

# Equine alimentary diseases (infectious)

Part B

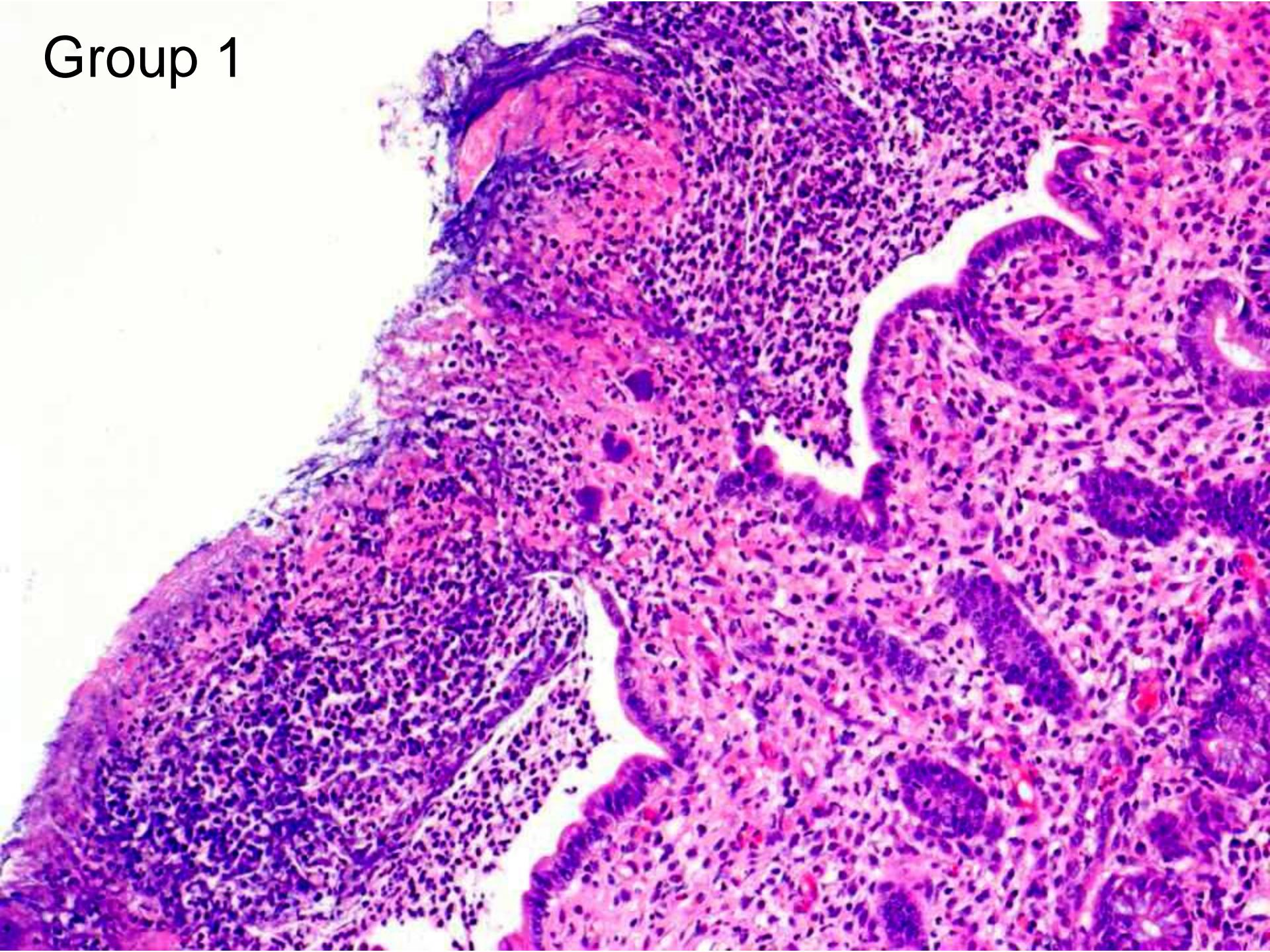
Francisco A. Uzal

California Animal Health and Food Safety Laboratory System,  
San Bernardino Branch, UC Davis

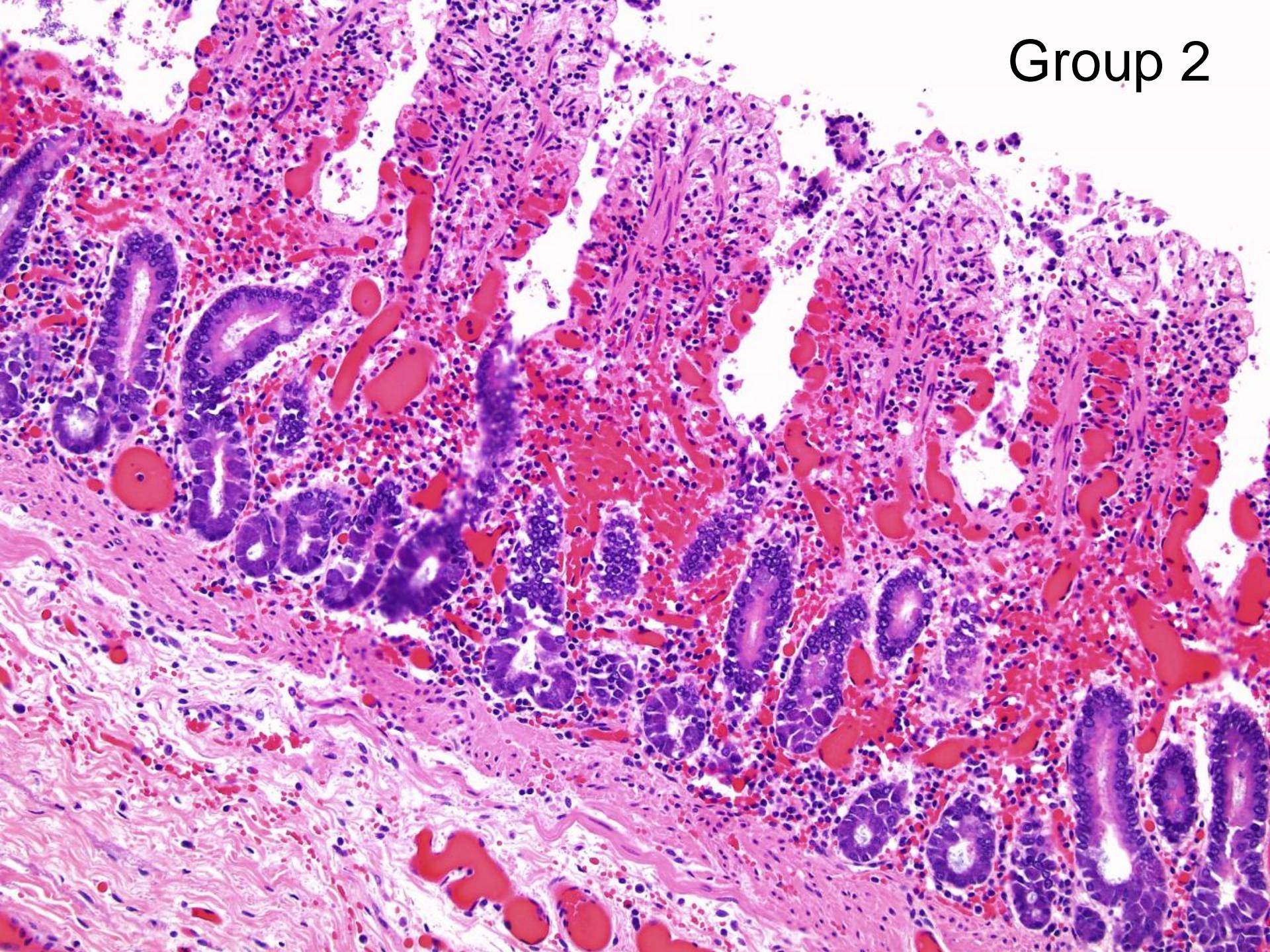
# Histology

4 main groups  
(~ 25% each)

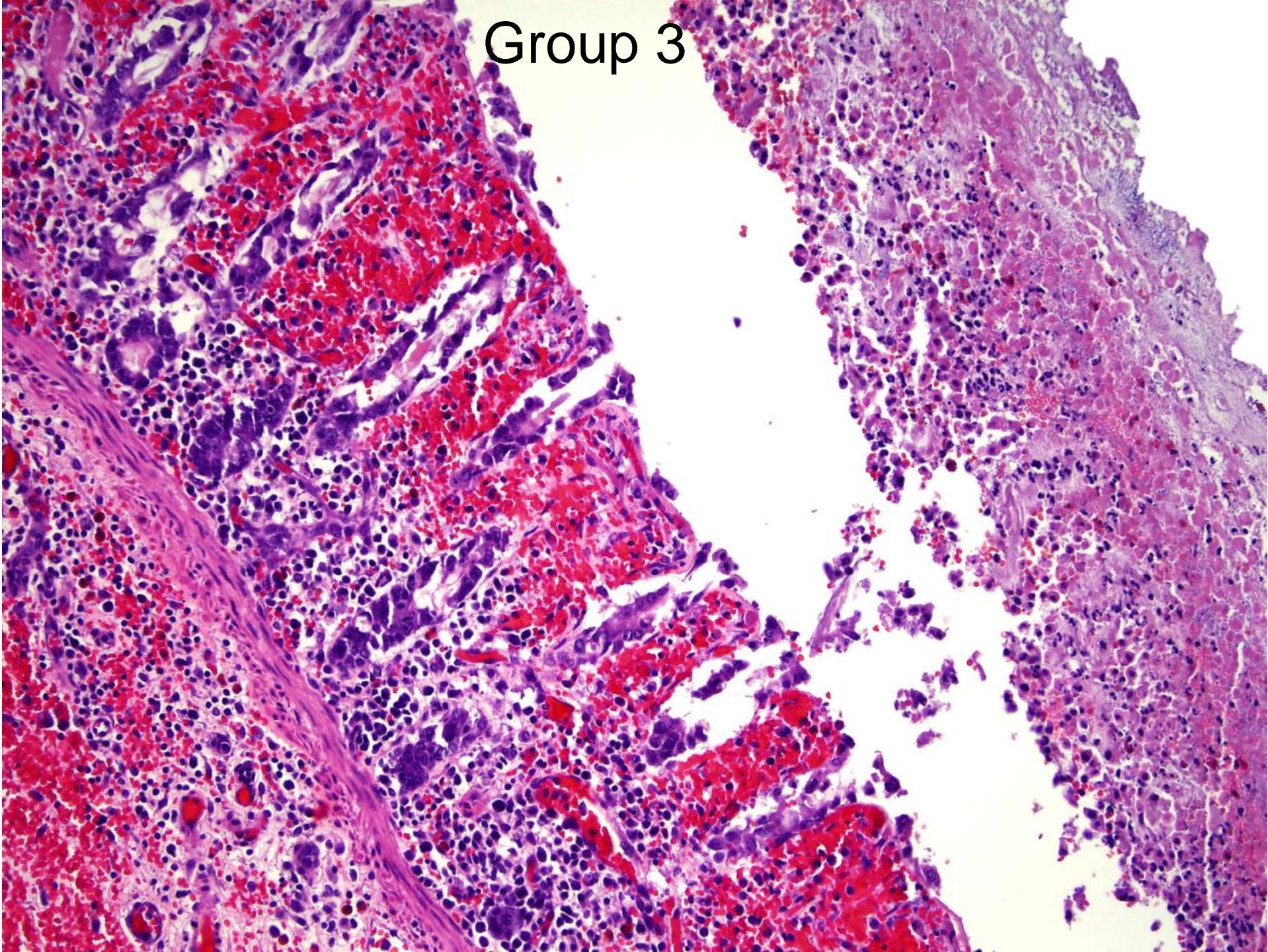
Group 1



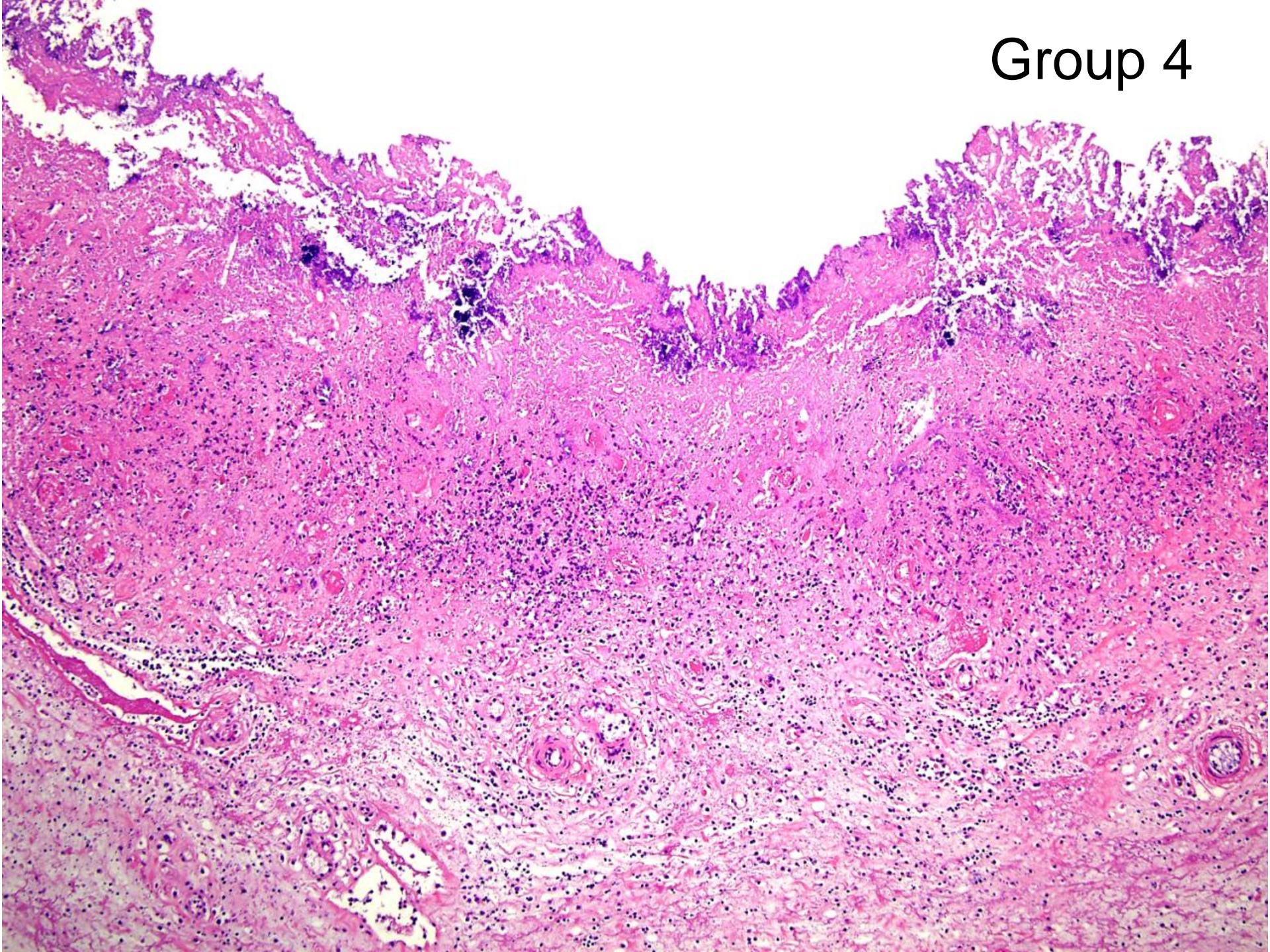
Group 2



Group 3

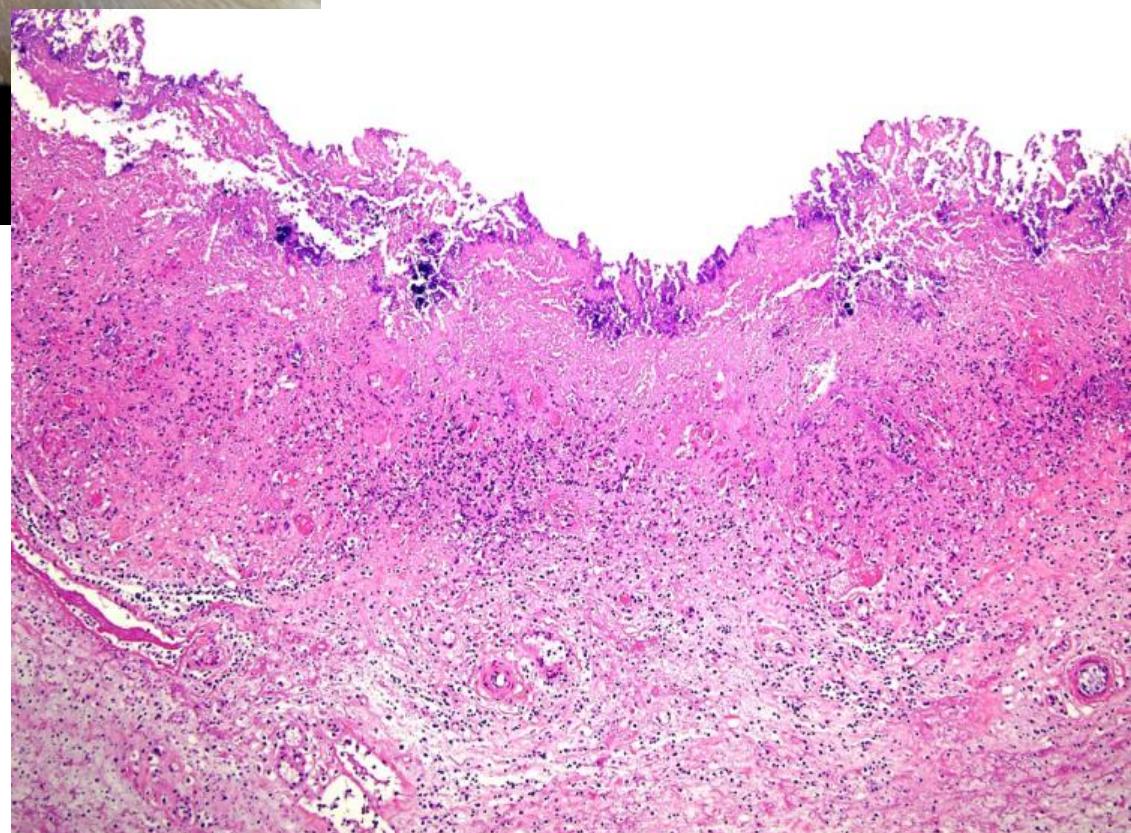
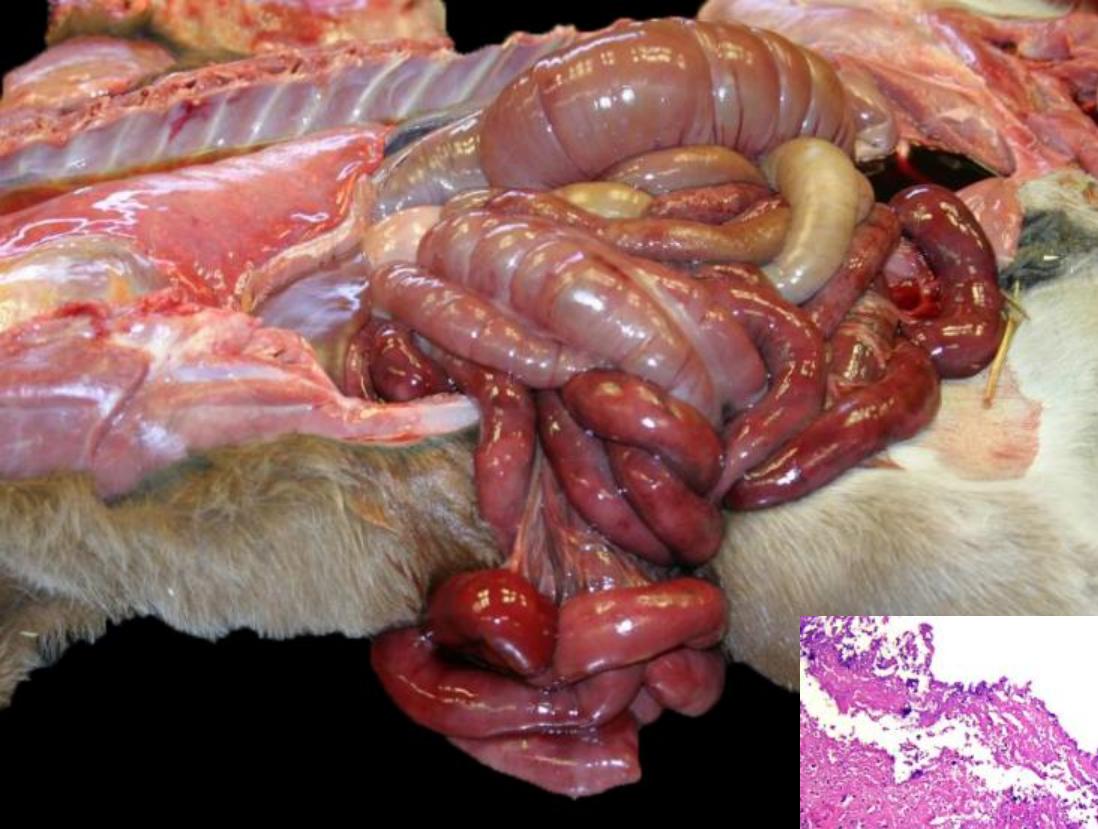


Group 4



# Diagnostic criteria

- |                 |   |            |
|-----------------|---|------------|
| 1-Clinics/gross | } | Suggestive |
| 2-Histology     | } | Suggestive |



# Diagnostic criteria

- 1-Clinics/gross } **Suggestive**
- 2-Histology } **Suggestive**
- 3-Culture (+ typing?)/PCR } **Suggestive +**

# Diagnostic criteria

1-Clinics/gross

}

**Suggestive**

2-Histology

}

**Suggestive**

3-Culture (+ typing?)/PCR

}

**Suggestive +**

4-Toxin detection (A/B)

}

**Confirmatory**

Co-infection:

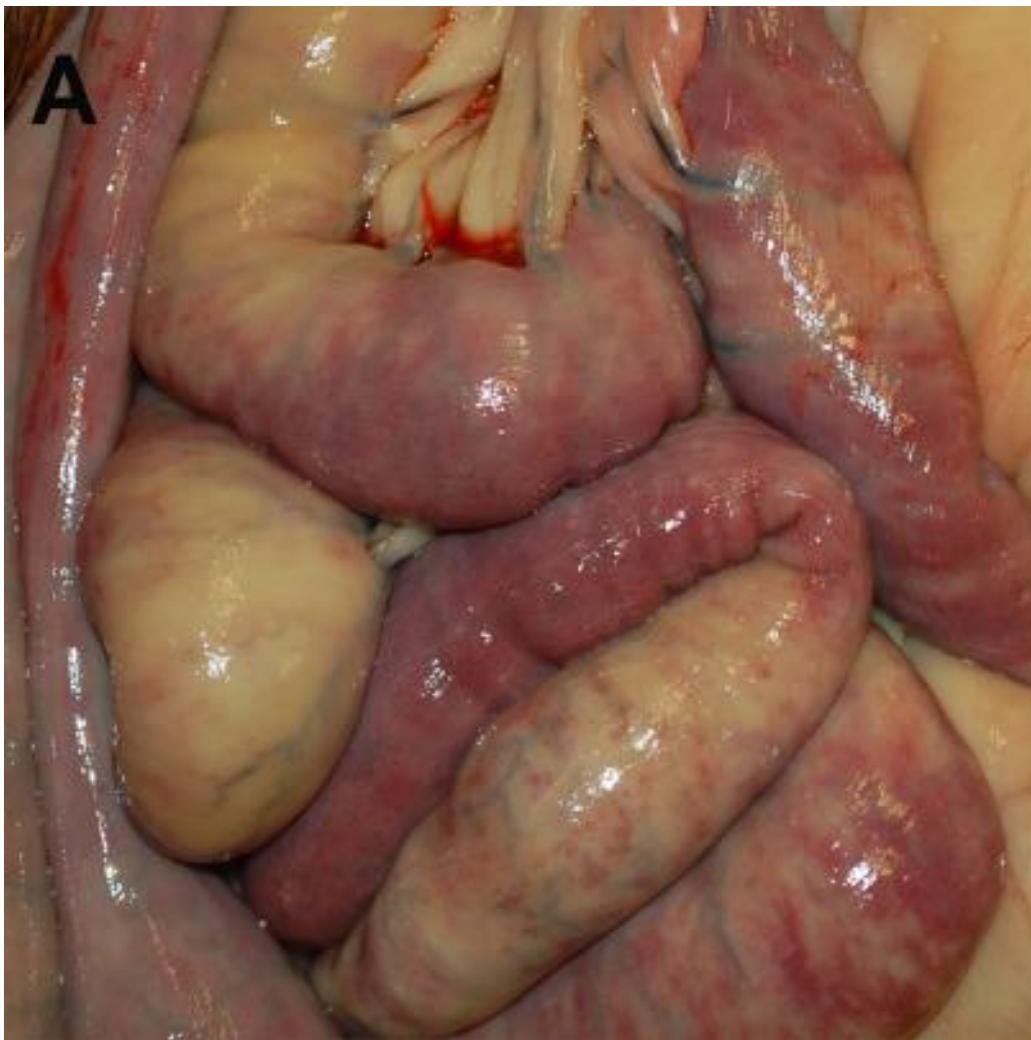
*C. difficile* and *C. perfringens* type C  
does occur

Full diagnostic work up recommended

# Differential diagnoses

- \* *C. perfringens* type C
- \* *Salmonella* spp.
- \* NSAIDs
- \* Others (oleander, canthridin, etc.)

# Duodenitis-Proximal Jejunitis



J Vet Intern Med 2017;31:158–163 Duodenitis-Proximal Jejunitis in Horses After Experimental Administration of Clostridium difficile Toxins  
L.G. Arroyo, M.C. Costa, B.B. Guest, B.L. Plattner, B.N. Lillie, and J.S. Weese

a few examples.....

# Horse: colic and diarrhea; necrotizing enteritis

ELISA for toxins of *C. difficile* (A&B): +

Isolation of *C. difficile*: +

Enteritis by *C. difficile*

Horse: colic and diarrhea;  
necrotizing enterocolitis

ELISA for toxins A/B of *C. difficile*: -

Isolation of *C. difficile*: +

Presumptive enterocolitis by *C. difficile*

Horse: colic and diarrhea;

necrotizing enterocolitis

ELISA for toxins A/B of *C. difficile*: +

Isolation of *C. difficile*: -

Enterocolitis by *C. difficile*

Horse: colic and diarrhea

Suppurative enteritis (vulcano lesions)

Anaerobic culture and toxins ELISA not done

Suspicious: enteritis by *C. difficile*



# Confirmed diseases

1-*C. perfringens* type C: enterocolitis

2-*C. difficile*: enterocolitis

3-*C. piliforme*: colitis, hepatitis, myocarditis

## Other less understood entities

1-Colitis X

2-*C. perfringens* type A NetF+

3-*C. perfringens* type A CPB2+/CPE+

4-*C. sordellii*

# Triad of lesions:

1-Myocarditis

2-Hepatitis

3-Colitis

**MESSAGE TO REMEMBER**

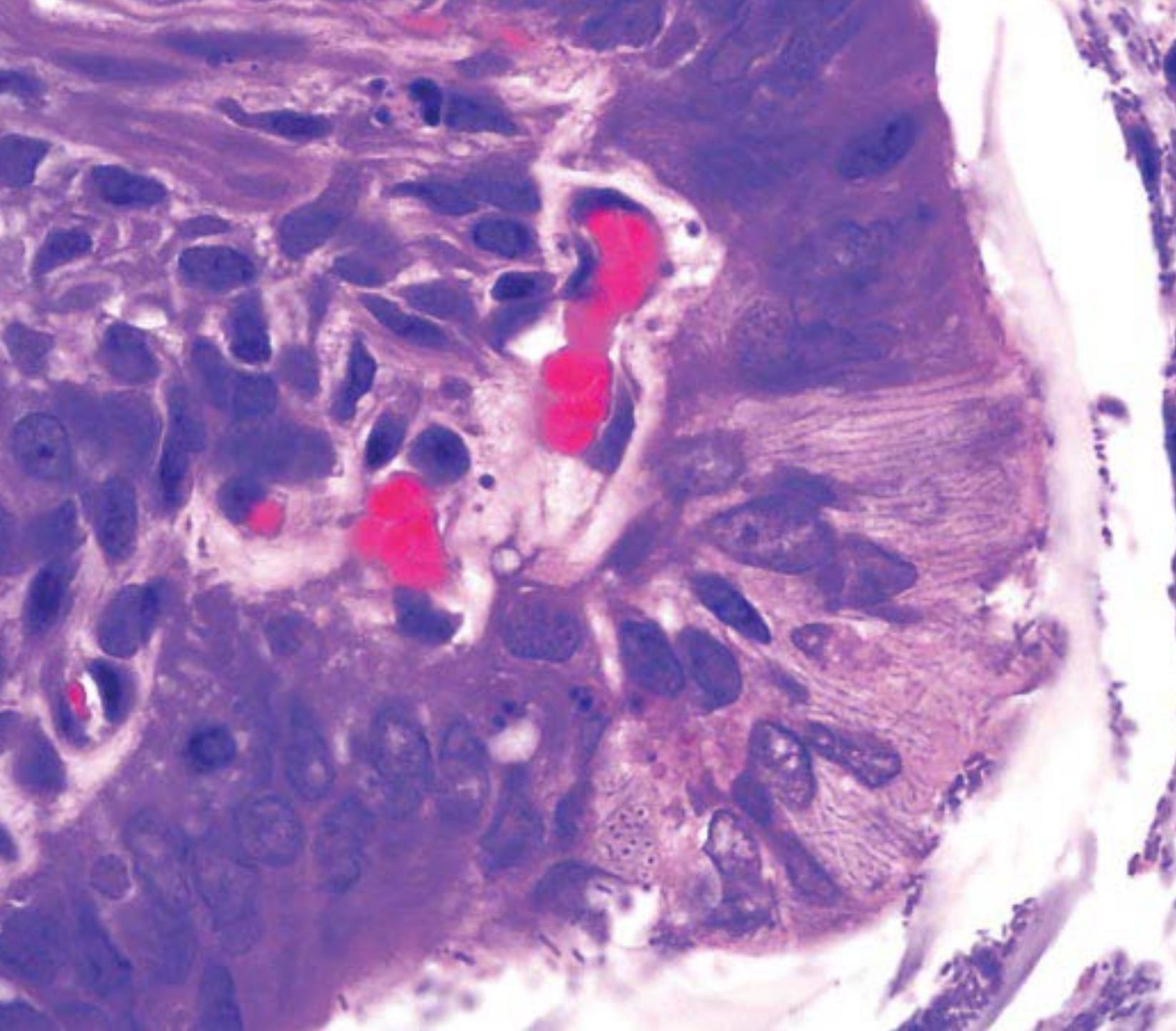
**MESSAGE TO REMEMBER**

Great majority of equine cases:  
Hepatitis









S. Diab

# Diagnosis

1-Embryonated egg inoculation (??)

2-PCR

3-Histology

# Confirmed diseases

1-*C. perfringens* type C: enterocolitis

2-*C. difficile*: enterocolitis

3-*C. piliforme*: colitis and hepatitis

## Other less understood entities

**1-Colitis X**

2-*C. perfringens* type A NetF+

3-*C. perfringens* type A CPB2+/CPE+

4-*C. sordellii* and others



D. Read

- \* Diagnosis by exclusion
- \* No Koch postulates
- \* No clear case definition
- \* No lab analysis available

Please do not use!!!!



Ariel uzal

# Confirmed diseases

1-*C. perfringens* type C: enteritis; enterocolitis

2-*C. difficile*: enterocolitis

3-*C. piliforme*: colitis and hepatitis

## Other less understood entities

1-Colitis X

2-*C. perfringens* type A NetF+

3-*C. perfringens* type A CPB2+

4-*C. sordellii* and others

# Canine hemorrhagic gastroenteritis Necrotizing enteritis of foals

*C. perfringens* type A NetF + isolates

High correlation isolation/disease

A novel pore-forming toxin in type A *Clostridium perfringens* is associated with both fatal canine hemorrhagic gastroenteritis and fatal foal necrotizing enterocolitis. Mehdizadeh Gohari I, Parreira VR, Nowell VJ, Nicholson VM, Oliphant K, Prescott JF. PLoS One. 2015 Apr 8;10(4):e0122684

# Identification of a novel pore-forming toxin in Type A *C. perfringens*

PLOS ONE

RESEARCH ARTICLE

## A Novel Pore-Forming Toxin in Type A *Clostridium perfringens* Is Associated with Both Fatal Canine Hemorrhagic Gastroenteritis and Fatal Foal Necrotizing Enterocolitis

Iman Mehdizadeh Gohari<sup>●</sup>, Valeria R. Parreira<sup>●</sup>, Victoria J. Nowell, Vivian M. Nicholson, Kaitlyn Oliphant, John F. Prescott\*

Department of Pathobiology, University of Guelph, Guelph, Ontario, Canada

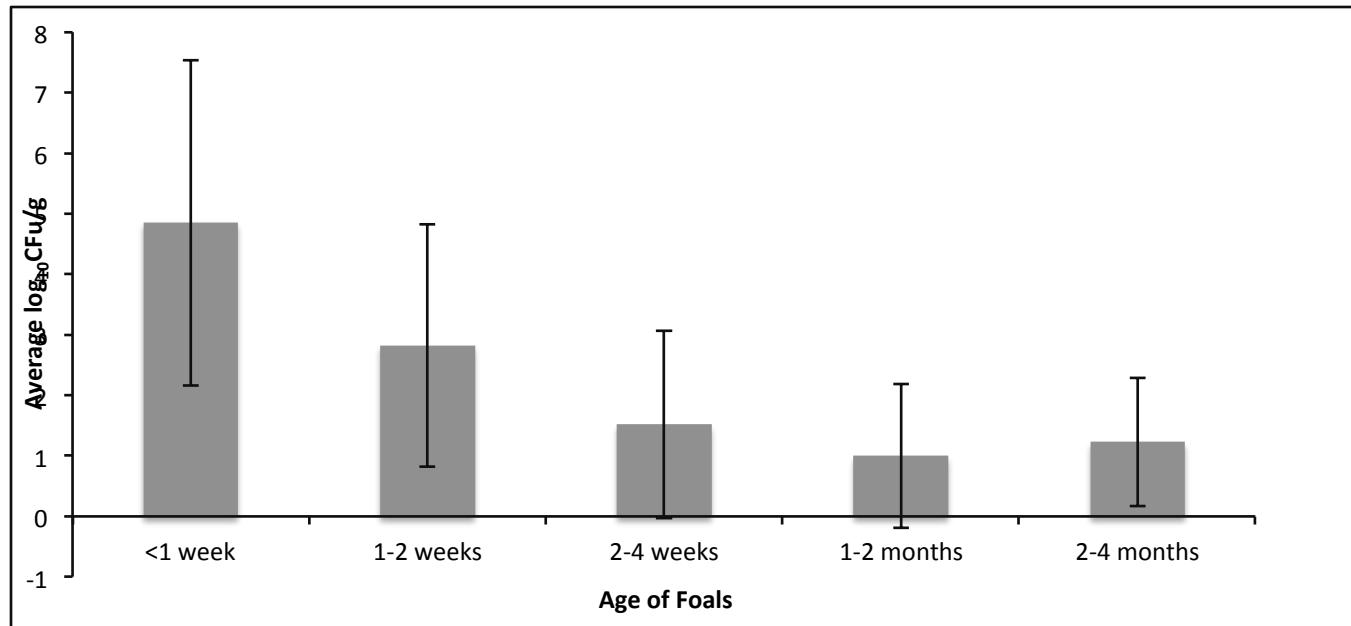
Published: April 8, 2015 • DOI: 10.1371/journal.pone.0122684





# Predisposition to NetF foal enteritis

- Foals: Trypsin inhibition by colostrum, no protection from NetF as multiply in small intestine?



*Clostridium perfringens* per gram of feces in foals, Ontario

*C. perfringens* type A beta 2 +

Type A *cpb2+* similar prevalence in  
healthy and sick horses

- Enterotoxin (*cpe*) in 20-30% of adults and foals with typhlocolitis (Donaldson and Palmer, 1999; Weese *et al.*, 2001)

Role CPE in disease  
undetermined

# Confirmed diseases

1-*C. perfringens* type C: enteritis; enterocolitis

2-*C. difficile*: enterocolitis

3-*C. piliforme*: colitis and hepatitis

## Other less understood entities

1-Colitis X

2-*C. perfringens* type A

3-*C. perfringens* type A CPB2

4-*C. sordellii* and others

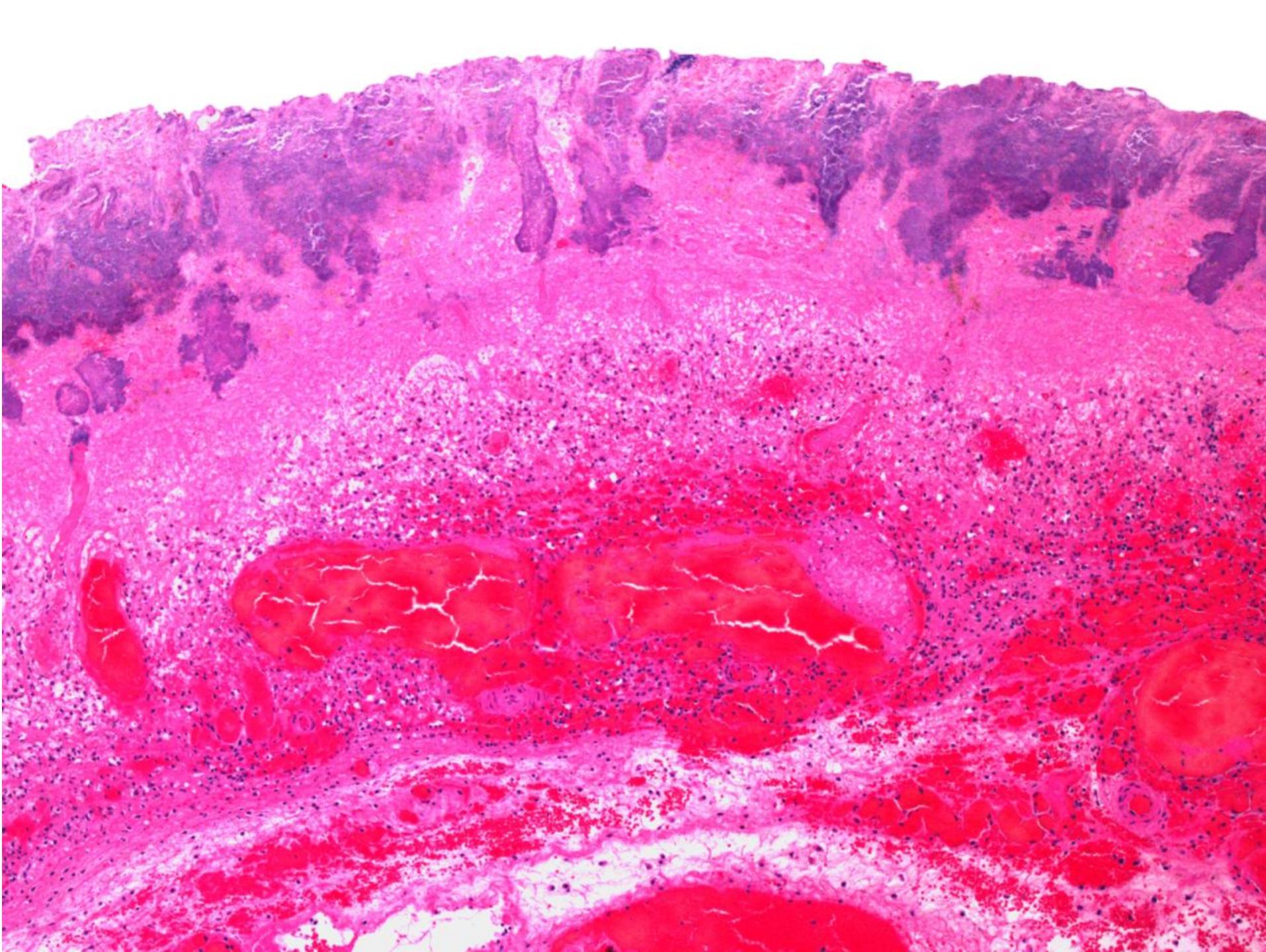
Enterocolitis with large # of

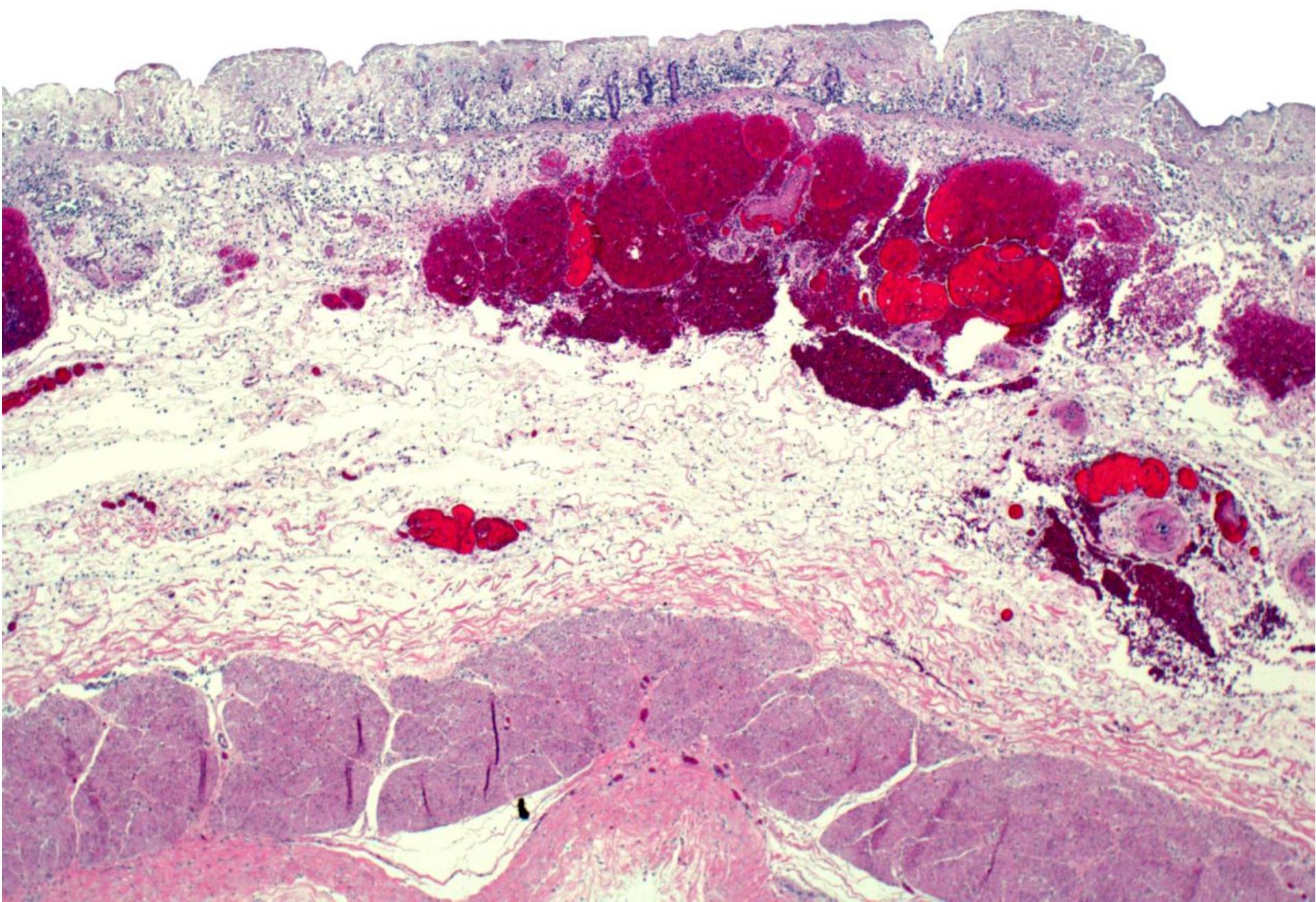
*Clostridium (Paeniclostridium) sordellii*

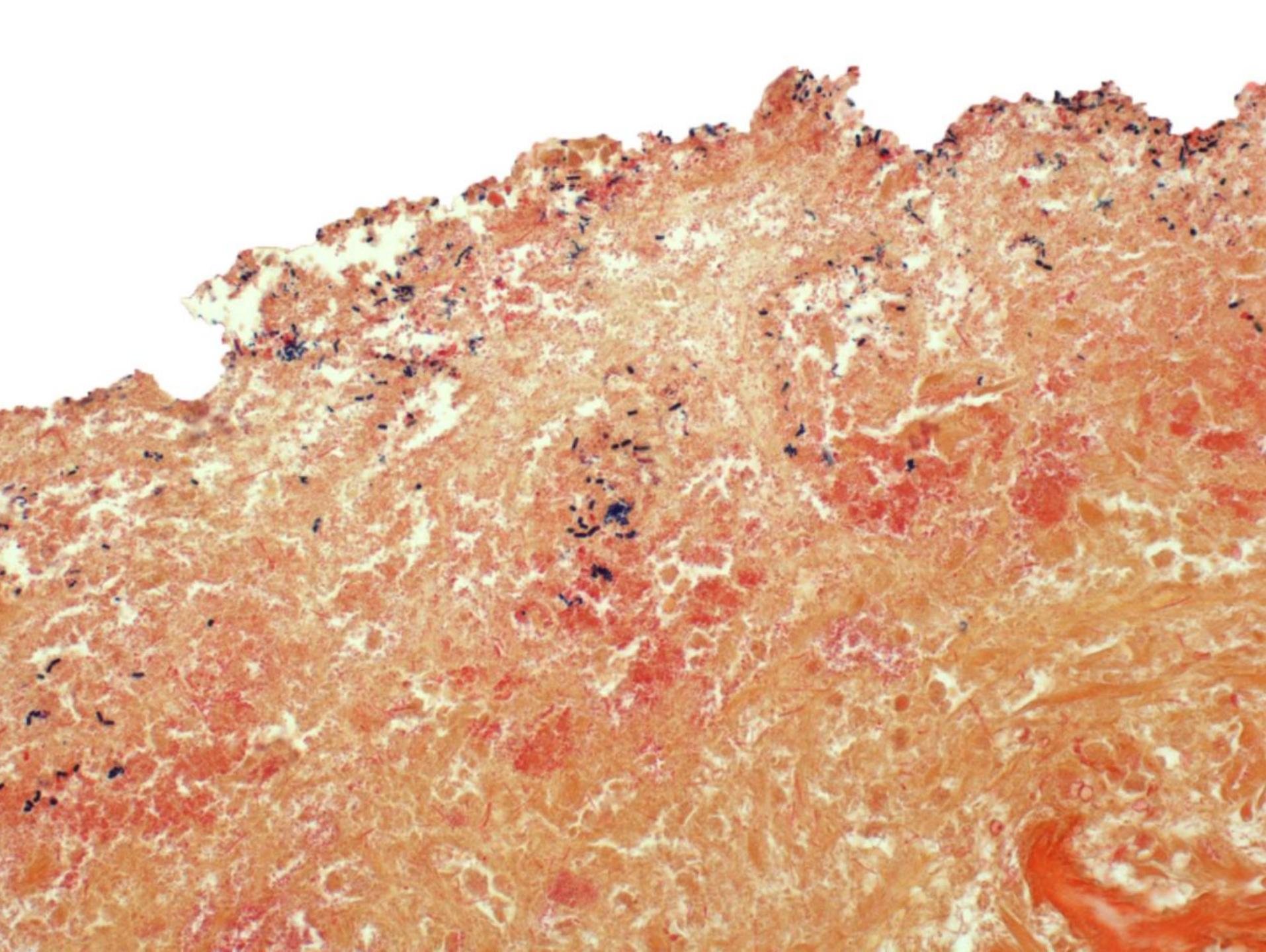
All other tests negative











# Diagnostic criteria: not established

Gross lesions

Micro lesions

Detection *C. sordellii*

Negative testing for other agents



Suggestive

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## Bacterial

*Clostridium* spp.

*Salmonella* spp.

*Rhodococcus equi*

*Ehrlichia ristiacci*

*Lawsonia intracellularis*

Others

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## Parasitic

*Strongylus* spp.

*Parascaris equorum*

Others

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## Viral

Rotavirus

Coronavirus

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## Fungal

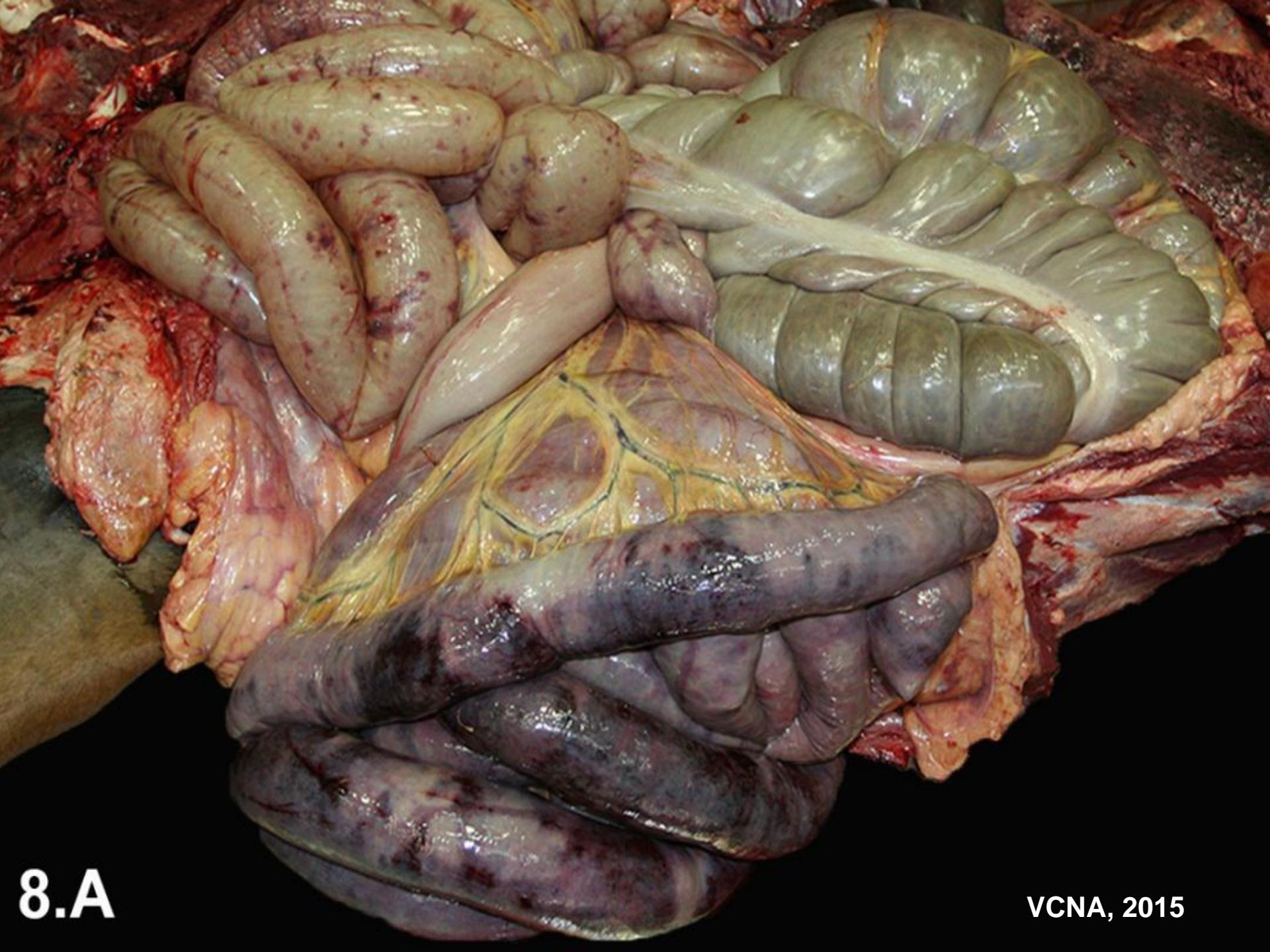
Various

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***Salmonella enterica* ssp. *enterica*  
serovar Typhimurium**

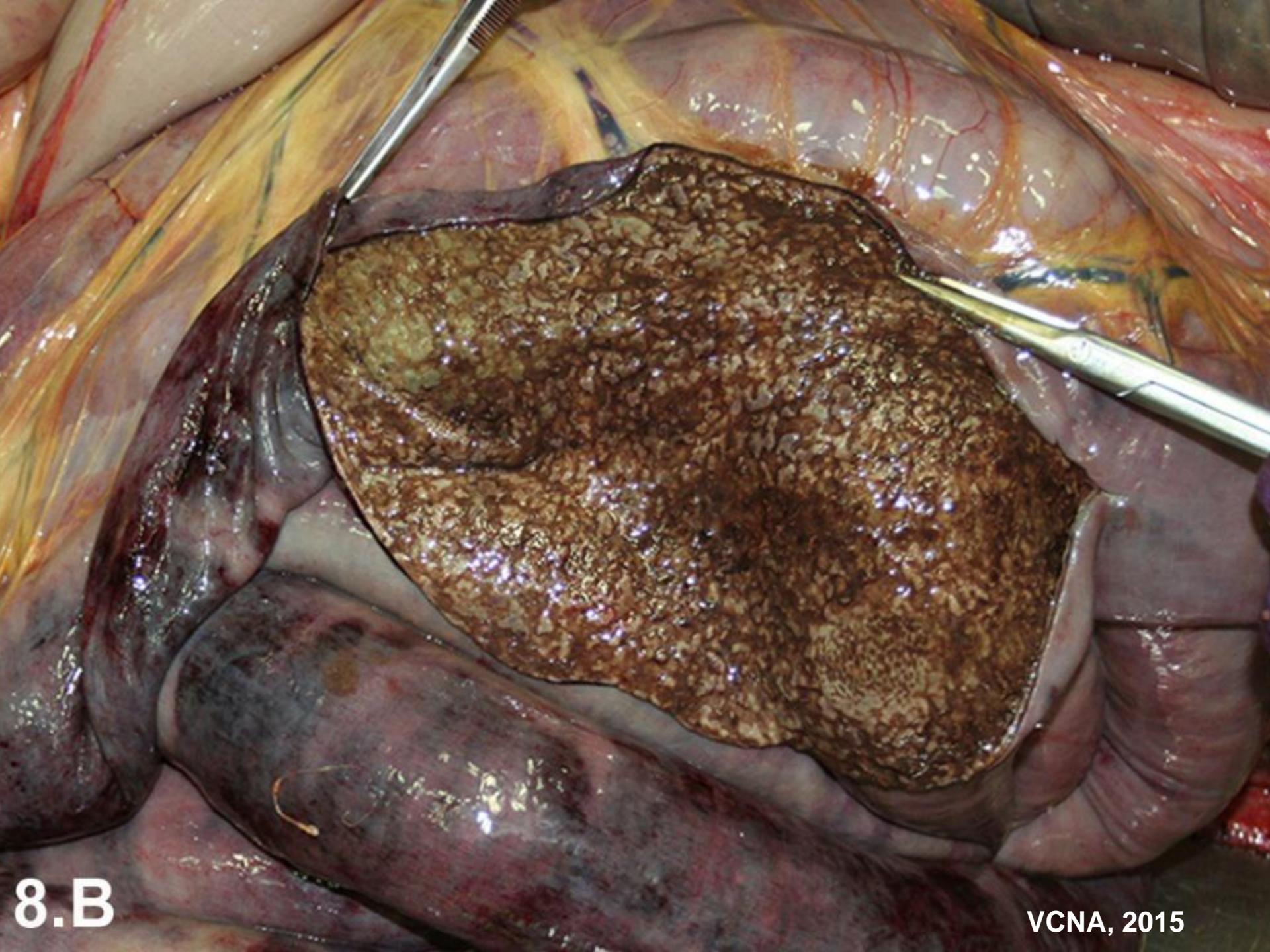
=

***Salmonella* Typhimurium**



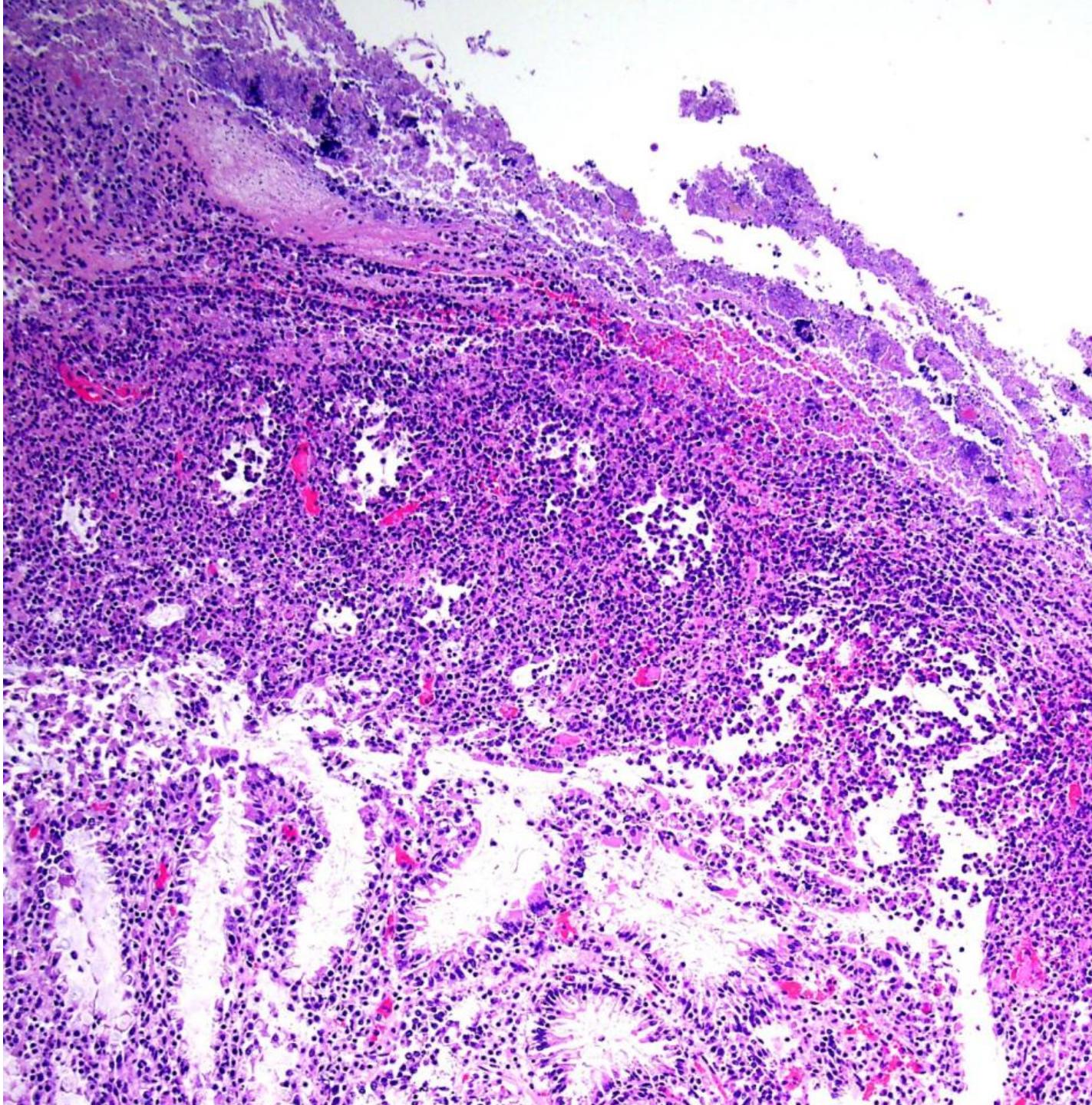
8.A

VCNA, 2015



8.B

VCNA, 2015



# **DIAGNOSIS**

**1-Gross/microscopic pathology**

**2-Culture/PCR: intestinal content/feces/tissues**

**3-Serogrouping/serotyping**

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## Bacterial

*Clostridium* spp.

*Salmonella* spp.

*Rhodococcus equi*

*Ehrlichia ristiacci*

*Lawsonia intracellularis*

Others

---

## Parasitic

*Strongylus* spp.

*Parascaris equorum*

Others

---

## Viral

Rotavirus

Coronavirus

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## Fungal

Various

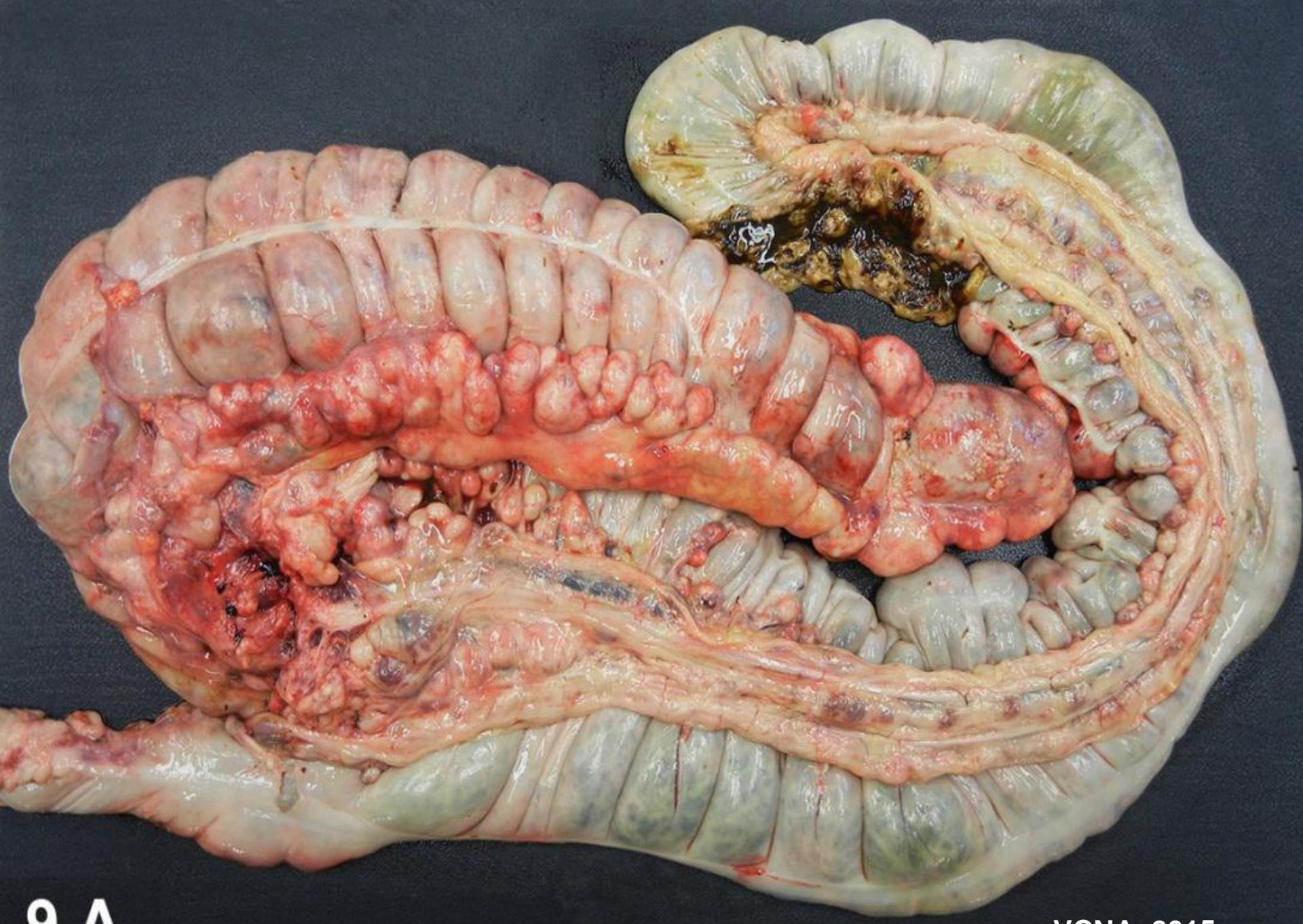
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# Abdominal lesions

(~ 50% of foals with *R. equi* pneumonia)

- \* pyogranulomatous enterotyphylocolitis
- \* pyogranulomatous lymphadenitis
- \* intra-abdominal abscesses
- \* peritonitis

- \* Bacteria swallowed in respiratory exudate
- \* Colitis without pneumonia?

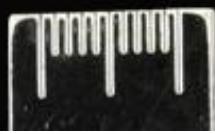
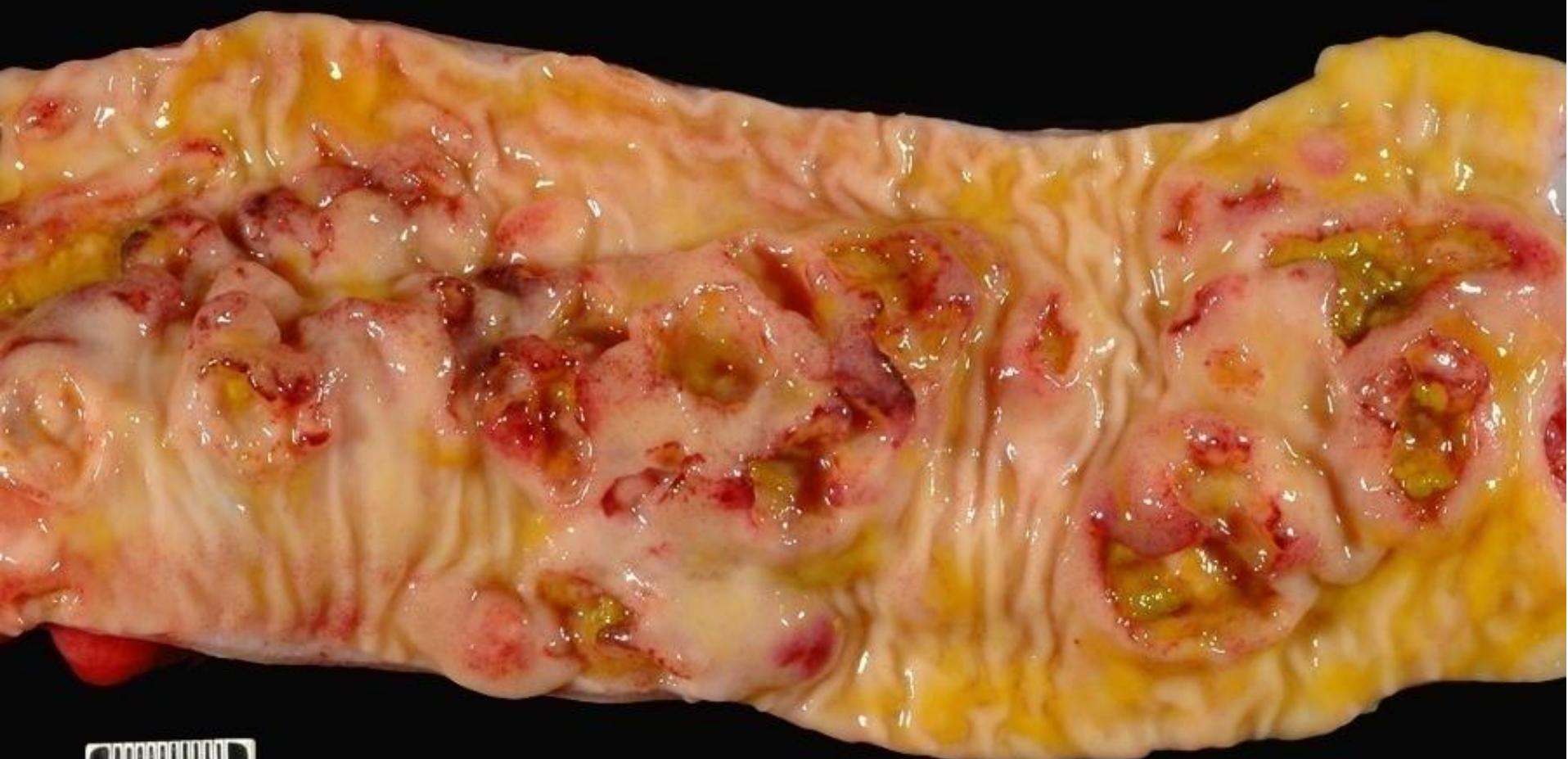


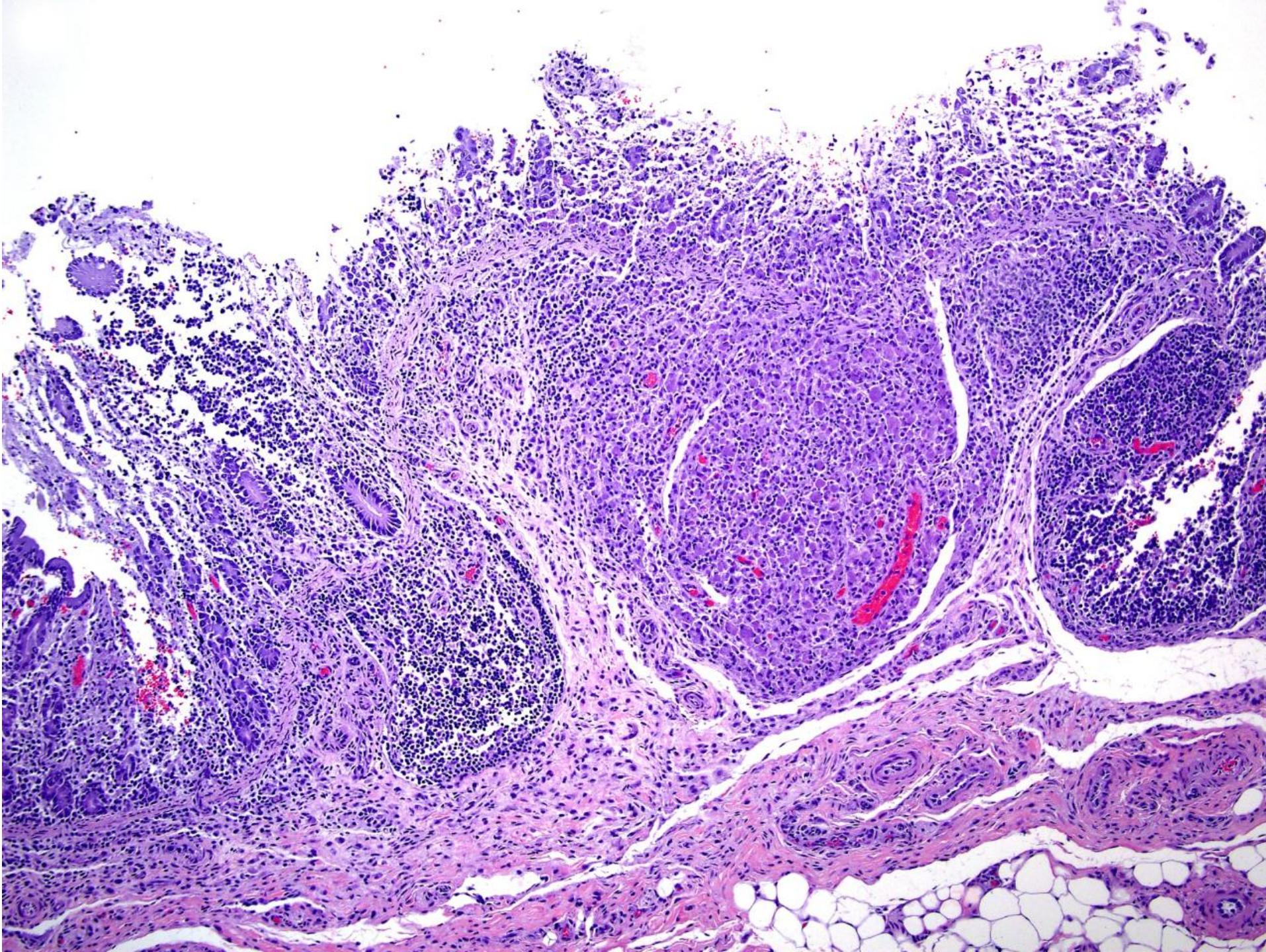
9.A

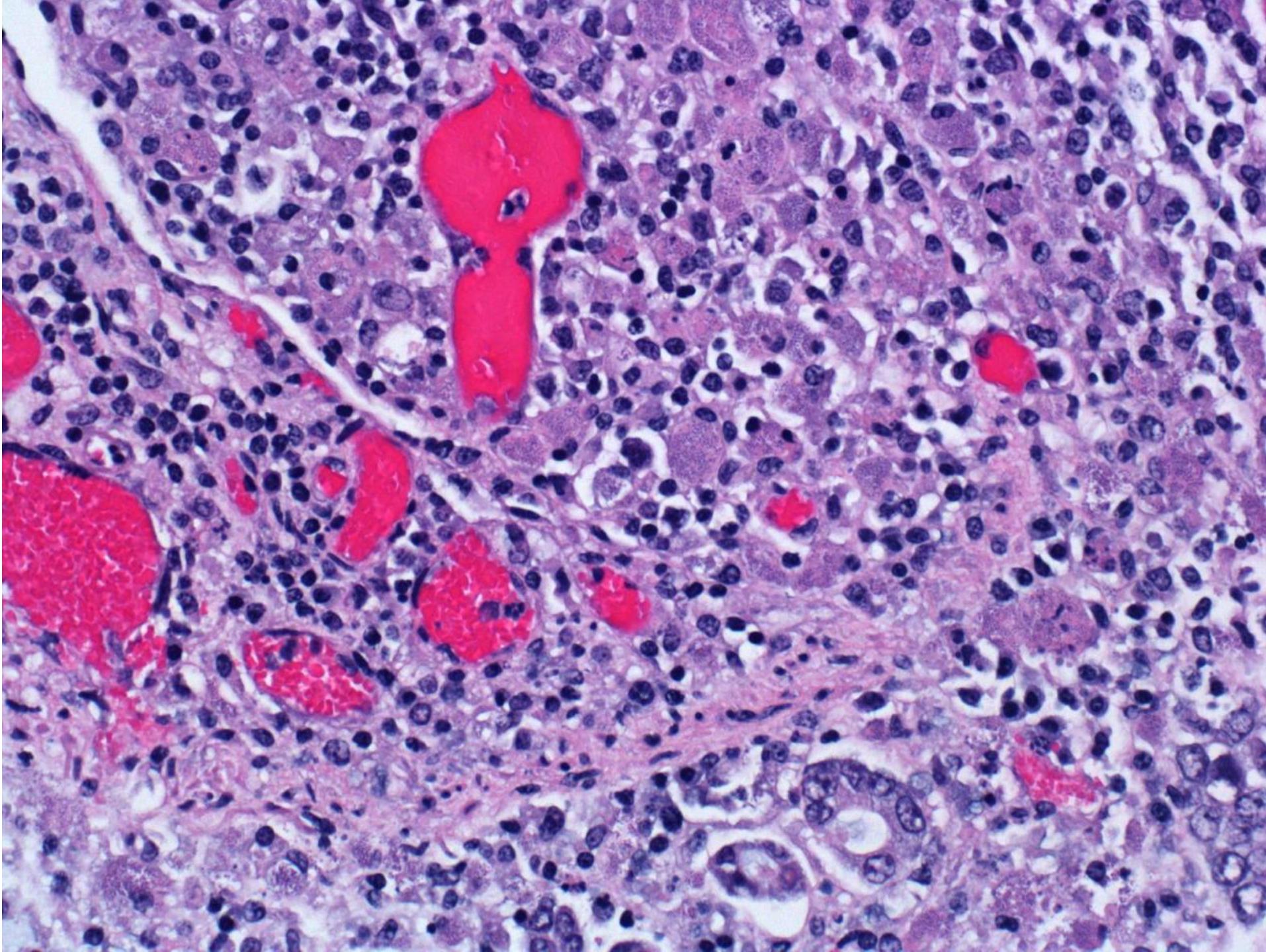
VCNA, 2015

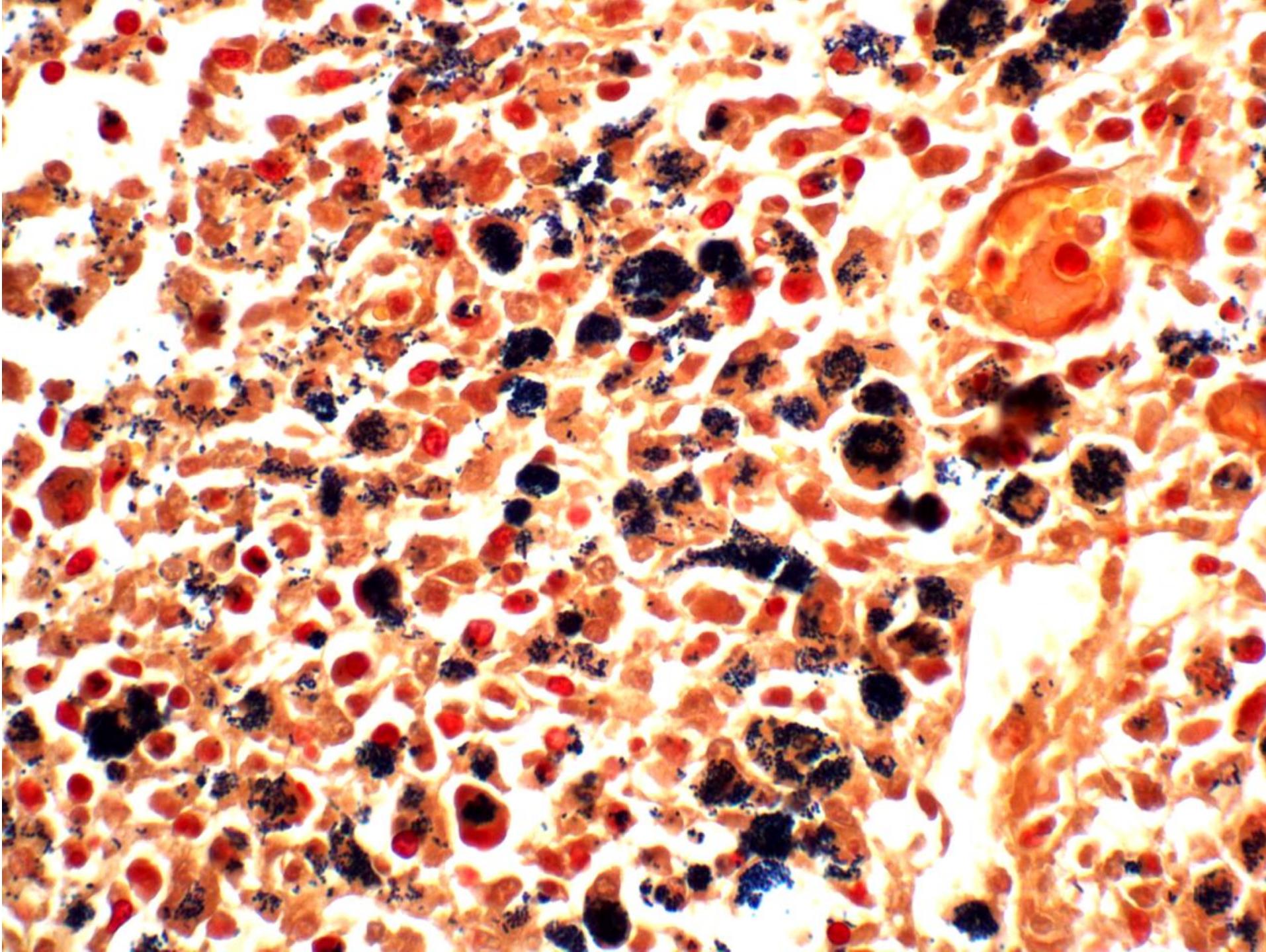


L. Minatel









# **DIAGNOSIS**

**1-Gross/histo lesions (almost.....)**

**2-Culture tissues/intestinal content  
(PCR determination virulence plasmid)**

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## Bacterial

*Clostridium* spp.

*Salmonella* spp.

*Rhodococcus equi*

*Ehrlichia ristiacci*

*Lawsonia intracellularis*

Others

---

## Parasitic

*Strongylus* spp.

*Parascaris equorum*

Others

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## Viral

Rotavirus

Coronavirus

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## Fungal

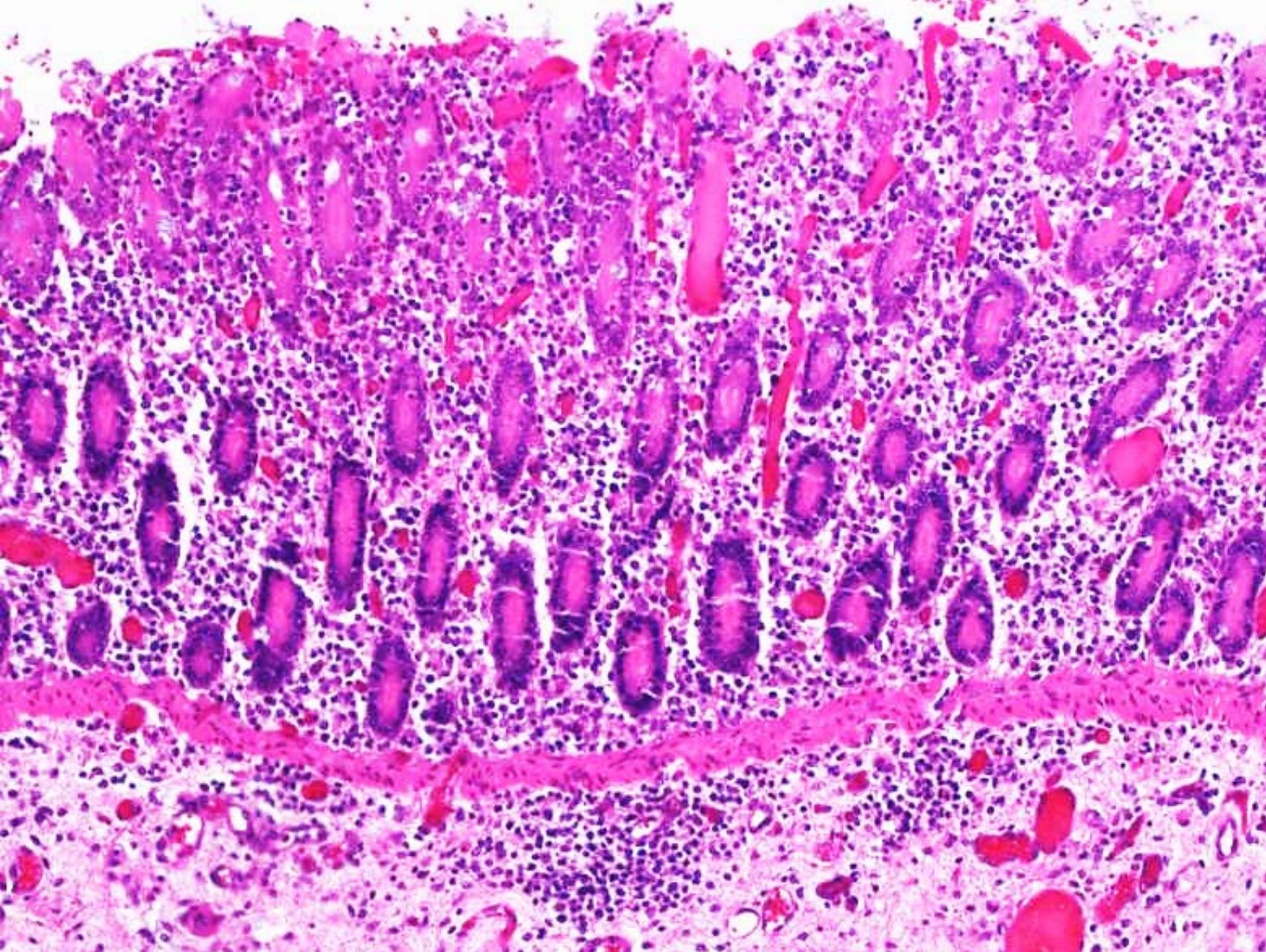
Various

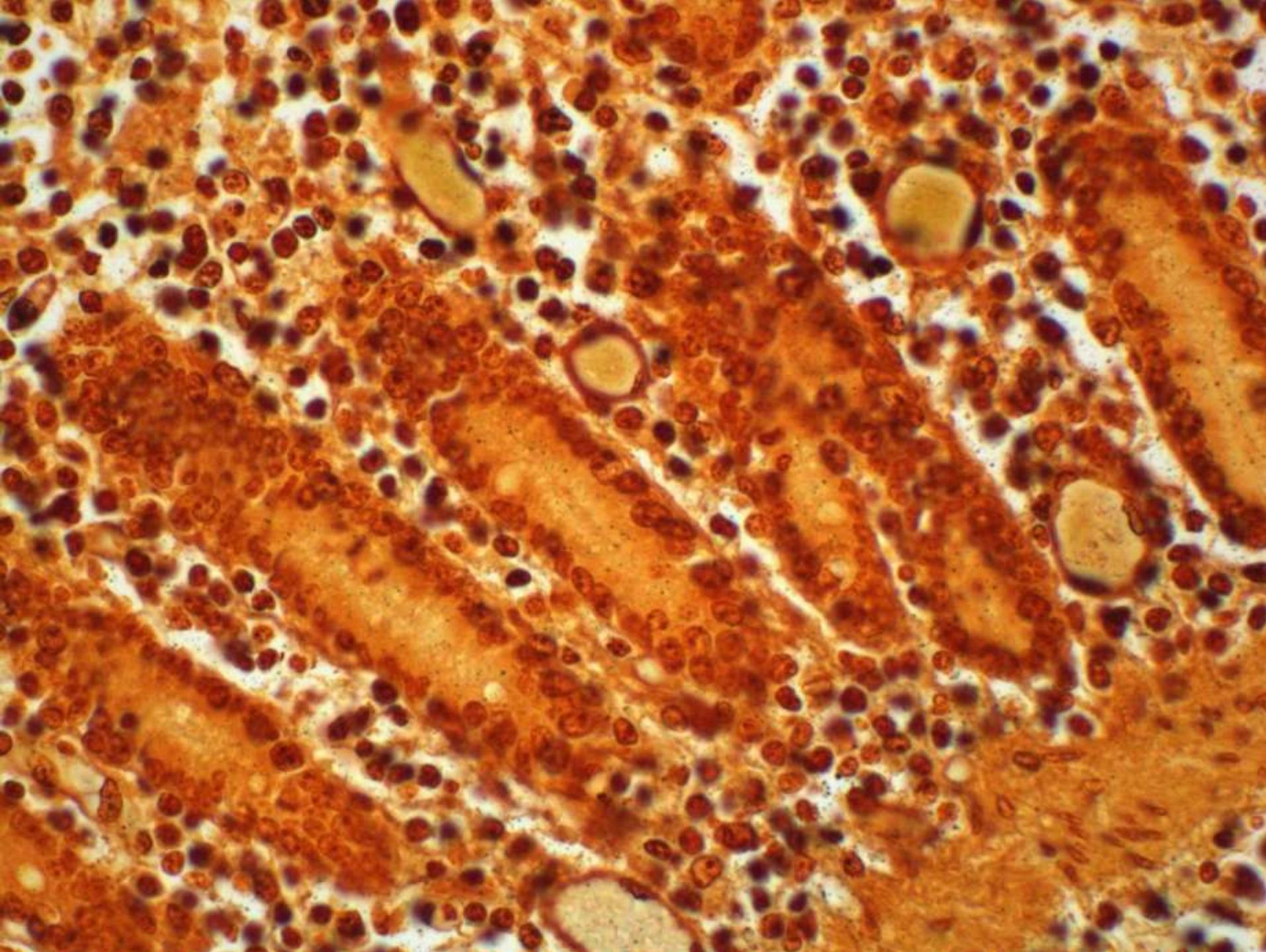
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# Potomac horse fever

70E1379 DDH







# DIAGNOSIS

1-Intracellular microorganisms (silver)  
(painful!!!!)

2- PCR: feces/peripheral buffy coat

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## **Bacterial**

*Clostridium* spp.

*Salmonella* spp.

*Rhodococcus equi*

*Ehrlichia ristiacci*

*Lawsonia intracellularis*

Others

---

## **Parasitic**

*Strongylus* spp.

*Parascaris equorum*

Others

---

## **Viral**

Rotavirus

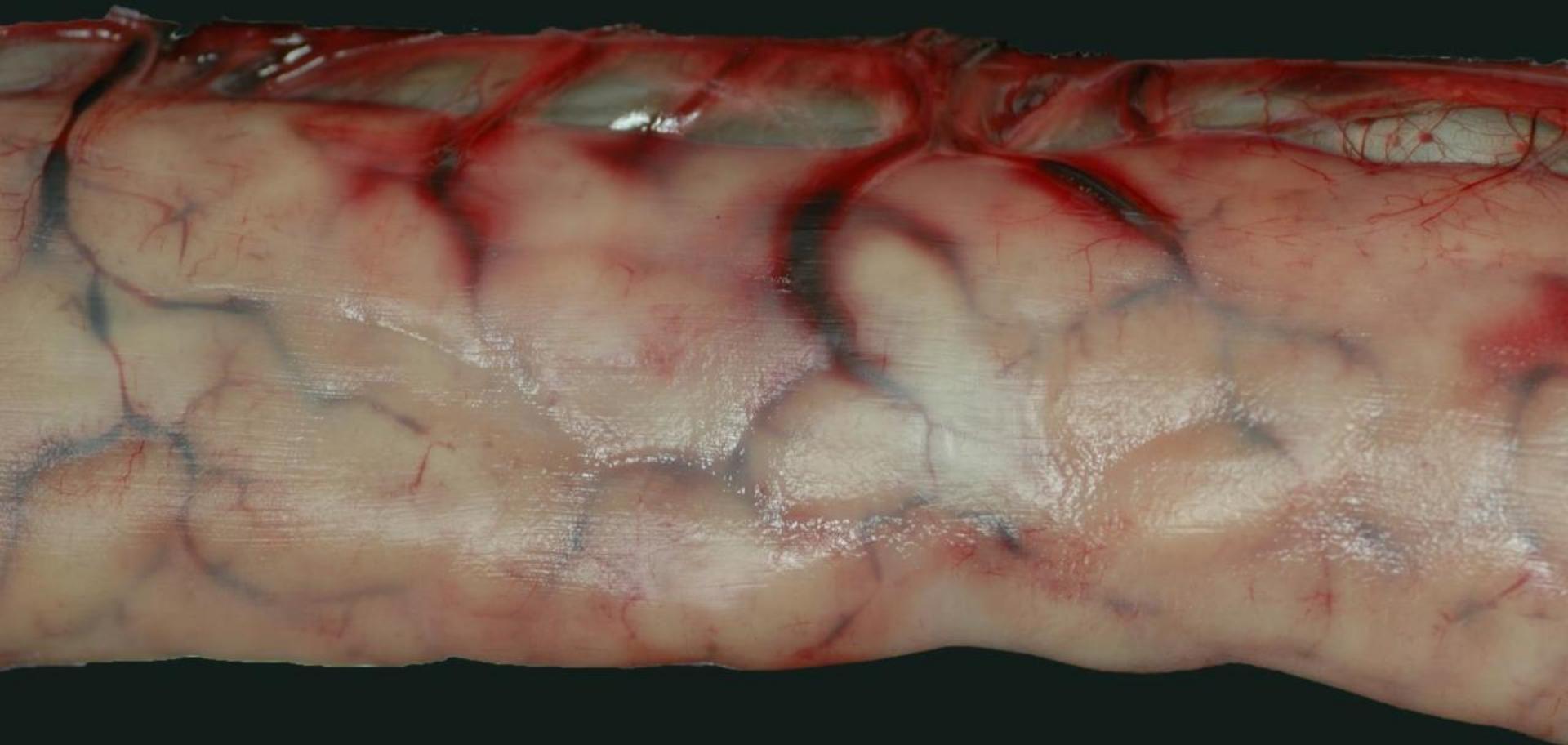
Coronavirus

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## **Fungal**

Various

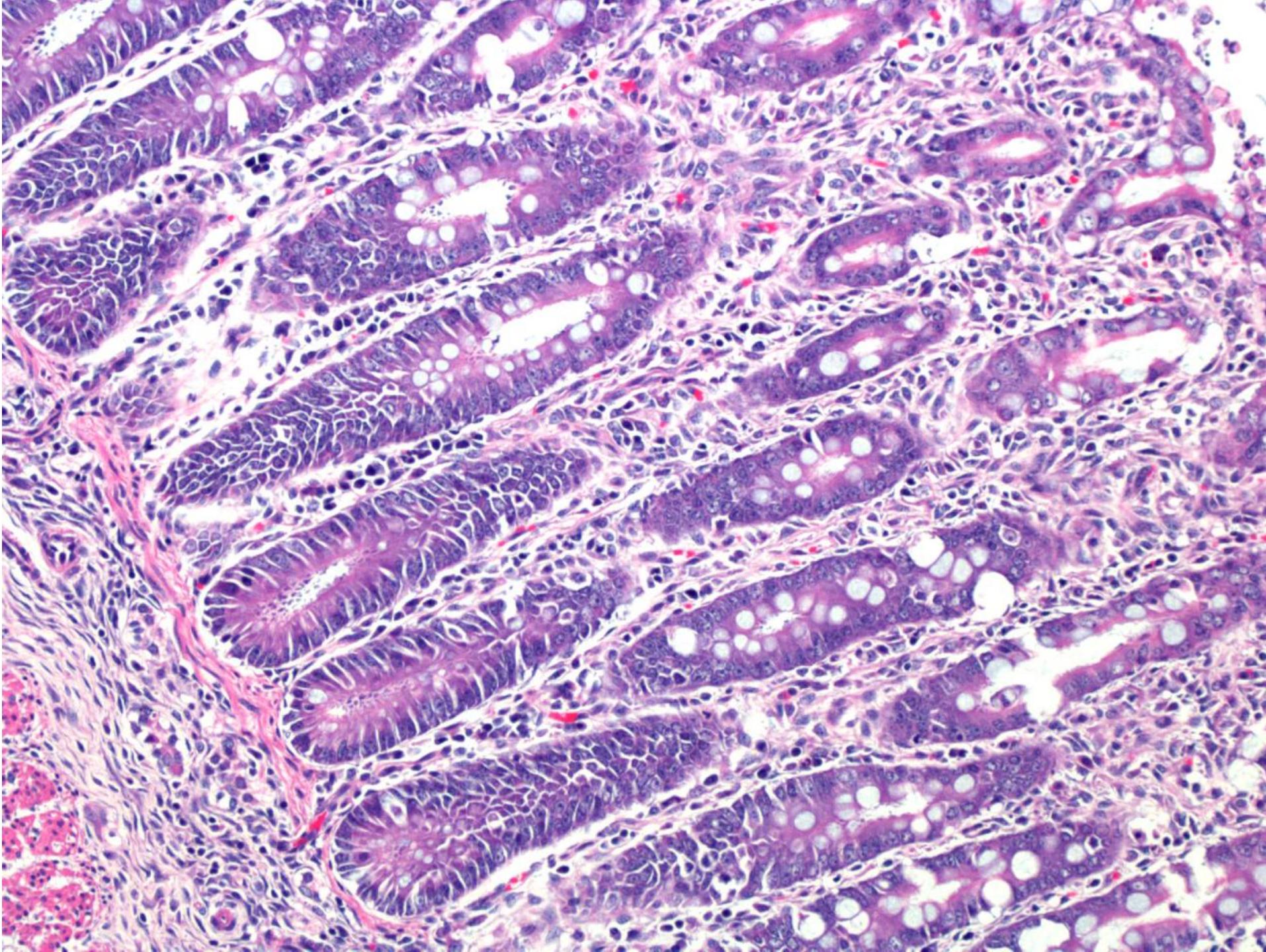
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Robert Heines



Robert Heines



A high-magnification light micrograph showing several tissue sections. The sections exhibit a mottled brown color, likely from hematoxylin staining, with darker, more concentrated areas suggesting cellular nuclei or specific tissue components. The overall texture is somewhat granular and lacks a clear, organized structure.

F. del Piero

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## **Bacterial**

*Clostridium* spp.

*Salmonella* spp.

*Rhodococcus equi*

*Ehrlichia ristiacci*

*Lawsonia intracellularis*

**Others**

---

## **Parasitic**

*Strongylus* spp.

*Parascaris equorum*

**Others**

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## **Viral**

Rotavirus

Coronavirus

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## **Fungal**

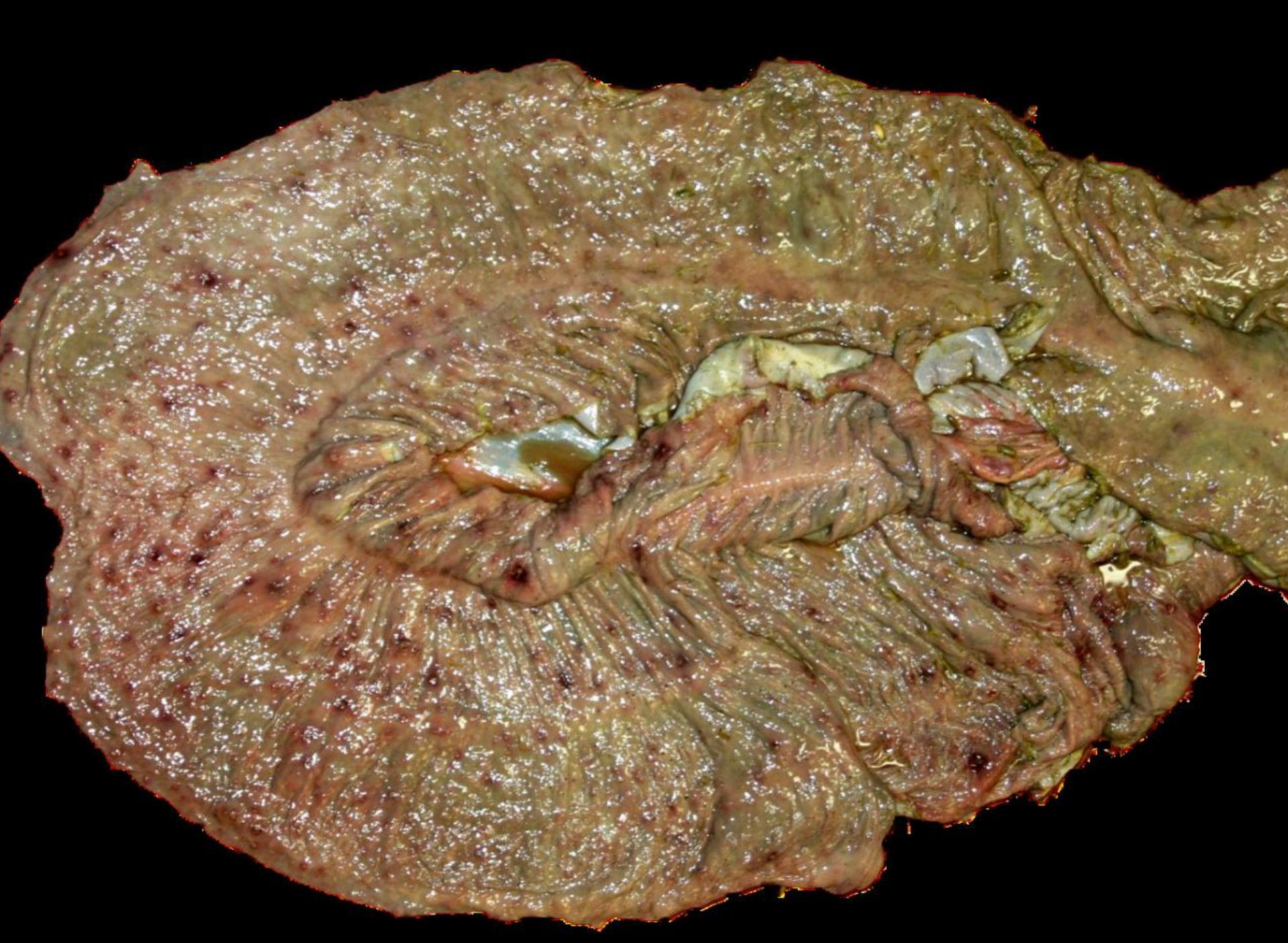
Various

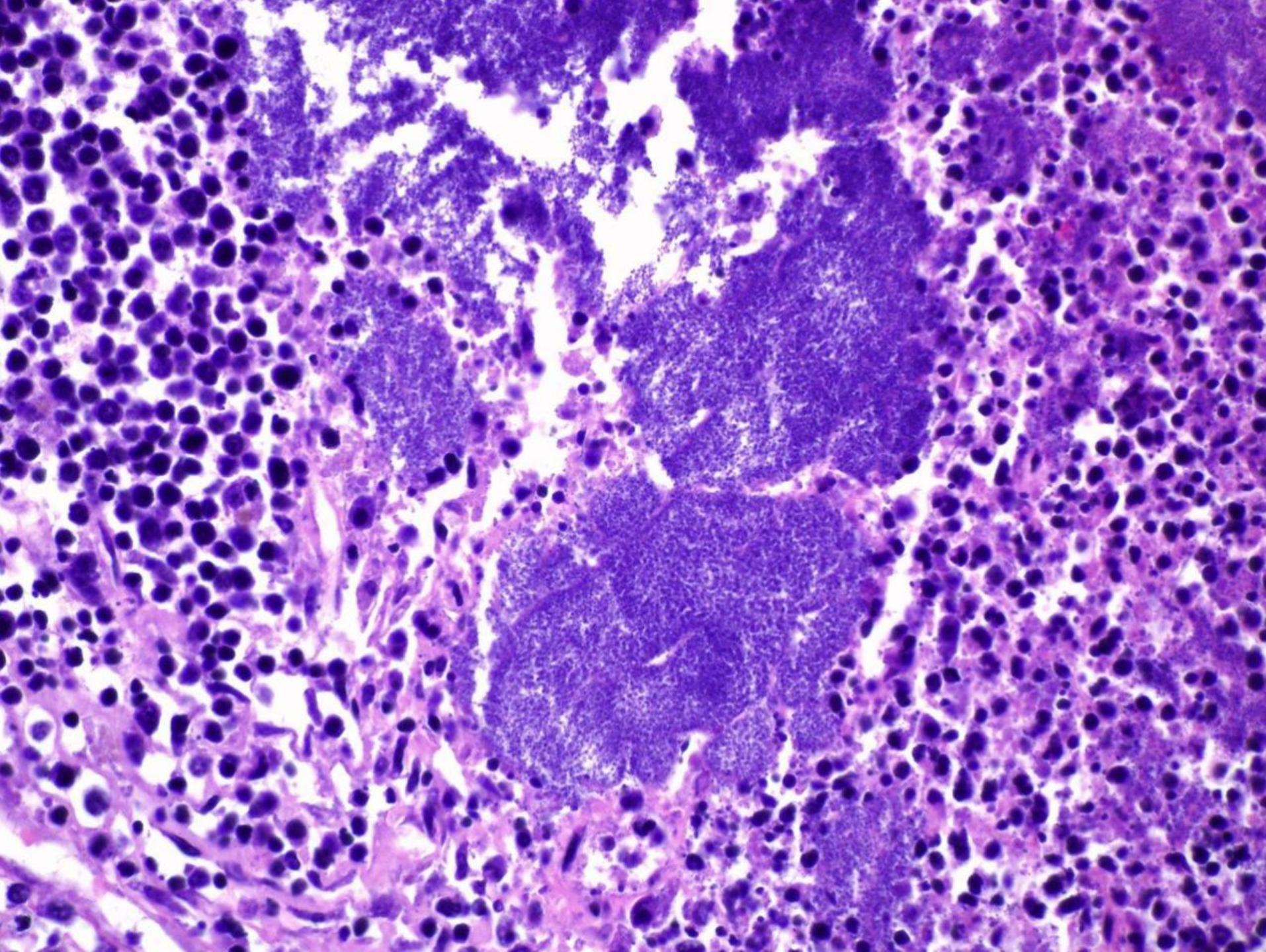
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*Actinobacillus equuli*



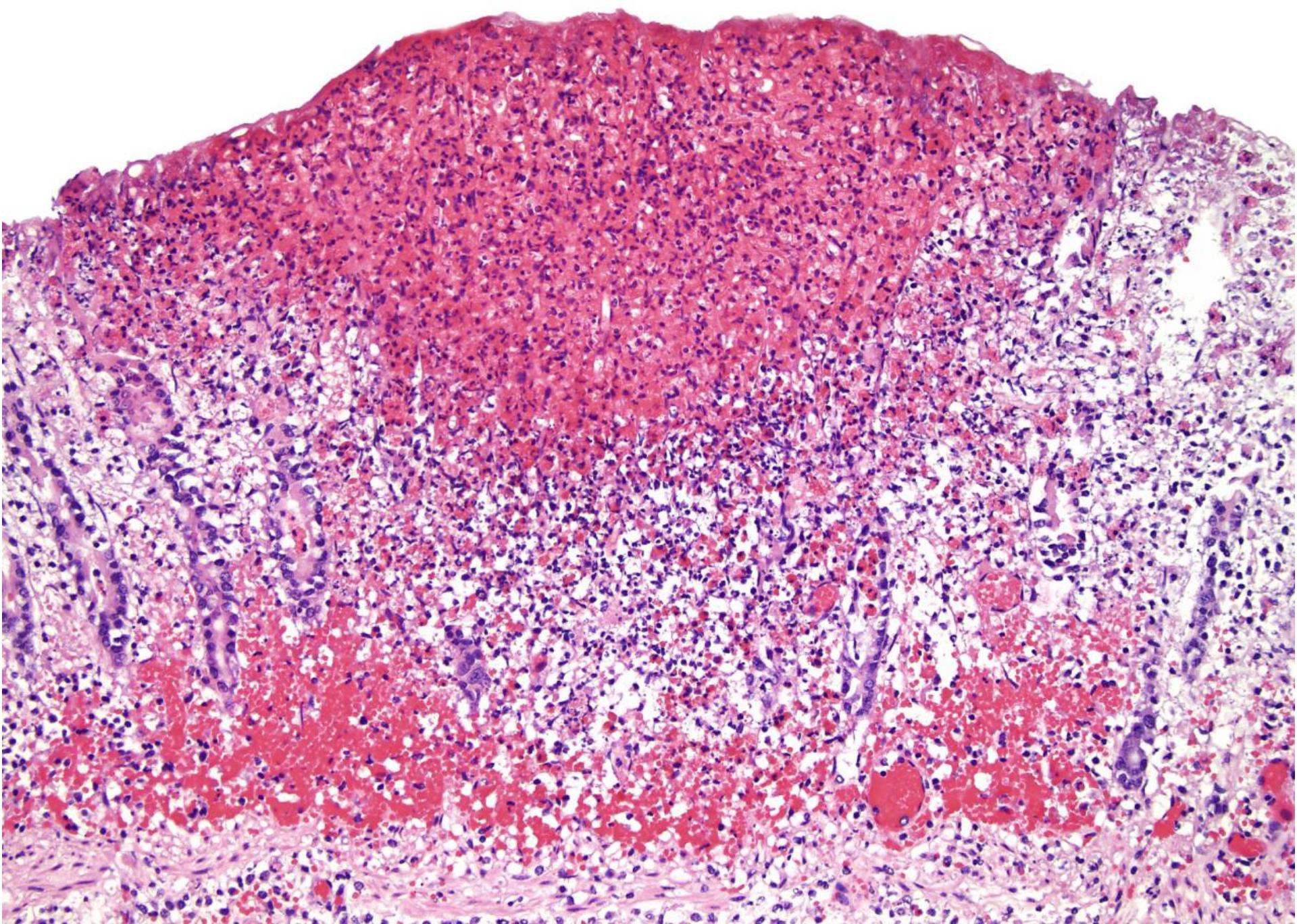


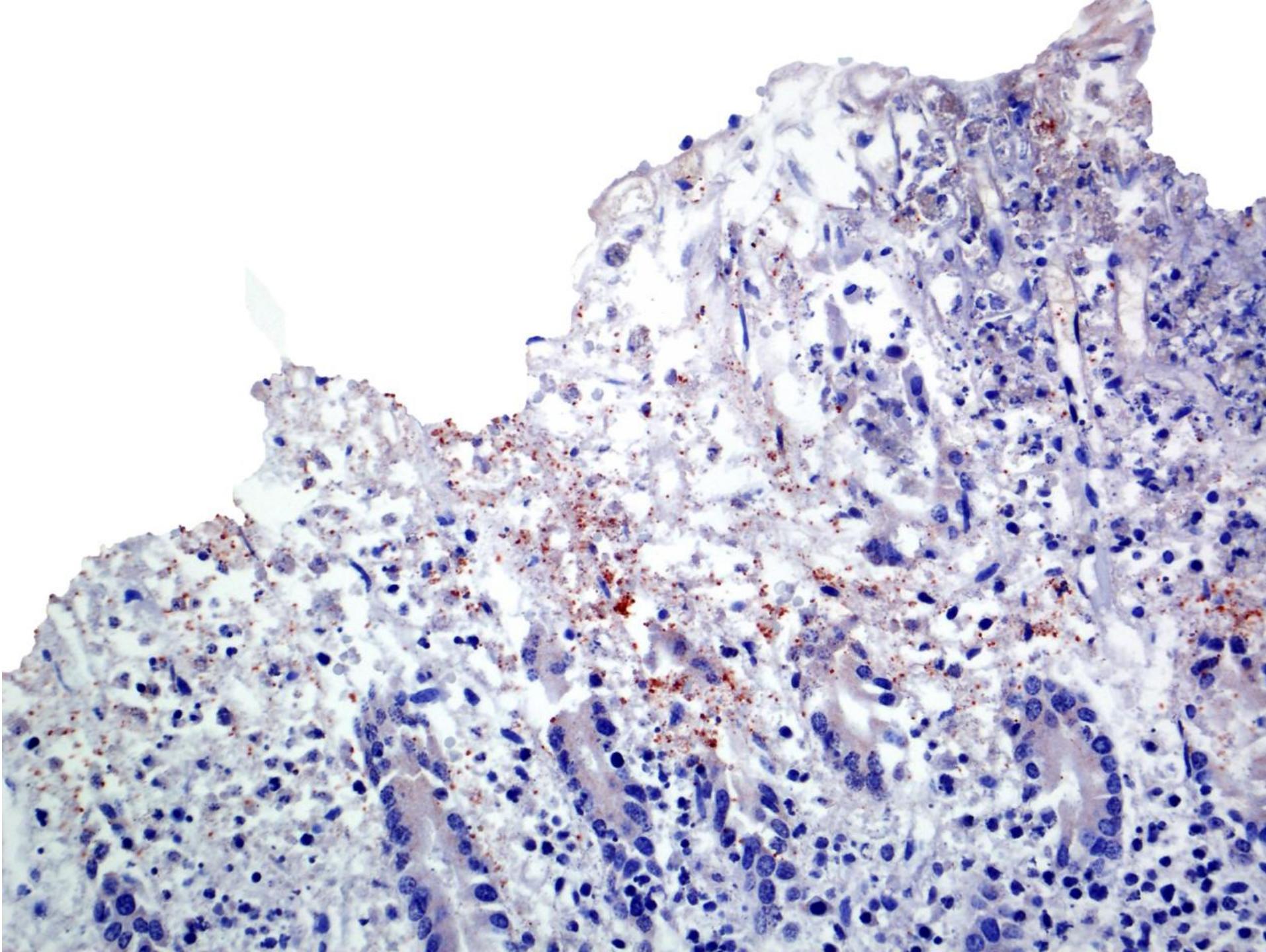




*Streptococcus equi*, *Klebsiella spp.*, *Listeria spp.*







# DIAGNOSIS

- 1-Gross/histo lesions
- 2-Ruling out other causes
- 3-Isolation/IHC/PCR?

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## Bacterial

*Clostridium* spp.

*Salmonella* spp.

*Rhodococcus equi*

*Ehrlichia ristiacci*

*Lawsonia intracellularis*

Others

---

## Parasitic

*Strongylus* spp.

*Parascaris equorum*

Others

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## Viral

Rotavirus

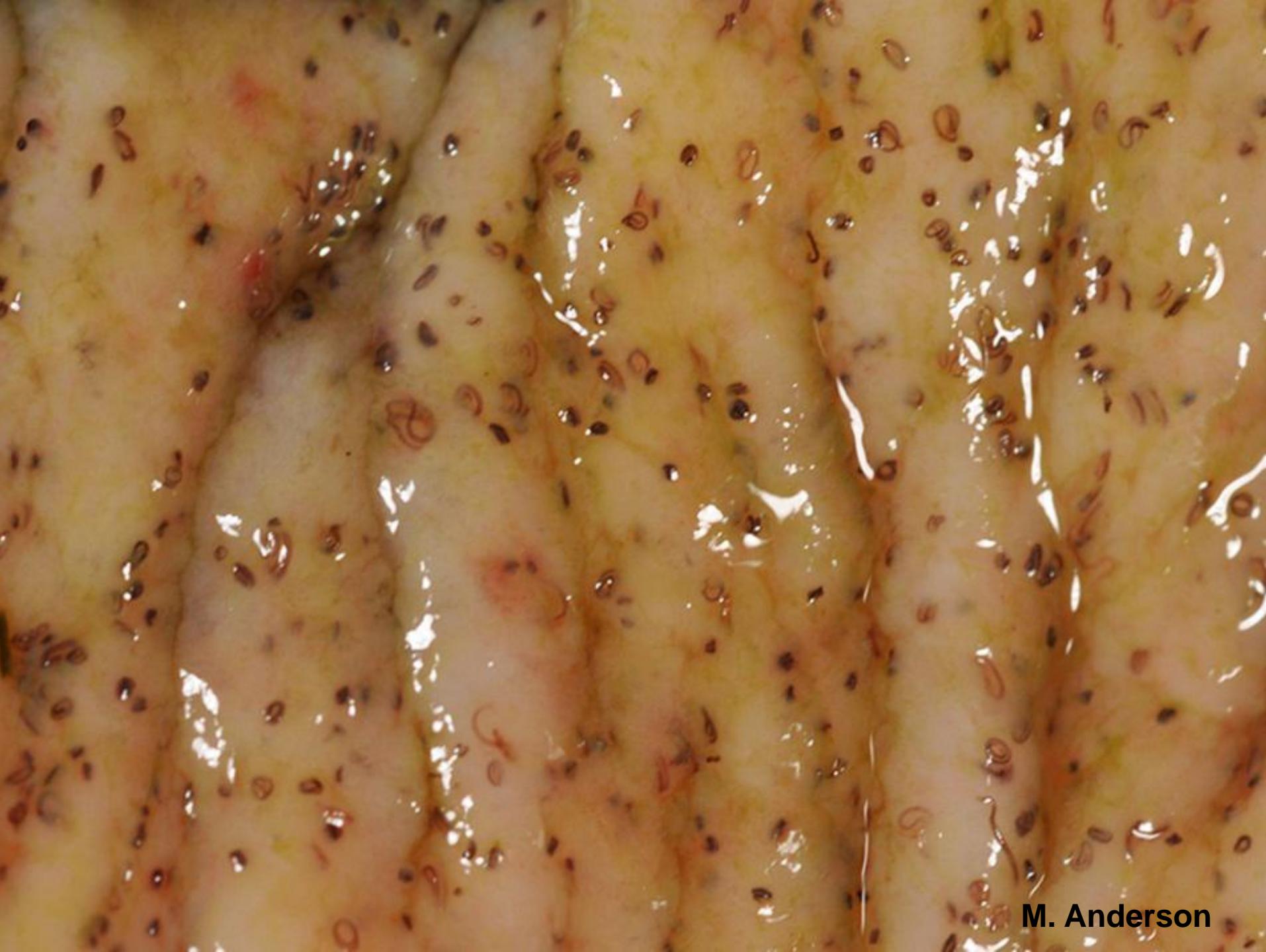
Coronavirus

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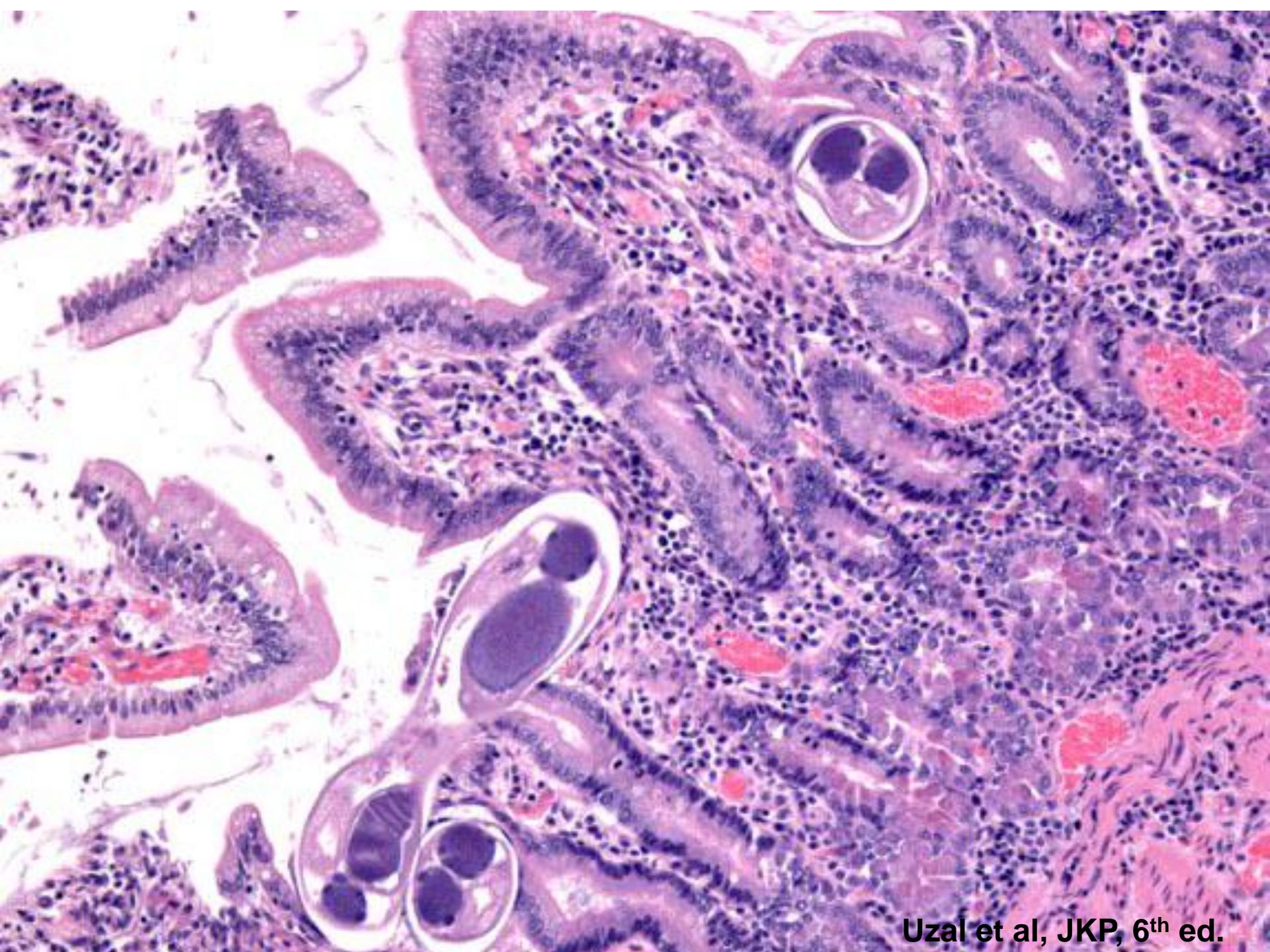
## Fungal

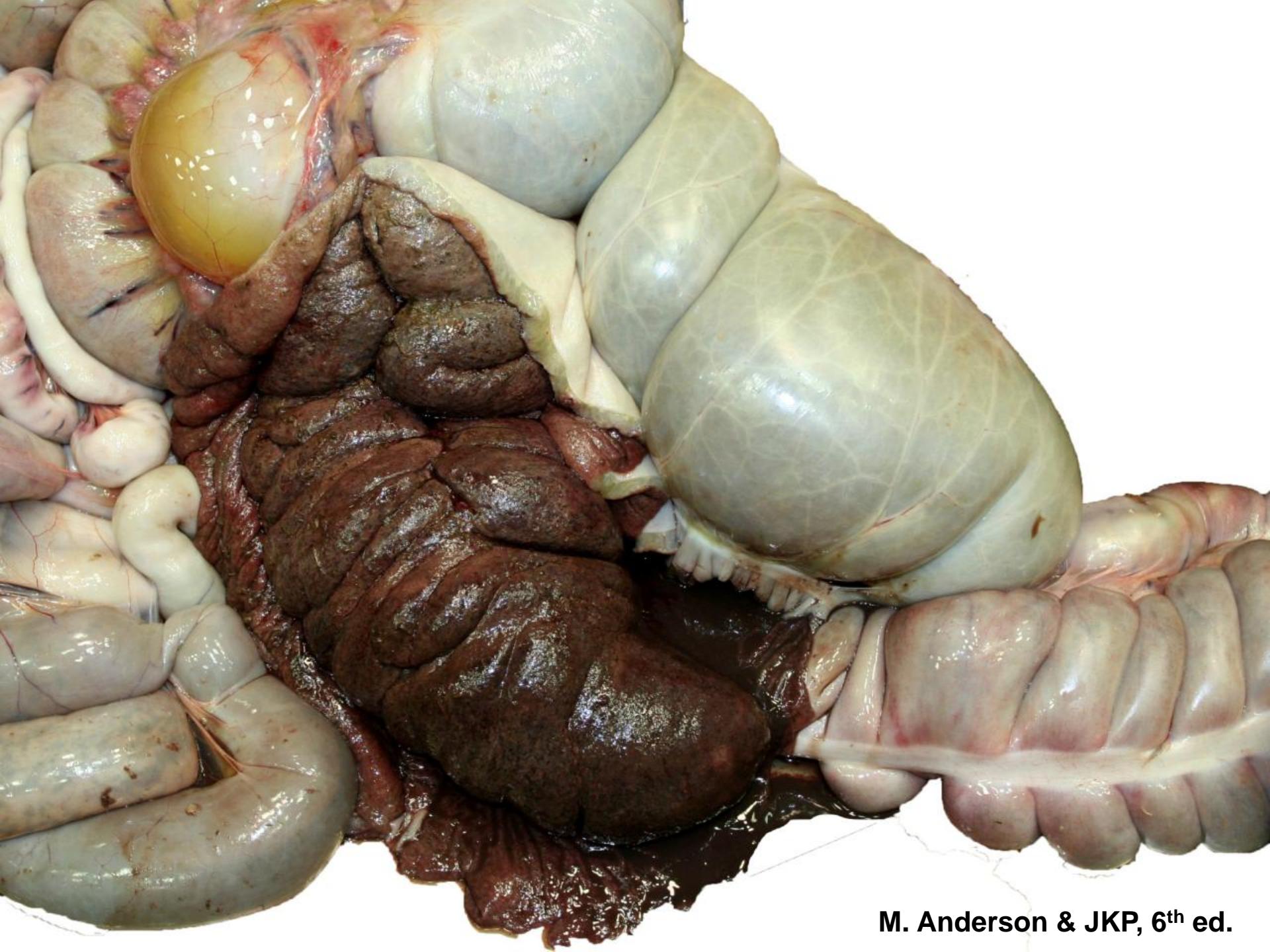
Various

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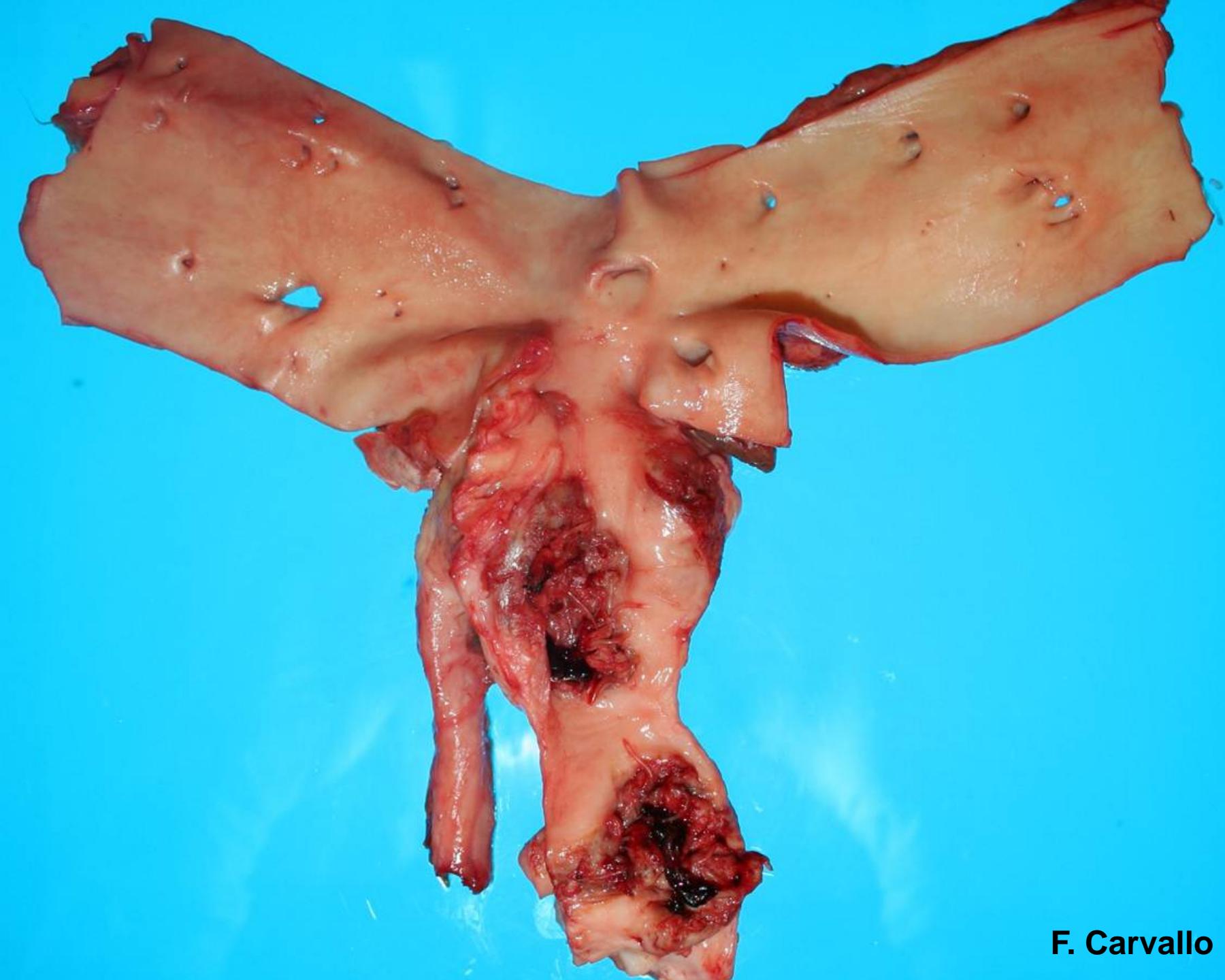


M. Anderson





M. Anderson & JKP, 6<sup>th</sup> ed.



F. Carvallo

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## Bacterial

*Clostridium* spp.

*Salmonella* spp.

*Rhodococcus equi*

*Ehrlichia ristiacci*

*Lawsonia intracellularis*

Others

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## Parasitic

*Strongylus* spp.

*Parascaris equorum*

Others

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## Viral

Rotavirus

Coronavirus

---

## Fungal

Various

---



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## Bacterial

*Clostridium* spp.

*Salmonella* spp.

*Rhodococcus equi*

*Ehrlichia ristiacci*

*Lawsonia intracellularis*

Others

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## Parasitic

*Strongylus* spp.

*Parascaris equorum*

Others

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## Viral

Rotavirus

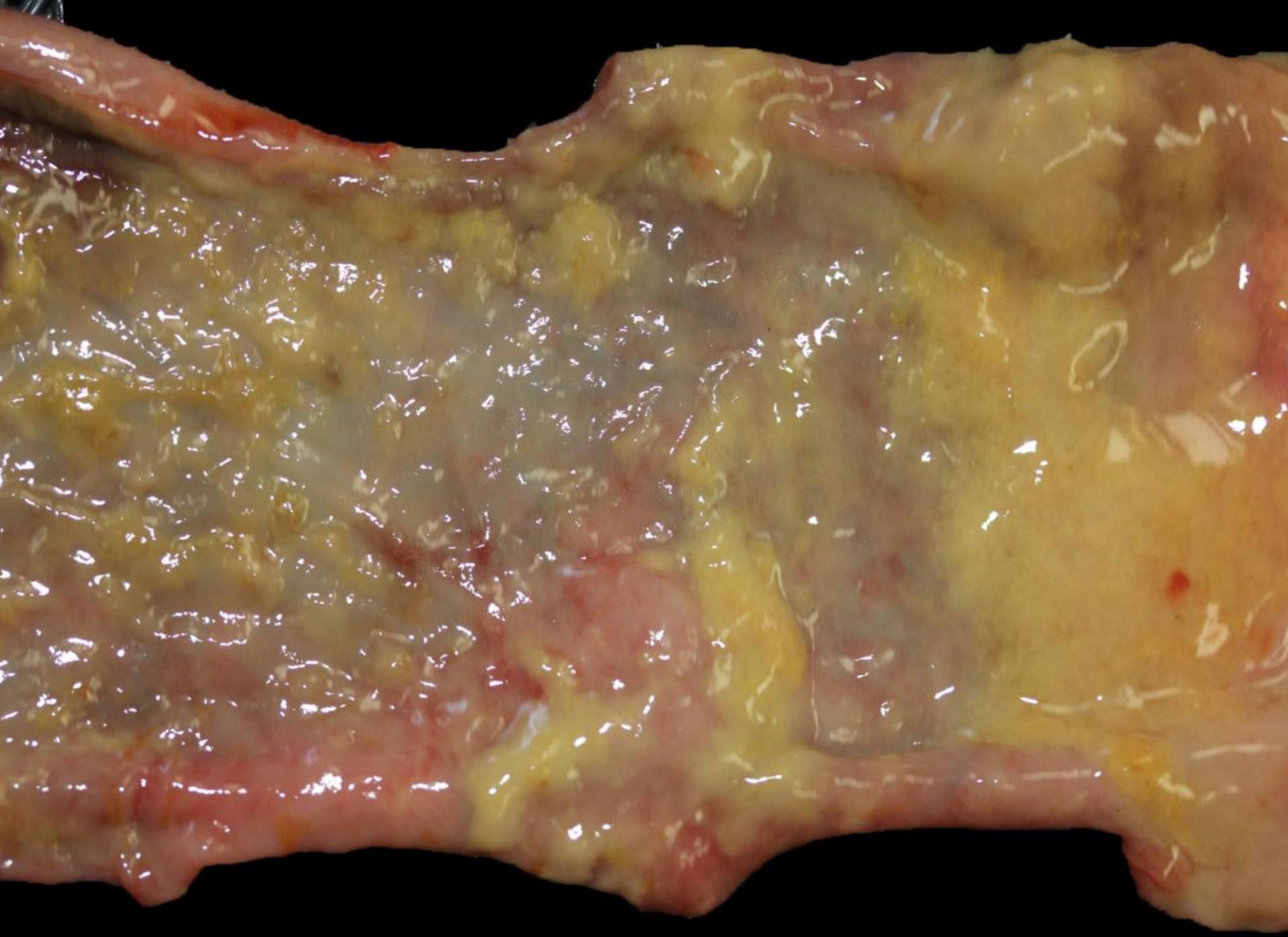
Coronavirus

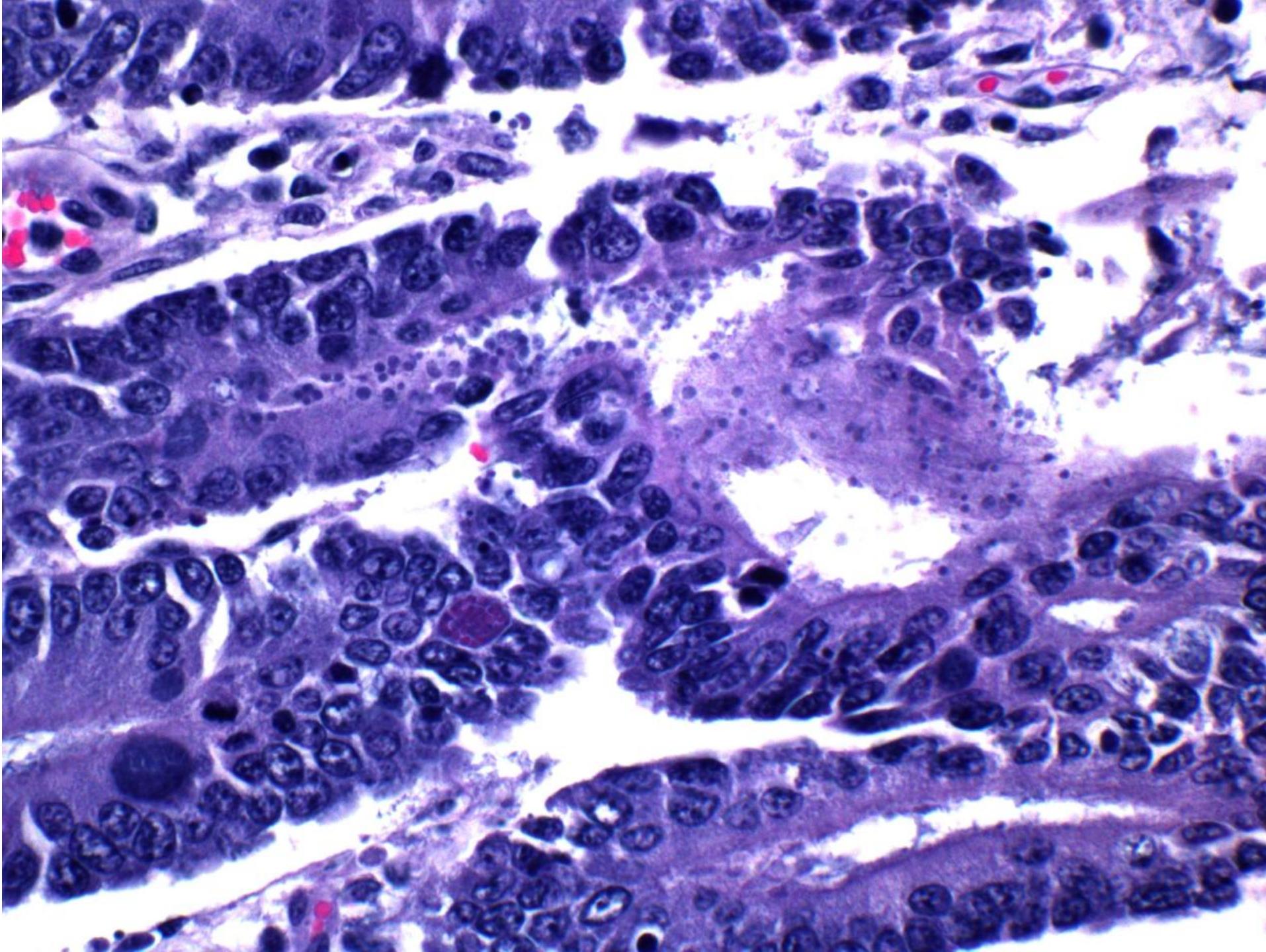
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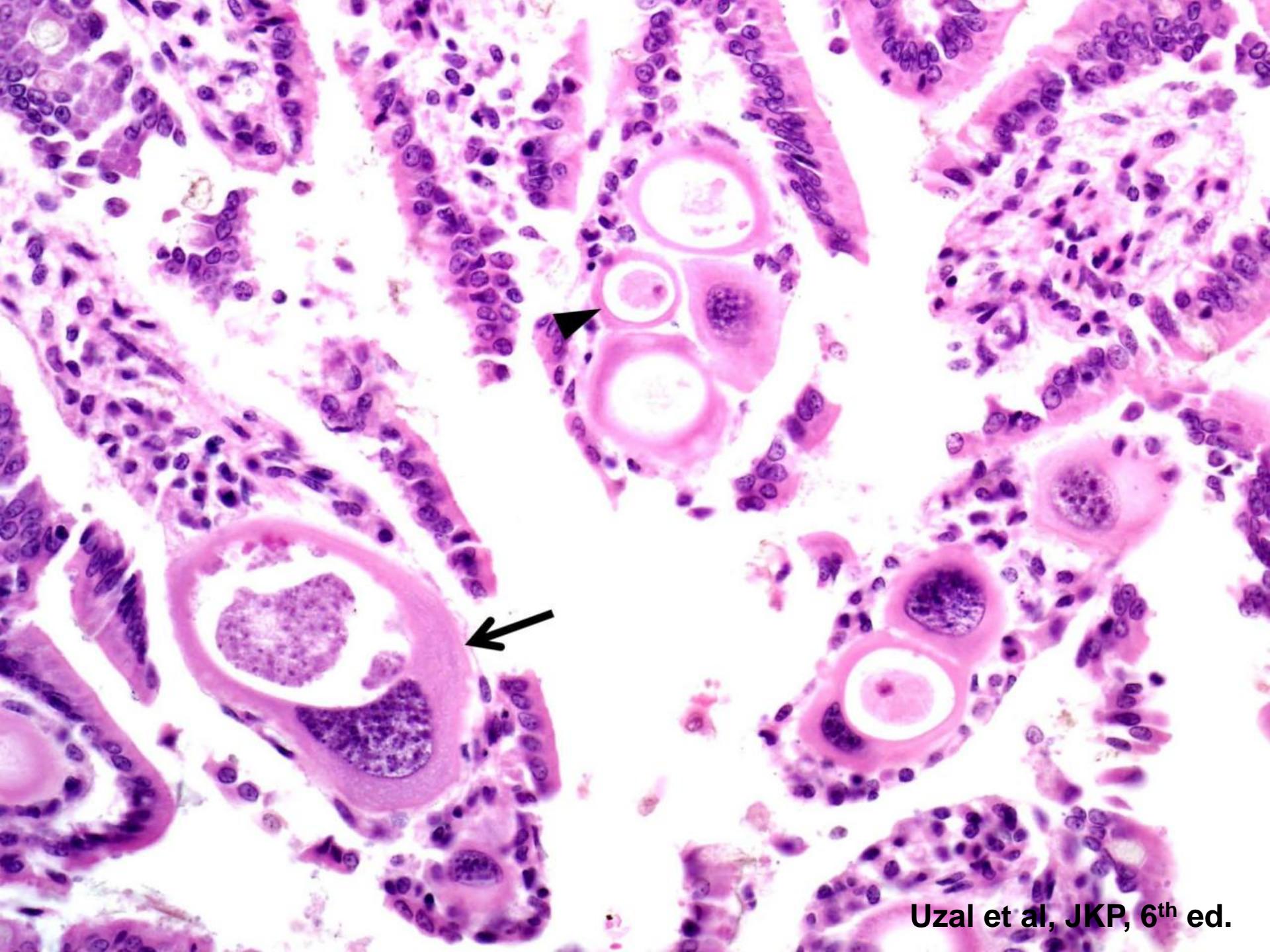
## Fungal

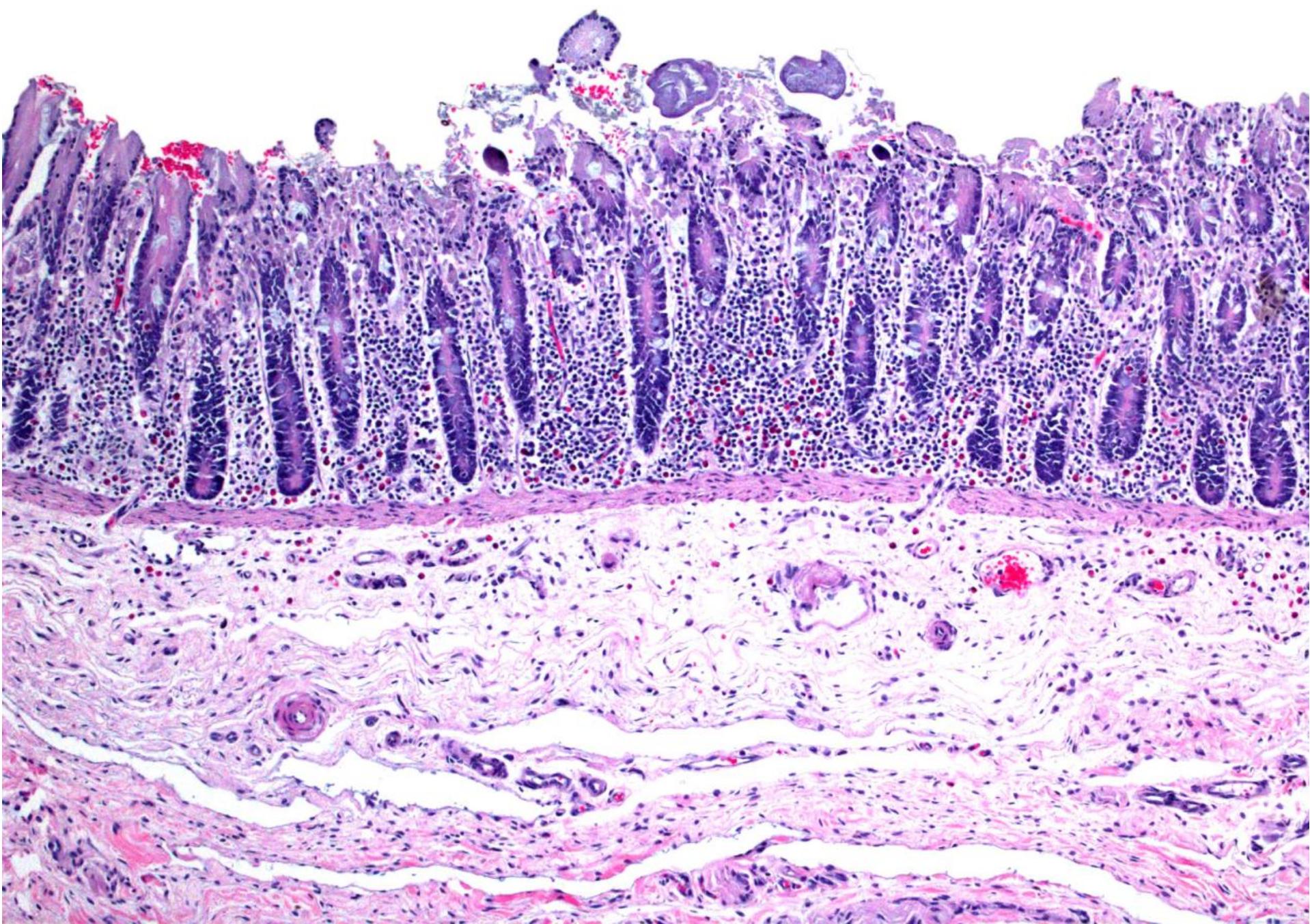
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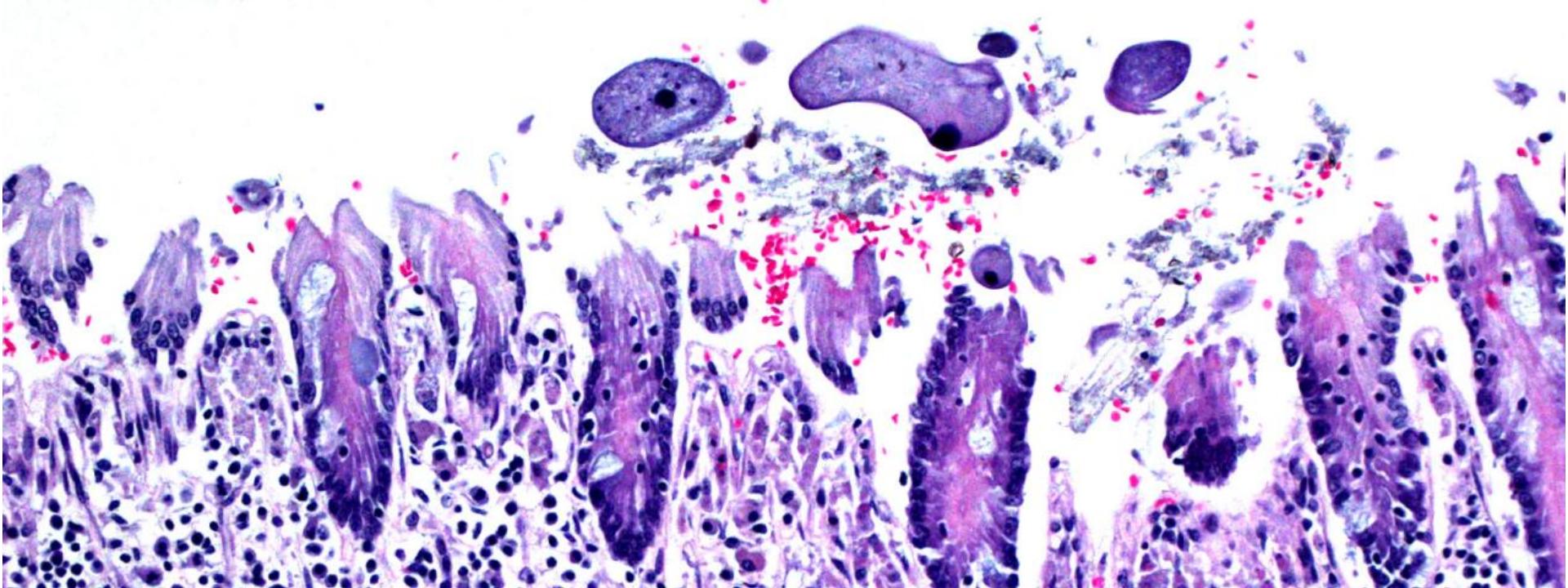
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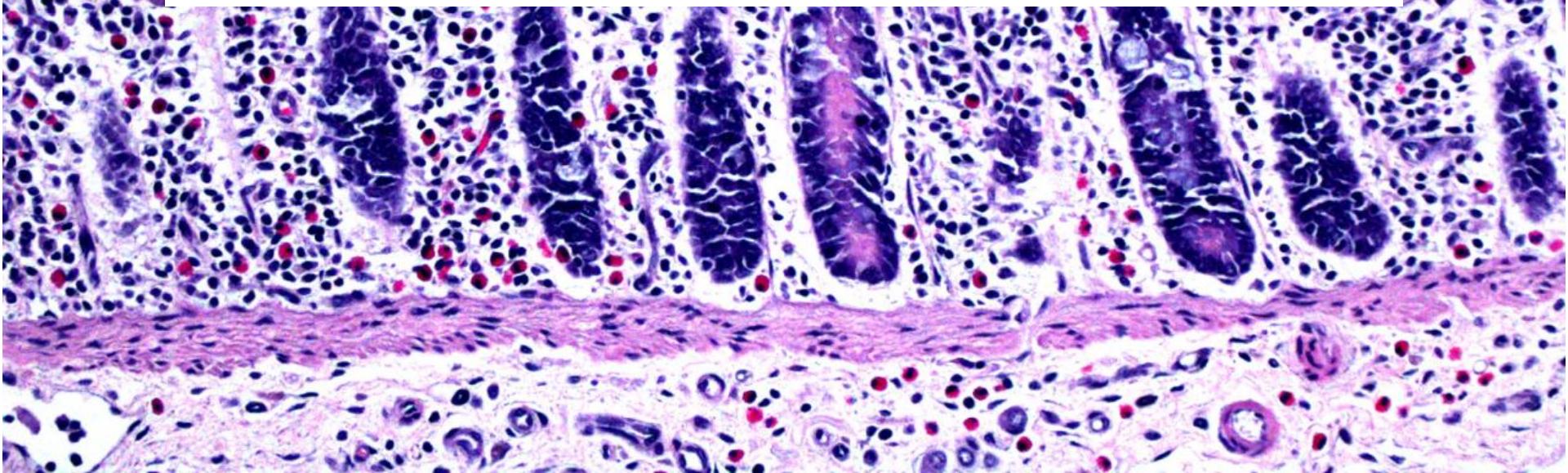








Pathogenic? People's opinion?



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## Bacterial

*Clostridium* spp.

*Salmonella* spp.

*Rhodococcus equi*

*Ehrlichia ristiacci*

*Lawsonia intracellularis*

Others

---

## Parasitic

*Strongylus* spp.

*Parascaris equorum*

Others

---

## Viral

Rotavirus

Coronavirus

---

## Fungal

Various

---

# **Rotavirus diarrhea**

Never seen one of these in the PM room

# **Clinician's opinion?**

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## Bacterial

*Clostridium* spp.

*Salmonella* spp.

*Rhodococcus equi*

*Ehrlichia ristiacci*

*Lawsonia intracellularis*

Others

---

## Parasitic

*Strongylus* spp.

*Parascaris equorum*

Others

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## Viral

Rotavirus

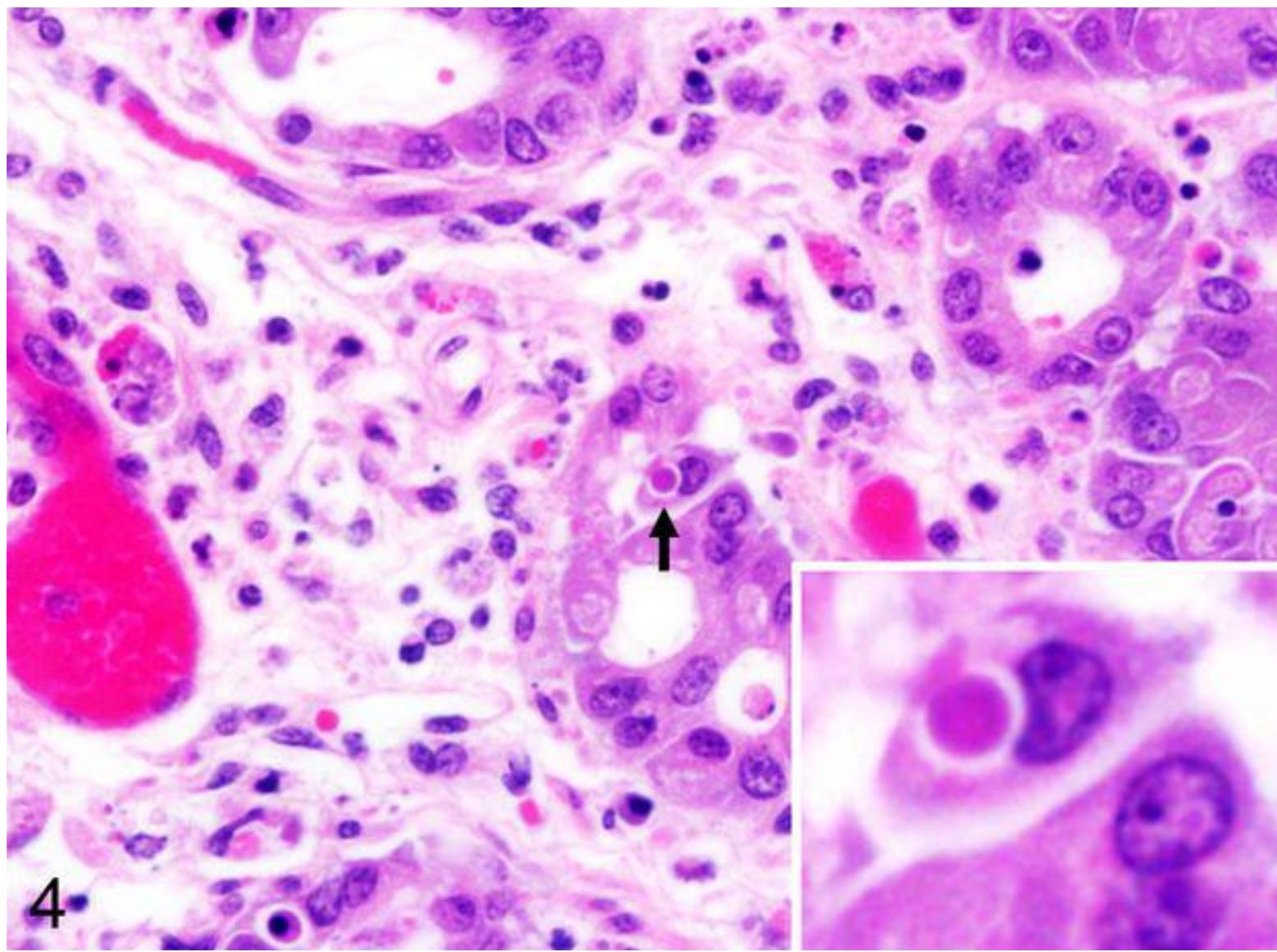
Coronavirus

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## Fungal

Various

---



---

## Bacterial

*Clostridium* spp.

*Salmonella* spp.

*Rhodococcus equi*

*Ehrlichia ristiacci*

*Lawsonia intracellularis*

Others

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## Parasitic

*Strongylus* spp.

*Parascaris equorum*

Others

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## Viral

Rotavirus

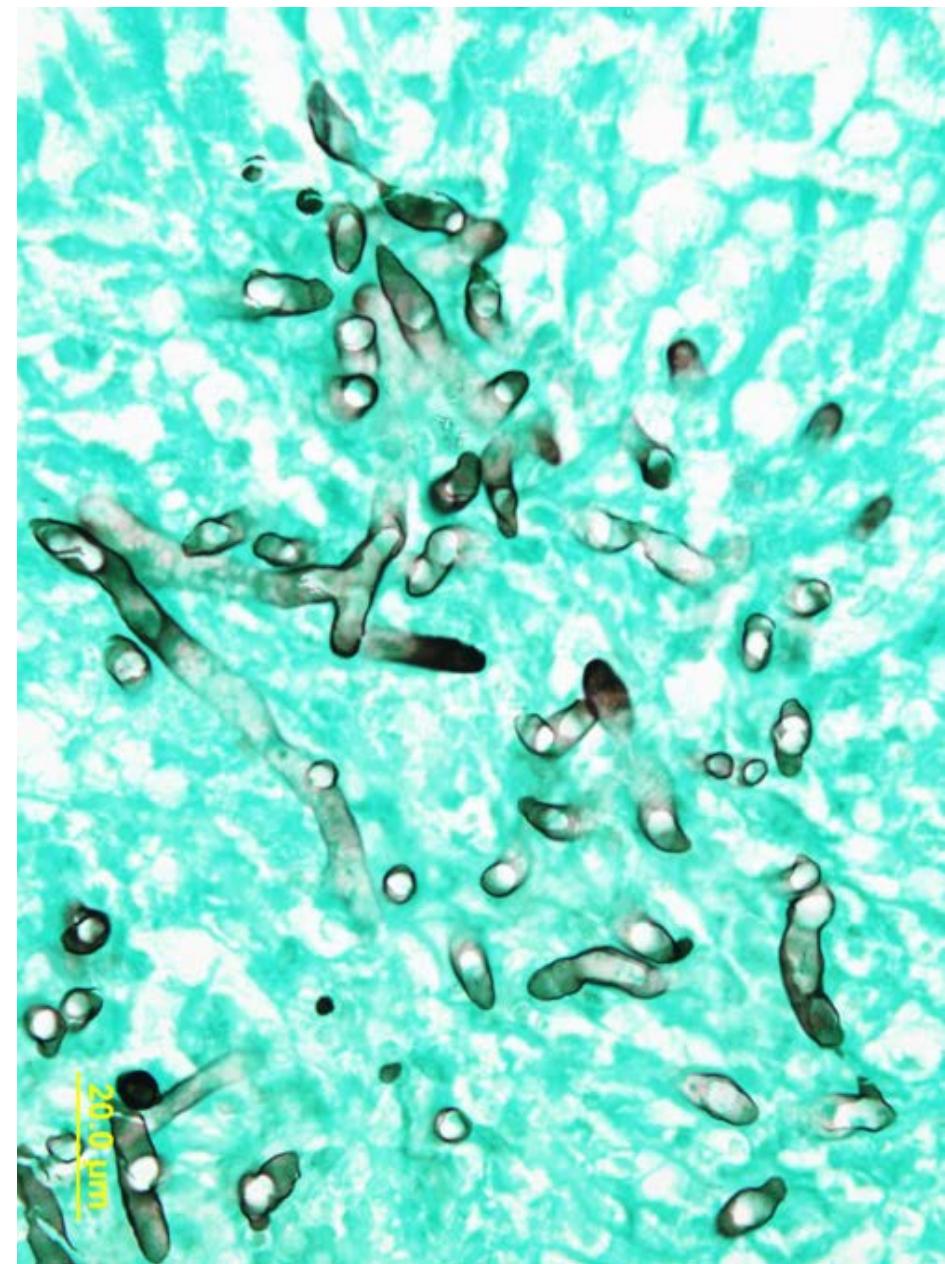
Coronavirus

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## Fungal

Various

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# **CAHFS Diagnostic work up**

## **(1)**

- \* Necropsy
- \* Histology (several segments of small intestine and colon; multiple organs)

# CAHFS Diagnostic work up (2)

- \* **Culture (aerobic and anaerobic)**

- Liver
- Lung
- Small/large intestine (*C. perfringens* isolates PCR typing)

- \* **Culture *C. difficile***

- Small/large intestine (*C. difficile* isolates PCR typing)\*

\* desired

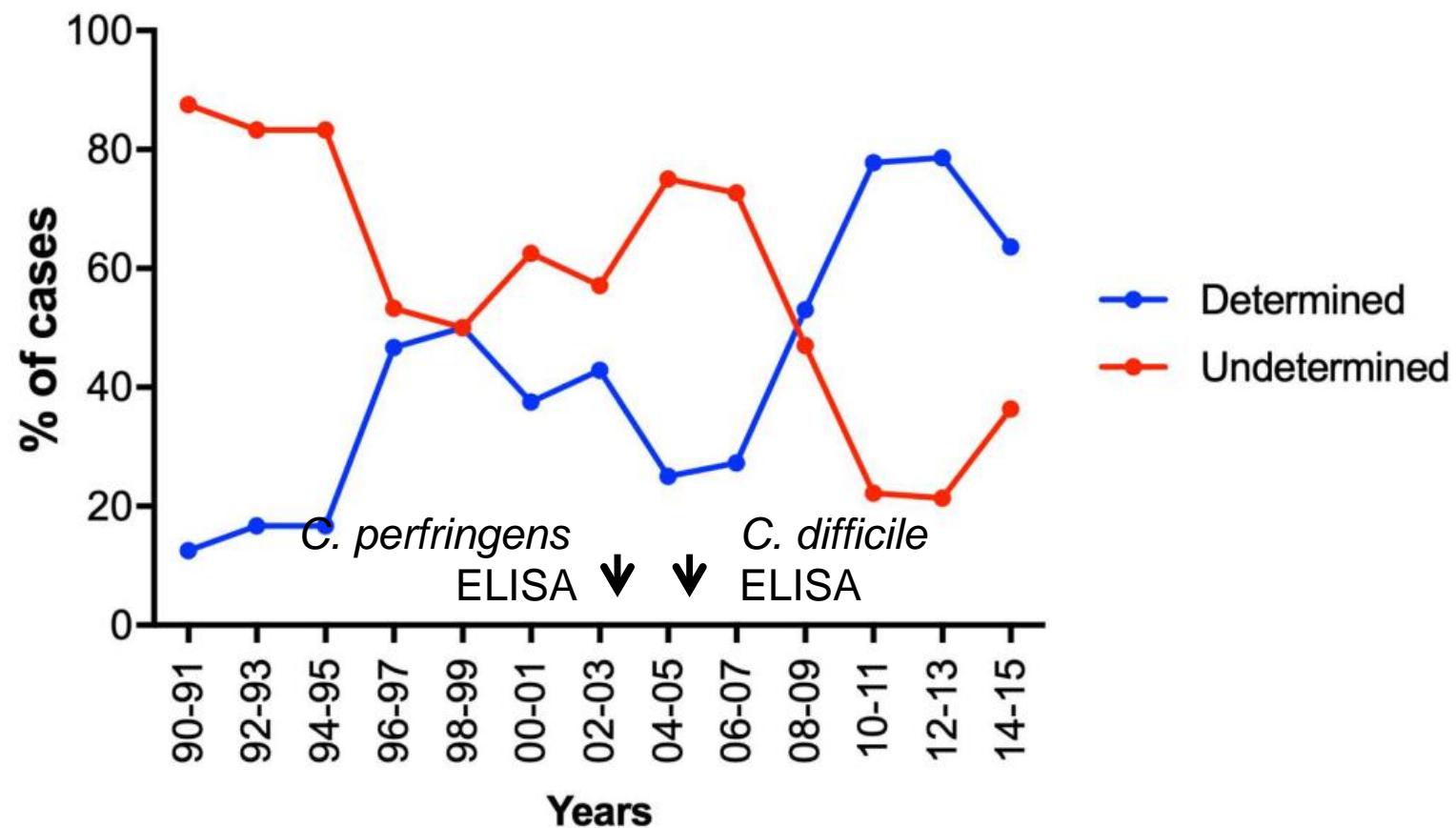
# CAHFS Diagnostic work up (3)

- \* *C. perfringens* toxins ELISA (CPA, CPB, ETX)
  - Small/large intestine
- \* *C. difficile* toxins ELISA (A/B)
  - Small/large intestine
- \* Other clostridial toxins ELISAs as needed  
(e.g. CPE)

# **CAHFS Diagnostic work up (4)**

- \* Fecal float
- \* Toxicology (HMS, oleander, other as needed)
- \* Other tests as needed

# Etiologic diagnosis of enteric disease in horses at CAHFS

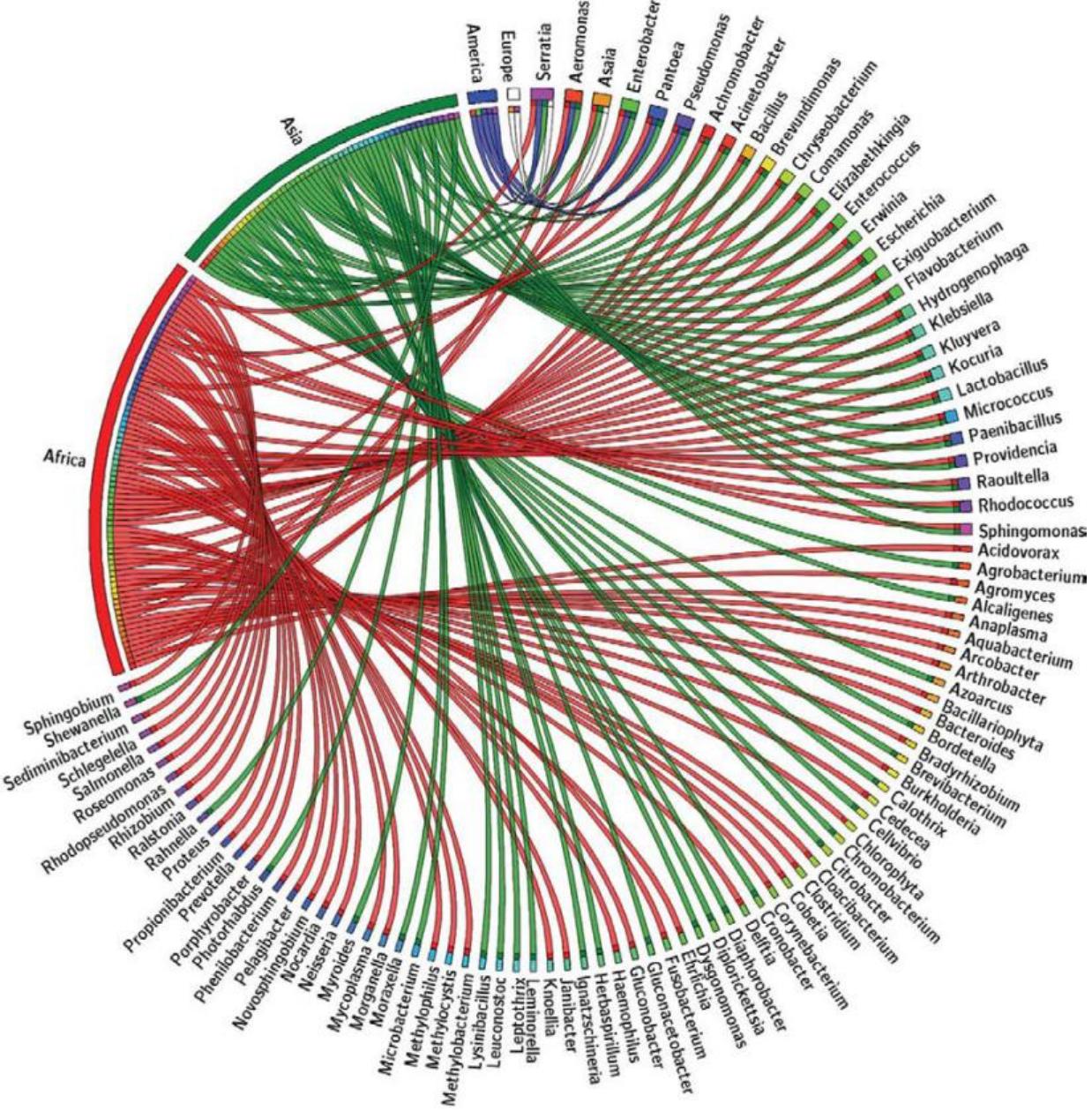


# CONCLUSIONS

- \* PCR and toxin ELISAs improved etiology determination
- \* Still, many cases: undetermined etiology

# Future work:

- \* PCR?
- \* Metagenomics?
- \* **Lawrence Livermore Microbial Detection Array (LLMDA)**
  - 12.000 species (bacteria, viruses, protozoa, fungi)



# **THANKS TO**

**M. Navarro**

**D. Read**

**P. Blanchard**

**F. Giannitti**

**J. King**

**M. Anderson**

**L. Minatel**

**J. Heines**

**F. del Piero**

**F. Carvallo**

**S. Diab**

**P. Chu**

**J. Hostetter**

**B. Plattner**

**P. Loukopoulos**

**P. Stromberg**



A wide-angle photograph of a large herd of horses in a fenced enclosure. A person in a light-colored shirt and blue jeans is seen from behind, using a long wooden stick to herd the horses towards the right. The horses are of various colors, including white, brown, and dark brown. The enclosure is made of a wooden fence. In the background, there is a vast, open landscape under a cloudy sky.

Thank you

