, emphysema; gram-positive rods; diphtheritic membrane
Clostridioides difficile	Birth to 2 weeks	Creamy diarrhea; dehydration; usually mild but can be severe if poor immunity	Erosive typhlocolitis with multifocal "volcano" lesions, suppuration, mesocolonic edema
Rotavirus	Birth to 6 weeks	Creamy diarrhea; dehydration; usually mild; decreased growth rate	Segmental villus blunting; epithelial necrosis; mild inflammation
E. coli	Birth to 7 weeks	Acute diarrhea, watery, severe; dehydration; neonates (1-7 days) or post-weaning (3-7 weeks)	None; short bacterial rods attached to enterocytes; congestion
Coccidia	1 - 4 weeks	Creamy diarrhea; dehydration; usually mild; decreased growth rate	Villous atrophy, fibrinonecrotic enteritis, intracellular merozoites
Salmonella	After 3 weeks	Diarrhea, mild to severe, may see fibrin flecks; fever	Ulceration and suppuration; colon often more severely affected
Lawsonia	After 5 weeks	Diarrhea, intermittent or severe with blood, pallor, rapid death; decreased growth	Crypt enterocyte hyperplasia, branching crypts, loss of goblet cells; necrosis; curved rods within epithelial cells
Brachyspira spp.	After 5 weeks	Mucoid diarrhea, +/- blood (dysentery); dehydration; reduced gain; deaths	Erosion of epithelium; goblet-cell hyperplasia, mixed inflammatory infiltrates, fibrinous exudate

- Small Intestinal Diseases
  - Enteric viruses
    - Coronaviruses -> rotaviruses -> sapovirus
      - Many farms are endemically infected
      - Disease expression varies by immune status
        - Rotaviruses have a segmented genome and reassortment is common
        - Immunity not cross-protective among RVs or Cvs
      - Mixed infections are common
    - Gross lesions are all similar
      - Thin-walled small intestine
      - Watery contents
      - Reduced/absent chyle in lymphatics



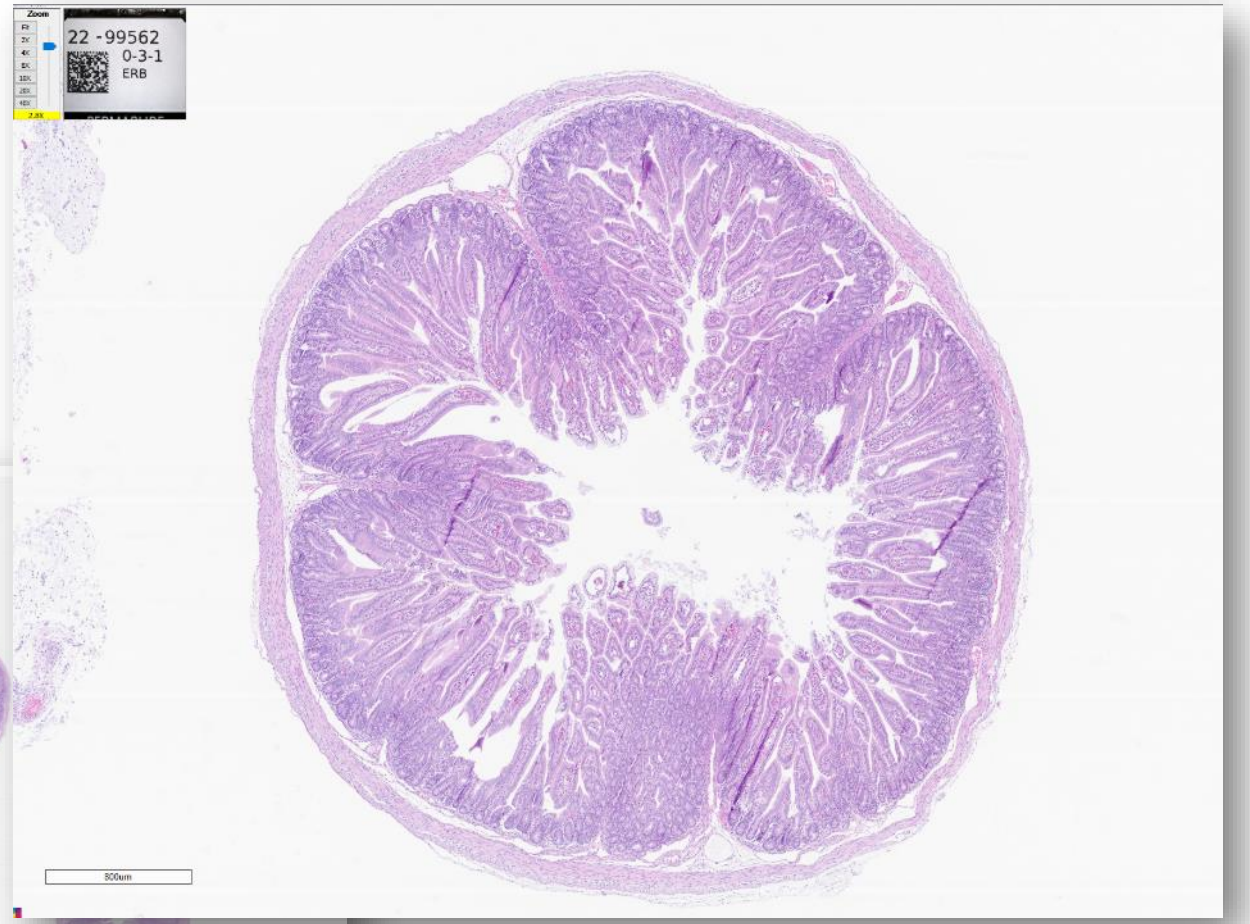
- Small Intestinal Diseases
  - Enteric viruses
    - Coronaviruses -> rotaviruses -> sapovirus
      - Diagnostics
        - Histopathology
          - Segmental disease, may need to look at multiple segments
        - PCR
          - Everything flows downstream
          - Cecal/colon content is best
        - Sequencing
          - Predict genotype/serotype
          - Match vaccines
          - Develop custom RNA vaccines
        - Direct detection (IHC, ISH)

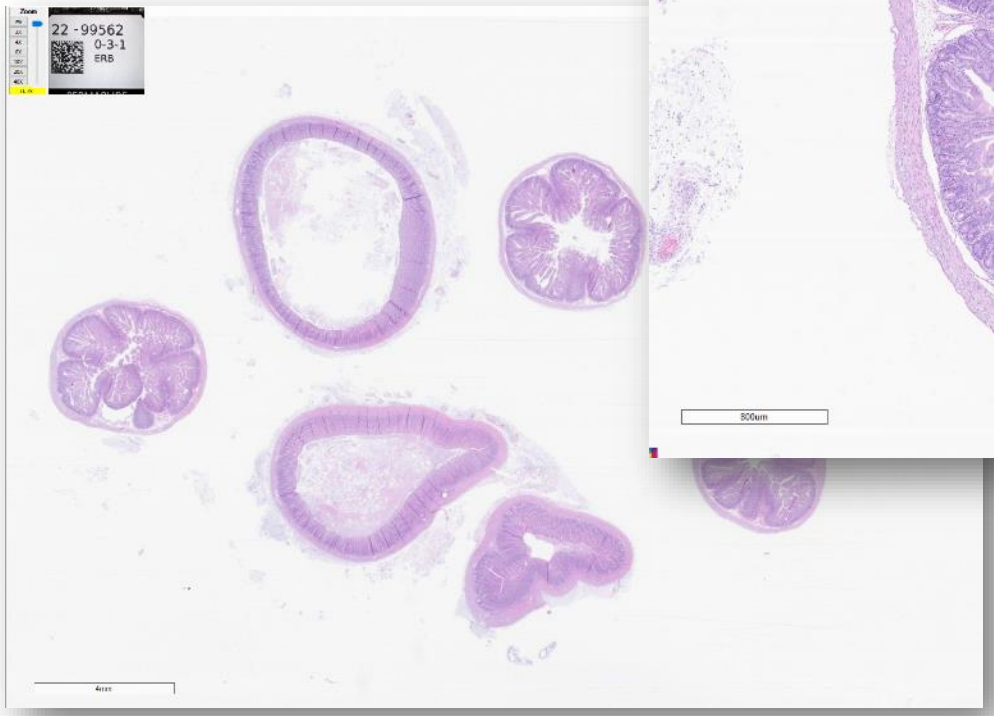


RVA VP7 Sequences at ISU VDL in 2020

Veterinary Diagnostic Laboratory

- Small Intestinal Diseases
  - Enteric viruses
    - CoVs -> rotaviruses -> sapovirus





Histology (acute):
- Vacuolation of villus tip enterocytes
- Possible syncytia

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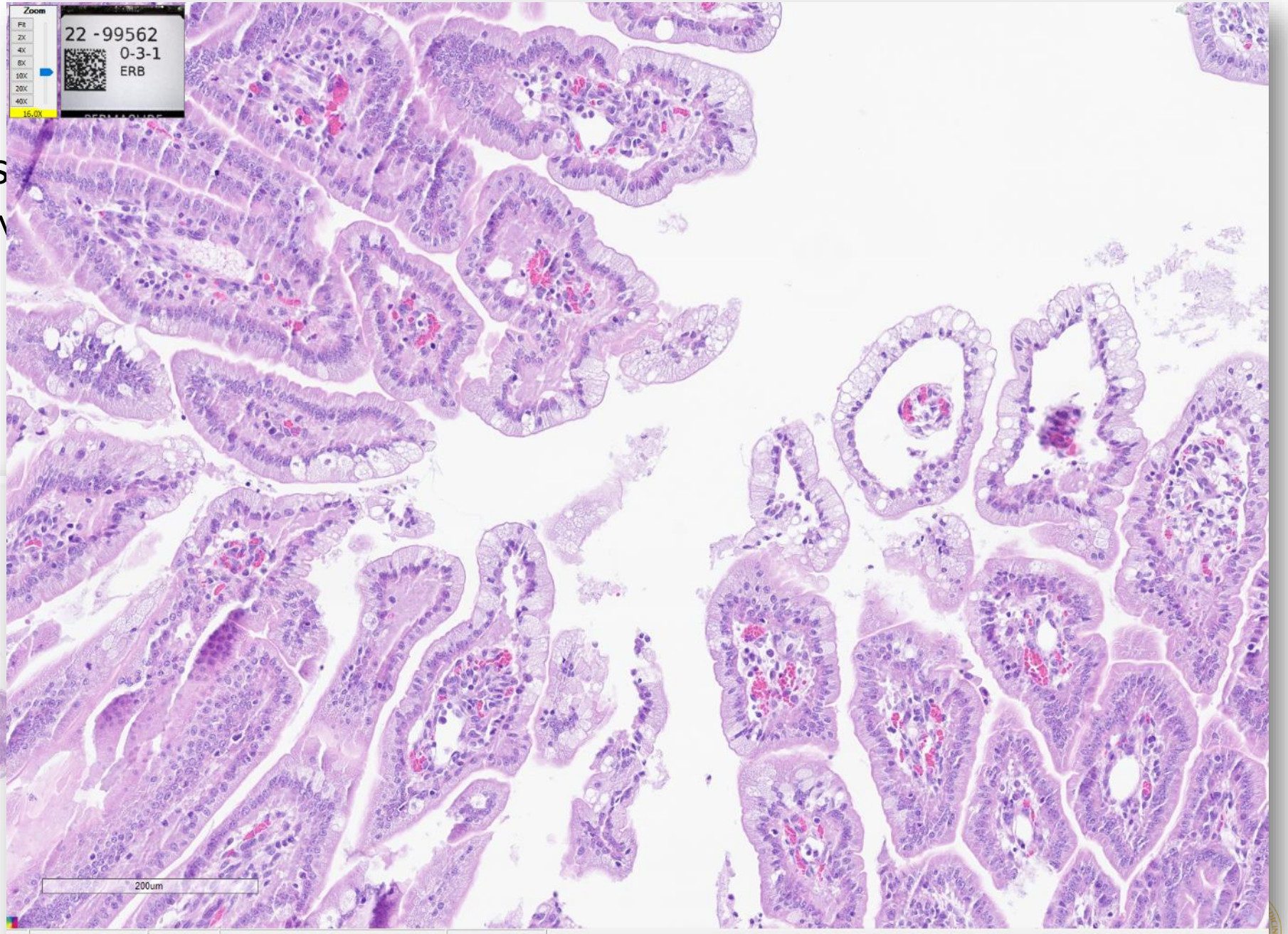
    - CoVs -> rotav



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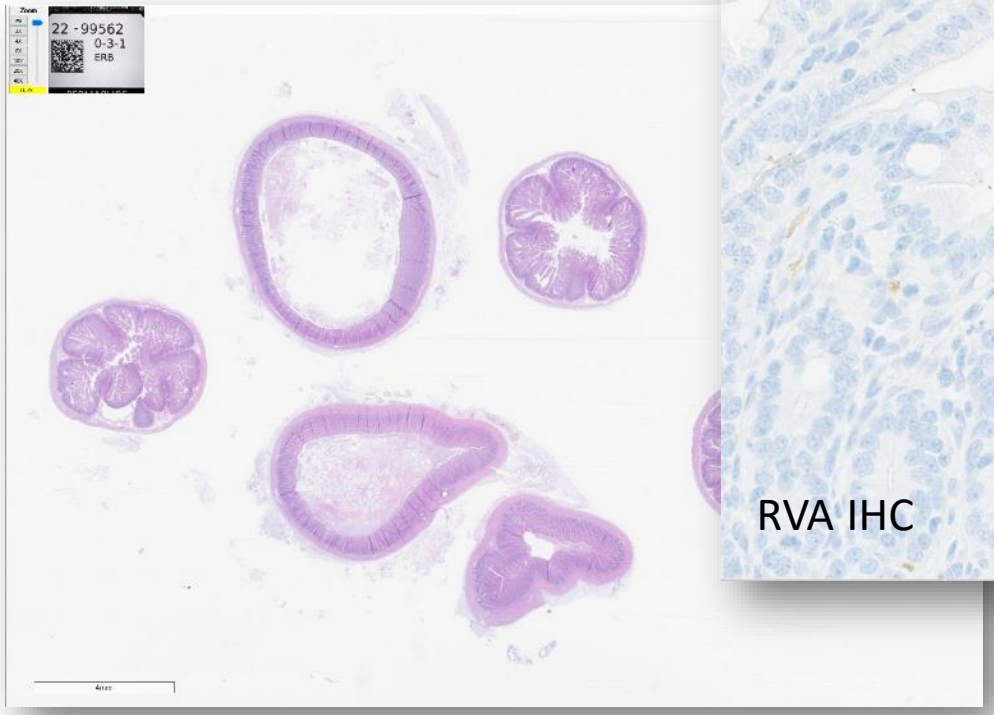

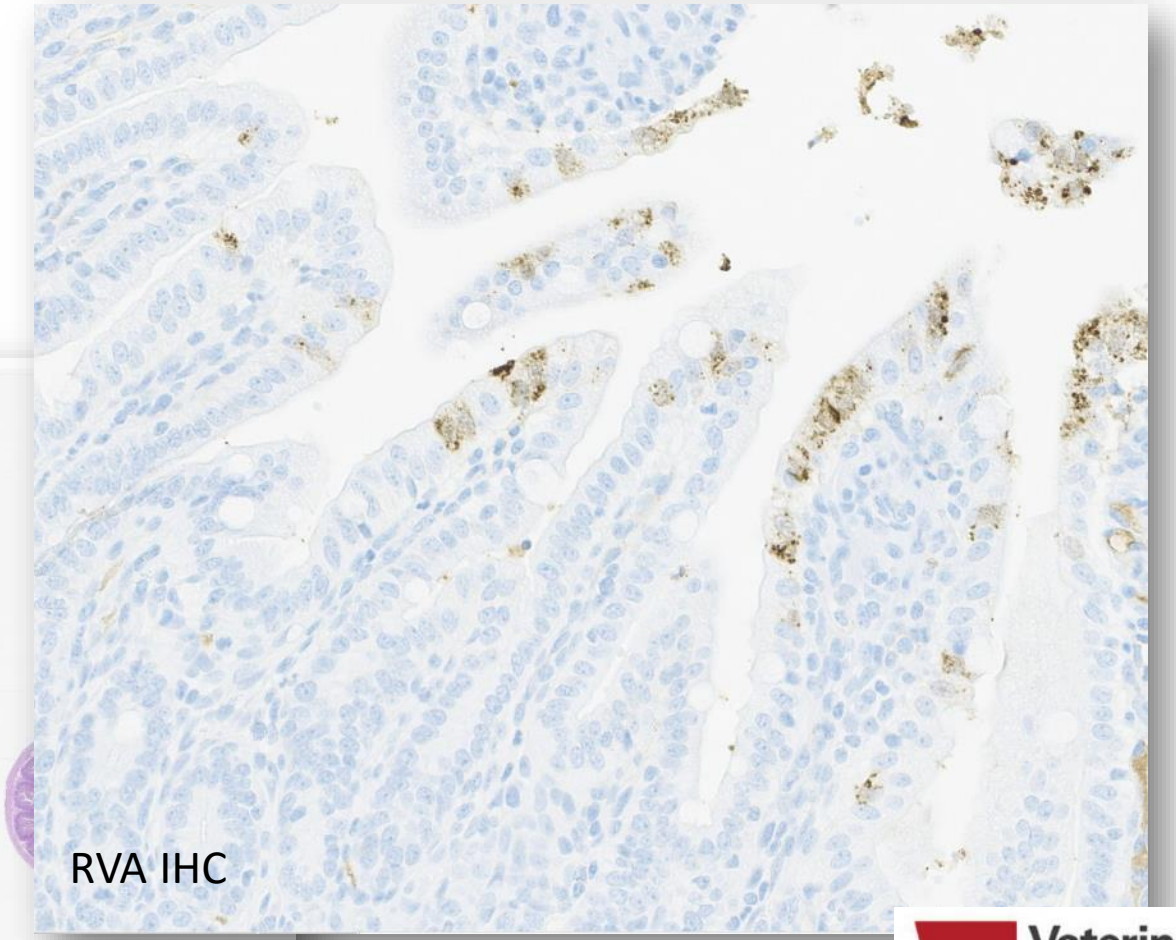

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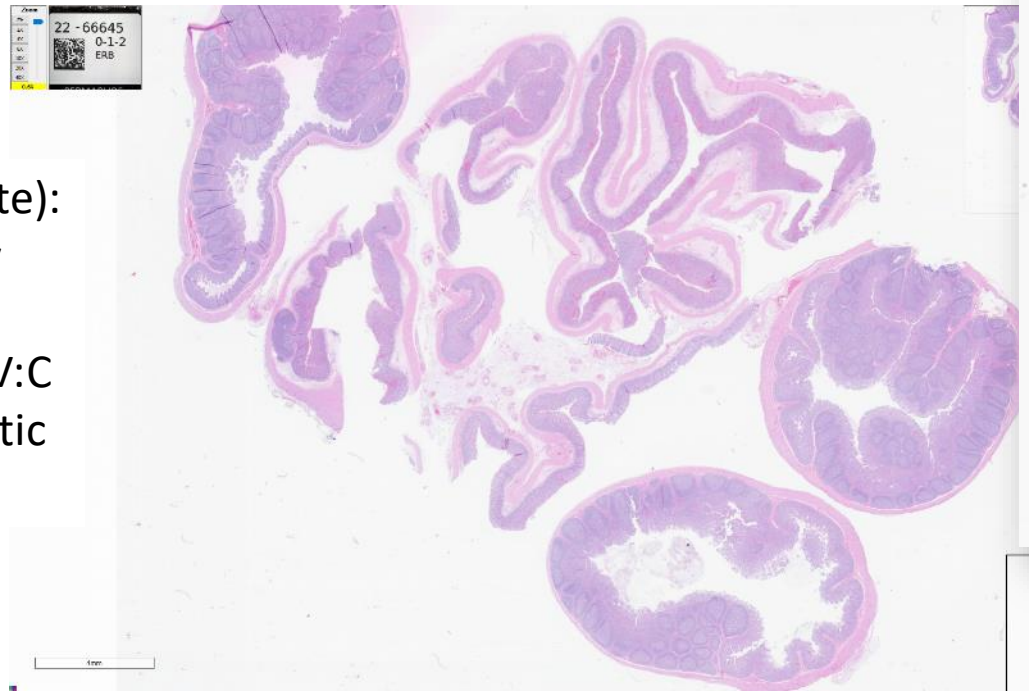

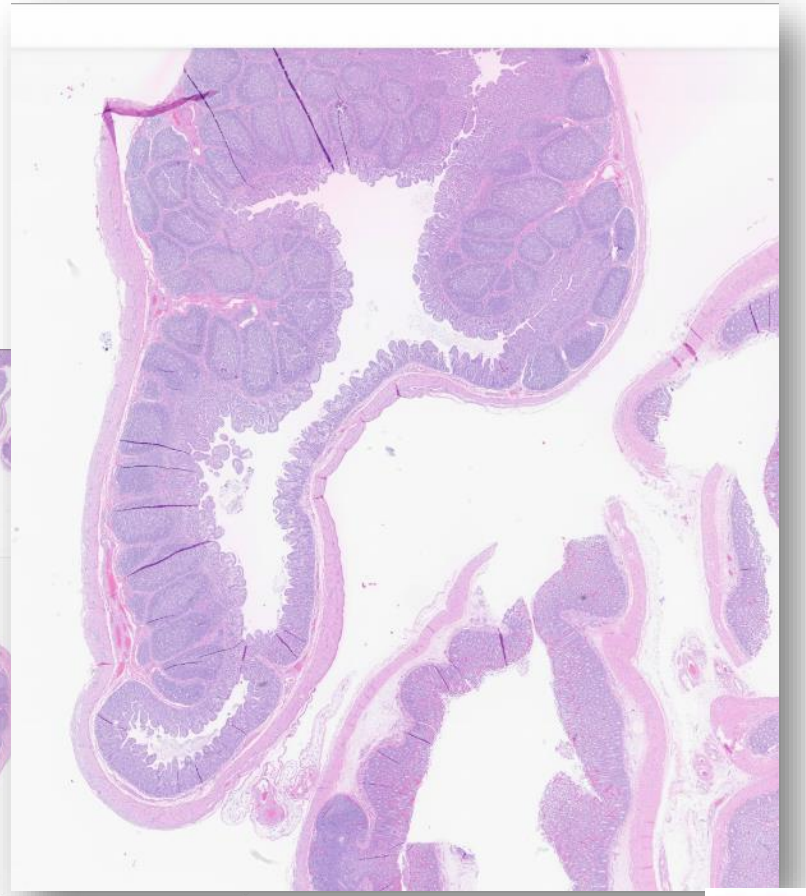

Histology (subacute):
- Villous atrophy and fusion
  - Reduced V:C
- Mild lymphocytic inflammation

Veterinary Diagnostic Laboratory

- Small Intestinal Diseases
  - Enteric viruses
    - Co

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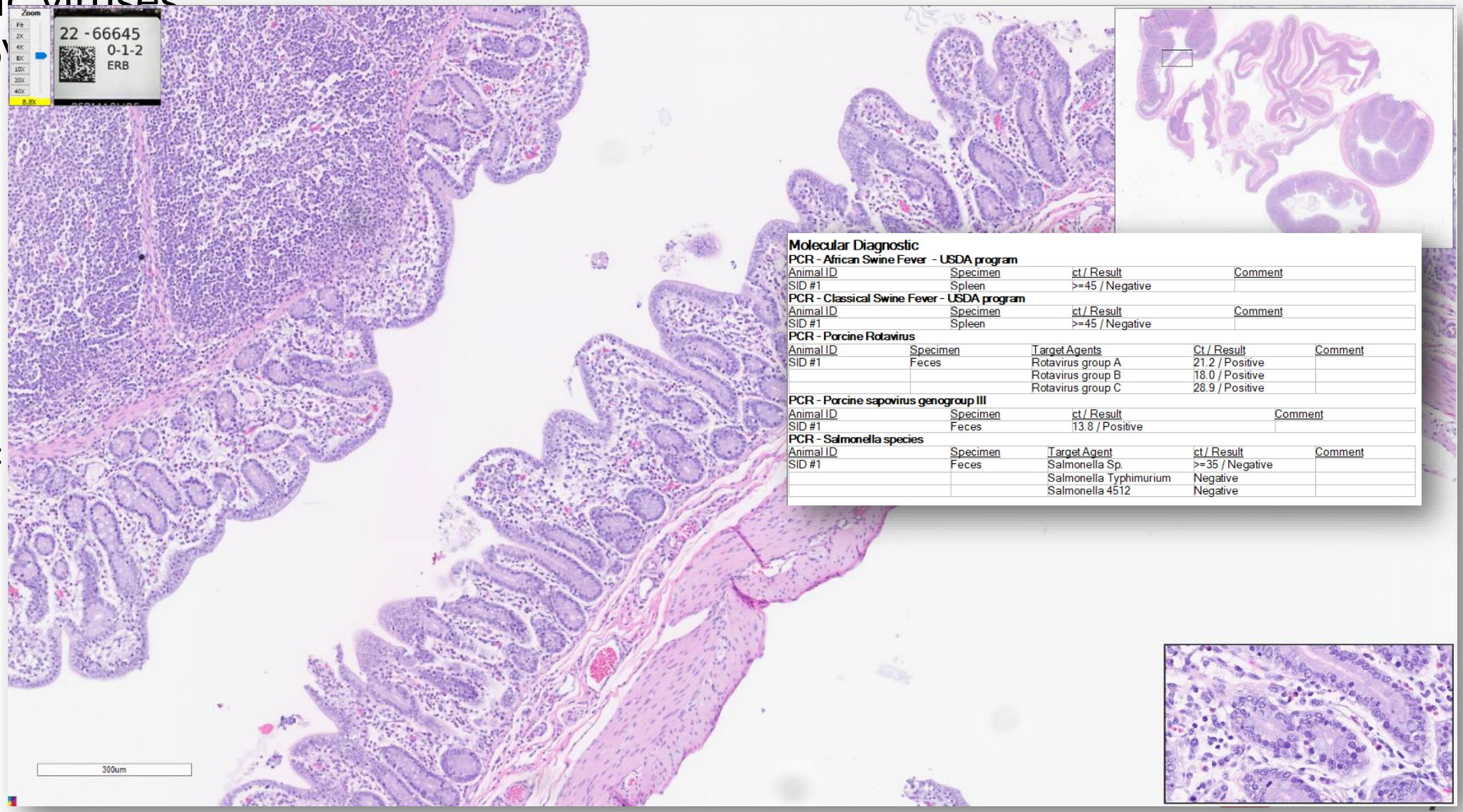

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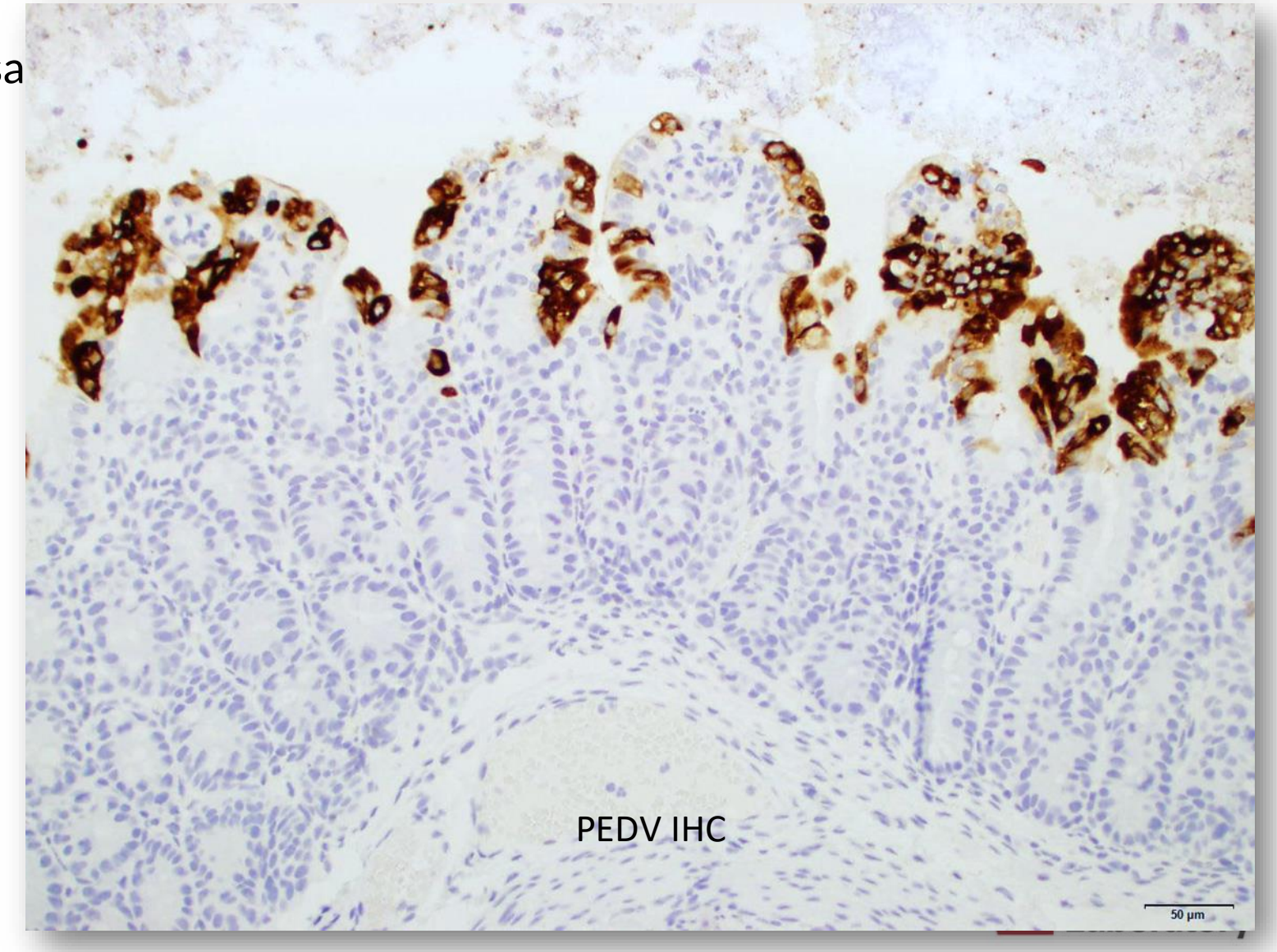


PEDV IHC

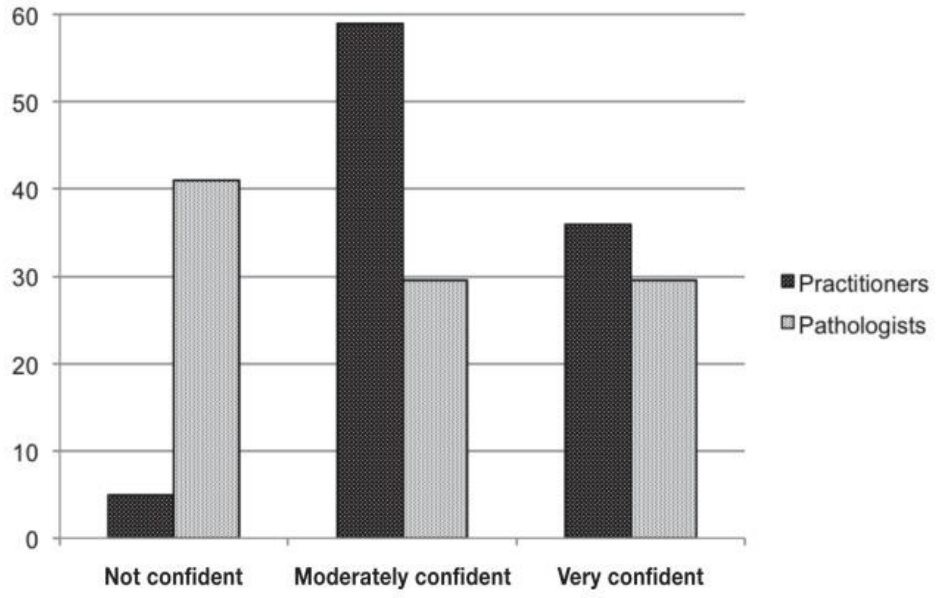
Histology (subacute):
- Villous atrophy and fusion
  - Reduced V:C
- Mild lymphocytic inflammation

- Small Intestinal Diseases
  - *Clostridium perfringens* Type A
    - Non-specific diarrhea in neonates
    - Low mortality
    - Disease is not consistently reproducible

    - Diagnostics
      - No defined diagnostic criteria
        - No consistent histologic lesions
        - Diagnosis by exclusion
      - Culture of limited use
        - Part of normal flora
        - Poor diagnostic specificity

- Small Intestinal Diseases
  - *Clostridium perfringens* Type A
    -

      How do swine practitioners and veterinary pathologists arrive at a diagnosis of *Clostridium perfringens* type A enteritis in neonatal piglets?

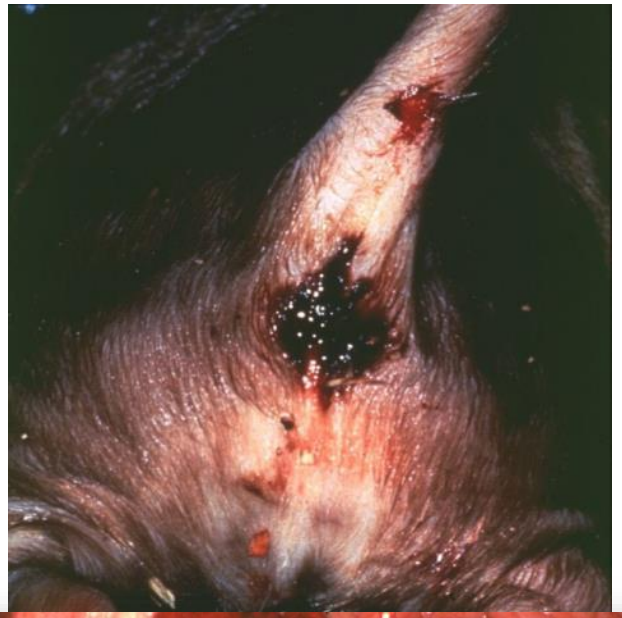


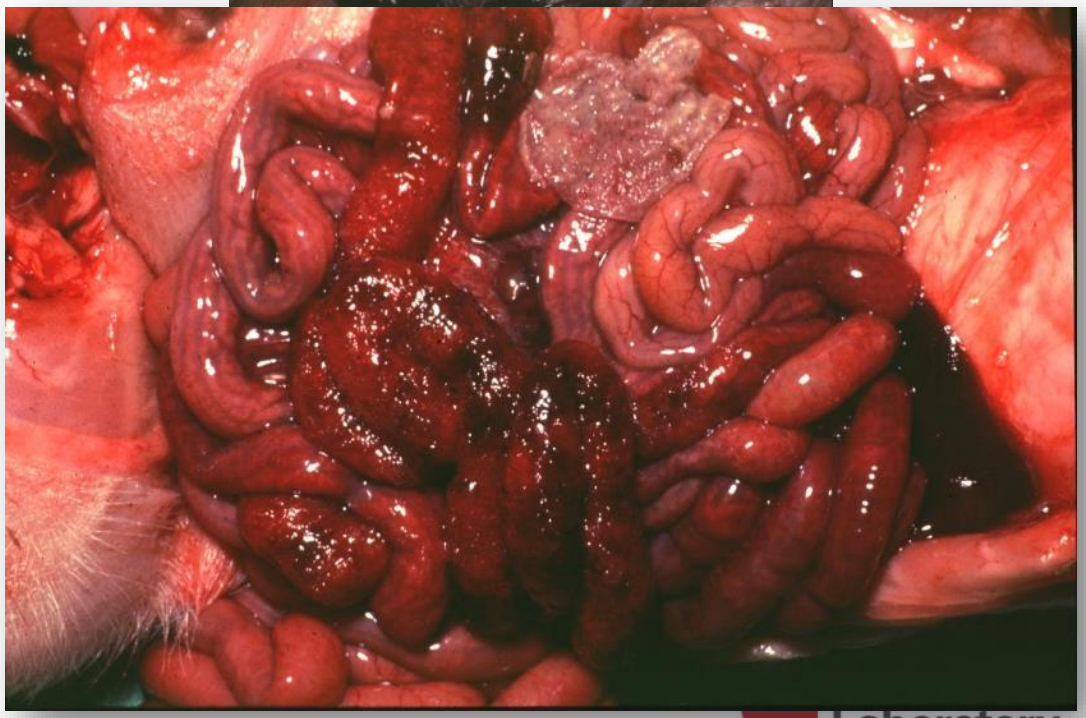
Chan G, Farzan A, Prescott J, Friendship R. 2013. Can Vet J 54(5):504-506

Over 90% of swine practitioners are moderately to very confident diagnosing *C. perfringens* type in A disease, while over 70% of veterinary pathologists are not confident to moderately confident making the same diagnosis!

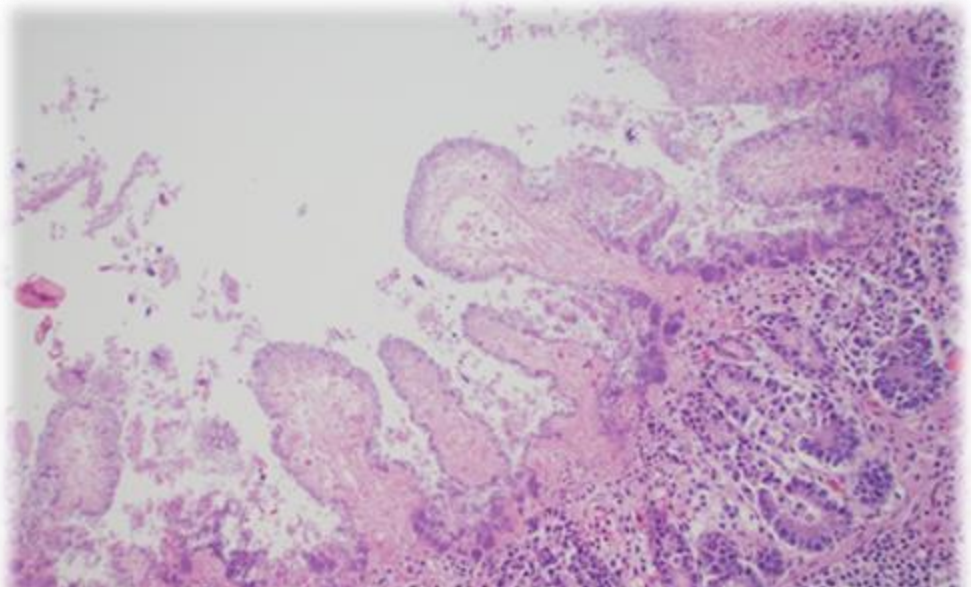
Veterinary Diagnostic Laboratory

- Small Intestinal Diseases
  - *Clostridium perfringens* Type C
    - Bloody diarrhea in neonates
      - 3 days of age is common
      - Disease due to beta toxin
        - trypsin-labile
    - High mortality with short course
    - Not all litters are affected
      - Death of entire litter may occur
    - Gross lesions:
      - Segmental hemorrhagic enteritis
      - May have emphysema
      - Perforation and peritonitis possible





- Small Intestinal Diseases
  - *Clostridium perfringens* Type C
    - Diagnostics:
      - Histopathology
        - Necrosis of luminal portion of villi
        - Lined by bacilli
      - ELISA for direct toxin detection
      - Routine Culture
        - Best if from intestine
      - Need genotyping of isolate



Bacteriology

Culture Summary

Animal ID	Specimen	Enrichment	Growth	Organism	Comment
o27649, SID #1	Colon		High	Smooth/mucoid Escherichia coli	
o27649, SID #1	Colon		High	Clostridium perfringens	
o27649, SID #1	Intestine		High	Smooth/mucoid Escherichia coli	
o27649, SID #1	Intestine		High	Clostridium perfringens	
o27649, SID #1	Lung			No Significant Growth	
o27649, SID #1	Spleen			No Significant Growth	
o36848, SID #2	Colon		High	Clostridium perfringens	
o36848, SID #2	Colon		Heavy	Smooth/mucoid Escherichia coli	
o36848, SID #2	Intestine		High	Clostridium perfringens	
o36848, SID #2	Lung		Few	Streptococcus suis serotype 5	
o36848, SID #2	Spleen			No Growth	

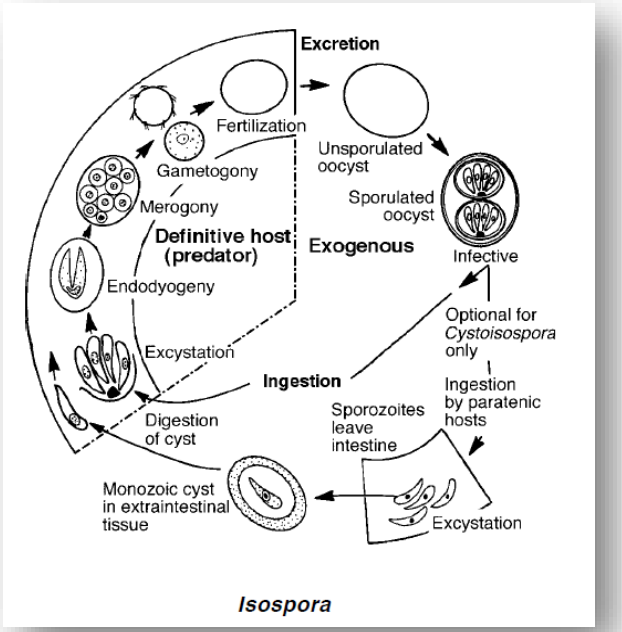
Molecular Diagnostic

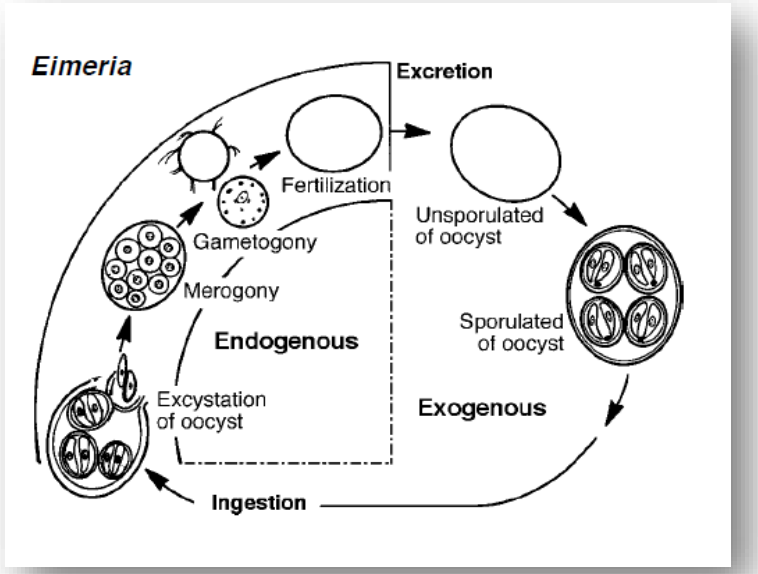
Clostridium perfringens Genotyping

Animal ID	Genotype	alpha	beta	epsilon	iota	enterotoxin	beta2
1, SID #1	C	Positive	Positive	Negative	Negative	Negative	Positive
Comment :							
2, SID #2	A	Positive	Negative	Negative	Negative	Negative	Positive
Comment :							

Diagnostic Laboratory

- Small Intestinal Diseases
  - Coccidia
    - *Cystoisospora suis* (also *Eimeria* spp.)
      - Most often observed in summer
      - Diarrhea in pre-weaned and recently weaned pigs
      - Inconsistent oocyst shedding
        - Fecal flotation often low yield





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      - Pathogenesis
        - Source may be the dam or environment
          - Sporulated oocysts ingested -> release sporozoites -> penetrate cells -> endogenous multiplication -> enterocyte destruction -> necrotic enteritis
        - Malabsorptive diarrhea (creamy to pasty) ensues
        - Affected animals often have lower body condition
        - Mortality rates may be low, but increase susceptibility to other enteric agents

      - Seasonality may be observed (warmer months)
        - *C. suis* oocysts sporulate within 24 hours in warm, moist environment
        - *Eimeria* take longer (~5 days)

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  - Coccidia
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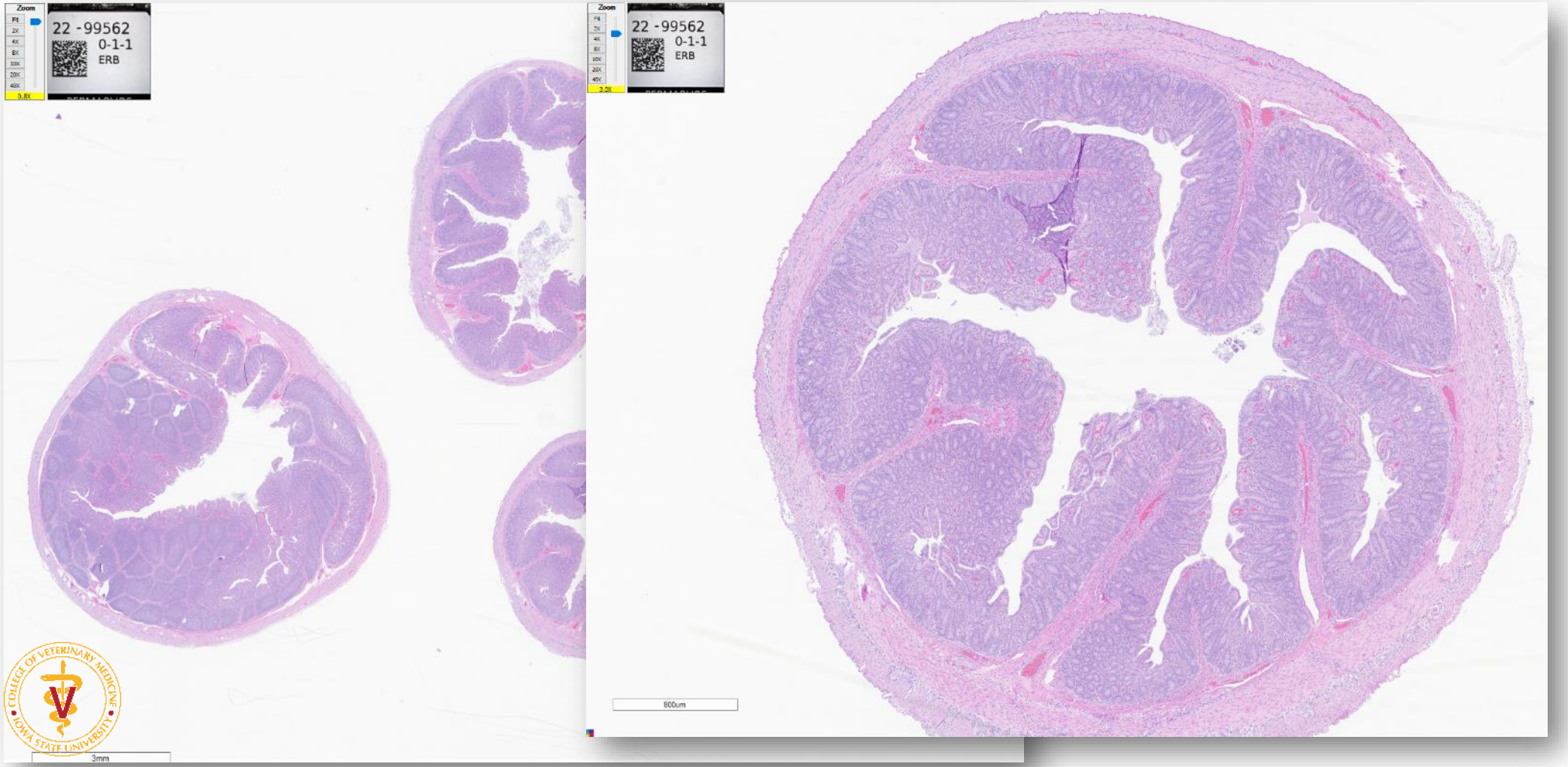
      - Most often observed in summer
      - Diarrhea in pre-weaned and recently weaned pigs
      - Inconsistent oocyst shedding
        - Fecal flotation often low yield
      - Fibrinonecrotic enteritis grossly in later stages (secondary)
      - Diagnostics
        - Microscopic lesions of villous atrophy +/- exudate
          - **Intraepithelial coccidia**
            - Merogony more common with *Cystoisospora*
            - Gametogony more common with *Eimeria*
        - Fecal flotation of limited sensitivity
        - PCR available, limited specificity

Veterinary Diagnostic Laboratory

- Small Intestinal Diseases
  - Coccidia
    - *Cystoisospora suis*



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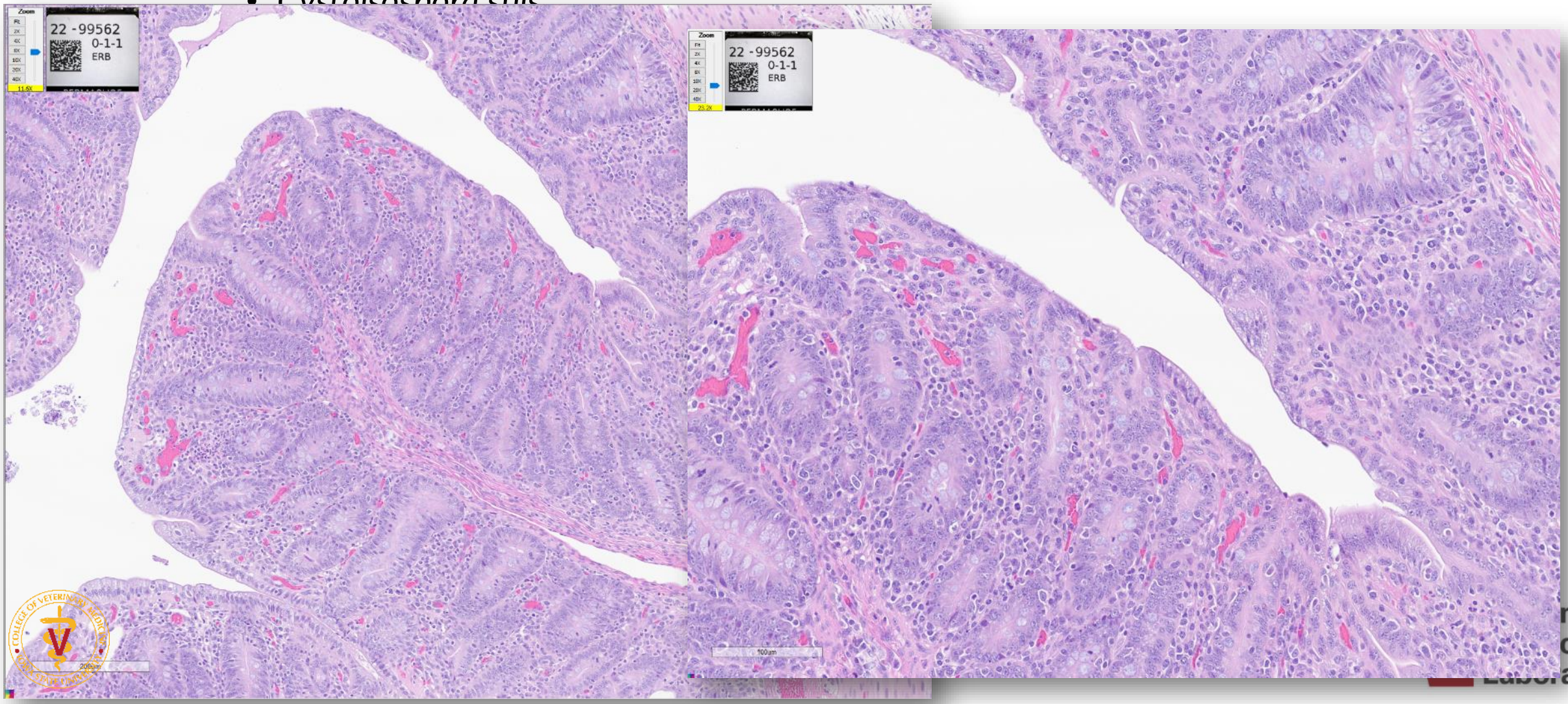
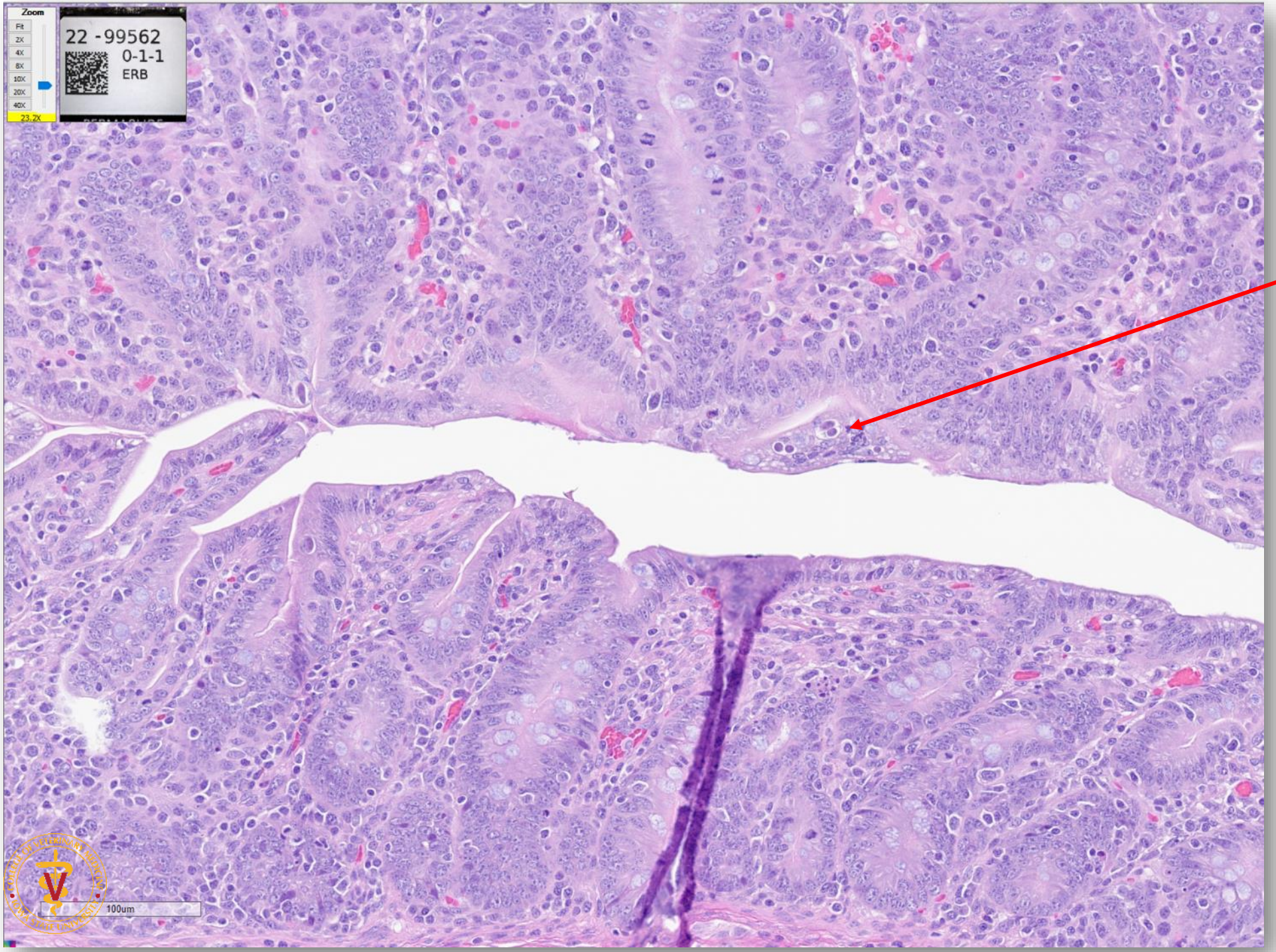
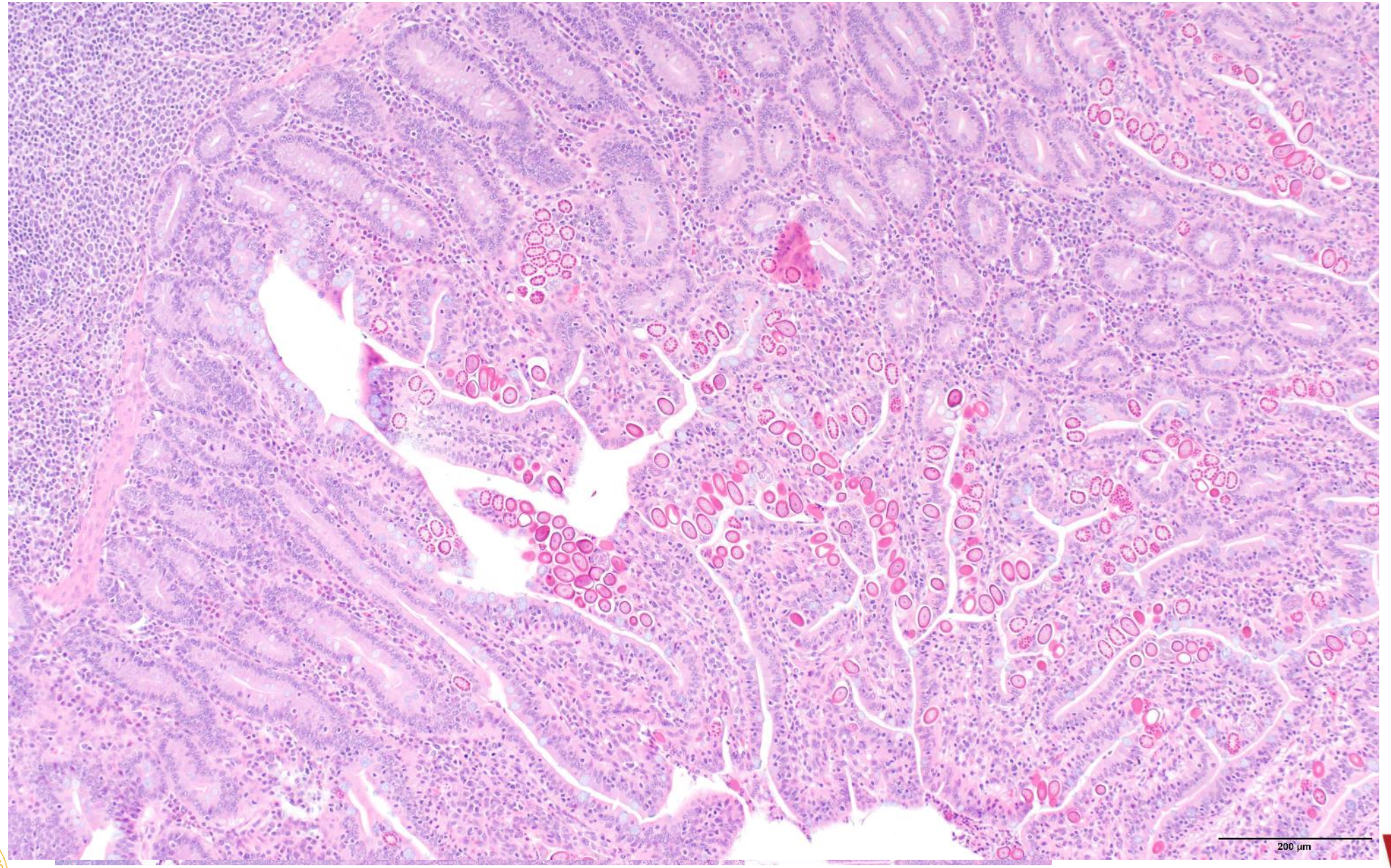


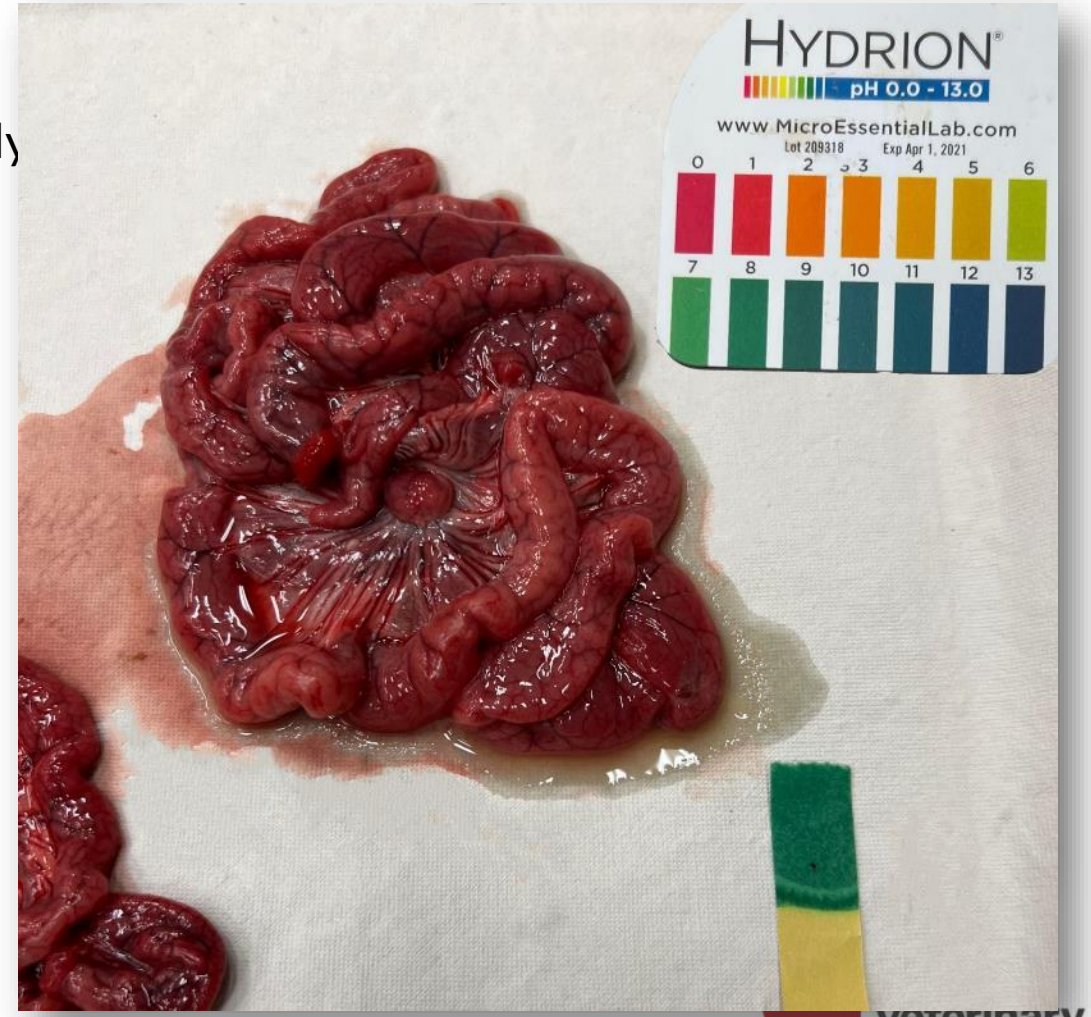


Intraepithelial meronts containing paired type I merozoites typical of *Cystoisospora suis*

Veterinary Diagnostic Laboratory



- Small Intestinal Diseases
  - Colibacillosis
    - Hemolytic *E. coli*
      - Disease is commonly observed immediately post-weaning
        - Watery diarrhea, dehydration
        - Some unexpected death
      - Gross lesions are very characteristic
      - This is a secretory diarrhea
        - pH is alkaline (≥8.0)
      - Some ETEC strains harbor Stx2e gene
        - May manifest in edema disease



Veterinary Diagnostic Laboratory

- Small Intestinal Diseases
  - Colibacillosis
    - Diagnostics:
      - Routine culture:
        - **In pigs, not all hemolytic *E. coli* are pathogens, but most pathogenic *E. coli* are hemolytic**
          - Suckling piglets may be affected by:
            - K88 (F4) - hemolytic
            - K99 (F5), F41, 987P - non-hemolytic
          - Weaned pigs are affected by:
            - K88 and F18 - both hemolytic
        - Hemolysis is a phenotypic trait
          - Colonies can be rough, intermediate, smooth, smooth/mucoid, or mucoid types
        - Genotyping
          - Performed on isolated colonies (can also be done of scrolls from FFPE tissues)
          - Must possess both fimbria and enterotoxin genes to be ETEC
        - Serotyping is not commonly performed in swine diagnostics (e.g. O157:H7 STEC)
          - Some research papers discuss serovirotype

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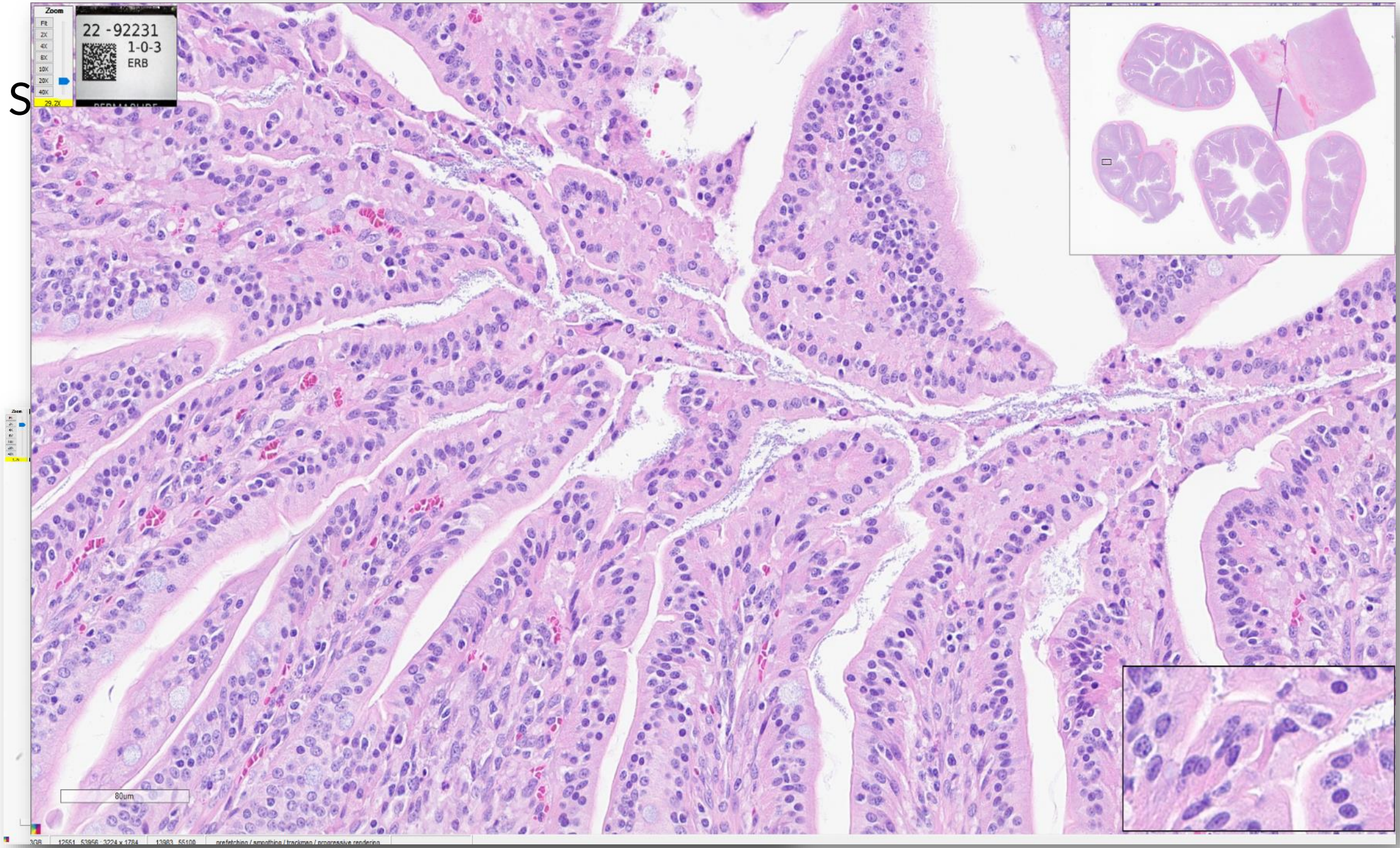

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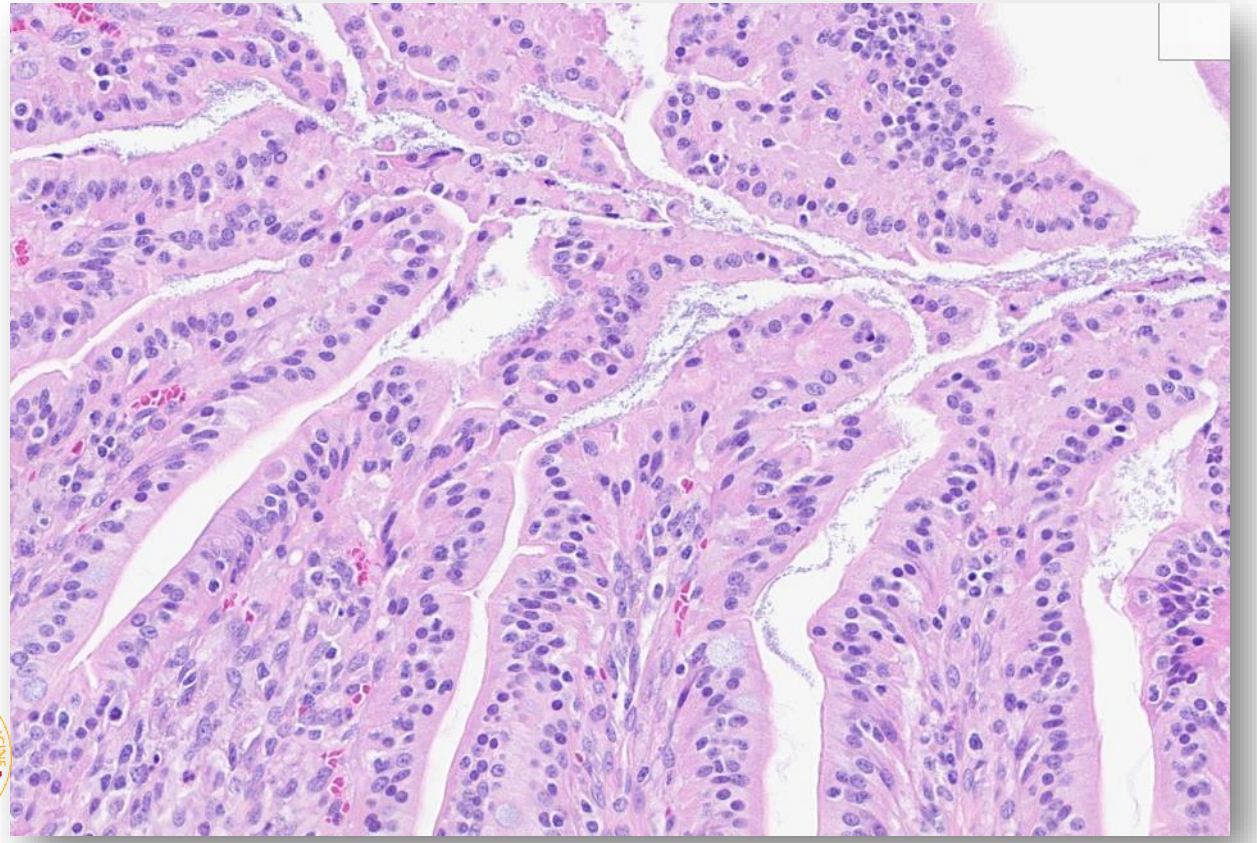

Bacteriology

Culture Summary

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GA [1-3]	Colon		Single	Salmonella species group B	
GA [1-3]	Intestine		Heavy	Escherichia coli - hemolytic (smooth/mucoid)	

Food Animal Susceptibility

GA [1-3]	Final Result	S.SB --> Salmonella species group B	
GA [1-3]	Final Result	E.COLH --> Escherichia coli haemolytic	

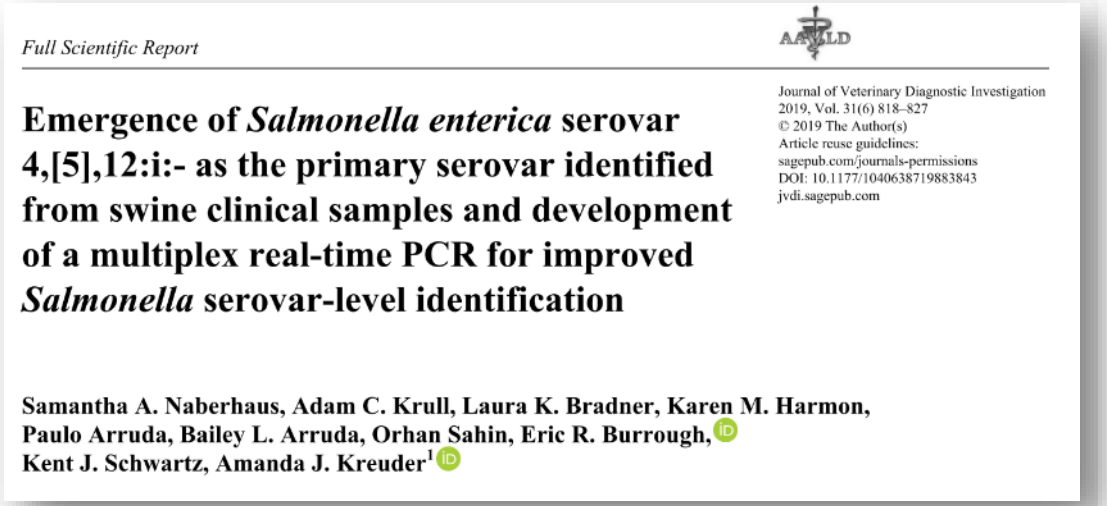
Antimicrobial	S.SB	E.COLH	
	*Int/MIC	*Int/MIC	
Ampicillin	**R** / >16.0000	**R** / >16.0000	
Ceftiofur	**S** / 1.0000	**S** / 0.5000	
Clindamycin	**NI** / >16.0000	**R** / >16.0000	
Danofloxacin	**NI** / <=0.1200	**NI** / >1.0000	
Enrofloxacin	**S** / <=0.1200	**R** / >2.0000	
Florfenicol	**I** / 4.0000	**R** / >8.0000	
Gamithromycin	**NI** / 8.0000	**NI** / 4.0000	
Gentamicin	**S** / <=1.0000	**I** / 8.0000	
Neomycin	**S** / <=4.0000	**R** / 16.0000	
Penicillin	**R** / >8.0000	**R** / >8.0000	
Sulfadimethoxine	**R** / >256.0000	**R** / >256.0000	
Spectinomycin	**S** / 32.0000	**R** / >64.0000	
Tetracycline	**R** / >8.0000	**R** / >8.0000	
Tiamulin	**R** / >32.0000	**R** / >32.0000	
Tildipirosin	**NI** / 8.0000	**NI** / 4.0000	
Tilmicosin	**R** / >16.0000	**R** / >16.0000	
Trimethoprim/Sulphamethoxazole	**S** / <=2.0000	**R** / >2.0000	
Tulathromycin	**NI** / <=8.0000	**NI** / <=8.0000	
Tylosin (Tartrate/Base)	**NI** / >32.0000	**NI** / >32.0000	
Positive Growth Control	**OK** / 3610.3333	**OK** / 3512.6667	

Molecular Diagnostic

E. coli Genotyping

Animal ID	Gene	Result
GA [1-3]	EAST1 (toxin)	Positive
	LT(toxin)	Positive
	STa(toxin)	Positive
	STb(toxin)	Positive
	Stx1 (toxin)	Negative
	Stx2 (toxin)	Positive
	Stx2e(toxin)	Positive
	F18(pilus)	Positive
	F41(pilus)	Negative
	K88(pilus)	Negative
	K99(pilus)	Negative
	987P(pilus)	Negative
	AIDA (adhesin)	Negative
	EAEA (adhesin)	Negative
	PAA (adhesin)	Negative
	Organism	Escherichia coli haemolytic

- Panintestinal Diseases
  - Salmonellosis
    - Serovars 4,[5],12:i:-, Typhimurium, Choleraesuis are known enteropathogens
    - All serovars are potential opportunists → commonly follow viral enteritis



Full Scientific Report

Emergence of *Salmonella enterica* serovar 4,[5],12:i:- as the primary serovar identified from swine clinical samples and development of a multiplex real-time PCR for improved *Salmonella* serovar-level identification

Journal of Veterinary Diagnostic Investigation
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Samantha A. Naberhaus, Adam C. Krull, Laura K. Bradner, Karen M. Harmon, Paulo Arruda, Bailey L. Arruda, Orhan Sahin, Eric R. Burrough, Kent J. Schwartz, Amanda J. Kreuder[1]

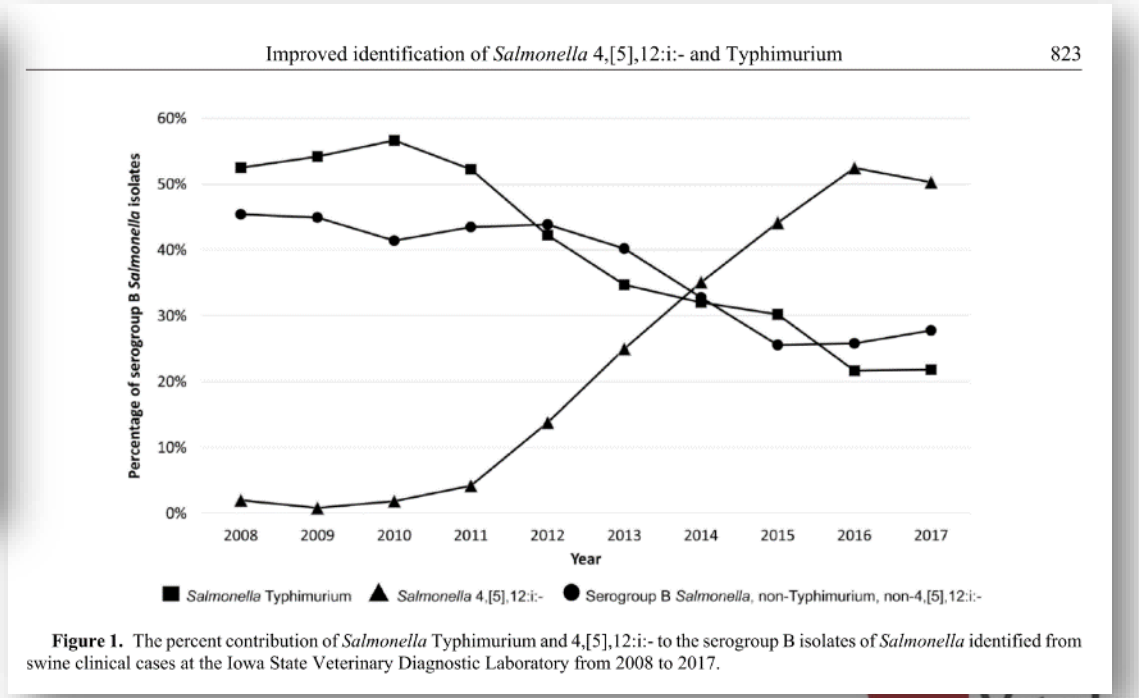
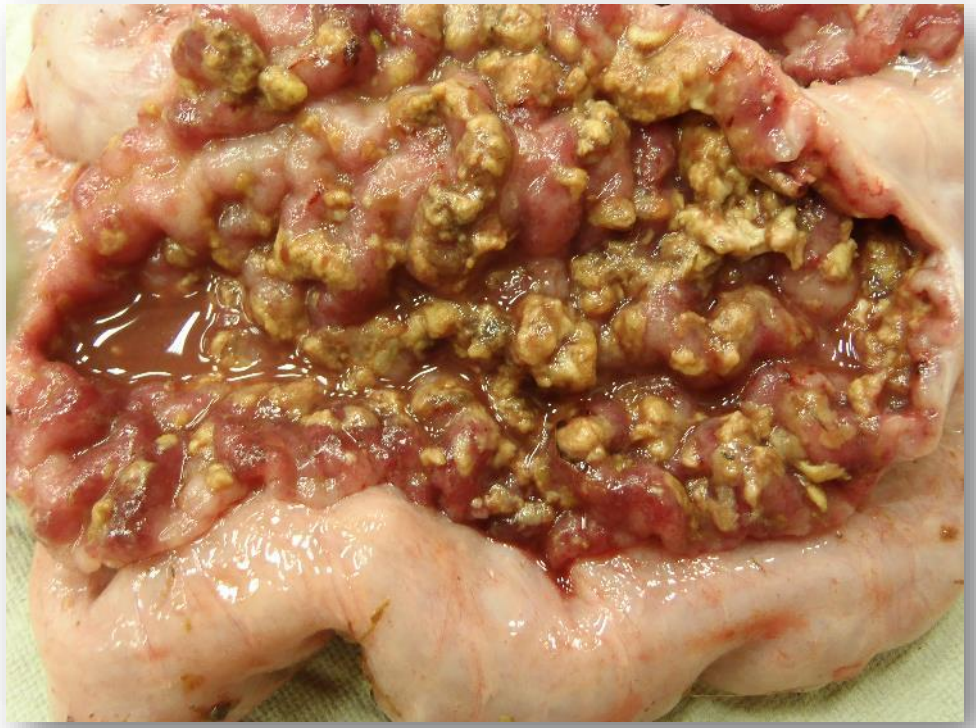


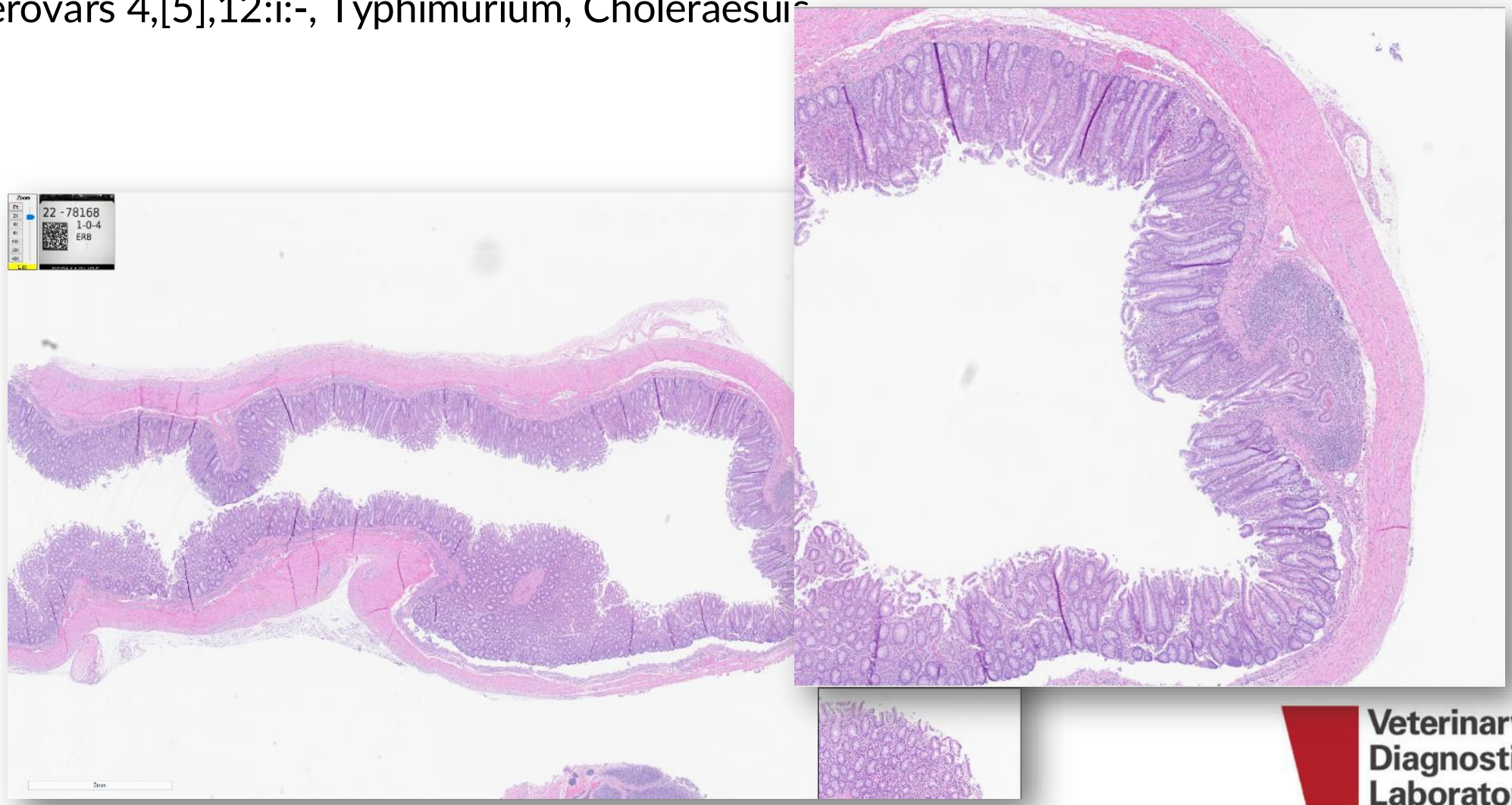
Figure 1. The percent contribution of *Salmonella* Typhimurium and 4,[5],12:i:- to the serogroup B isolates of *Salmonella* identified from swine clinical cases at the Iowa State Veterinary Diagnostic Laboratory from 2008 to 2017.

Veterinary Diagnostic Laboratory

- Panintestinal Diseases
  - Salmonellosis
    - Serovars 4,[5],12:i:-, Typhimurium, Choleraesuis
    - Gross lesions are multifocal to diffuse ulcerative enterocolitis
      - Often pseudomembrane formation and enlarged mesenteric lymph nodes
    - Diagnostics
      - Histopathology
      - Routine culture +/- enrichment
        - Followed by serotyping
      - PCR



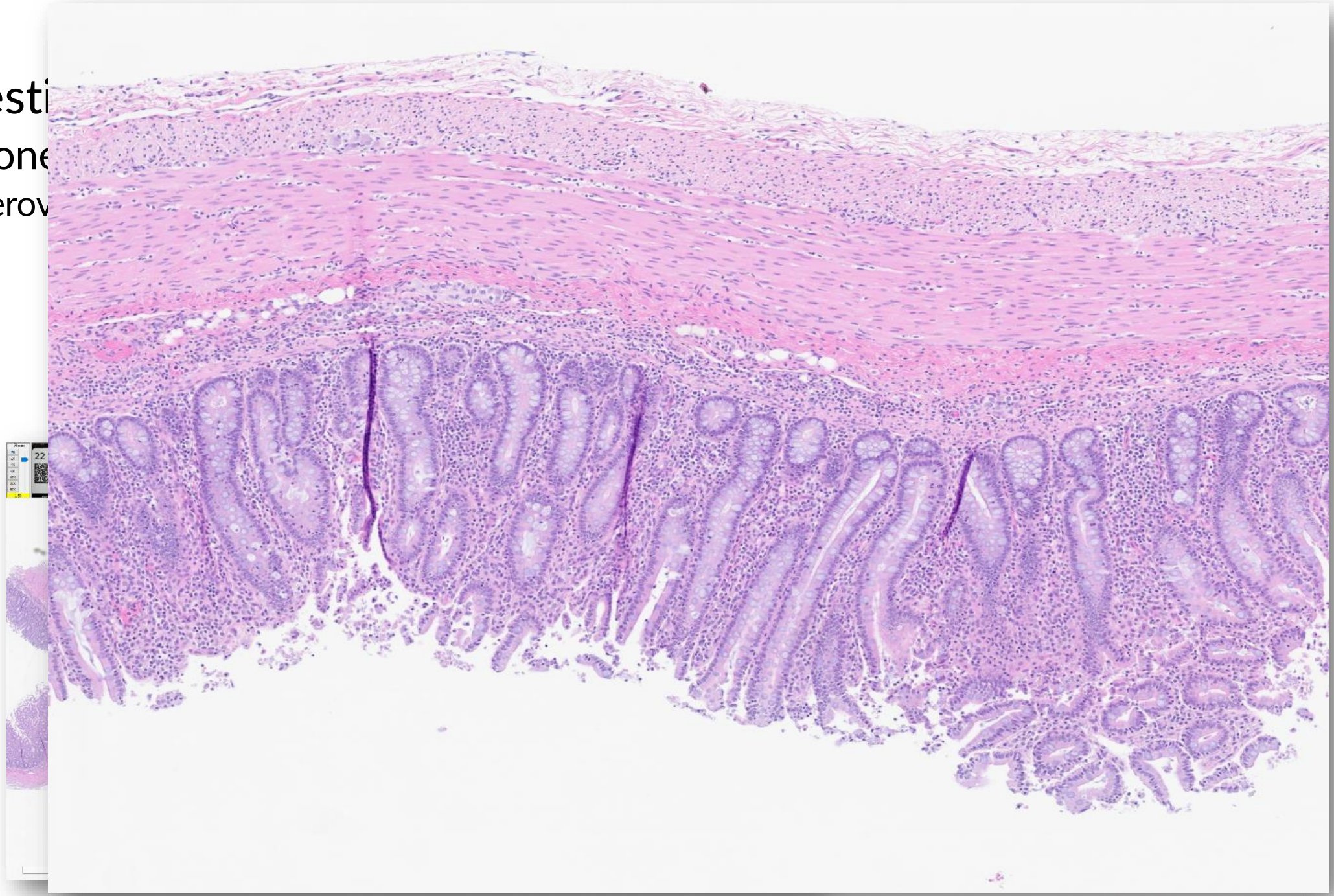
- Panintestinal Diseases
  - Salmonellosis
    - Serovars 4,[5],12:i:-, Typhimurium, Choleraesuis



Histology (early):
- Shallow erosions
- Scant proprial inflammation
- Neutrophils in crypts

Veterinary Diagnostic Laboratory

- Panintesti
  - Salmone
    - Serov



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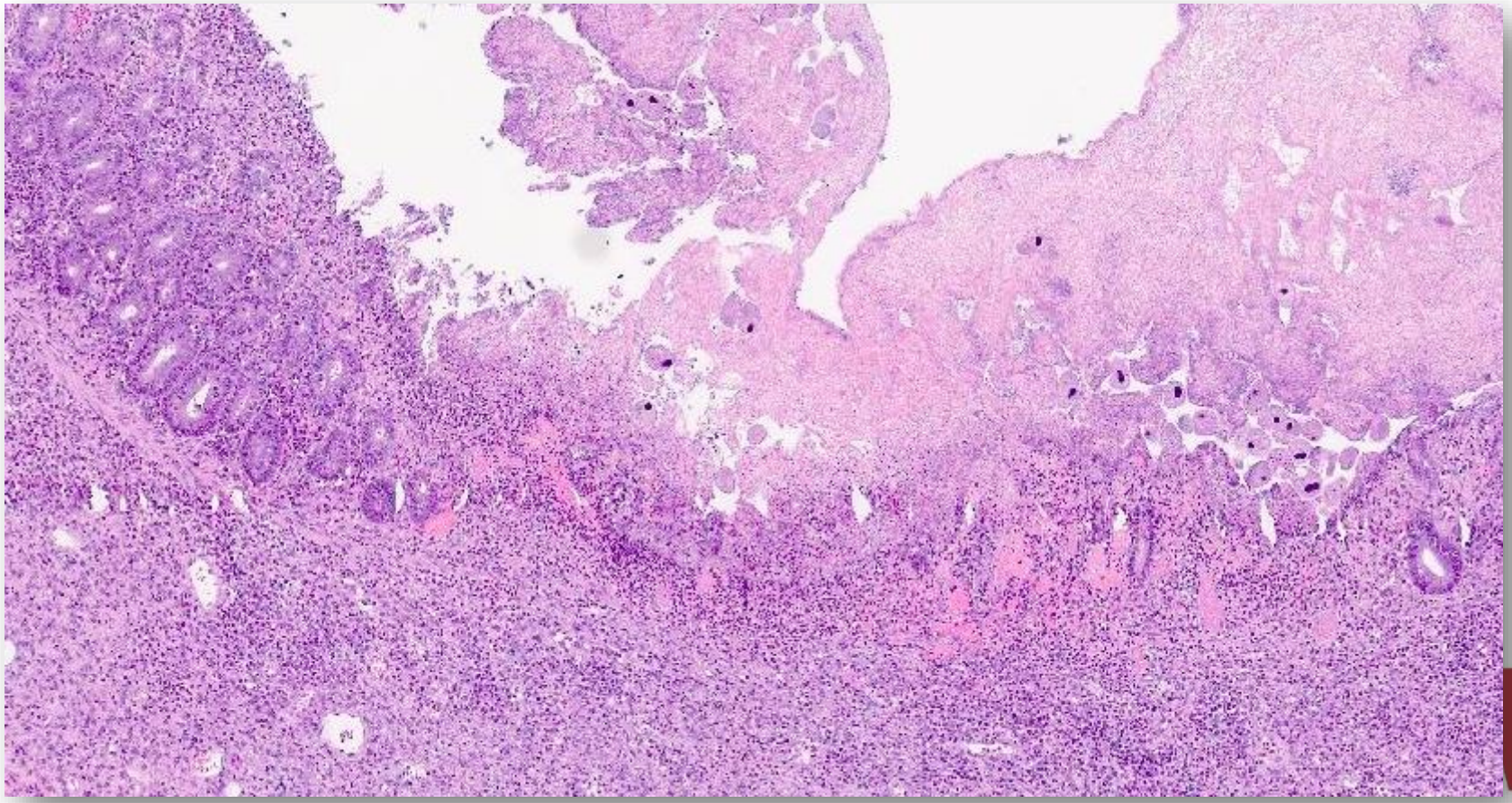
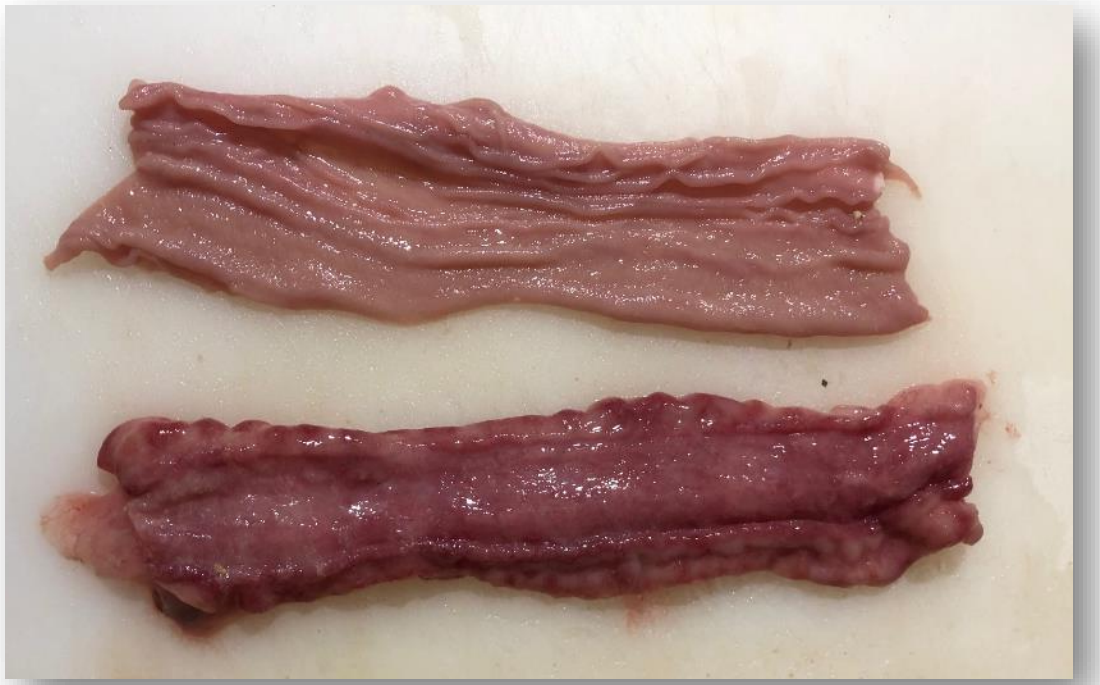


Histology (late):
- Deep ulcerations
- Fibrosis
- Inflammation into submucosa
- Colonization by ciliates

- Panintestinal Diseases
  - *Lawsonia intracellularis*
    - Obligate intracellular bacterium
      - Grows freely in the cytosol, passes to each daughter cell in mitosis
      - Infected cells do not mature → immortalized
        - Hence the original disease name “porcine intestinal adenomatosis”
    - Endemic in many pig populations
      - Disease most often in grow-finish age as immunity wanes
      - Subclinical disease is common
      - Three clinical forms
        - Porcine intestinal adenomatosis (PIA)
        - Necrotic enteritis (NE)
        - Proliferative hemorrhagic enteropathy (PHE)

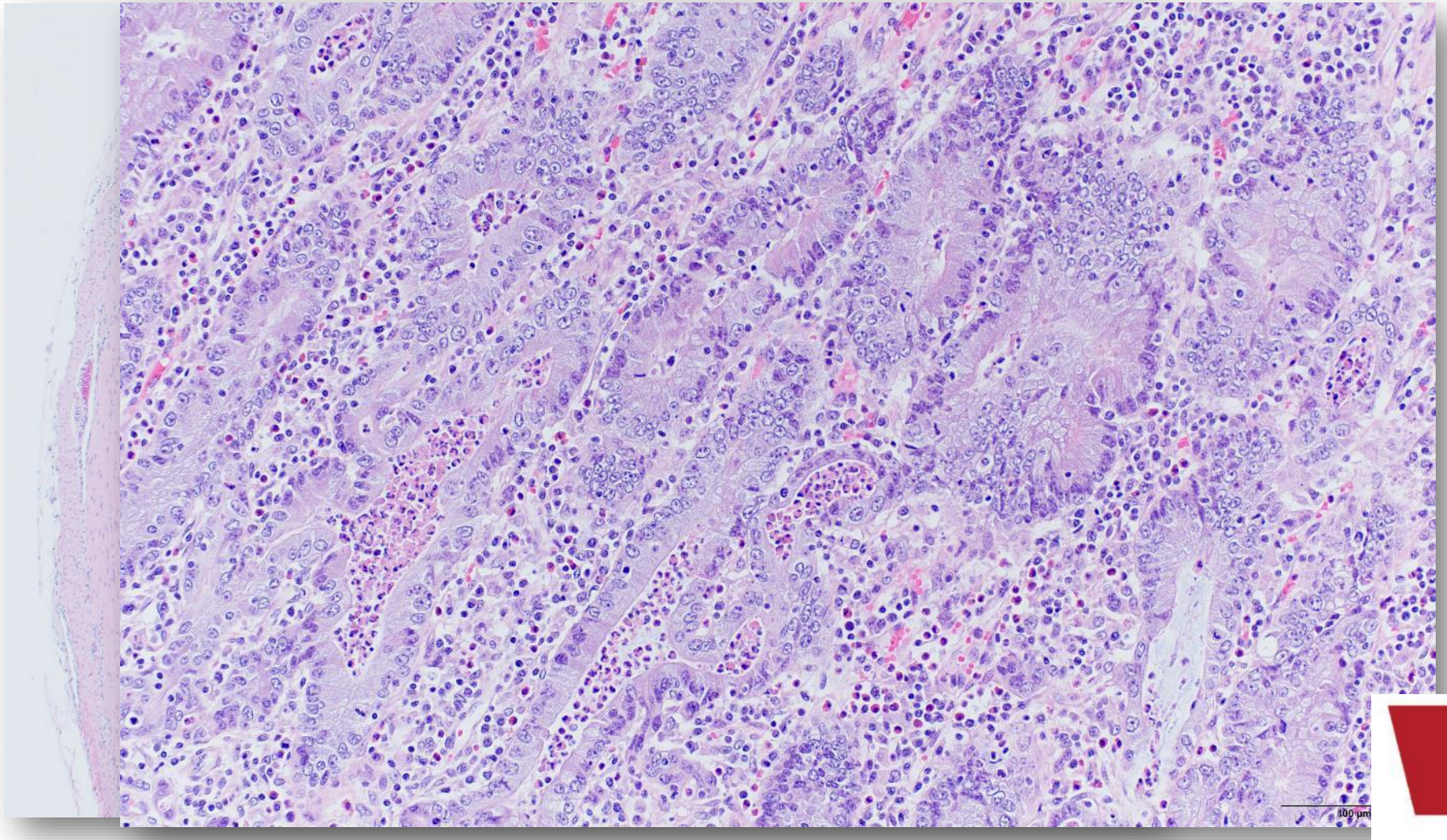
- Panintestinal Diseases
  - *Lawsonia intracellularis*
    - Gross lesions
      - PIA form
        - Typically reported in the ileum
        - Can be anywhere from jejunum through spiral colon
        - Thickened, crowded mucosal folds adjacent to Peyer's patches
          - Often superficial congestion



- Panintestinal Diseases
  - *Lawsonia intracellularis*

Histology (PIA):

- Swollen epithelial cells with abundant apical cytoplasm
- Reduced goblet cells
- Increased mitoses
- Neutrophils in crypts



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- Panintestinal Diseases
  - *Lawsonia intracellularis*

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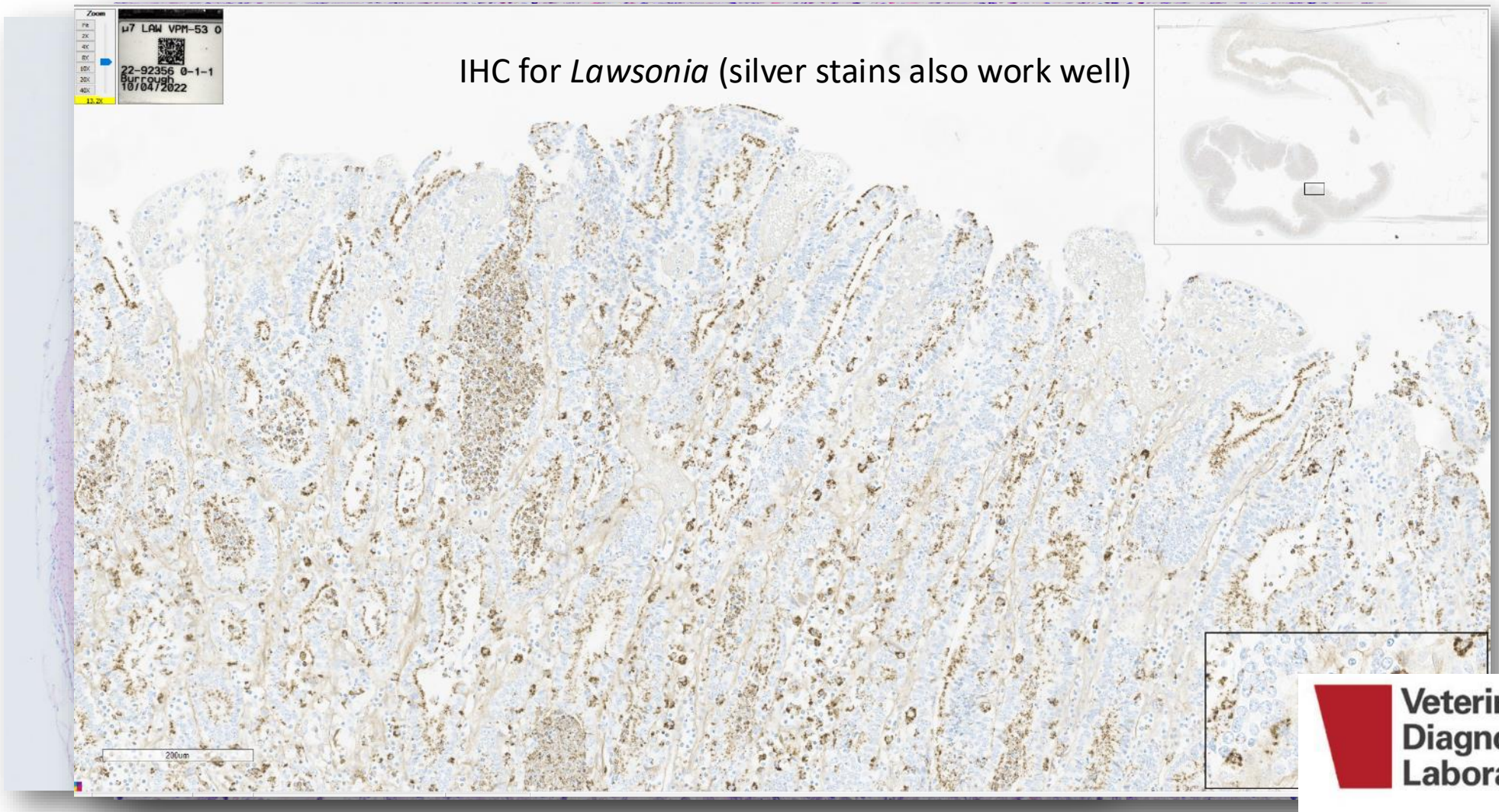
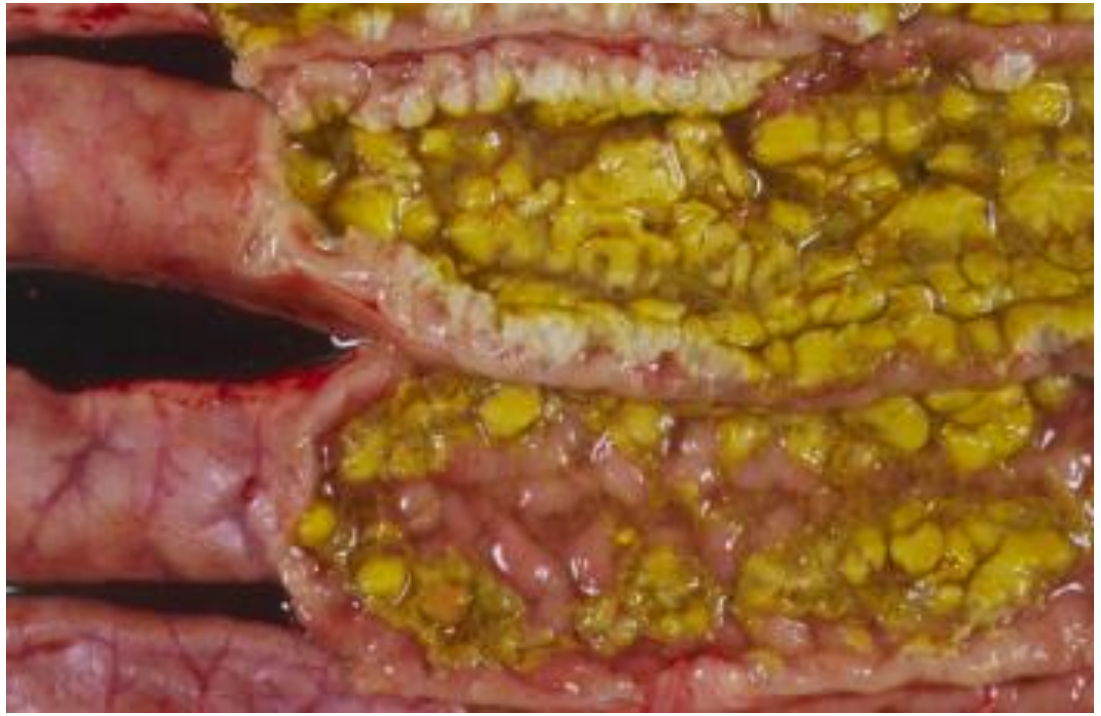
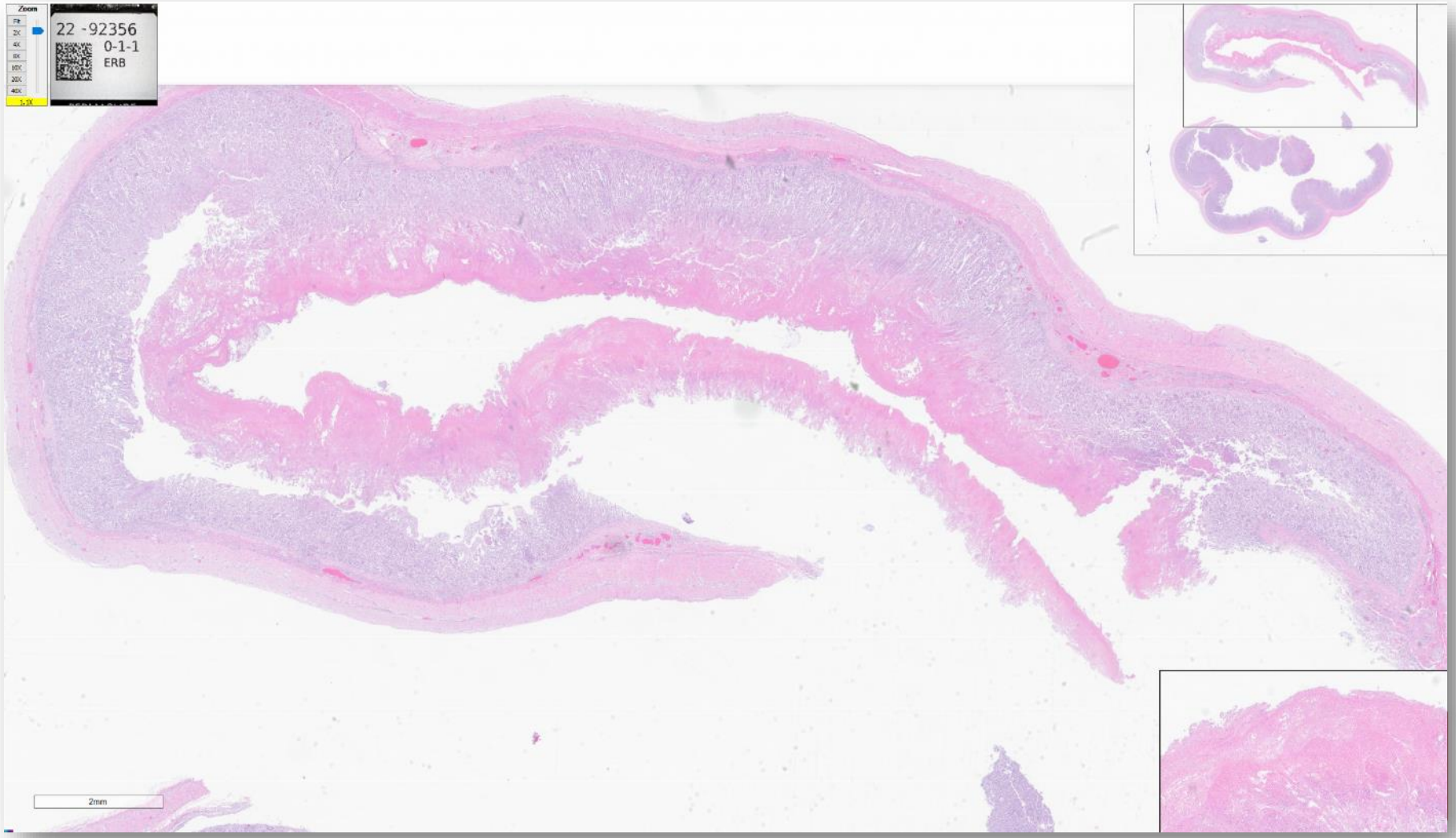


- Panintestinal Diseases
  - *Lawsonia intracellularis*
    - Gross lesions
      - NE form
        - Occurs in PIA form with chronicity and secondary bacterial involvement
        - Often marked pseudomembrane formation



- Panintestinal Diseases
  - *Lawsonia intracellularis*

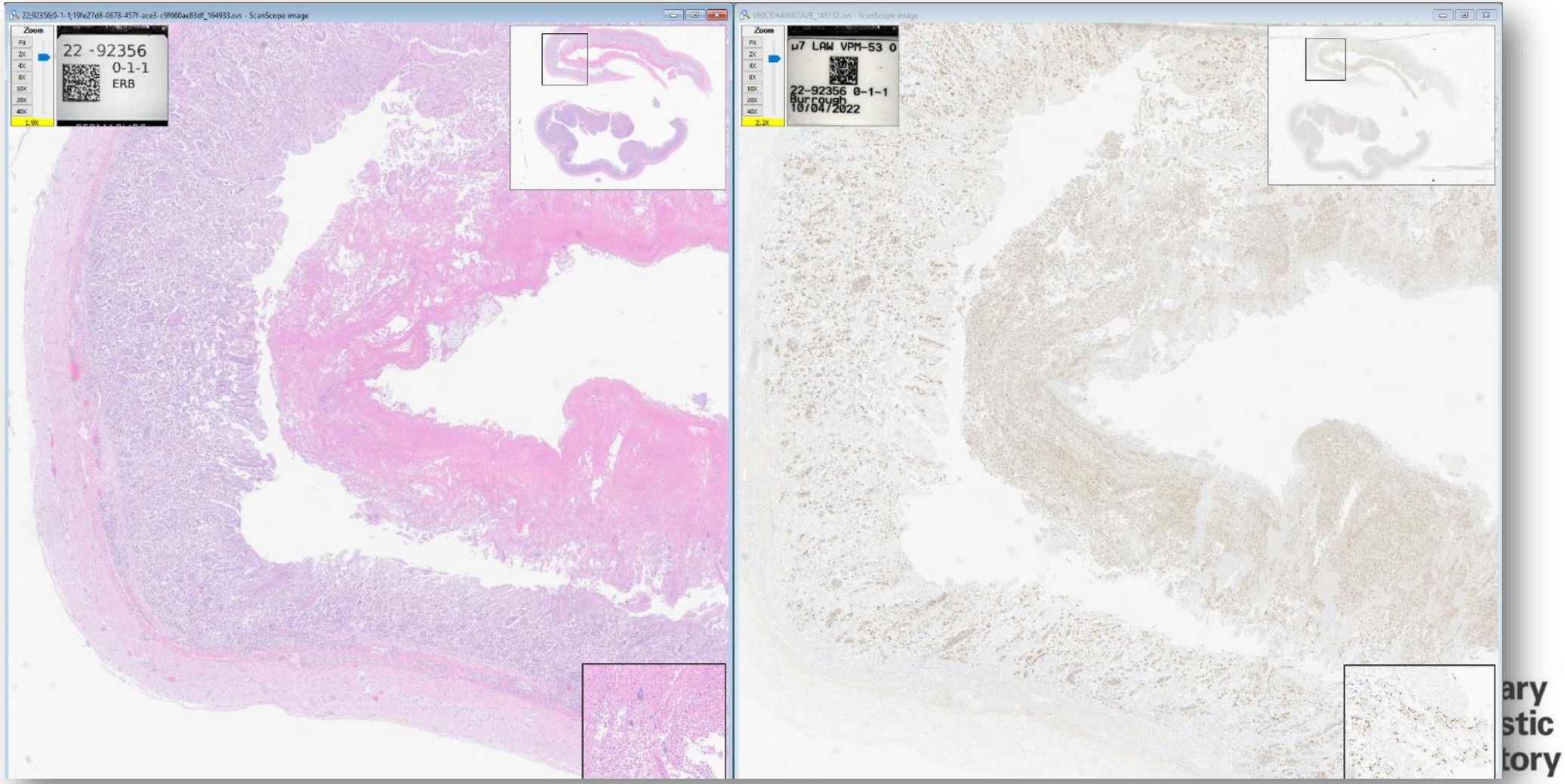


Histology (NE):

- Similar to PIA with added pseudomembrane
- Crypt lesions may begin to resolve

Veterinary Diagnostic Laboratory

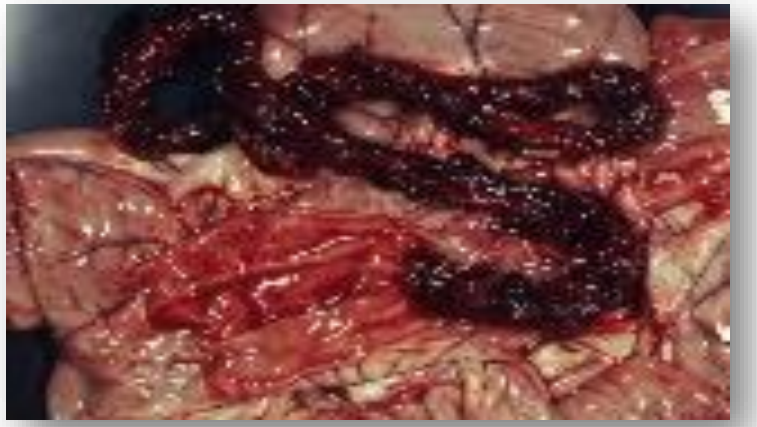
- Panintestinal Diseases
  - *Lawsonia intracellularis*

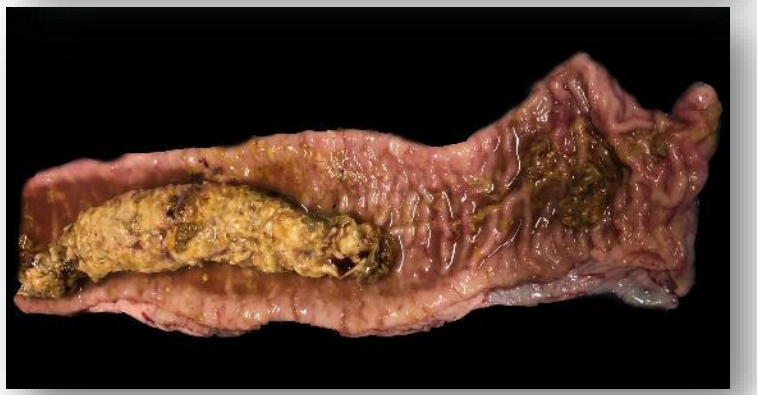


Histology (NE):

- Similar to PIA with added pseudomembrane
- Crypt lesions may begin to resolve

- Panintestinal Diseases
  - *Lawsonia intracellularis*
    - Gross lesions
      - PHE form
        - The most acute form observed
          - Manifests as unexpected death
        - Commonly in young breeding-age gilts
        - Ileal lumen contains clotted blood and may contain a cast of fibrin-enmeshed debris
        - Microscopic features are similar but less severe than PIA form
    - Diagnostics
      - PCR
        - Feces, oral fluids
      - Histopathology + IHC or silver stains
      - Serology (herd monitoring)

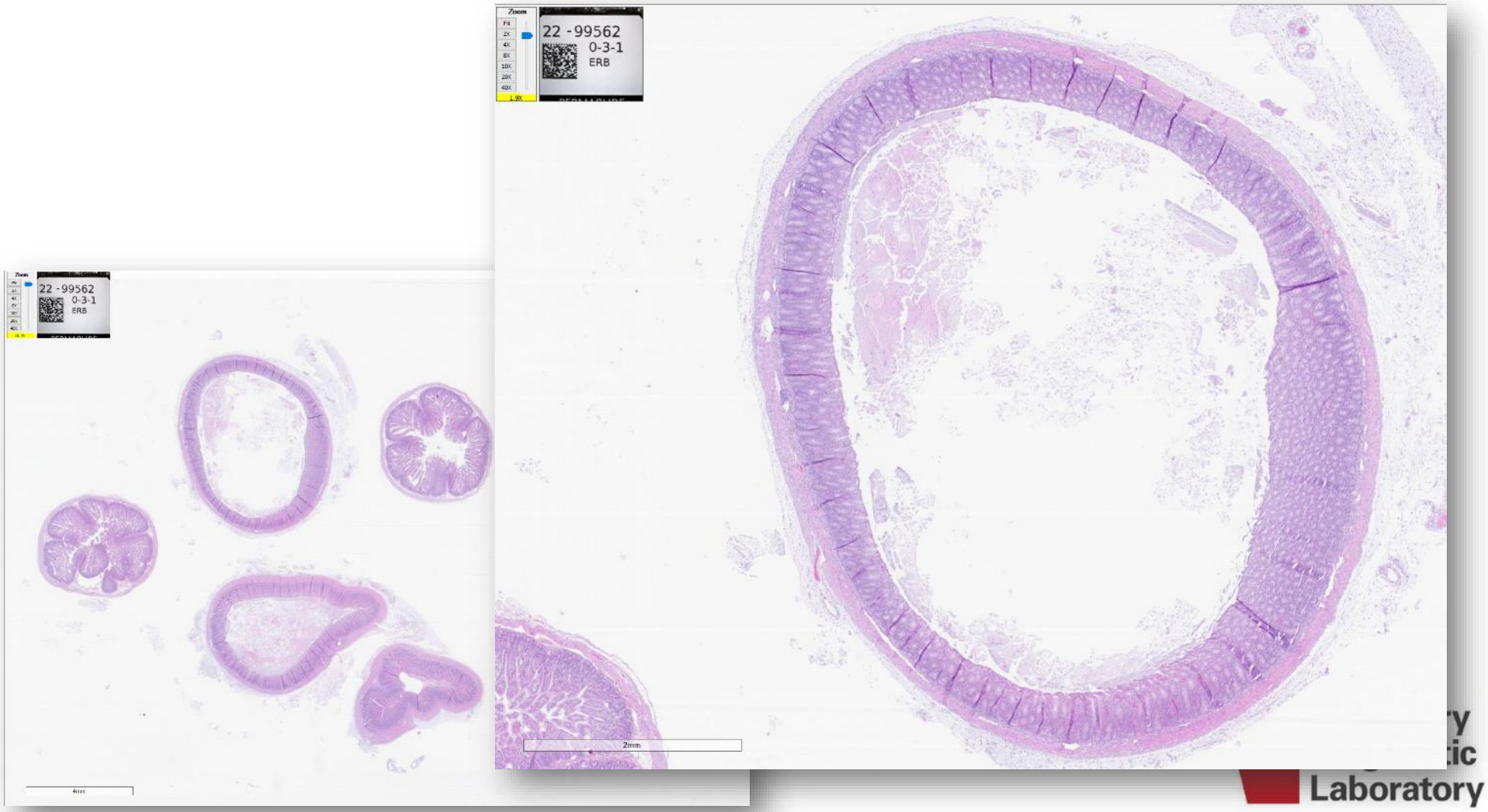




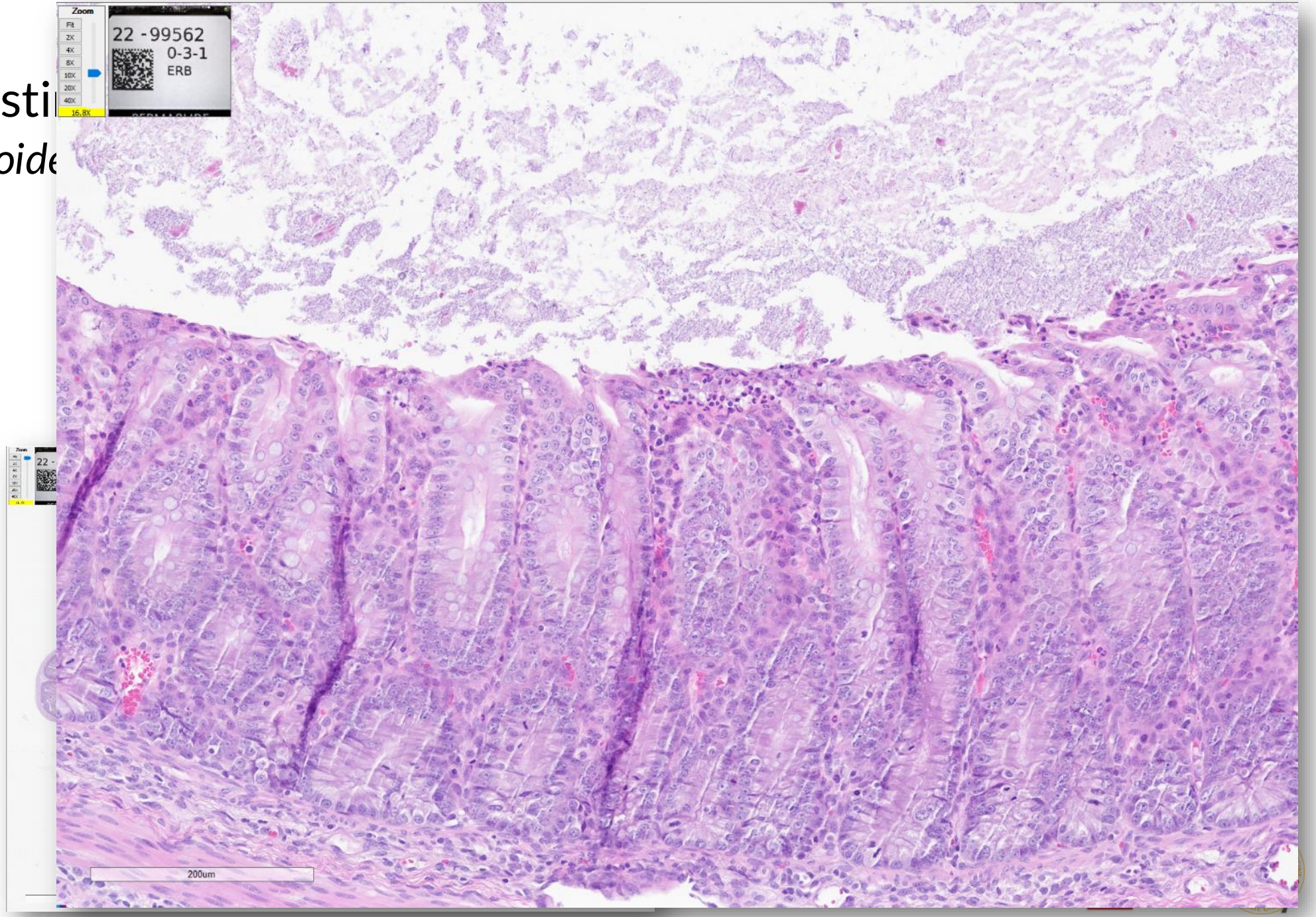
- Large Intestinal Diseases
  - *Clostridioides difficile*
    - Most sows are colonized
    - Piglets typically acquire CD in first 48 hours of life
      - Disease typically occurs in **first week of life**
    - Toxin-medicated disease
      - Precise triggers unknown
      - Pasty to watery diarrhea
      - Induces mesocolonic edema
    - Diagnostics
      - Histopathology
      - Toxin ELISA (TcdA, TcdB)?

- Large Intestinal Diseases
  - *Clostridioides difficile*

Histology (acute):

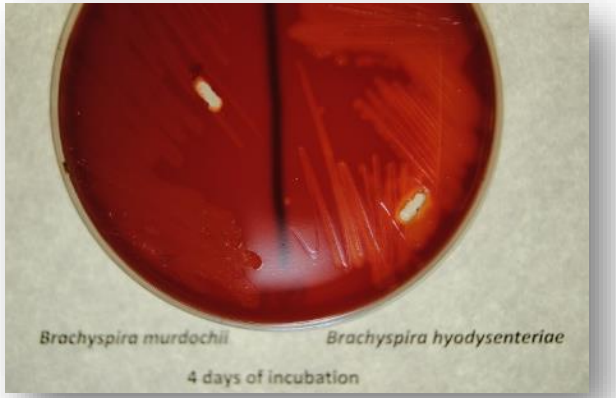


- Large Intesti
  - *Clostridioide*

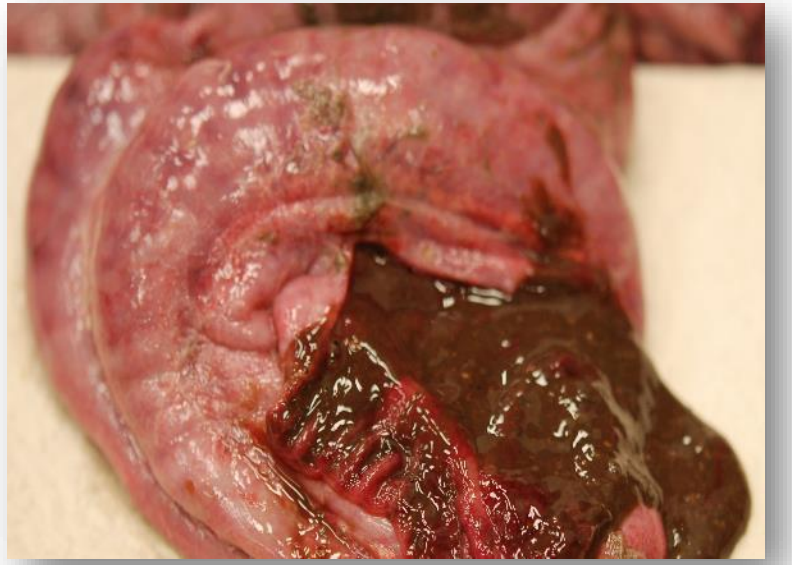


Histology (acute):
- Superficial suppurative colitis
- Volcano lesions

- Large Intestinal Diseases
  - *Brachyspira* spp.
    - Anaerobic spirochetes requiring specialized selective media
      - Broadly classified as strongly beta-hemolytic and weakly beta-hemolytic
    - Infection is limited to the colon
      - Diarrhea of varying degrees and poor growth are observed
    - Diagnostics
      - Selective anaerobic culture
        - Speciation by PCR, MALDI-TOF, or sequencing
      - Direct PCRs
      - Histopathology + ISH or silver stains

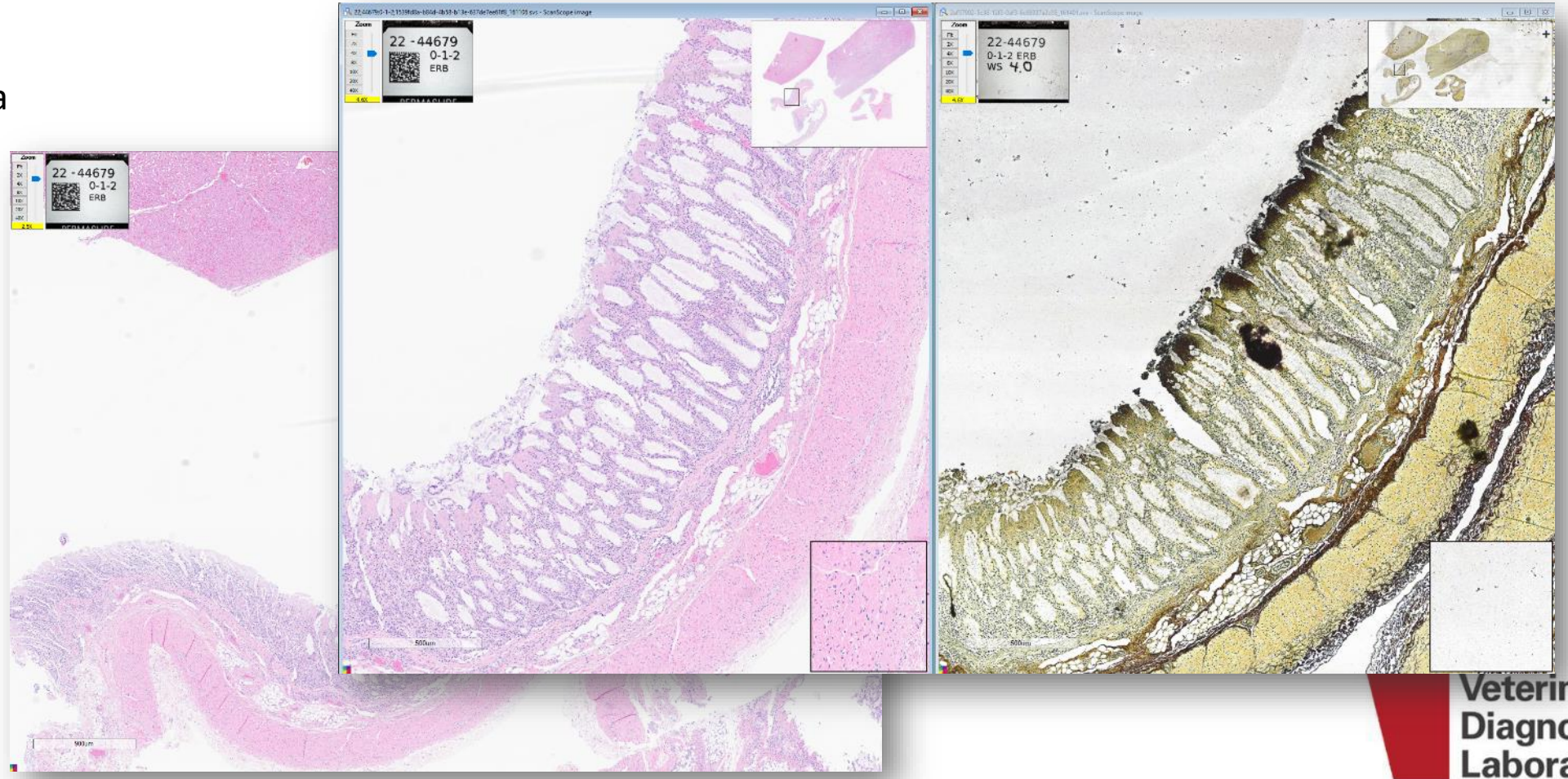


- Large Intestinal Diseases
  - *Brachyspira* spp.
    - Swine Dysentery (SD)
      - Strongly beta-hemolytic species
        - *B. hyodysenteriae*
        - *B. hampsonii*
      - Clinical disease often triggered by stressors such as weaning and feed changes
        - Bloody and mucoid diarrhea
        - Varying the amount of dietary fiber can enhance or suppress clinical disease
      - Gross lesions
        - Mucohemorrhagic and fibrinous colitis



- Large Intestinal Diseases
  - *Brachyspira* spp.
    - Swine Dysentery (SD)

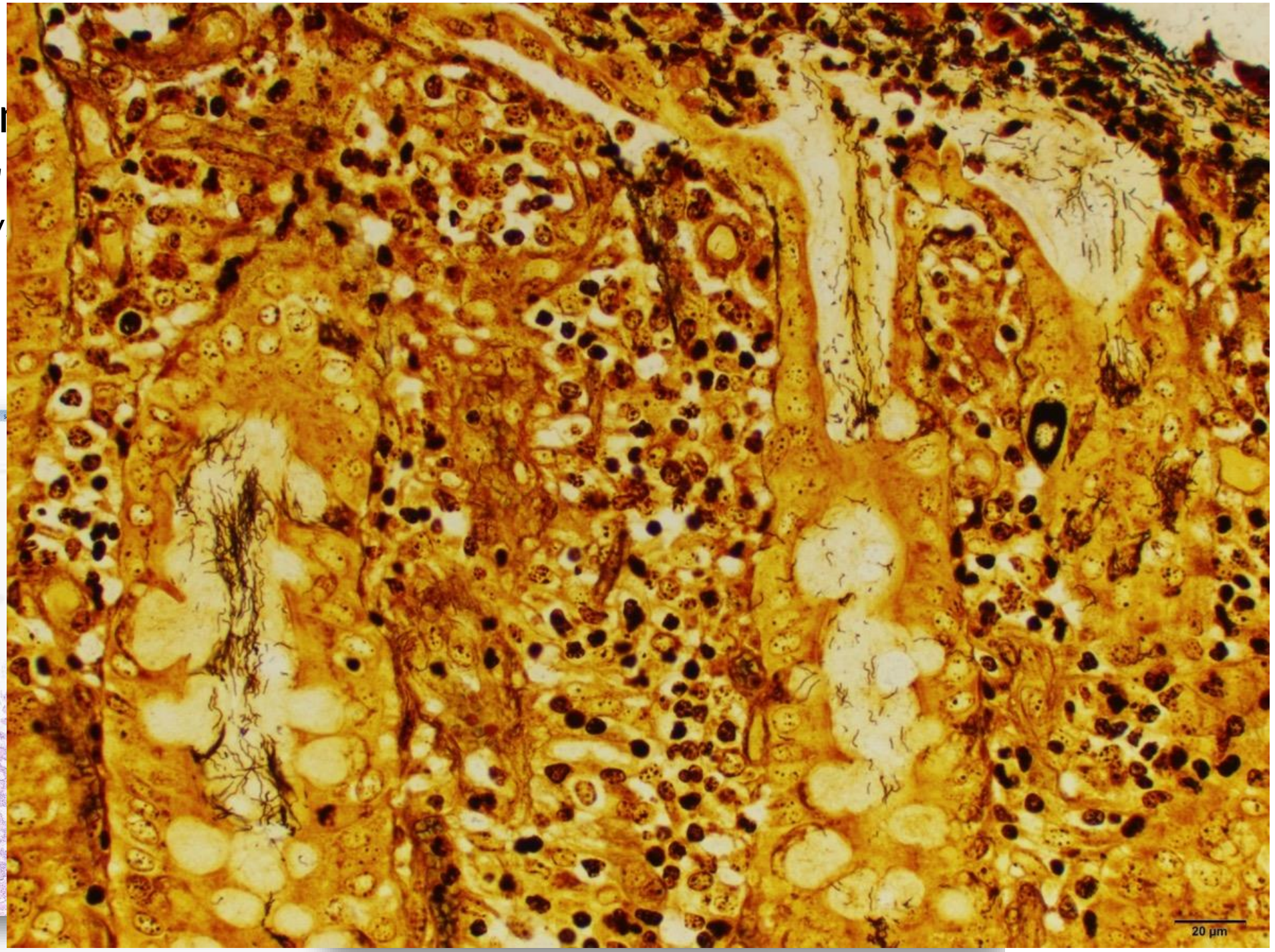
Histology (SD):
- Thickened mucosa
- Increased goblet cells
- Superficial hemorrhage
- Mucus efflux
- Mild to moderate mixed inflammation



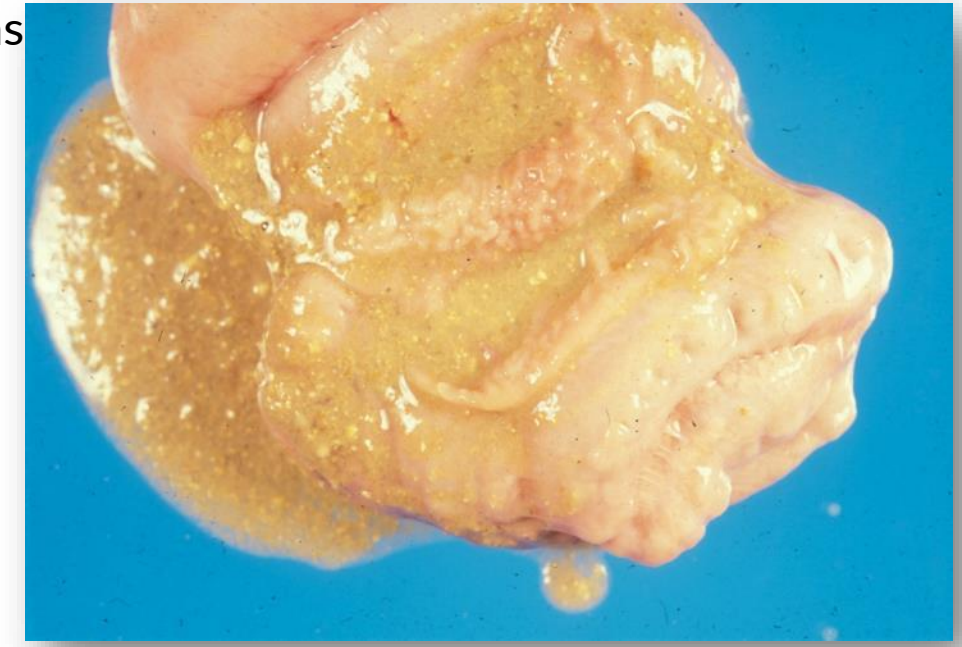
Veterinary Diagnostic Laboratory

- Large Intesti
  - *Brachyspira*
    - Swine Dy

Histology (SD):



- Large Intestinal Diseases
  - *Brachyspira* spp.
    - Porcine Intestinal Spirochetosis (PIS)
      - Weakly beta-hemolytic
        - *B. pilosicoli*
      - Clinical disease often triggered by stressors such as weaning and feed changes
        - Mucoid diarrhea
      - Gross lesions
        - Mild to moderate mucoid colitis



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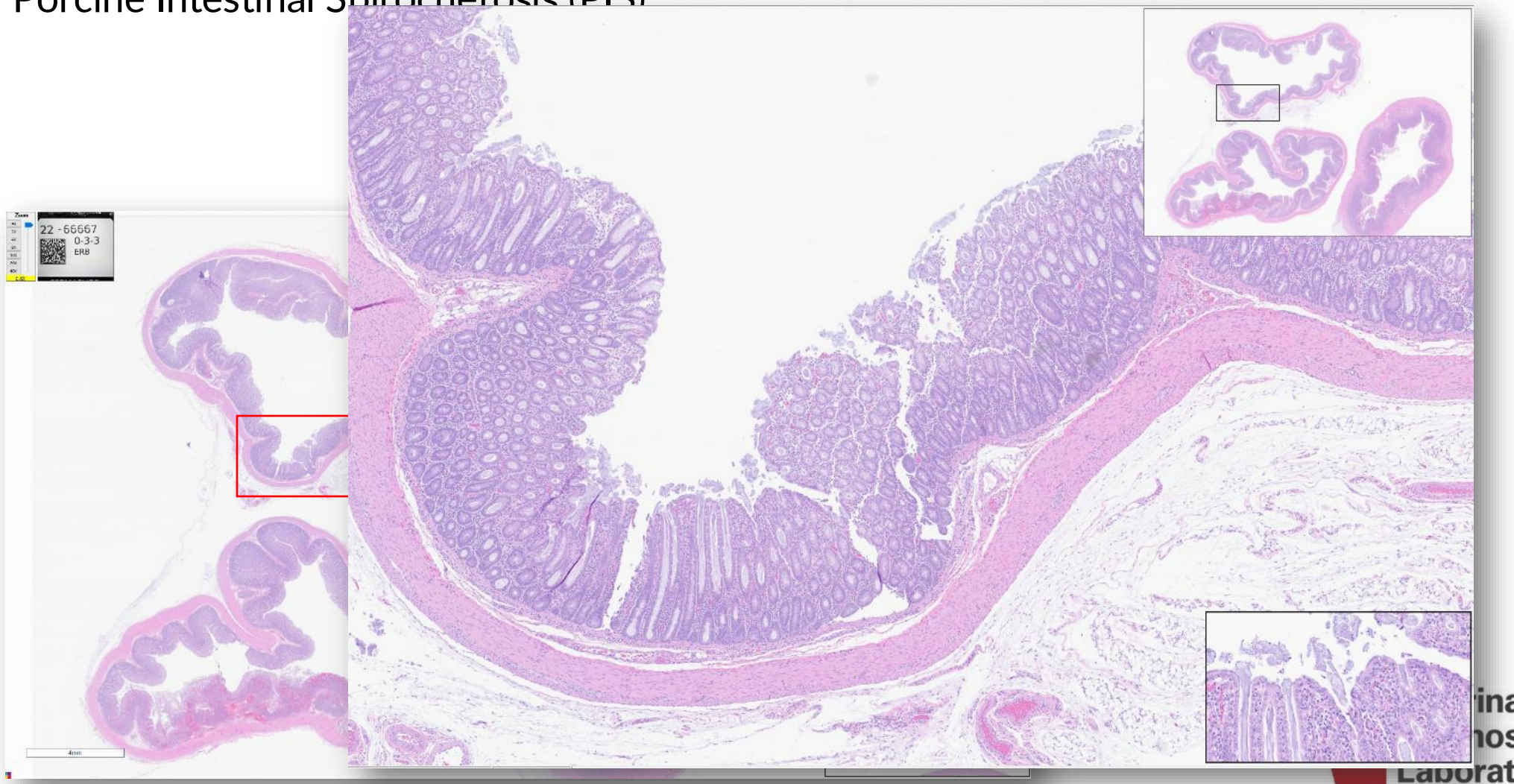
- Large Intestinal Diseases
  - *Brachyspira* spp.
    - Porcine Intestinal Spirochetosis (PIS)

Histology (PIS):
- Milder than SD
- Typical to see end-on-attached spirochetes at the surface



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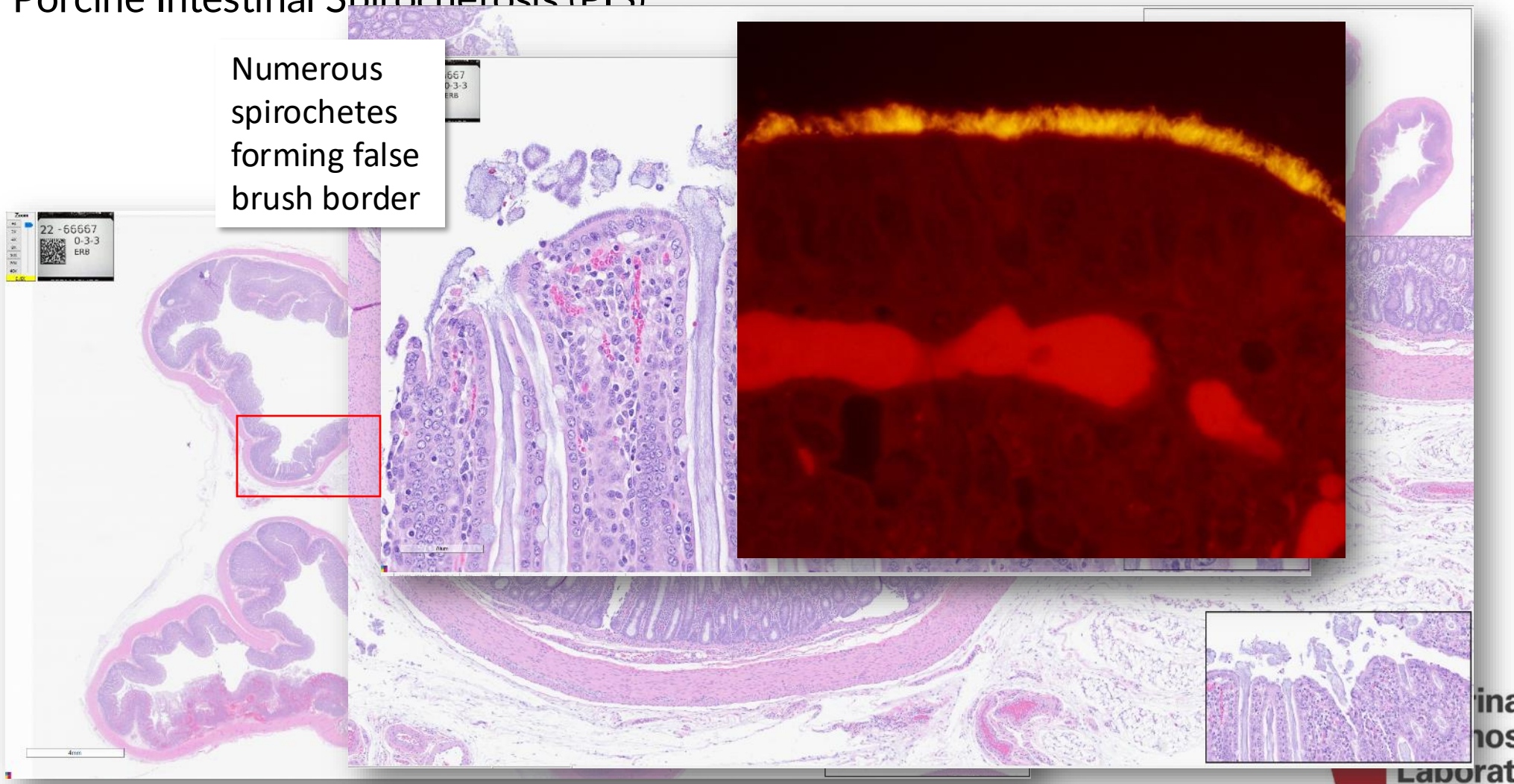
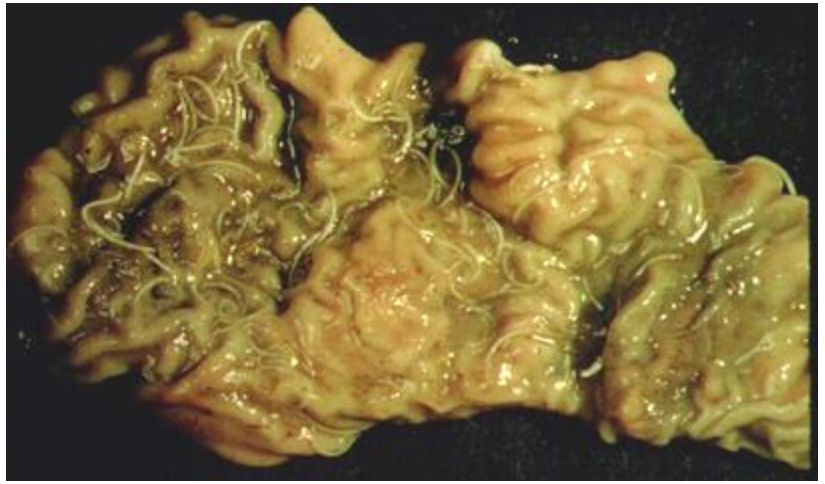
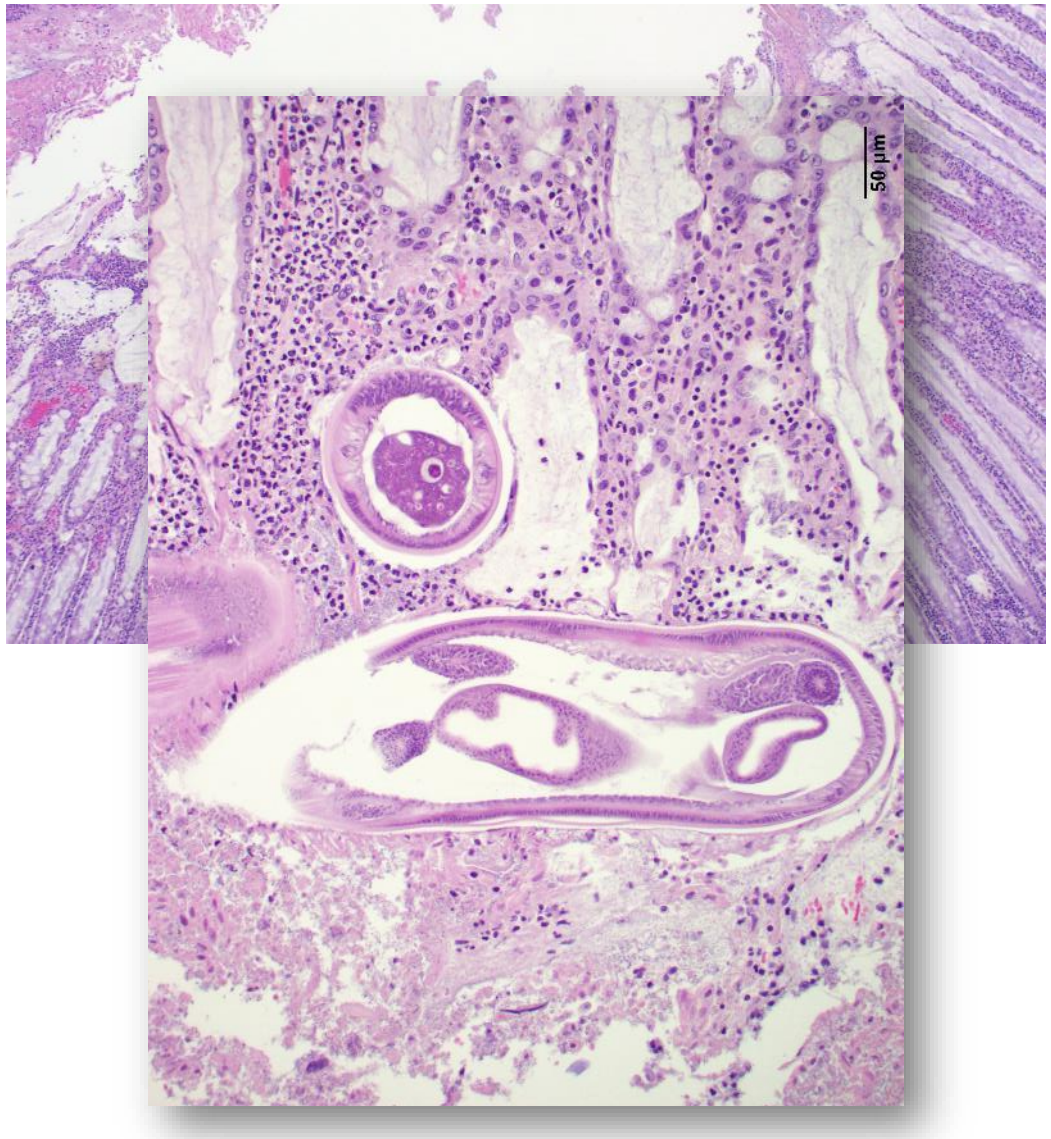


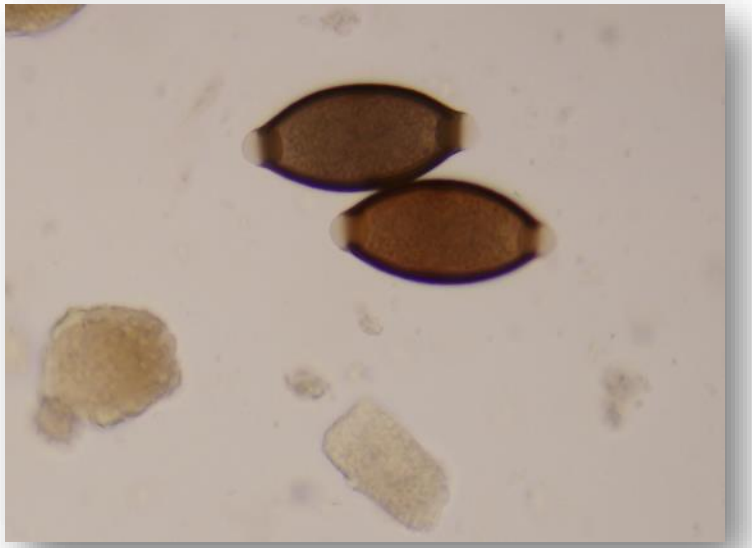
- Large Intestinal Diseases
  - *Trichuris suis*
    - Diarrhea sometimes with blood and mucus
      - May resemble swine dysentery
    - Common in older, outdoor pigs
    - Gross Lesions
      - Adult worms are ~2 inches long
      - Primarily in the cecum, may be in spiral colon



- Large Intestinal Diseases
  - *Trichuris suis*
    - Diagnostics:
      - Gross observation
      - Histopathology
        - ***Can occur with other diseases***



      - Fecal flotation (long prepatent period)
        - Not useful for acute infections

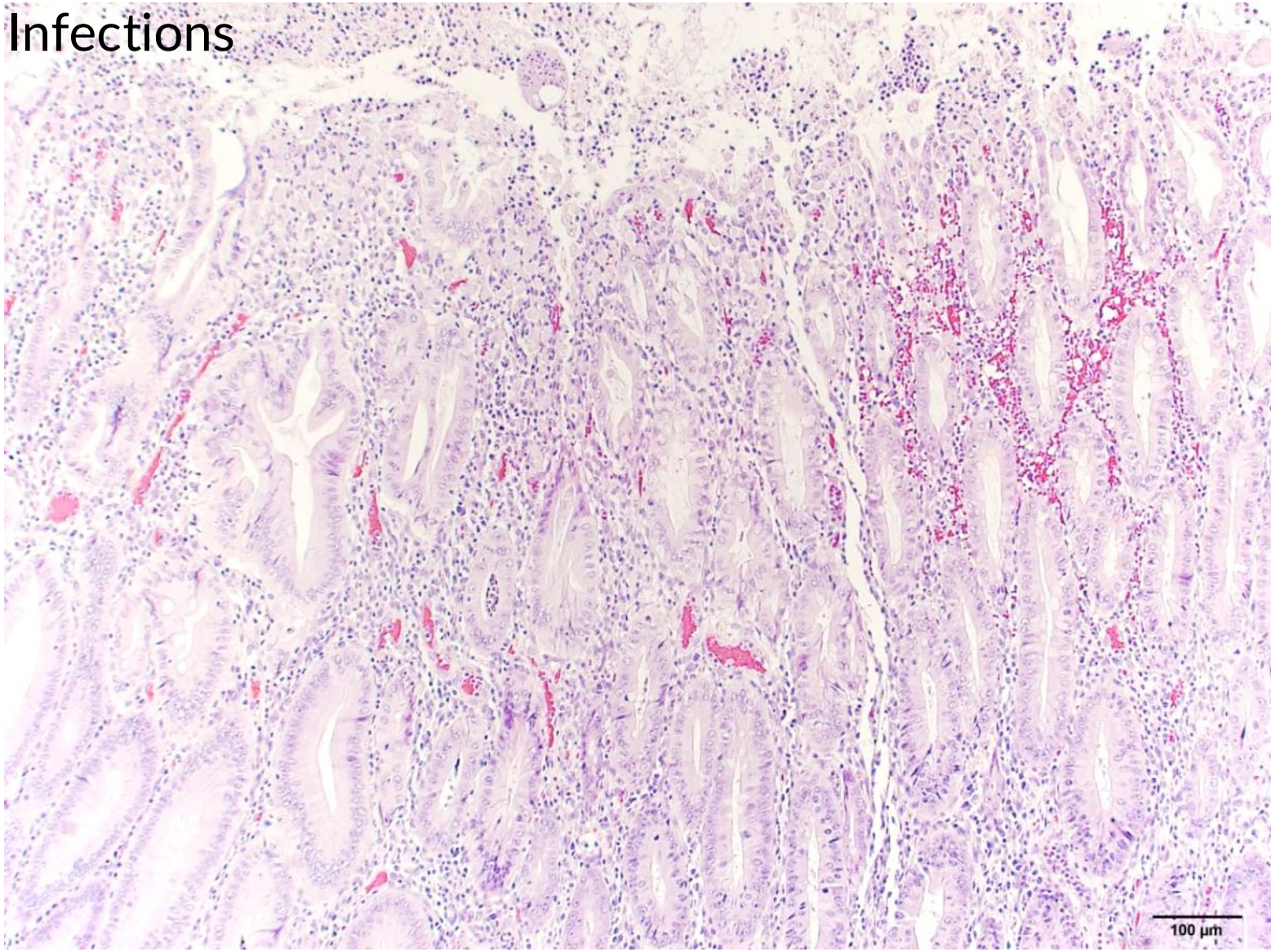


Veterinary Diagnostic Laboratory

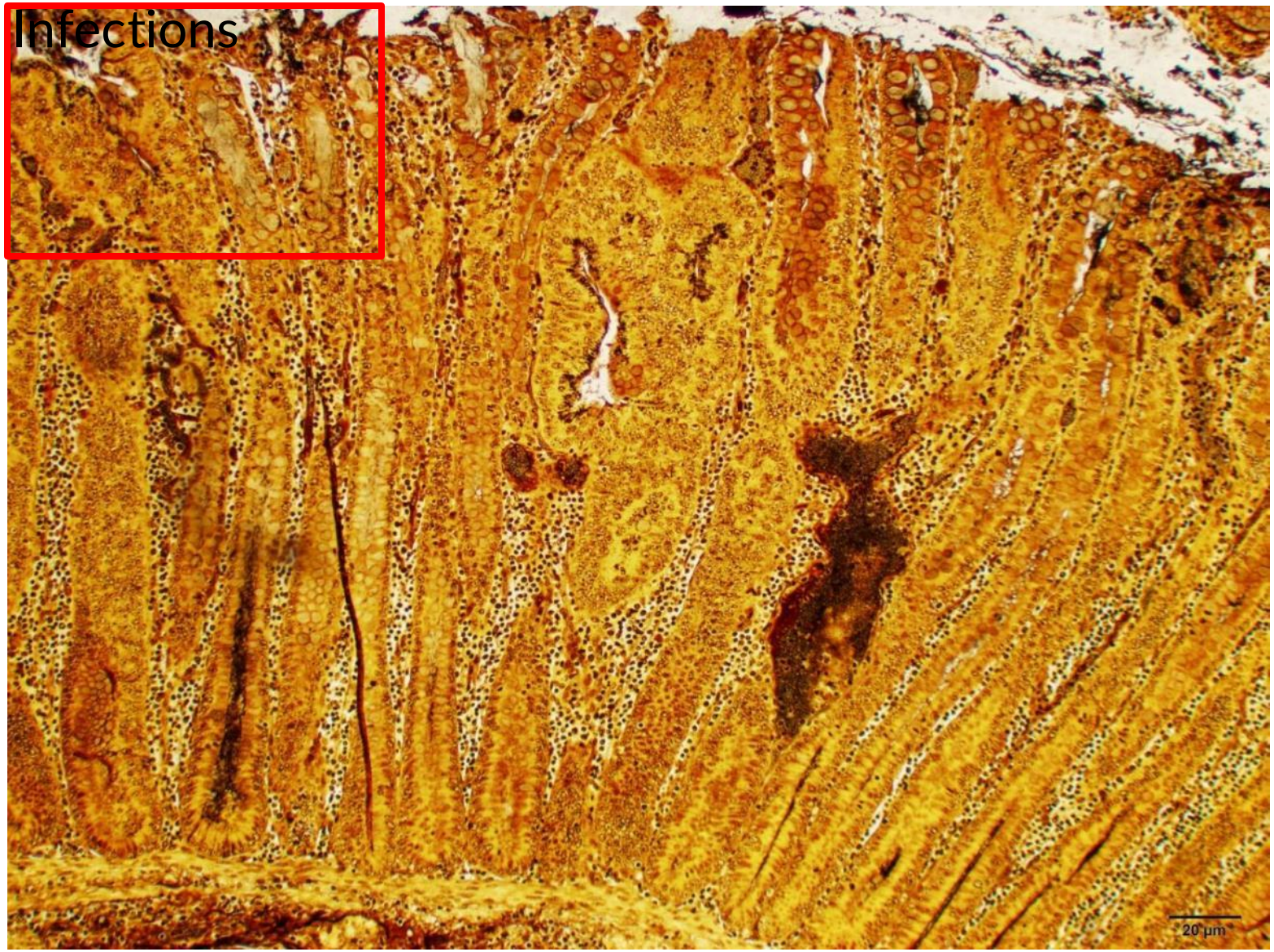
- Large Intestinal Diseases
  - Mixed Infections

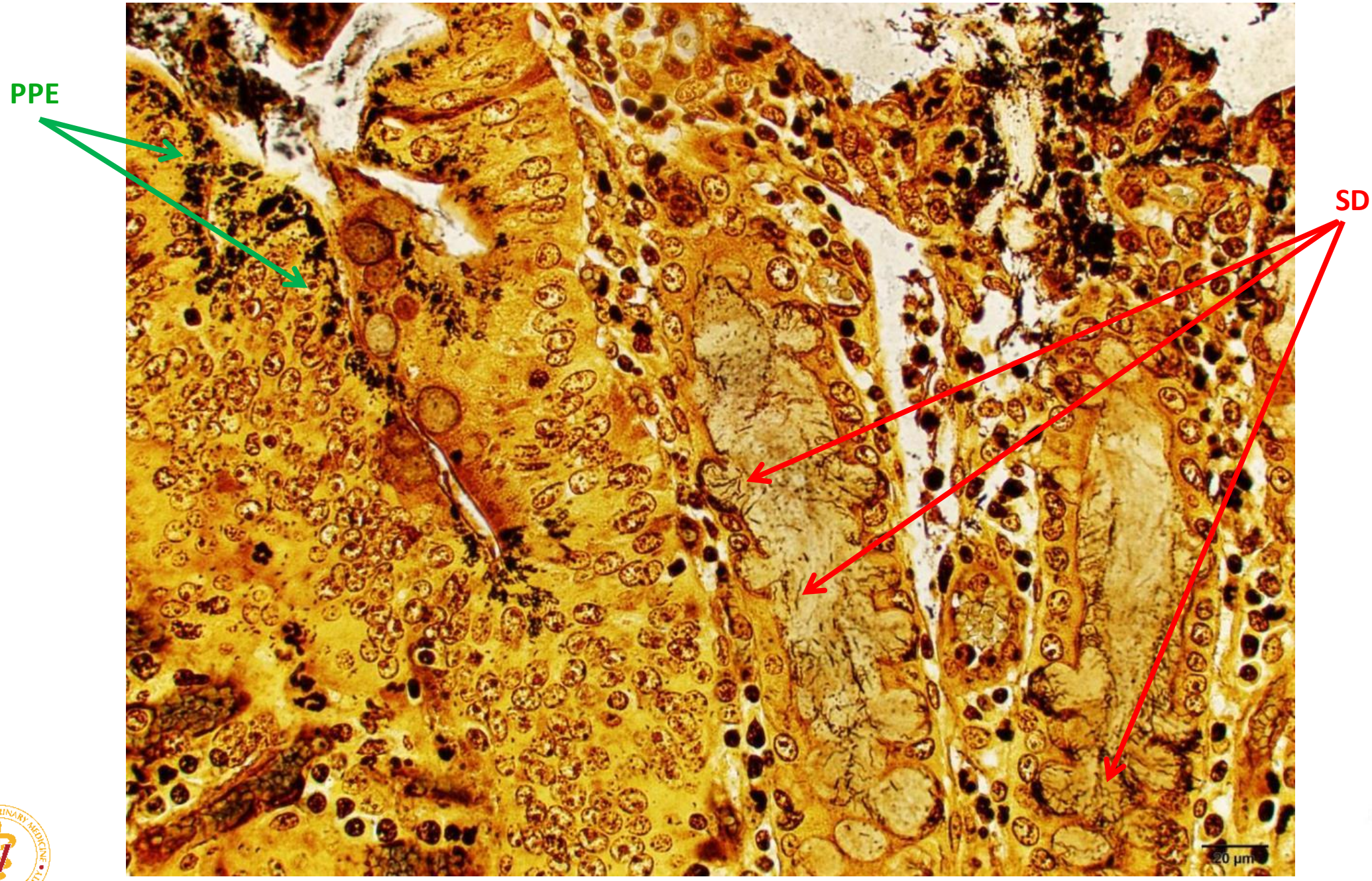
Mixed infections with *Lawsonia, Brachyspira*, and *Salmonella* are very common

- Large Intestinal Diseases
  - Mixed Infections



- Large Intestinal Diseases
  - Mixed Infections




PPE
SD
20 µm

- 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*
      - PDCoV, PSaV, *B. hampsonii*, 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; however, the focus is still on ***lesions***
    - Brain, heart, lung, liver, lymph node, kidney, spleen, small intestine, and colon

Questions?

Eric R. Burrough, DVM, PhD, DACVP | Professor
Diagnostic Pathologist | Pathology Section Leader
Iowa State University Veterinary Diagnostic Laboratory
1937 Christensen Drive | Ames, IA 50011
(515) 294-1950 | burrough@iastate.edu | @erburrough

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