



UCDAVIS

VETERINARY MEDICINE

California Animal Health and
Food Safety Laboratory System



Equine enterocolitis (infectious)

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San Bernardino Branch, UC Davis



Equine enteritis–colitis

1-Infectious

2-Non-infectious

Equine enteritis–colitis

1-Infectious

2-Non-infectious

Bacterial

Clostridium spp.

Salmonella spp.

Rhodococcus equi

Ehrlichia risticii

Lawsonia intracellularis

Others

Parasitic

Strongylus spp.

Parascaris equorum

Others

Viral

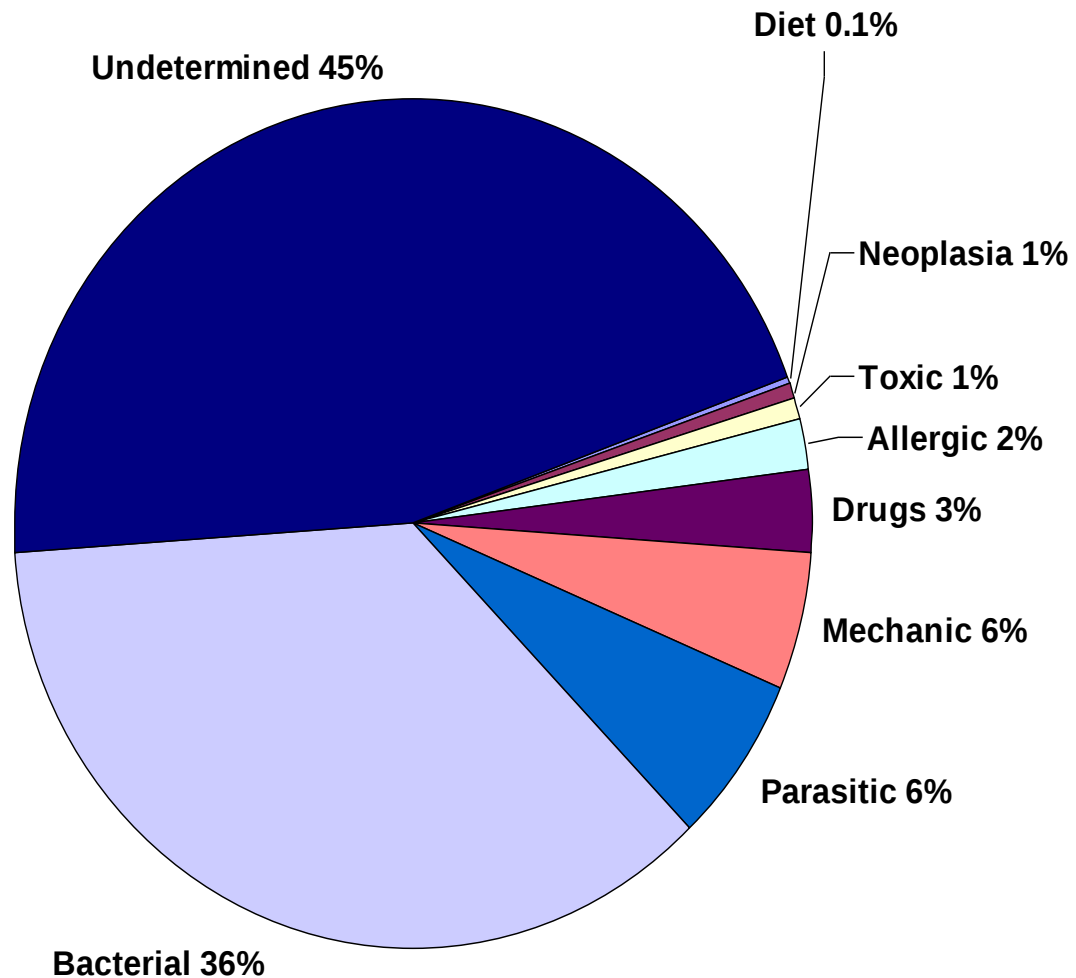
Rotavirus

Coronavirus

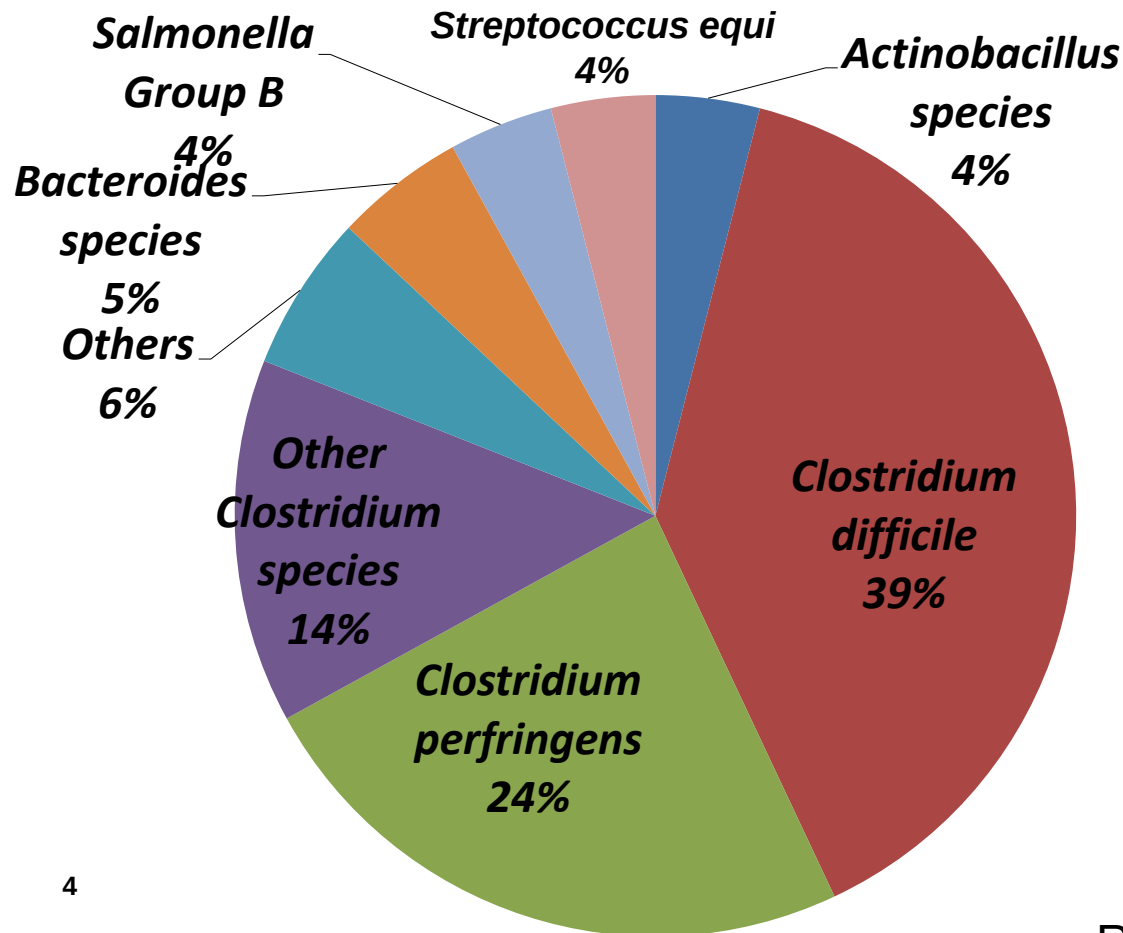
Fungal

Various

Intestinal disease: CAHFS 1990-2016 (n= 750)



Bacterial causes (1990-2016)



Bacterial

Clostridium spp.

Salmonella spp.

Rhodococcus equi

Ehrlichia risticii

Lawsonia intracellularis

Others

Parasitic

Strongylus spp.

Parascaris equorum

Others

Viral

Rotavirus

Coronavirus

Fungal

Various

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* and others

Confirmed diseases

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The 2018 *C. perfringens* toxin-based typing scheme

Toxinotype	α -toxin (cpa)	β -toxin (cpb)	ϵ -toxin (etx)	ι -toxin (iap and ibp)	CPE (cpe)	NetB (netB)
A	+	-	-	-	-	-
B	+	+	+	-	-	-
C	+	+	-	-	+/-	-
D	+	-	+	-	+/-	-
E	+	-	-	+	+/-	-
F	+	-	-	-	+	-
G	+	-	-	-	-	+

Beta toxin

- * NECROTIZING

- * VERY sensitive to trypsin

Due to this.....

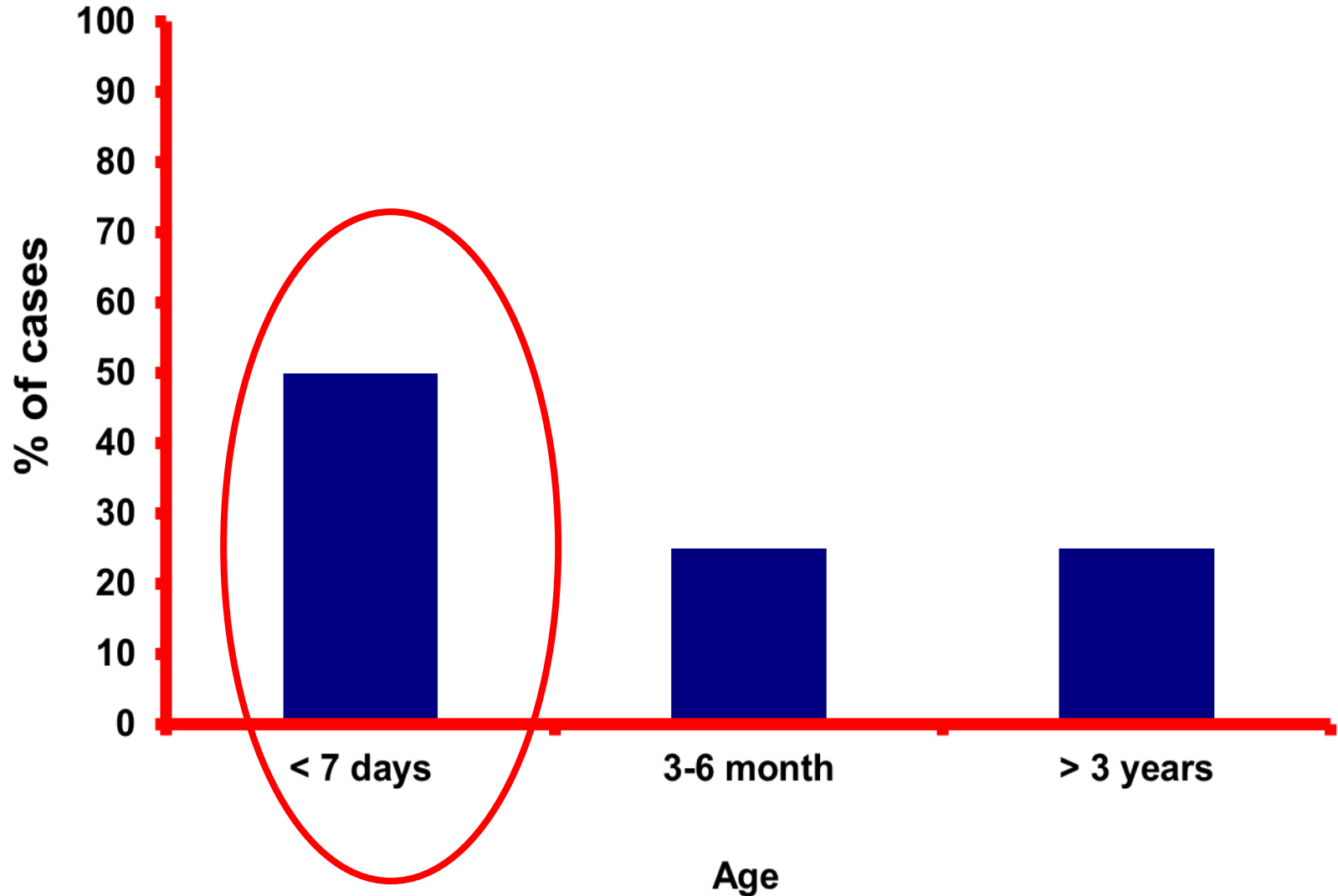
1-Intestinal trypsin: natural defense against
type C disease

2-Type C disease:

- neonates
- pancreatic disease
- trypsin inhibitors
(sweet potato; soybean)

CAHFS: 2003-2008 (n=20)

Age



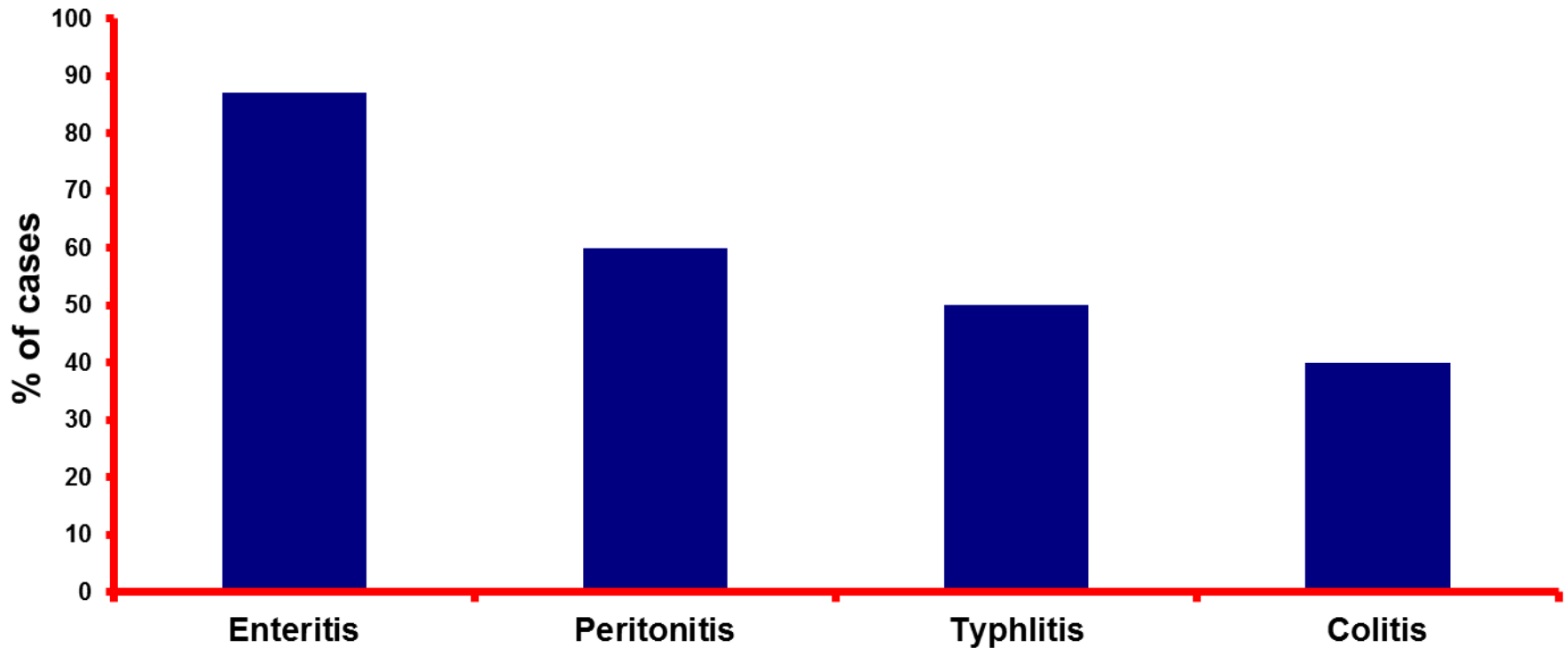
mainly foals

(cases in adults may occur)

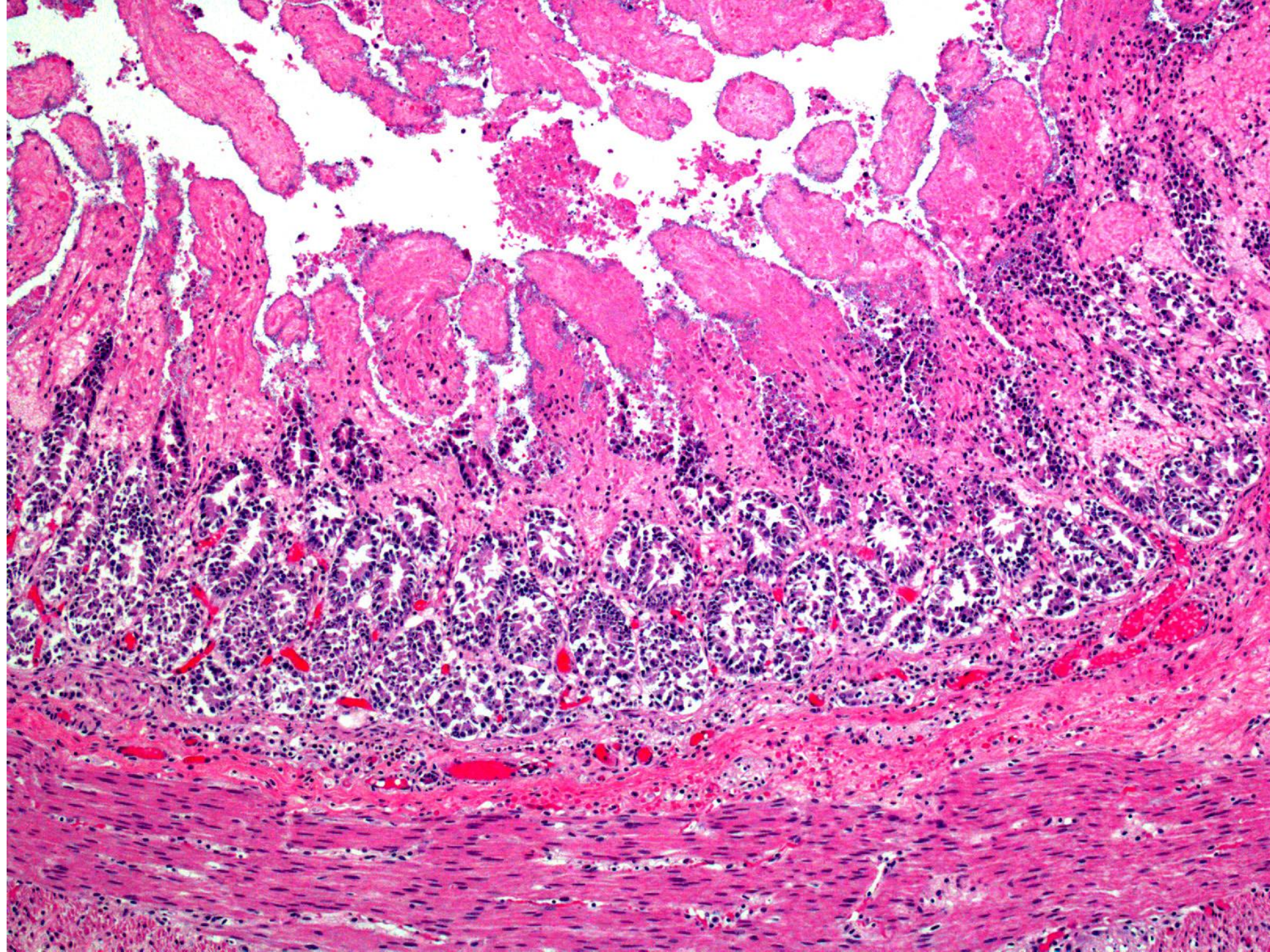
MESSAGE TO REMEMBER

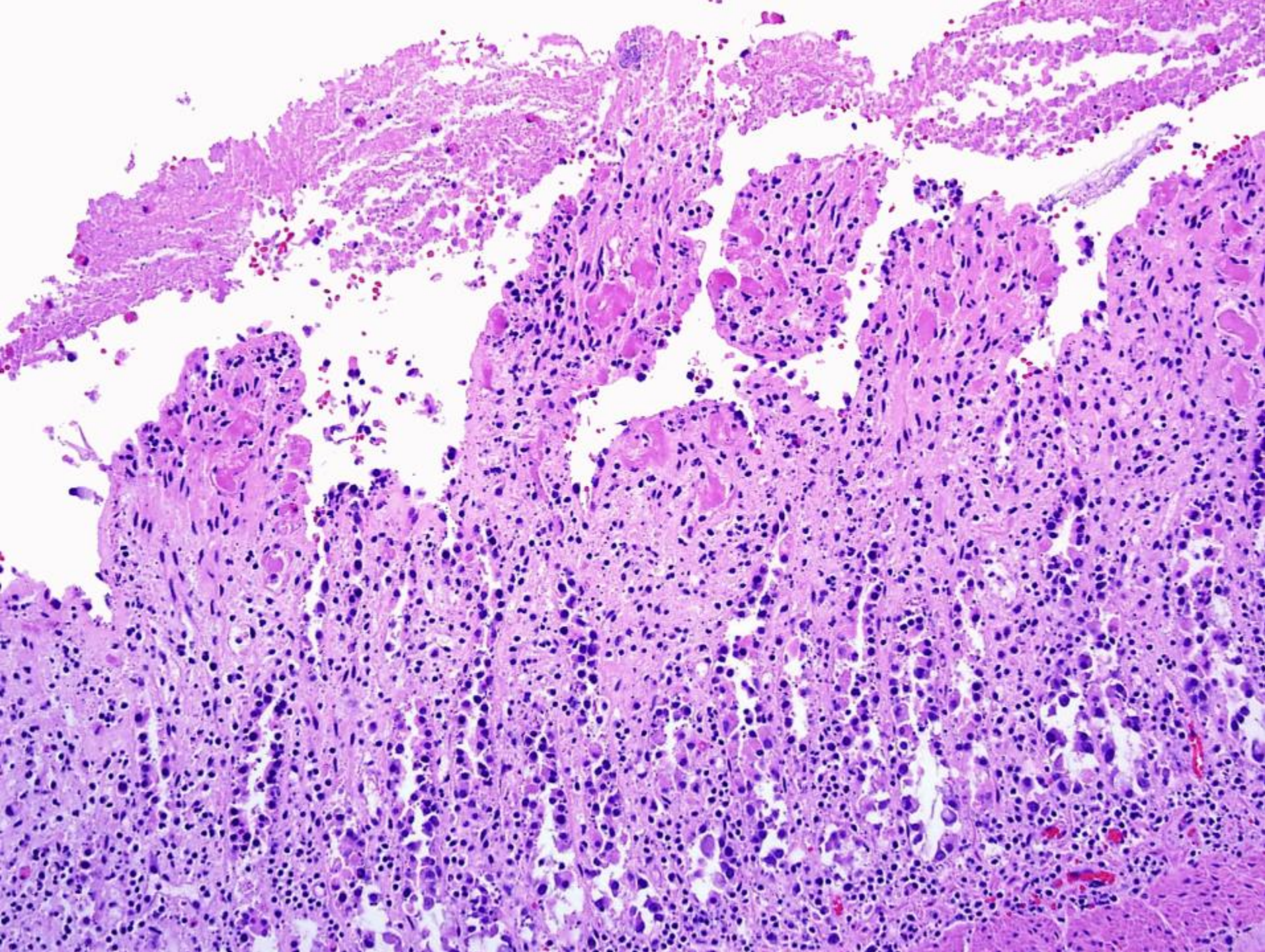
CAHFS: 2003-2008 (n=30)

Pathology of the GI tract









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-CPB toxin detection (ELISA)	}	Confirmatory

C. difficile and *C. perfringens* type C co-infection
may occur

FULL DIAGNOSTIC WORK UP
RECOMMENDED

Differential diagnoses

- C. difficile*
- Salmonella spp.*
- NSAIDs

Others?????



Confirmed diseases

1-*C. perfringens* type C: enterocolitis

2-*C. difficile*: enterocolitis

3-*C. piliforme*: colitis and hepatitis

Other less understood entities

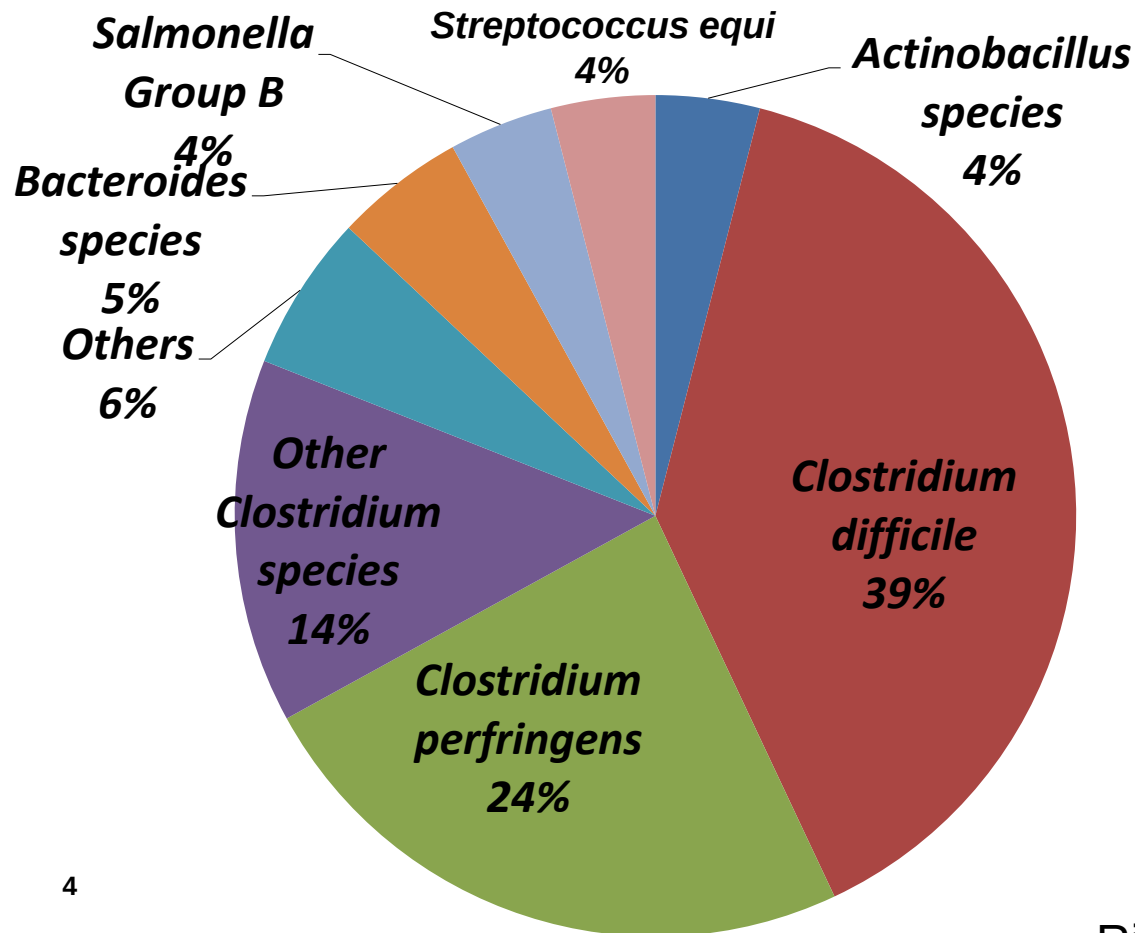
1-Colitis X

2-*C. perfringens* type A NetF+

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

4-*C. sordellii*

Bacterial causes (1990-2016)



CAHFS database 2000-2016:

Enteric disease and:

1-*C. difficile* isolation

and/or

2-*C. difficile* toxins A/B detected

Culture (n=34)

+: 33

-: 1

Toxin (n=28)

+: 27

-: 1

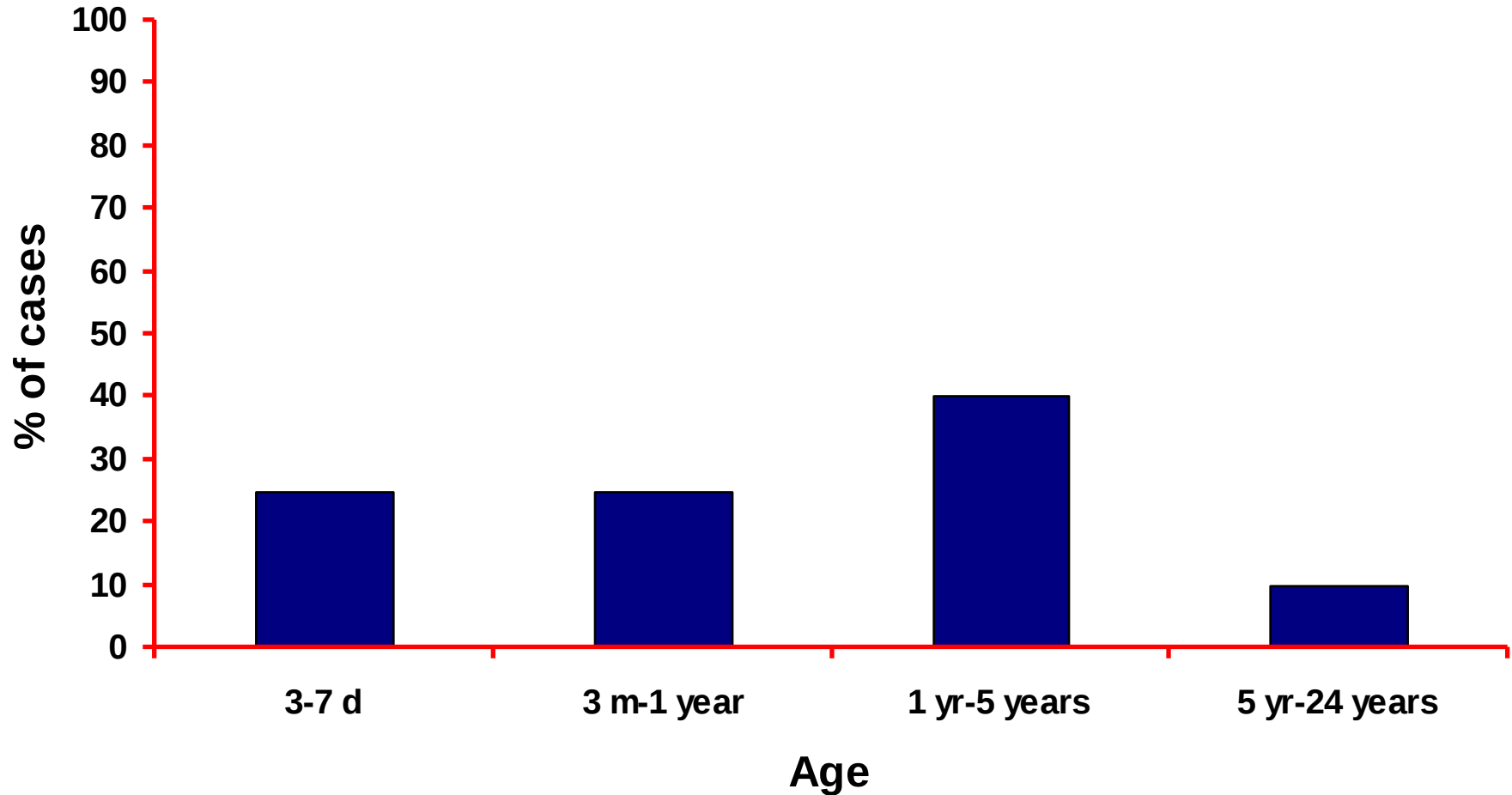
Controls:

40 horses with no enteric disease:
catastrophic leg injuries

(negative *C. difficile* culture and toxin
detection)

CAHFS: 2003-2016 (n=55)

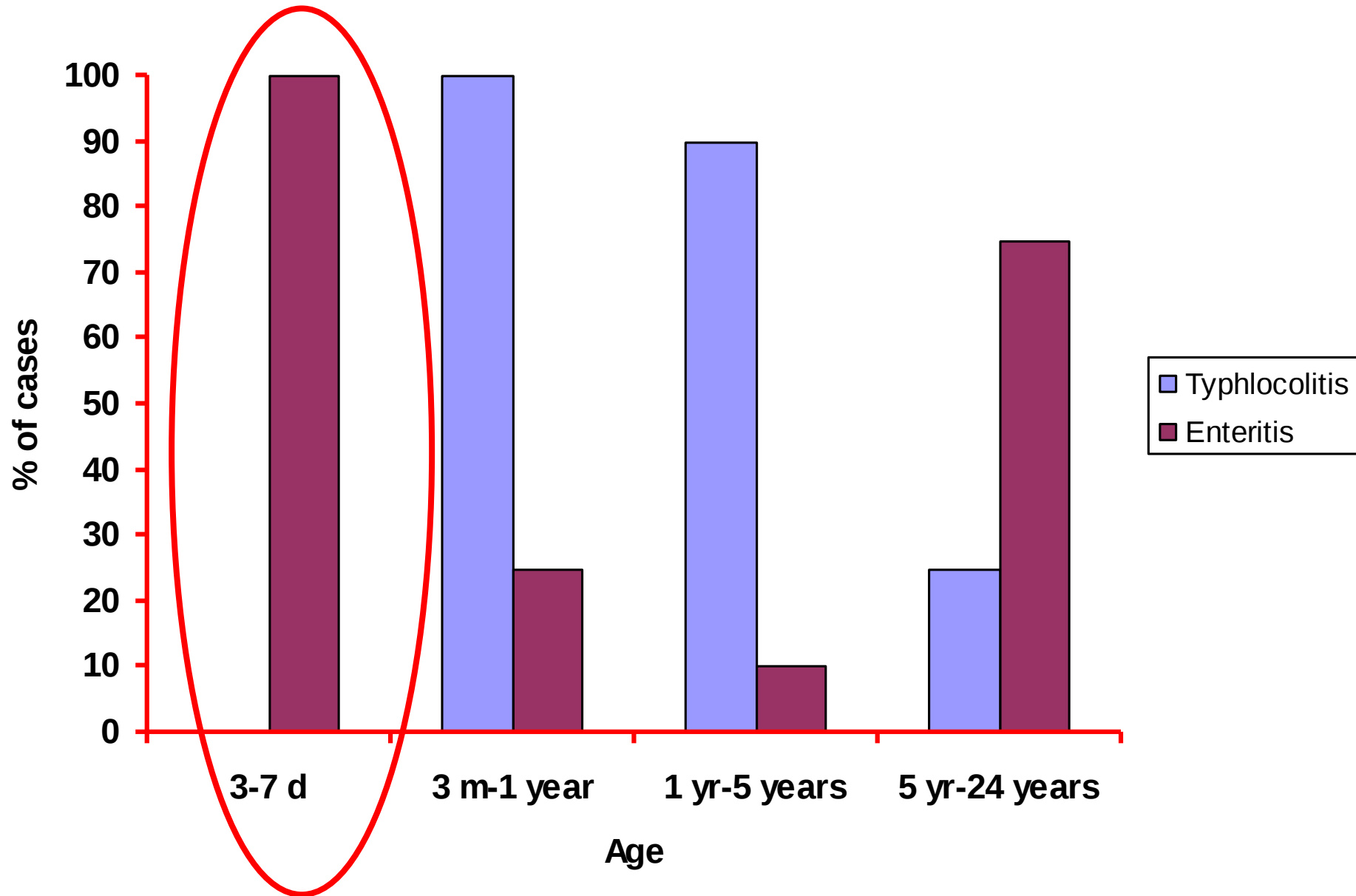
Age

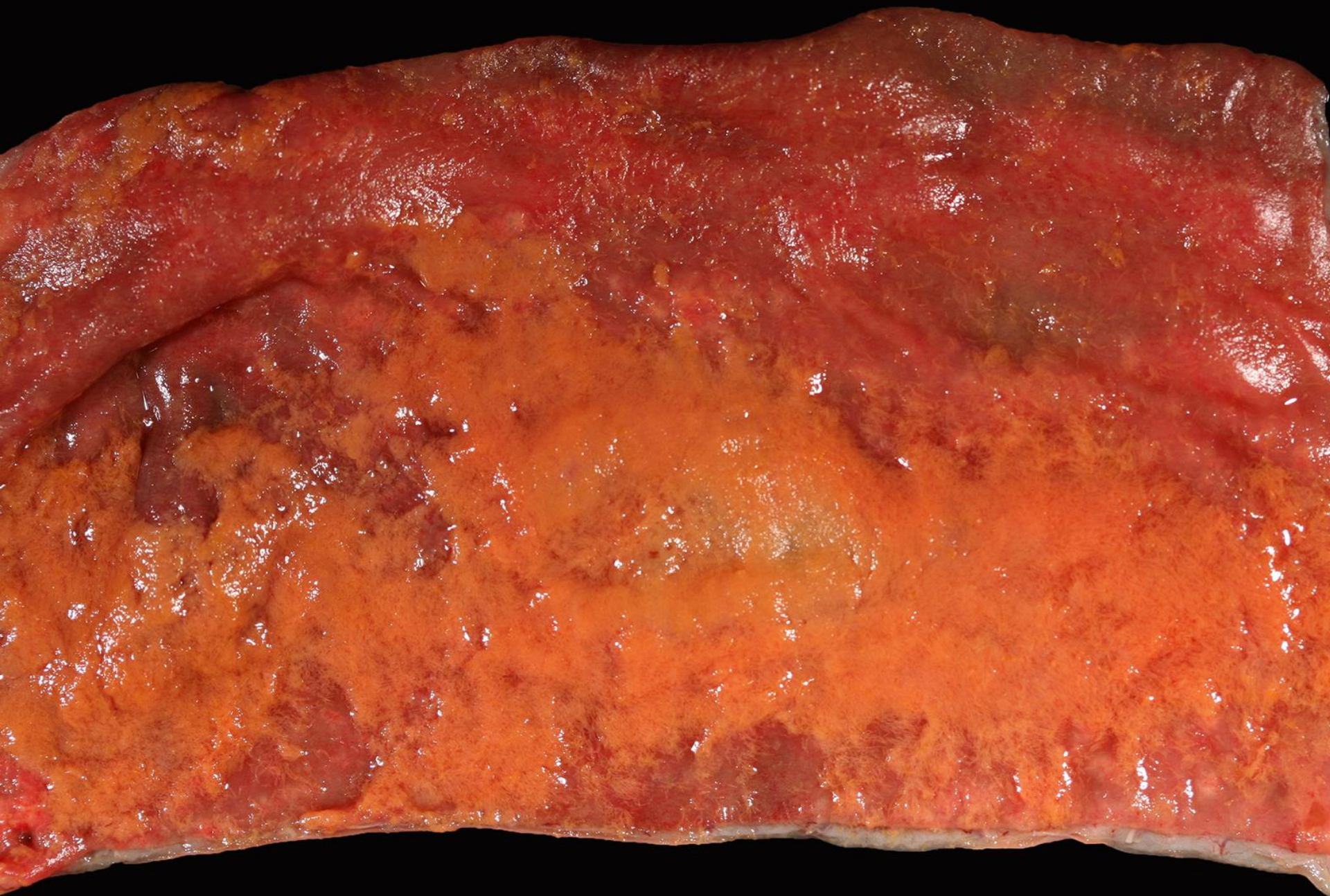


Affects all ages

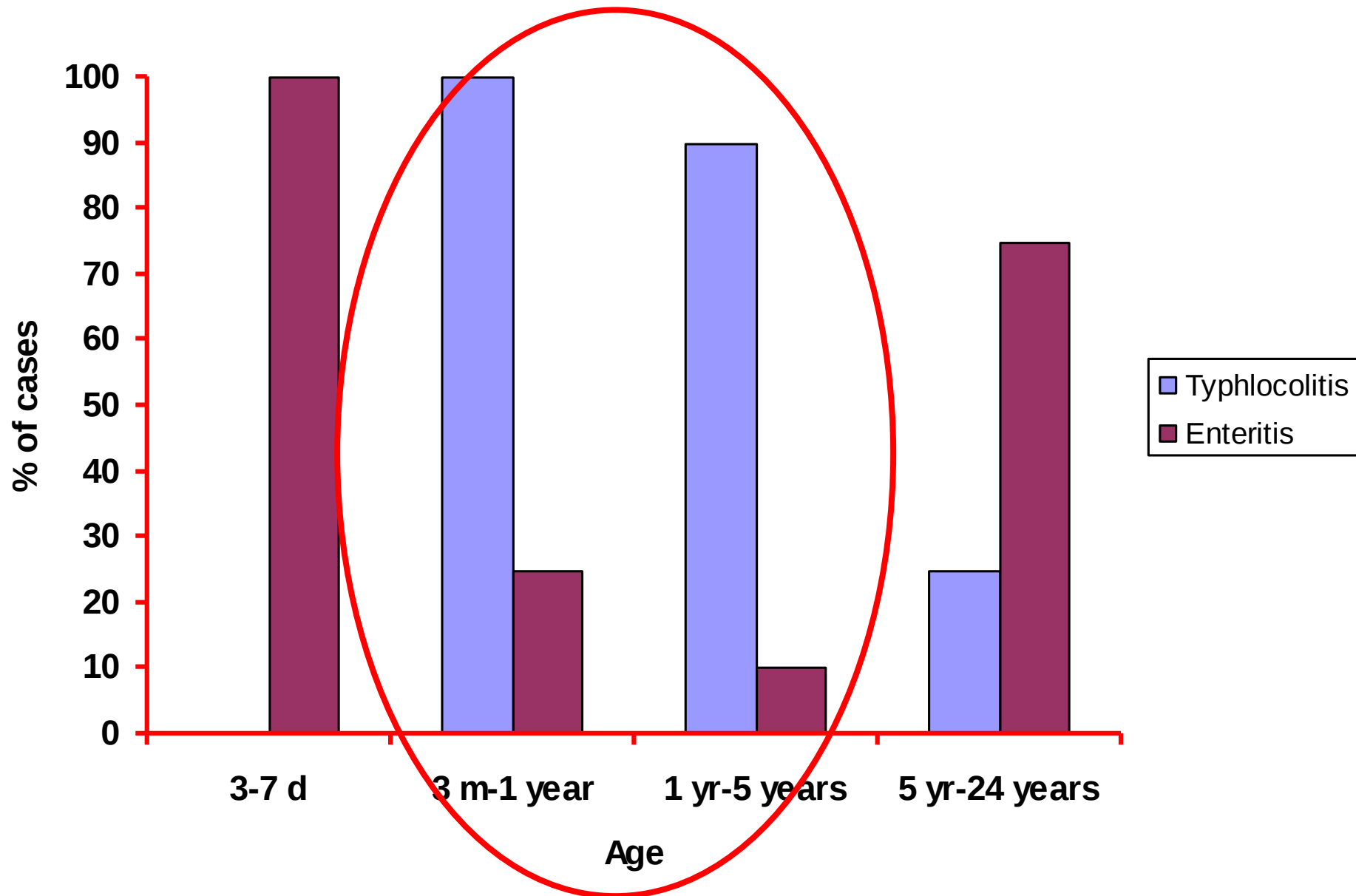
MESSAGE TO REMEMBER

CAHFS: 2003-2016 (n=55)





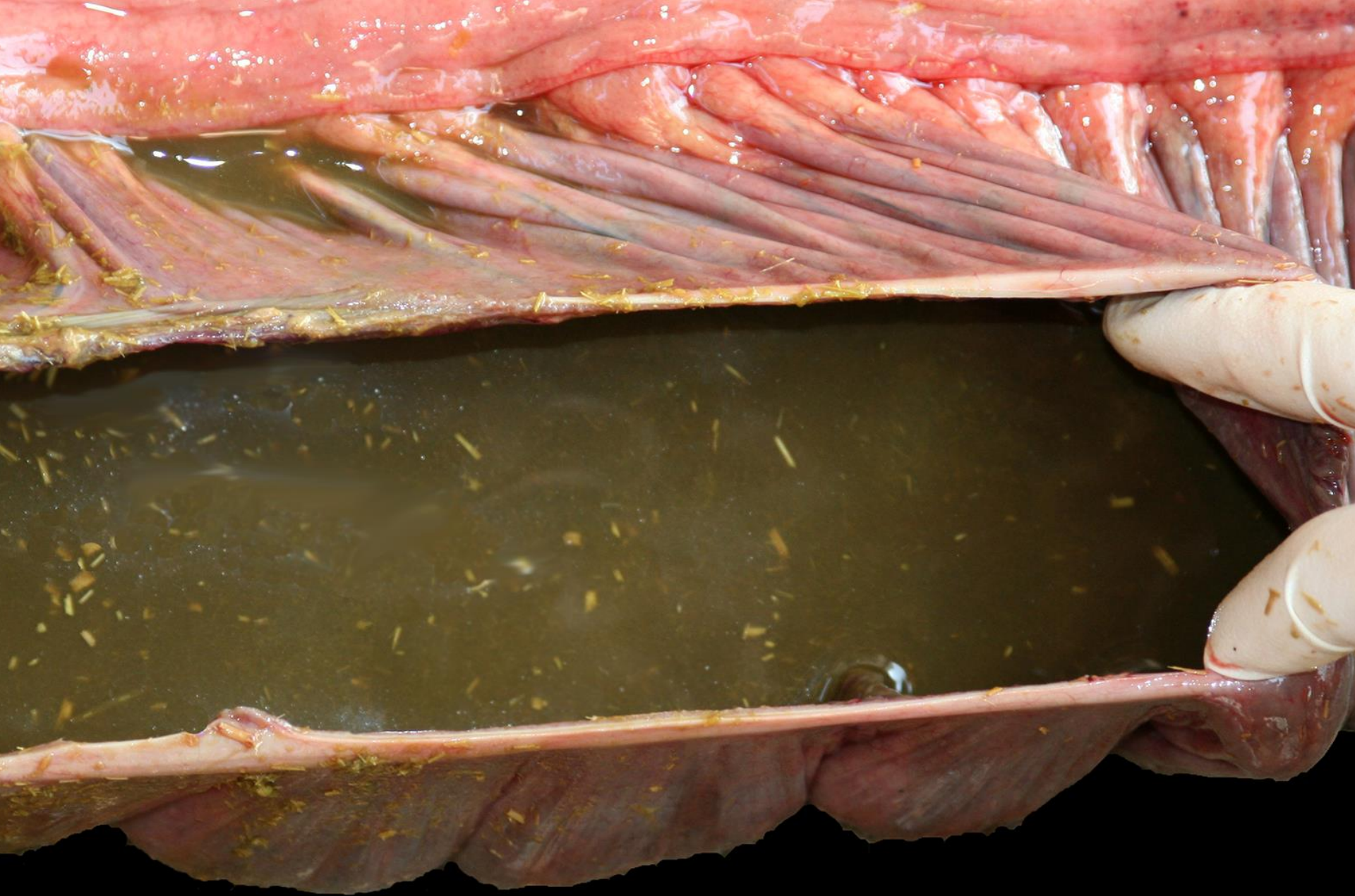
CAHFS: 2003-2016 (n=55)

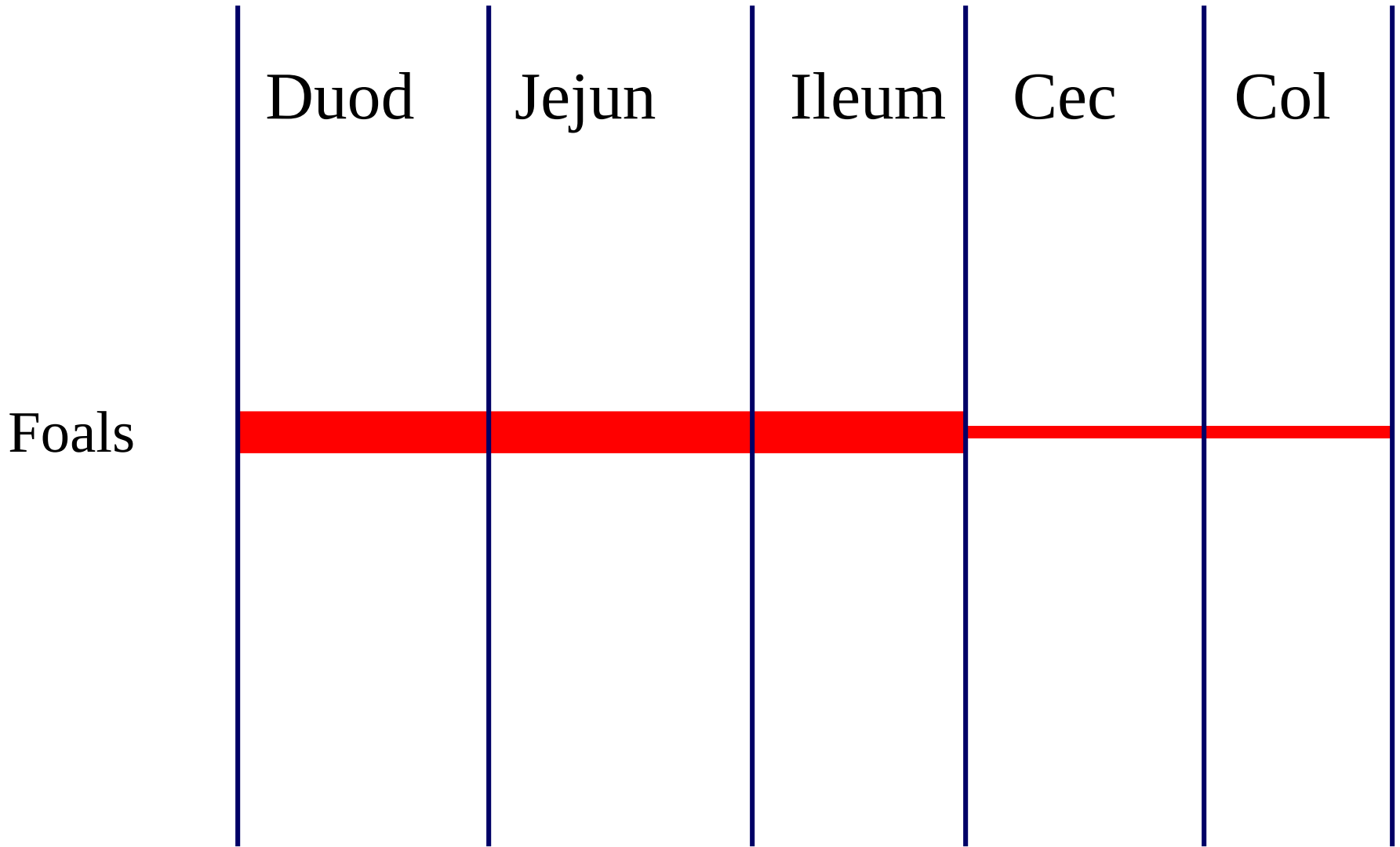


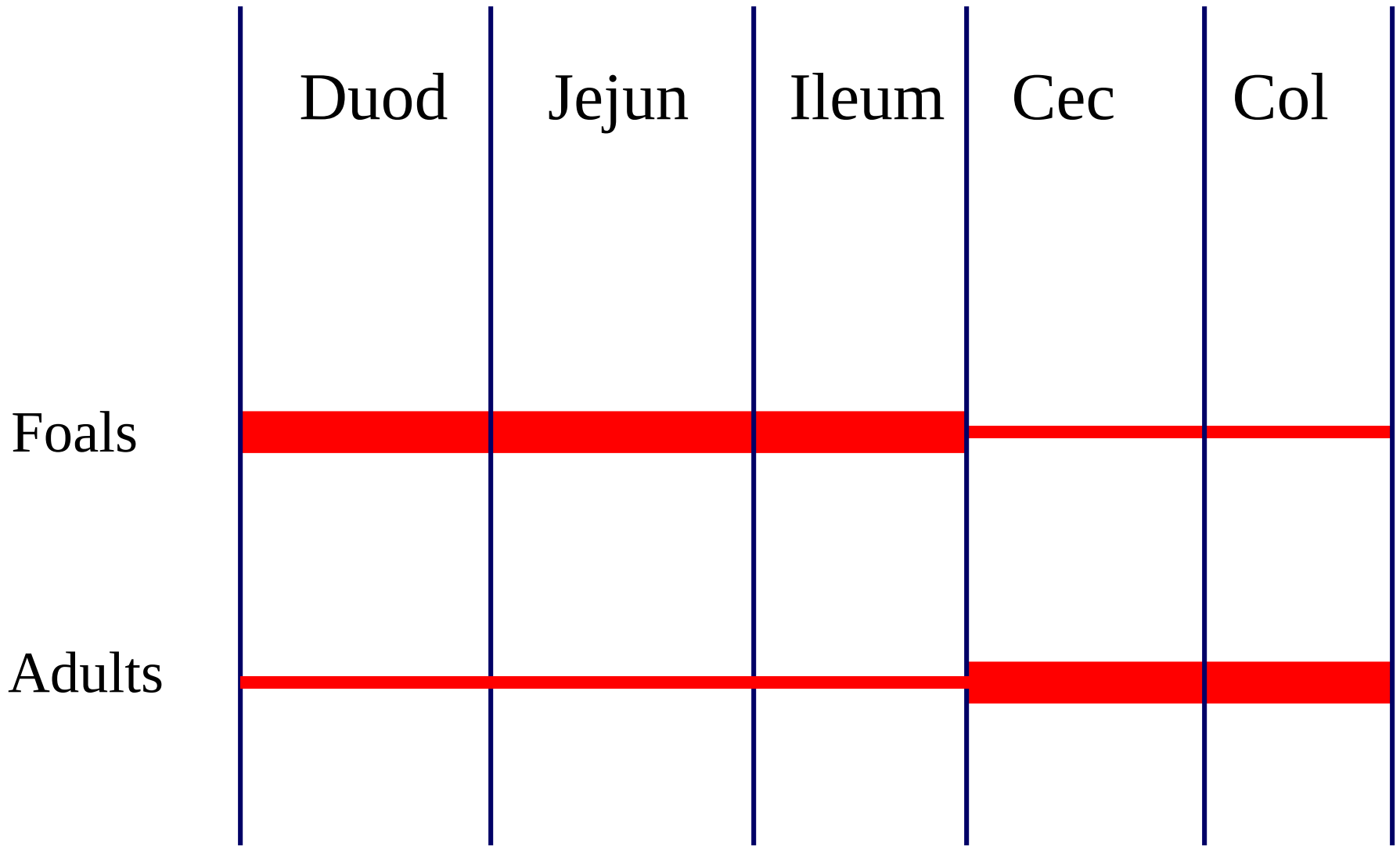






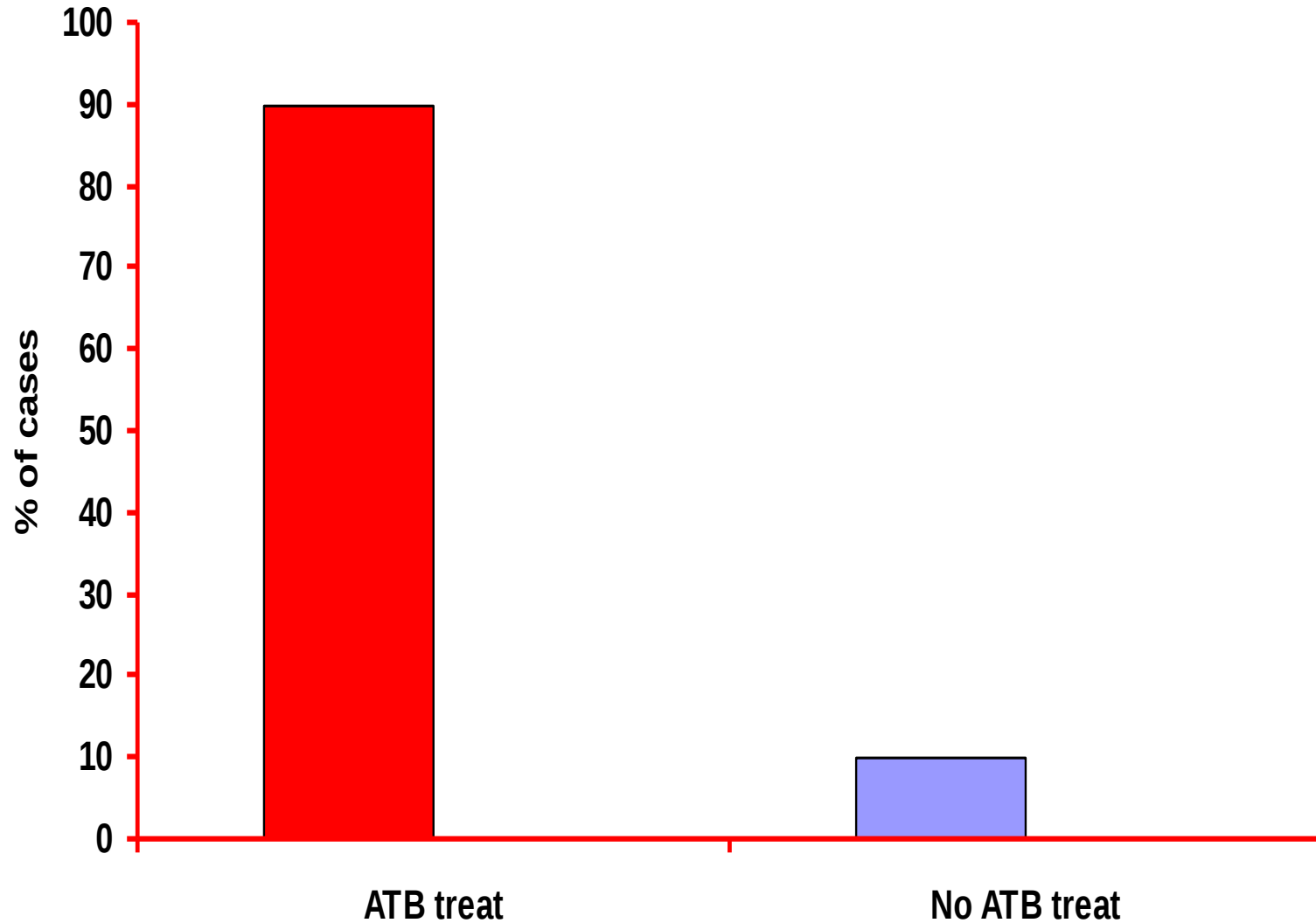






Modified from Keel at el, 2008

CAHFS: 2003-2016 (n=55)



Diagnostic criteria

1-Clinics/gross

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2-Histology

} **Suggestive+**

Diagnostic criteria

1-Clinics/gross

} **Suggestive**

2-Histology

} **Suggestive +**

3-Culture (+ typing?)/PCR

} **Suggestive +**

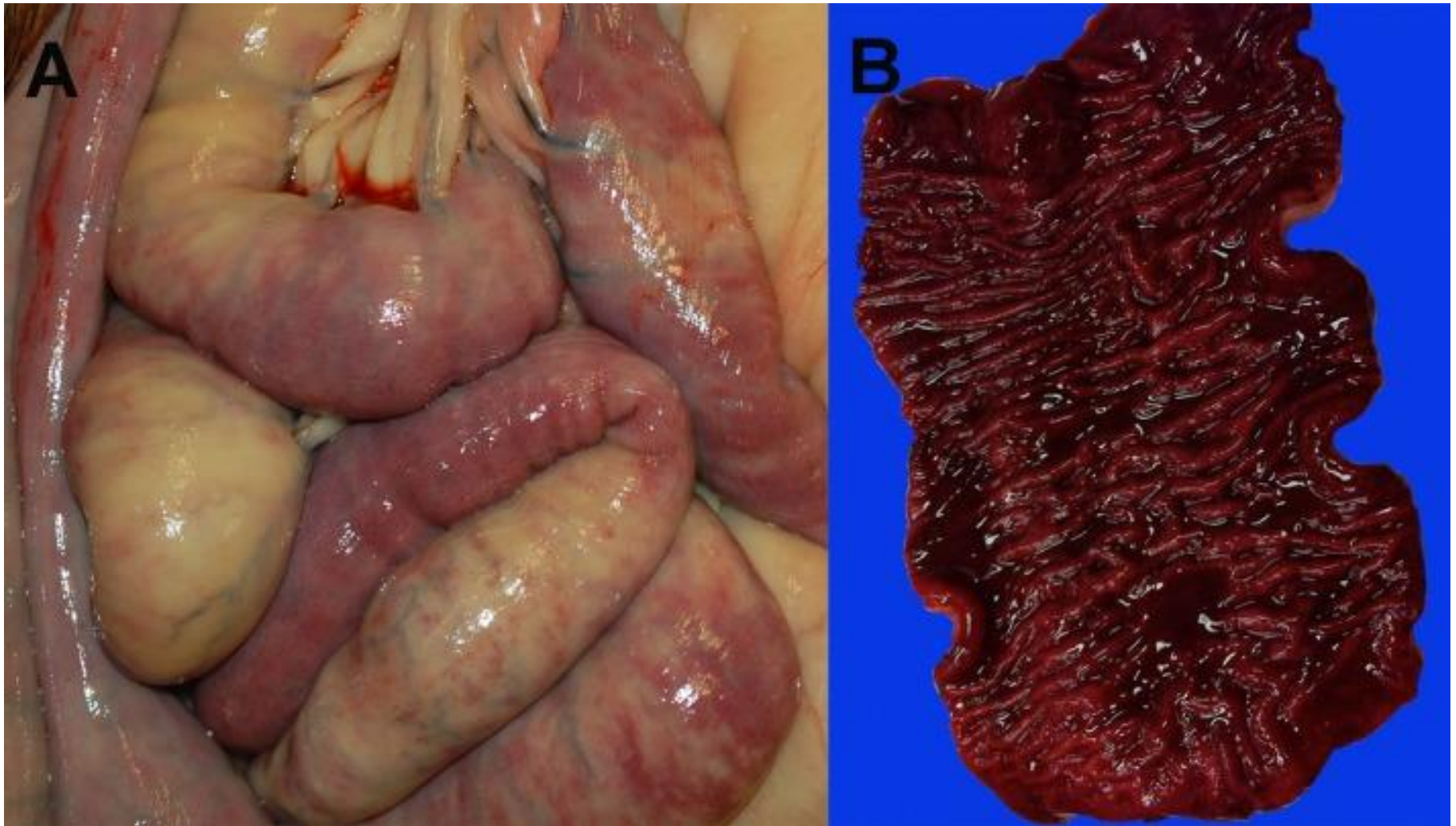
Diagnostic criteria

1-Clinics/gross	}	Suggestive
2-Histology	}	Suggestive
3-Culture (+ typing?)/PCR	}	Suggestive +
4-Toxin detection (A/B)	}	Confirmatory

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



Confirmed diseases

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Other less understood entities

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

4-*C. sordellii*

Triad of lesions:

1-Myocarditis

2-Hepatitis

3-Colitis

MESSAGE TO REMEMBER

Great majority of equine cases:

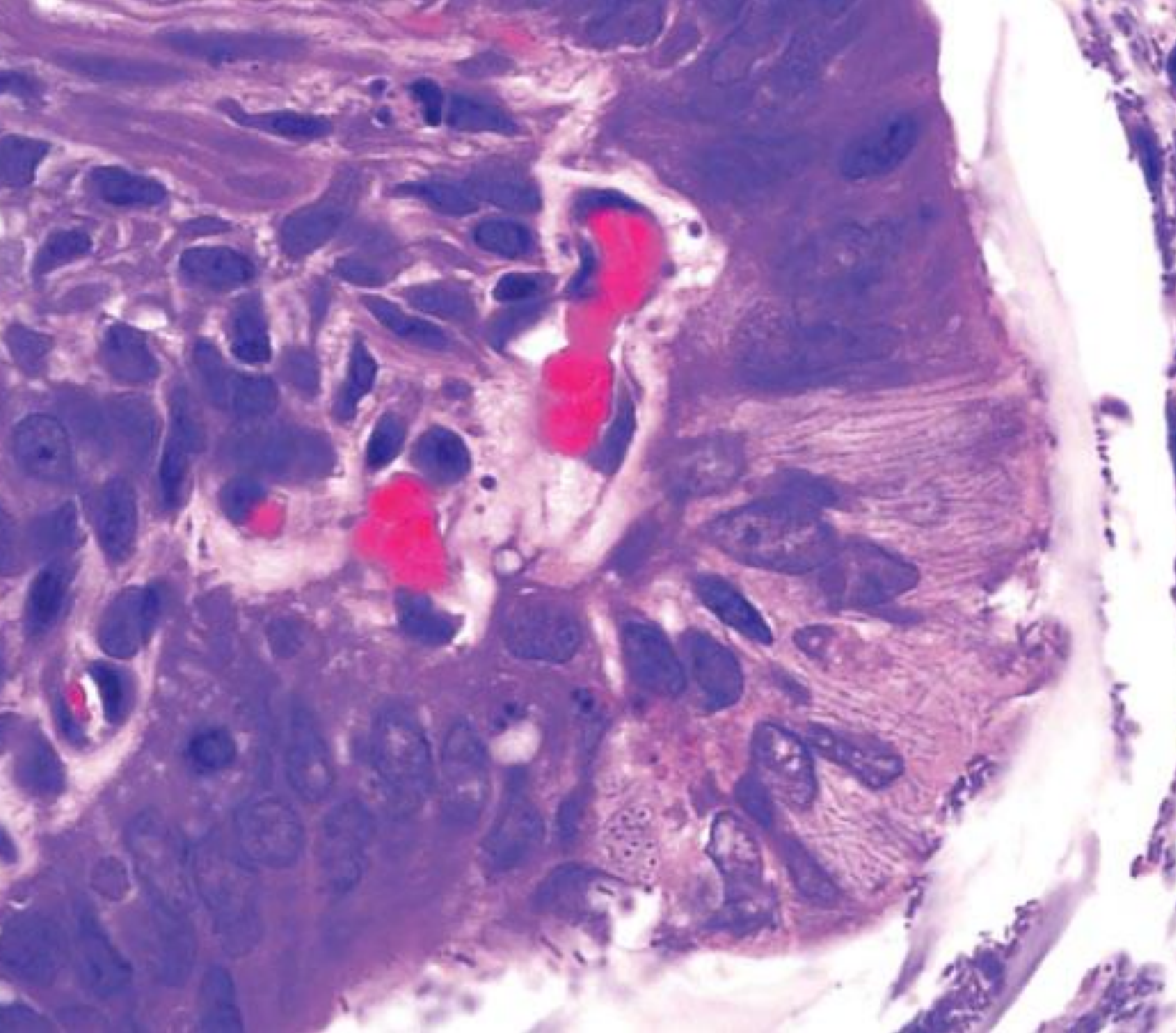
Hepatitis

MESSAGE TO REMEMBER









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

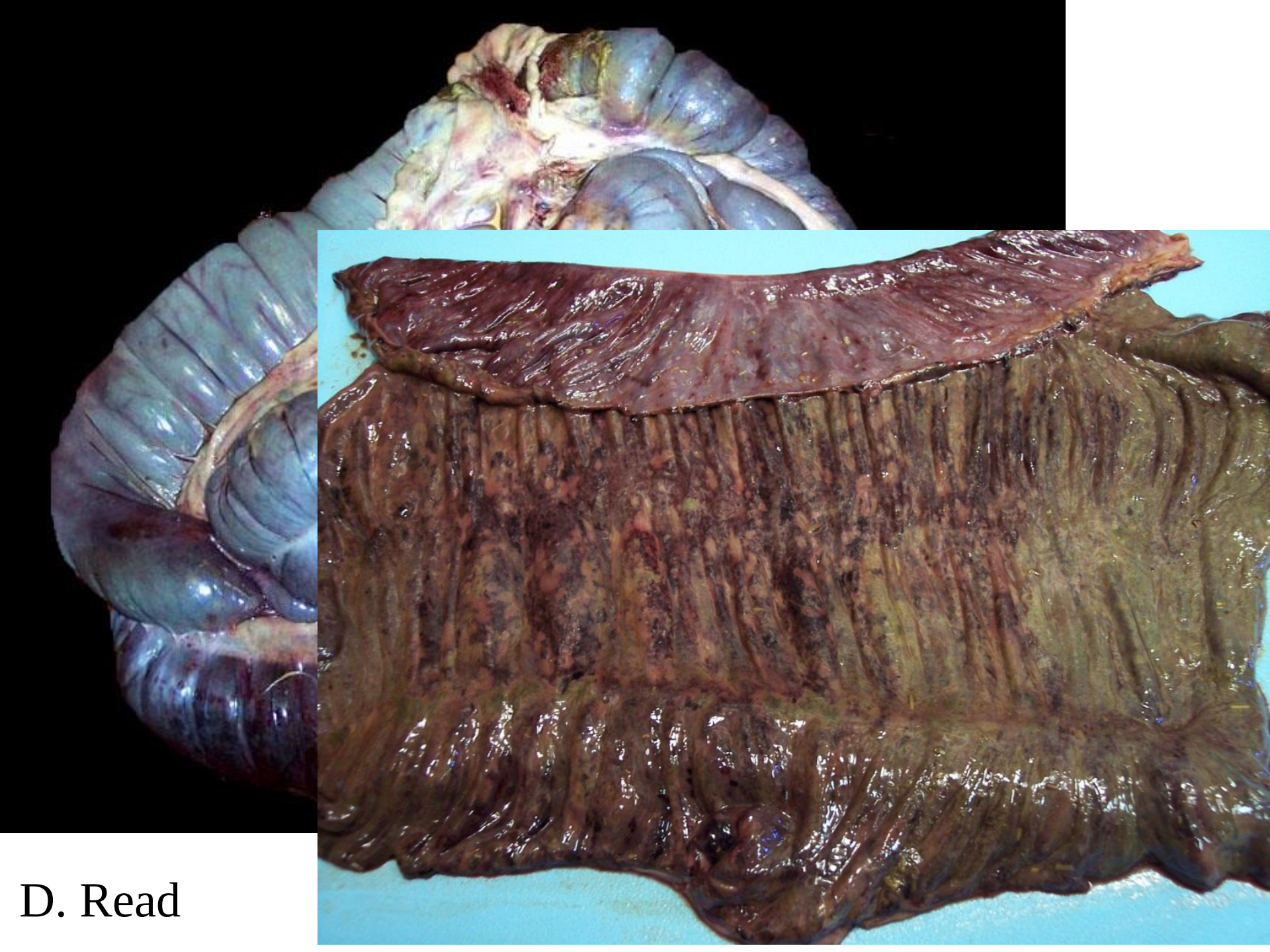
Other less understood entities

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 exculsion
- * 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[☯], Valeria R. Parreira[☯], 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](https://doi.org/10.1371/journal.pone.0122684)



Jennifer Davis



C. perfringens type A beta 2 +

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

Confirmed diseases

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

2-*C. difficile*: enterocolitis

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Other less understood entities

1-Colitis X

2-*C. perfringens* type A

3-*C. perfringens* type A CPB2

4-*C. sordellii* and others

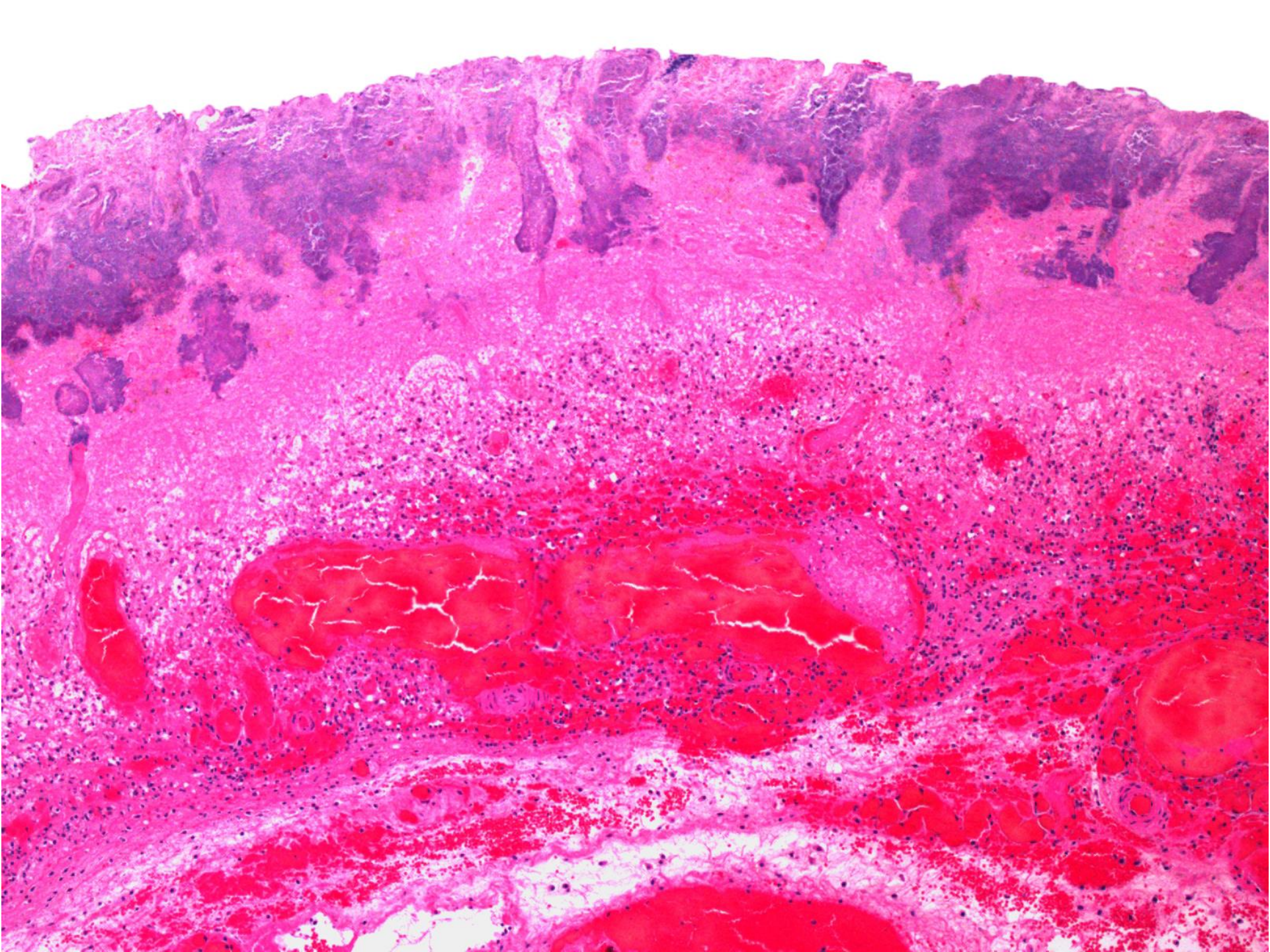
Enterocolitis with large # of

Clostridium (*Paeniclostridium*) *sordellii*

All other tests negative







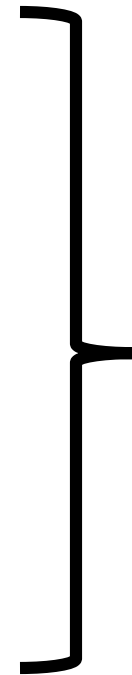
Diagnostic criteria: not established

Gross lesions

Micro lesions

Detection *C. sordellii*

Negative testing for other agents



Suggestive

Bacterial

Clostridium spp.

Salmonella spp.

Rhodococcus equi

Ehrlichia risticii

Lawsonia intracellularis

Others

Parasitic

Strongylus spp.

Parascaris equorum

Others

Viral

Rotavirus

Coronavirus

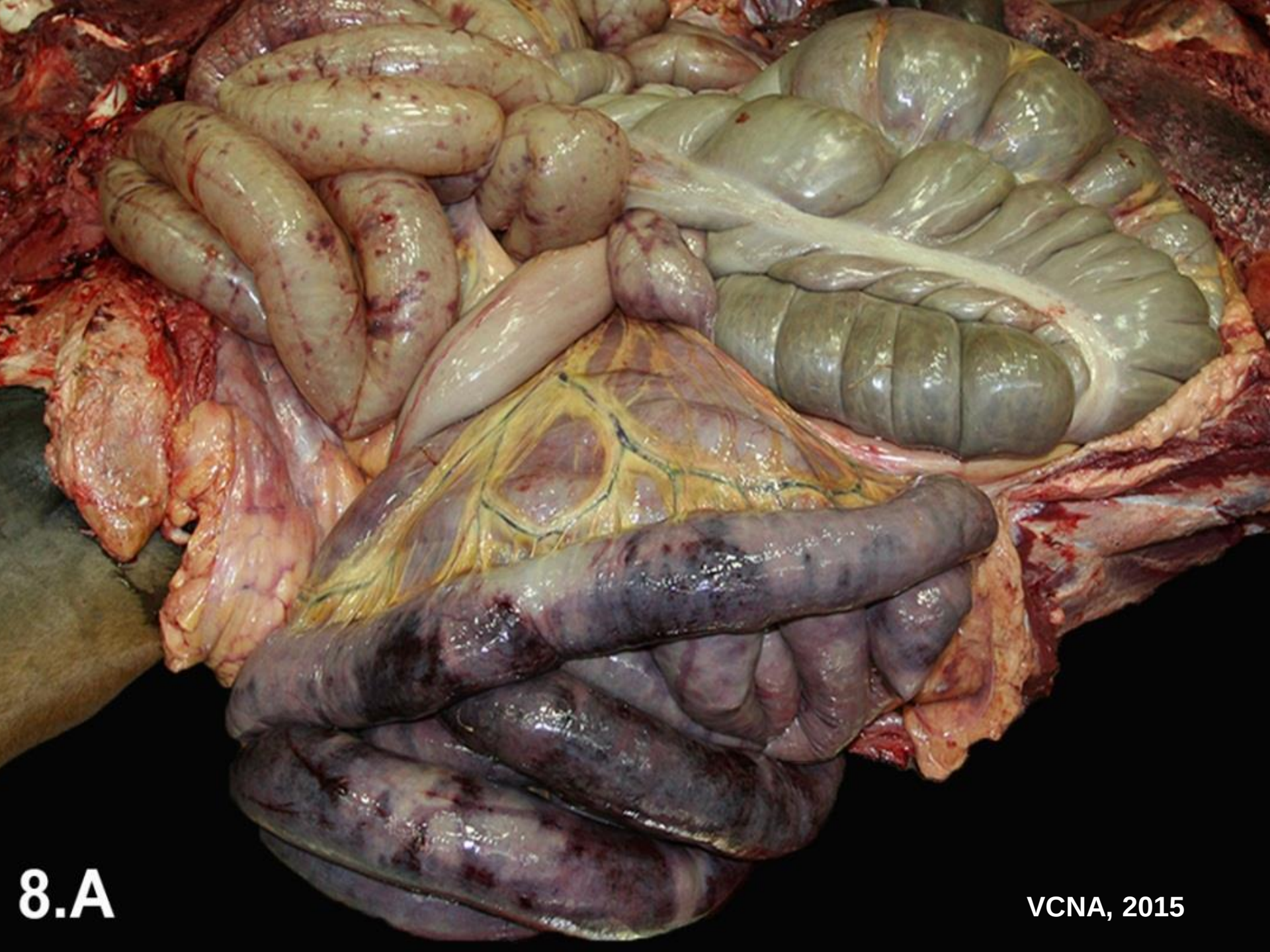
Fungal

Various

Salmonella enterica* ssp. *enterica
serovar Typhimurium

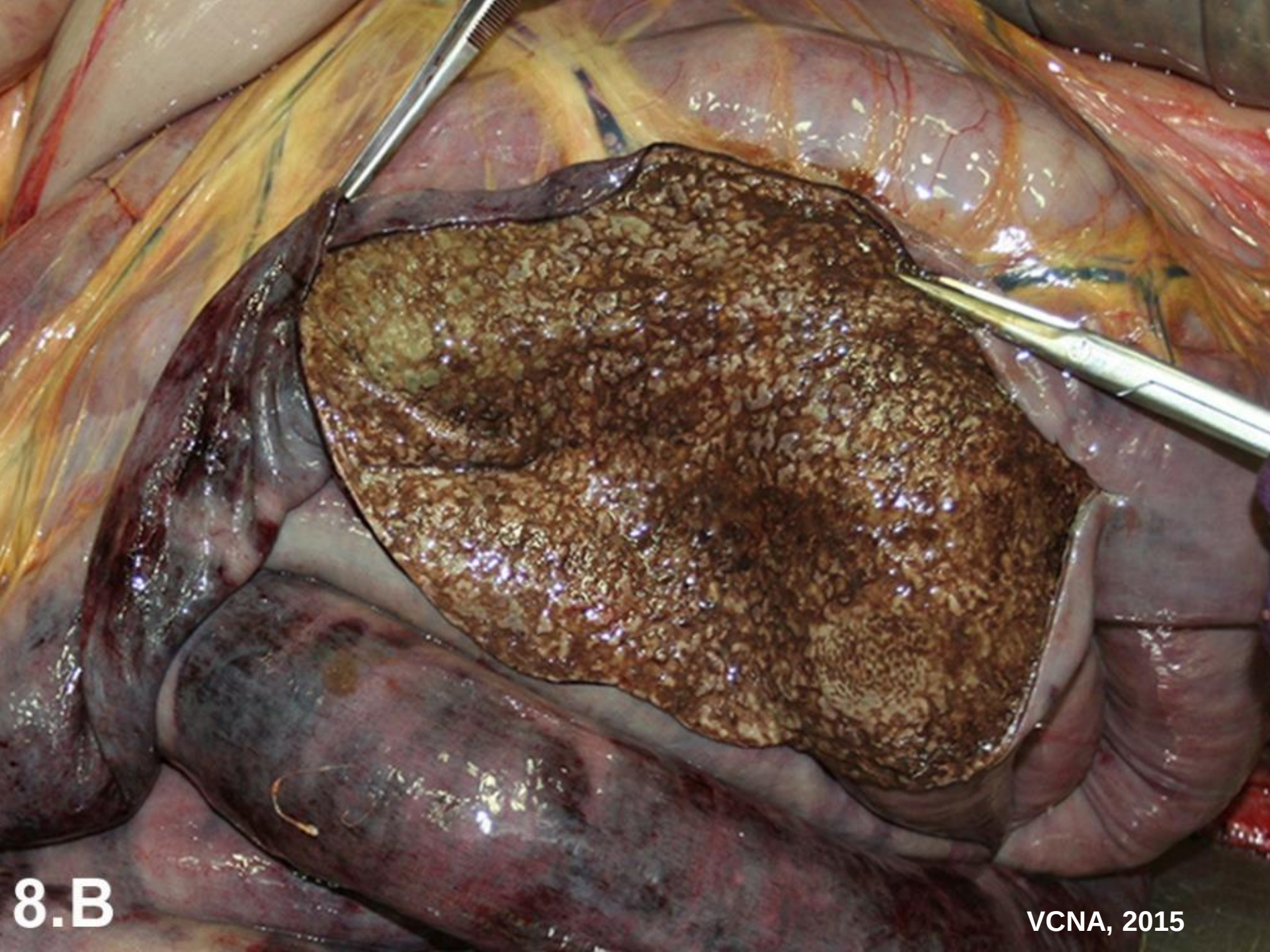
=

***Salmonella* Typhimurium**



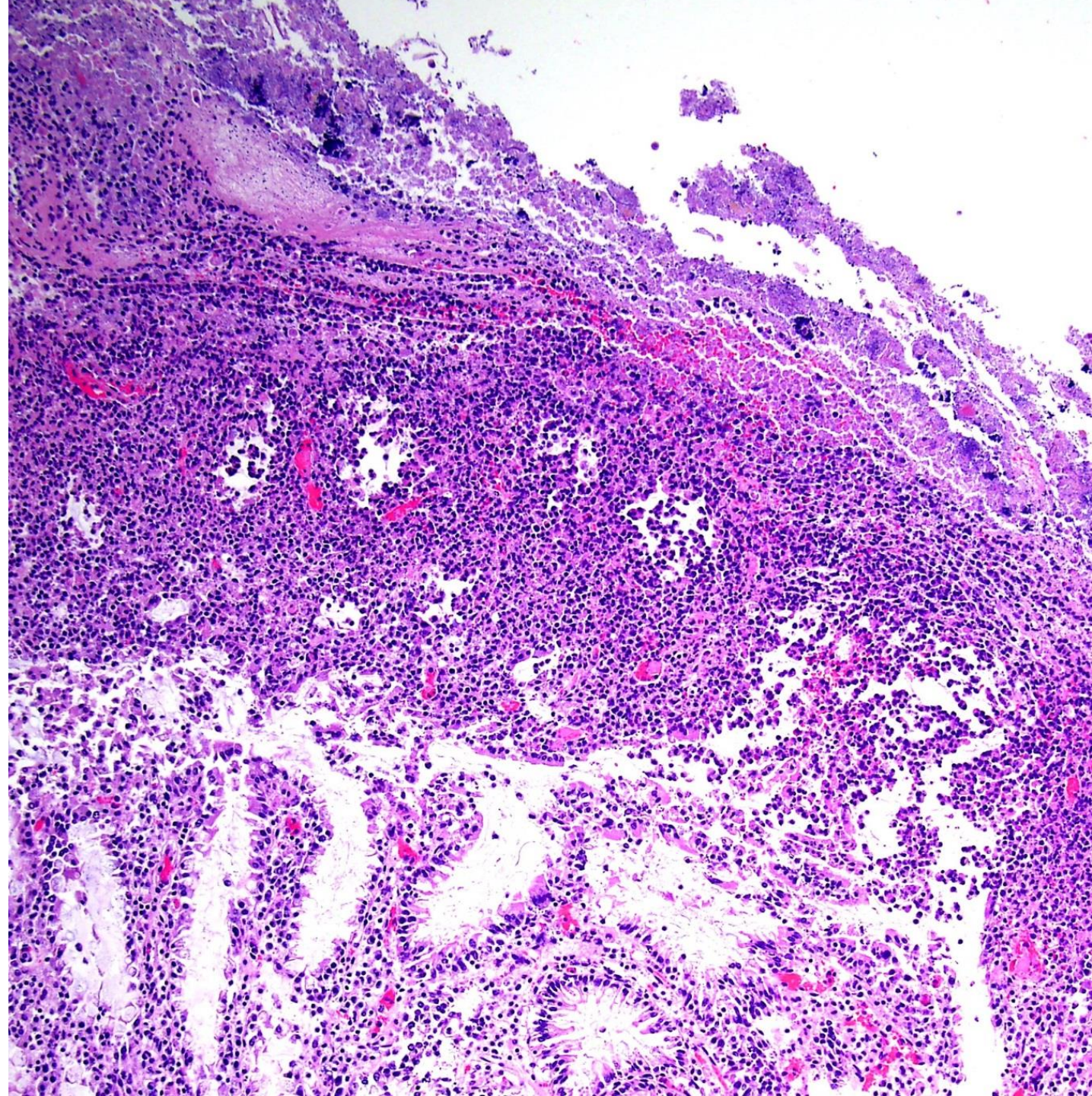
8.A

VCNA, 2015



8.B

VCNA, 2015



DIAGNOSIS

1-Gross/microscopic pathology

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

3-Serogrouping/serotyping

Bacterial

Clostridium spp.

Salmonella spp.

Rhodococcus equi

Ehrlichia risticii

Lawsonia intracellularis

Others

Parasitic

Strongylus spp.

Parascaris equorum

Others

Viral

Rotavirus

Coronavirus

Fungal

Various

Abdominal lesions

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

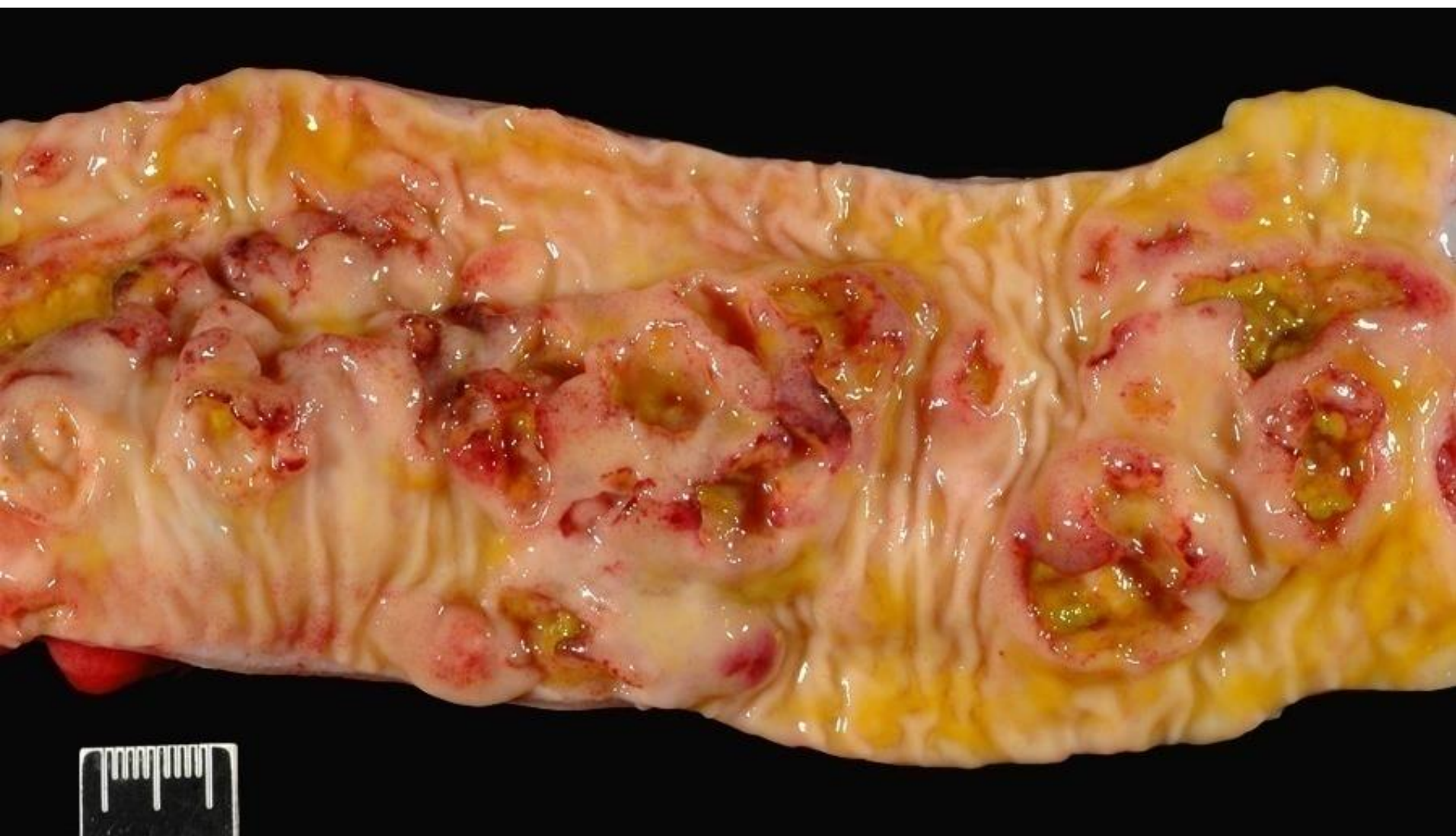
- * pyogranulomatous enterotyphlocolitis
- * pyogranulomatous lymphadenitis
- * intra-abdominal abscesses
- * peritonitis

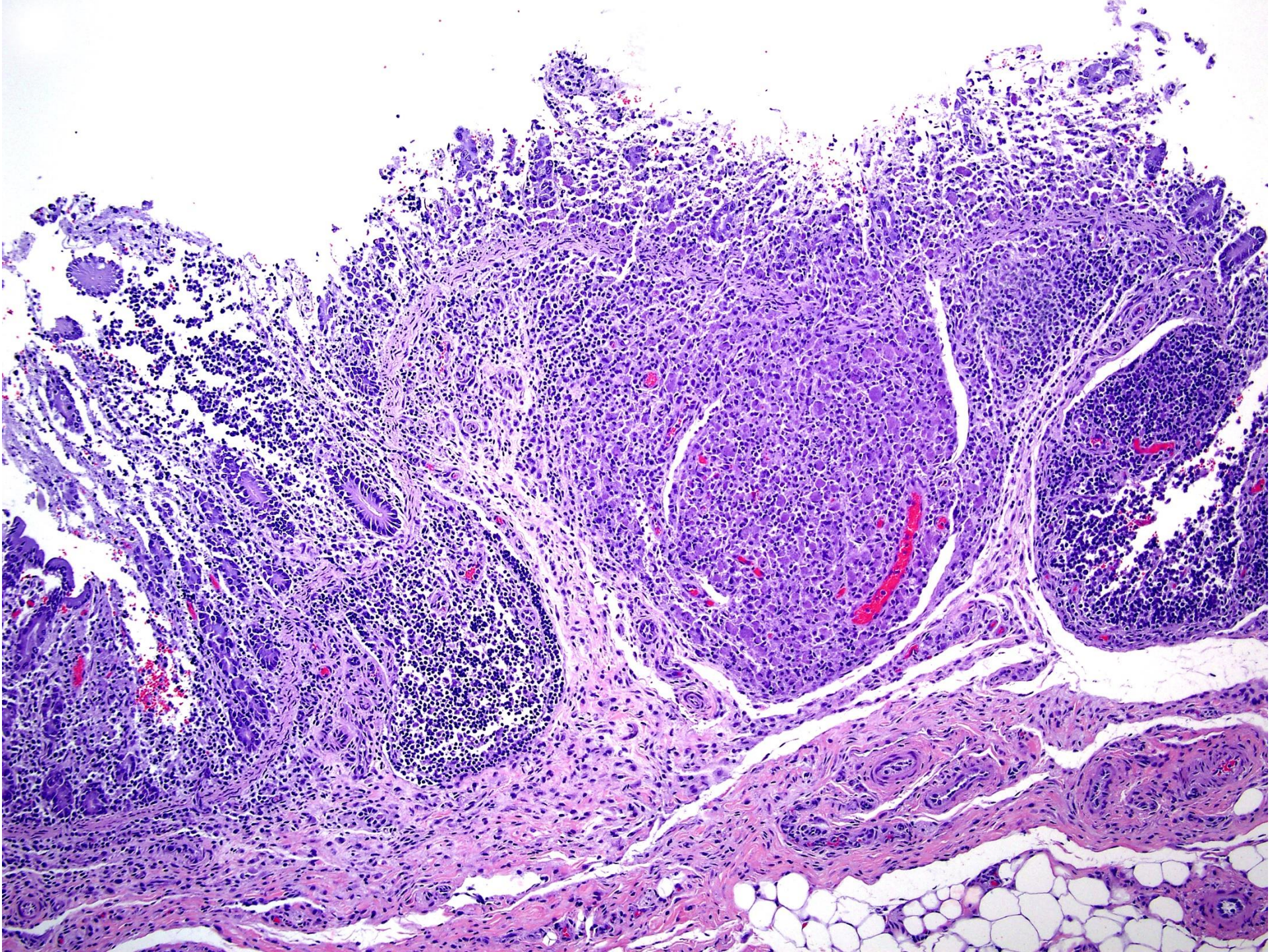
- * Bacteria swallowed in respiratory exudate
- * Colitis without pneumonia?

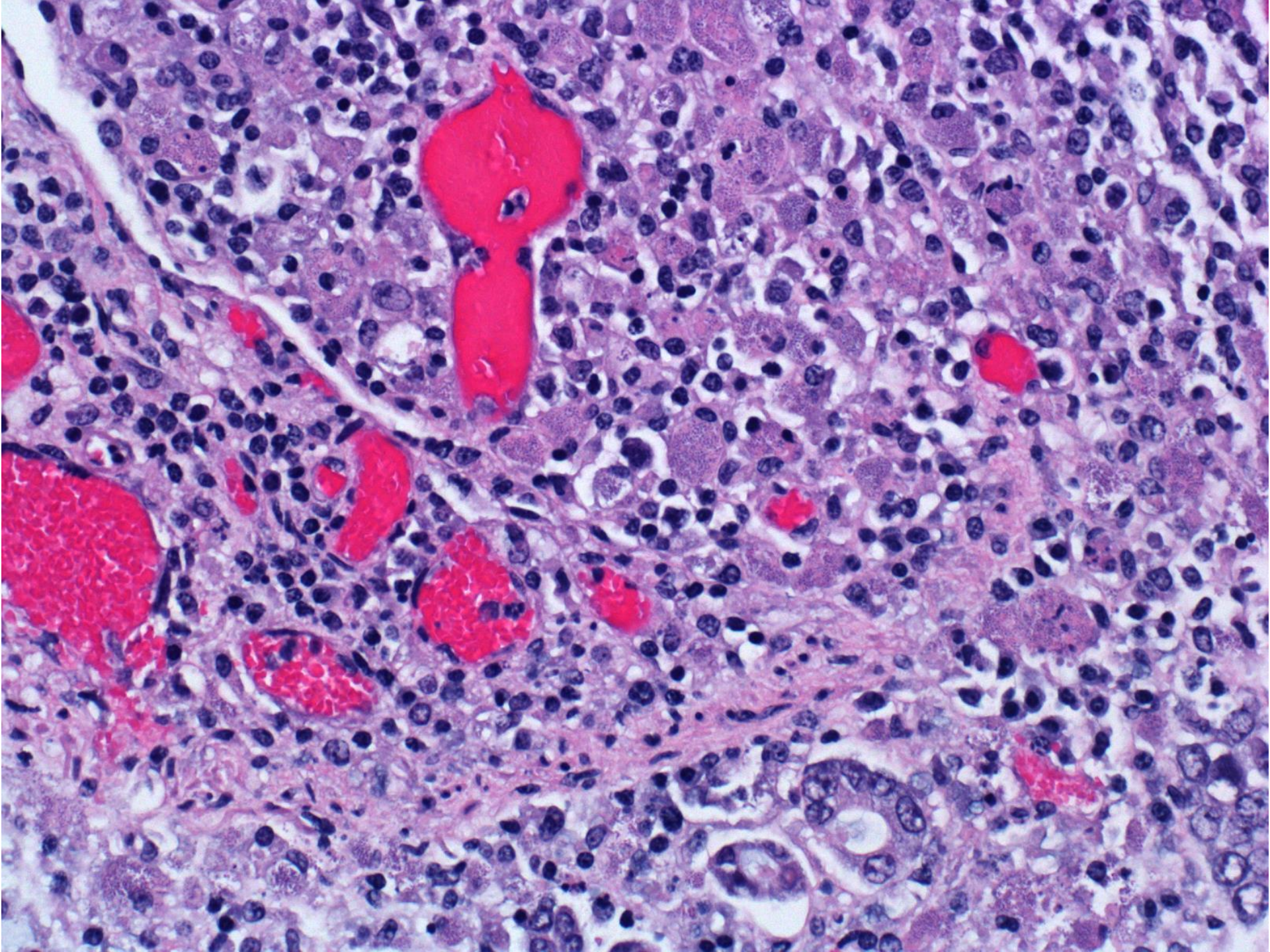


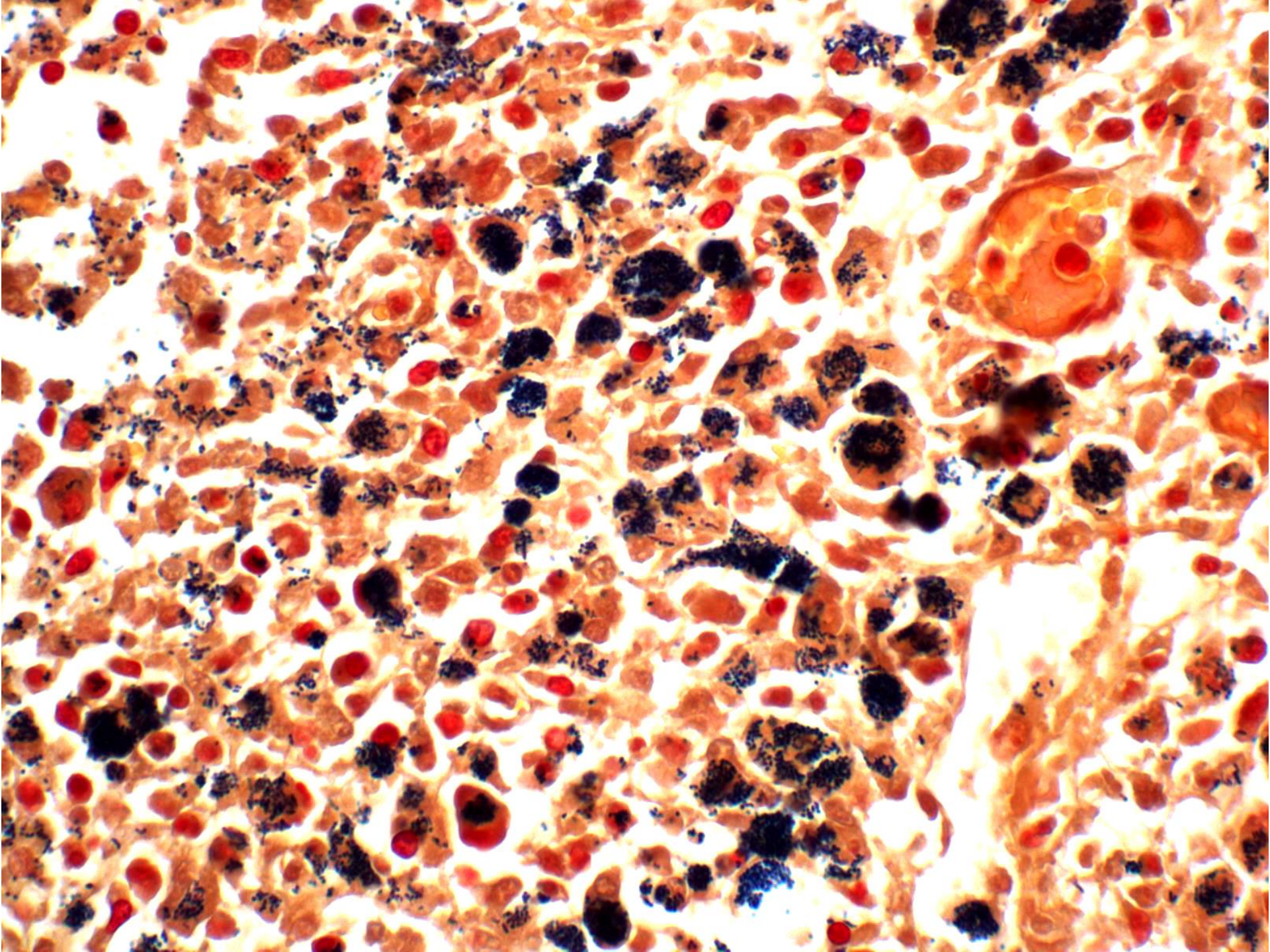
9.A

VCNA, 2015









DIAGNOSIS

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

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

Bacterial

Clostridium spp.

Salmonella spp.

Rhodococcus equi

Ehrlichia risticii

Lawsonia intracellularis

Others

Parasitic

Strongylus spp.

Parascaris equorum

Others

Viral

Rotavirus

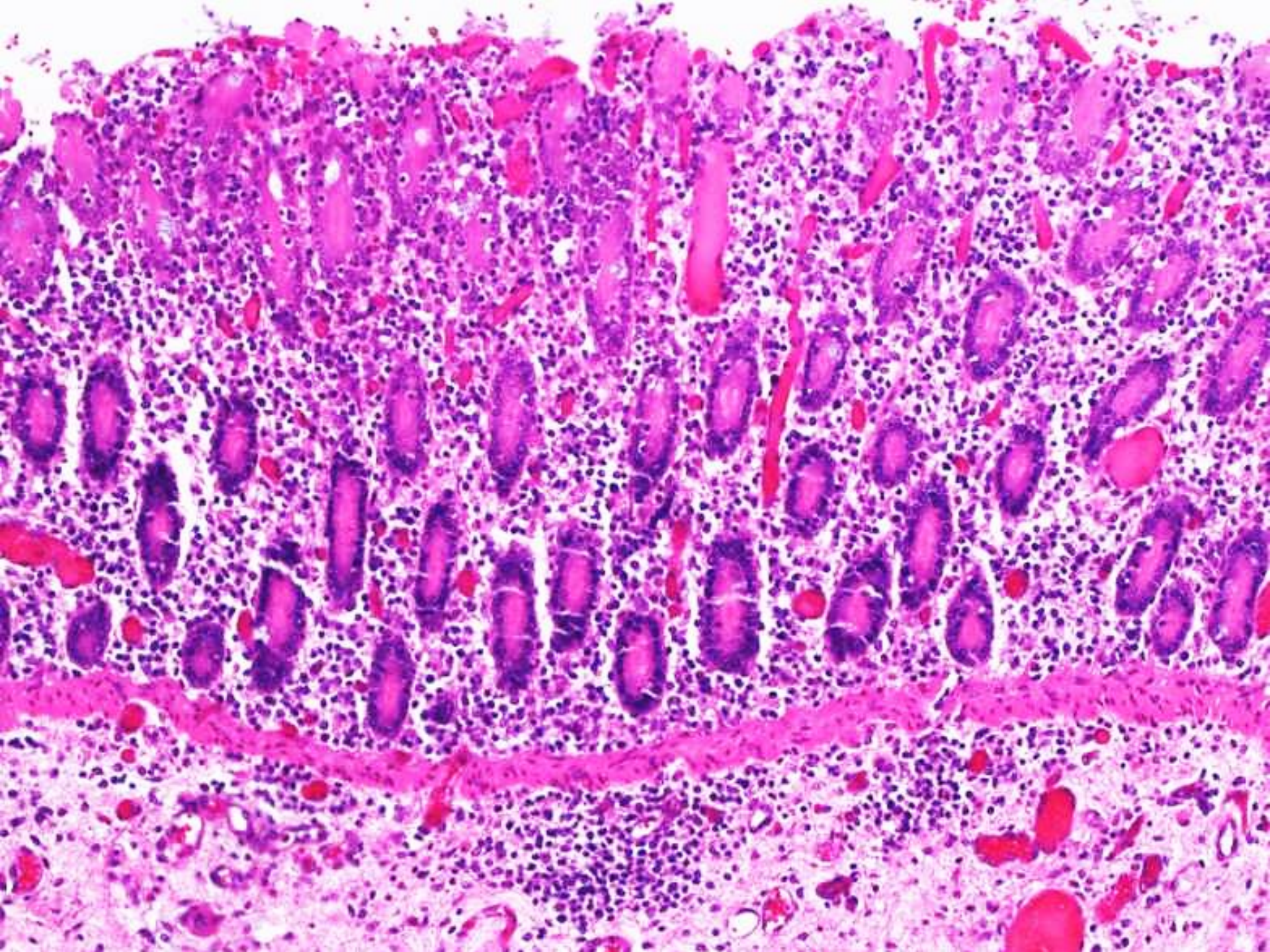
Coronavirus

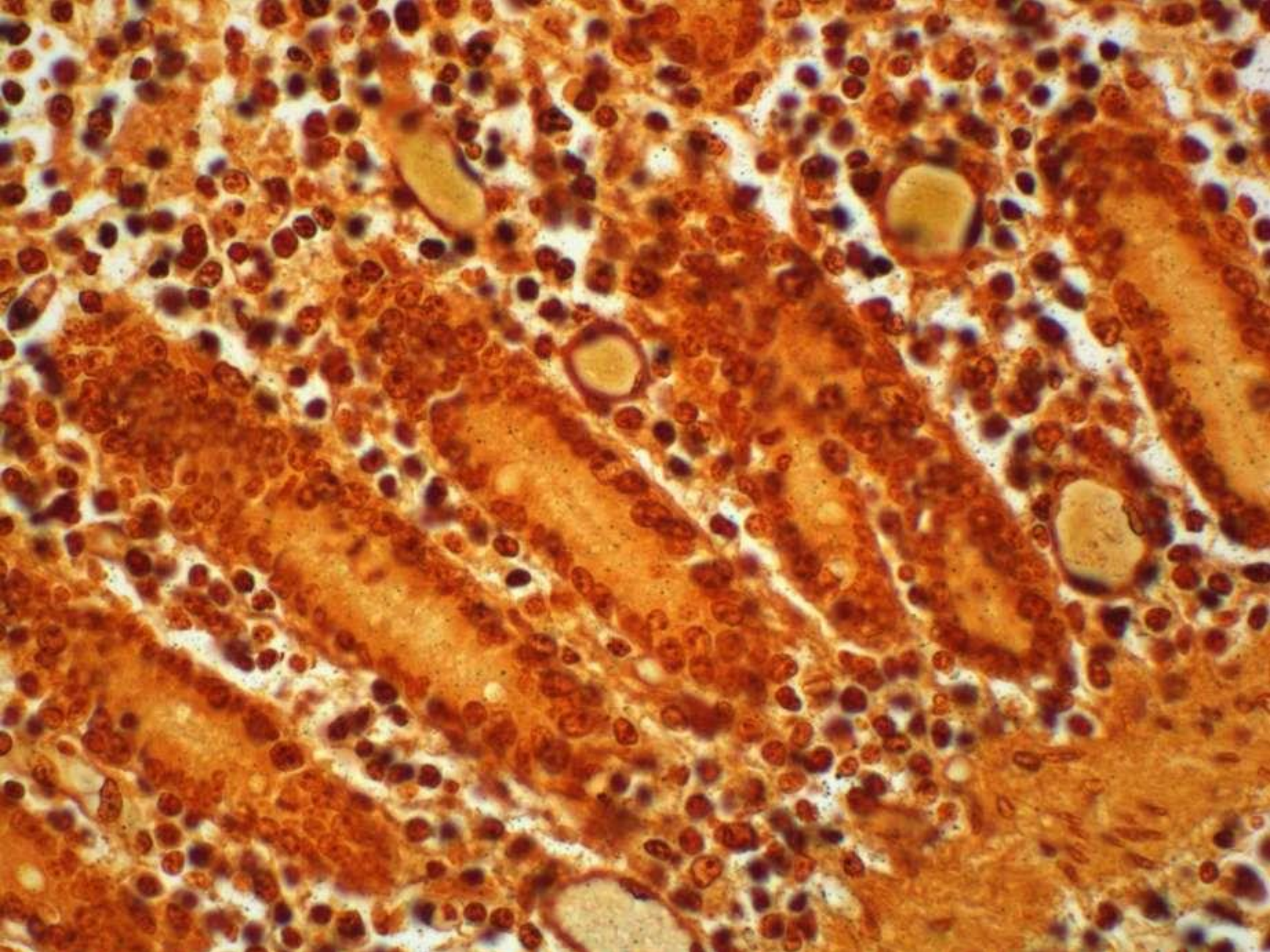
Fungal

Various

Potomac horse fever







DIAGNOSIS

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

2- PCR: feces/peripheral buffy coat

Bacterial

Clostridium spp.

Salmonella spp.

Rhodococcus equi

Ehrlichia risticii

Lawsonia intracellularis

Others

Parasitic

Strongylus spp.

Parascaris equorum

Others

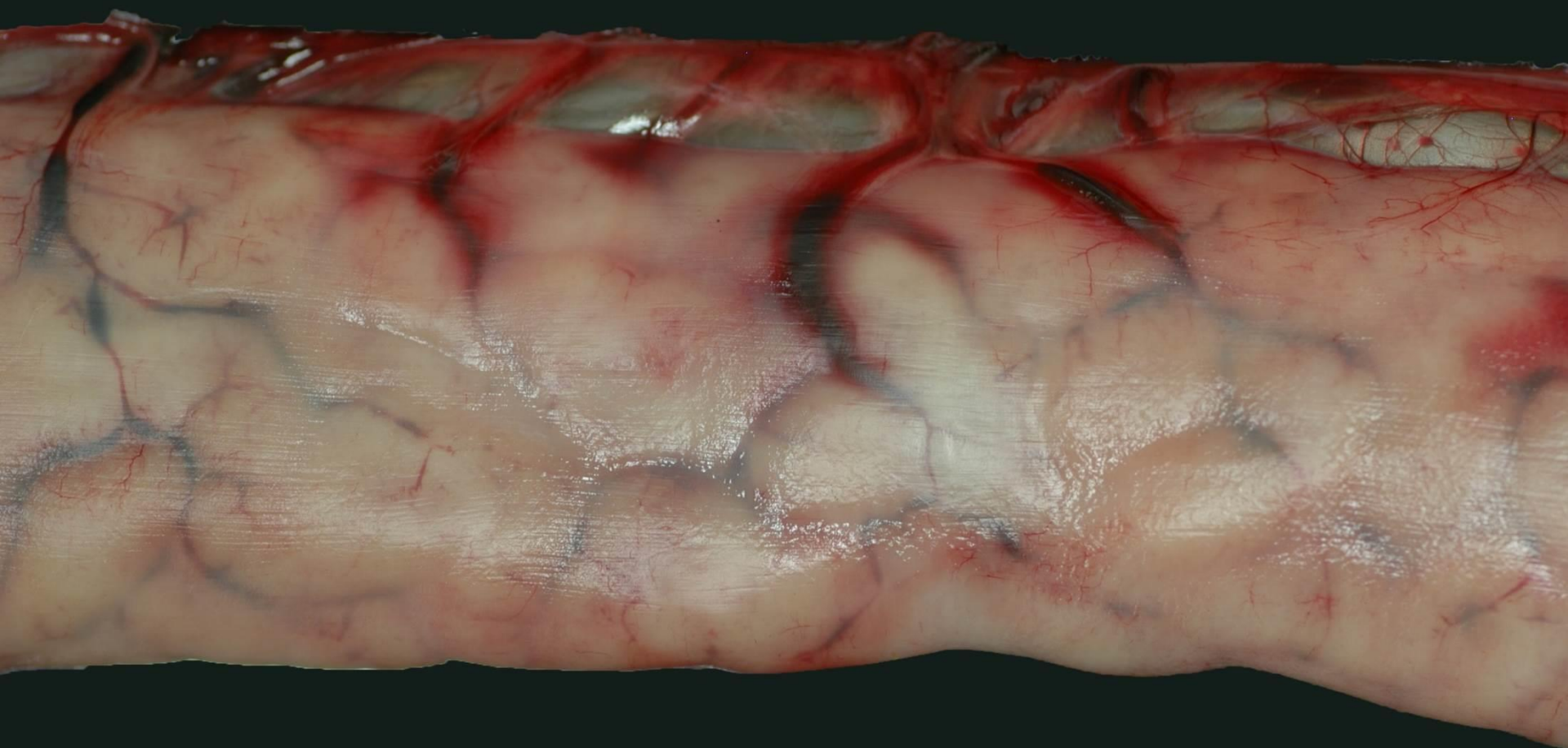
Viral

Rotavirus

Coronavirus

Fungal

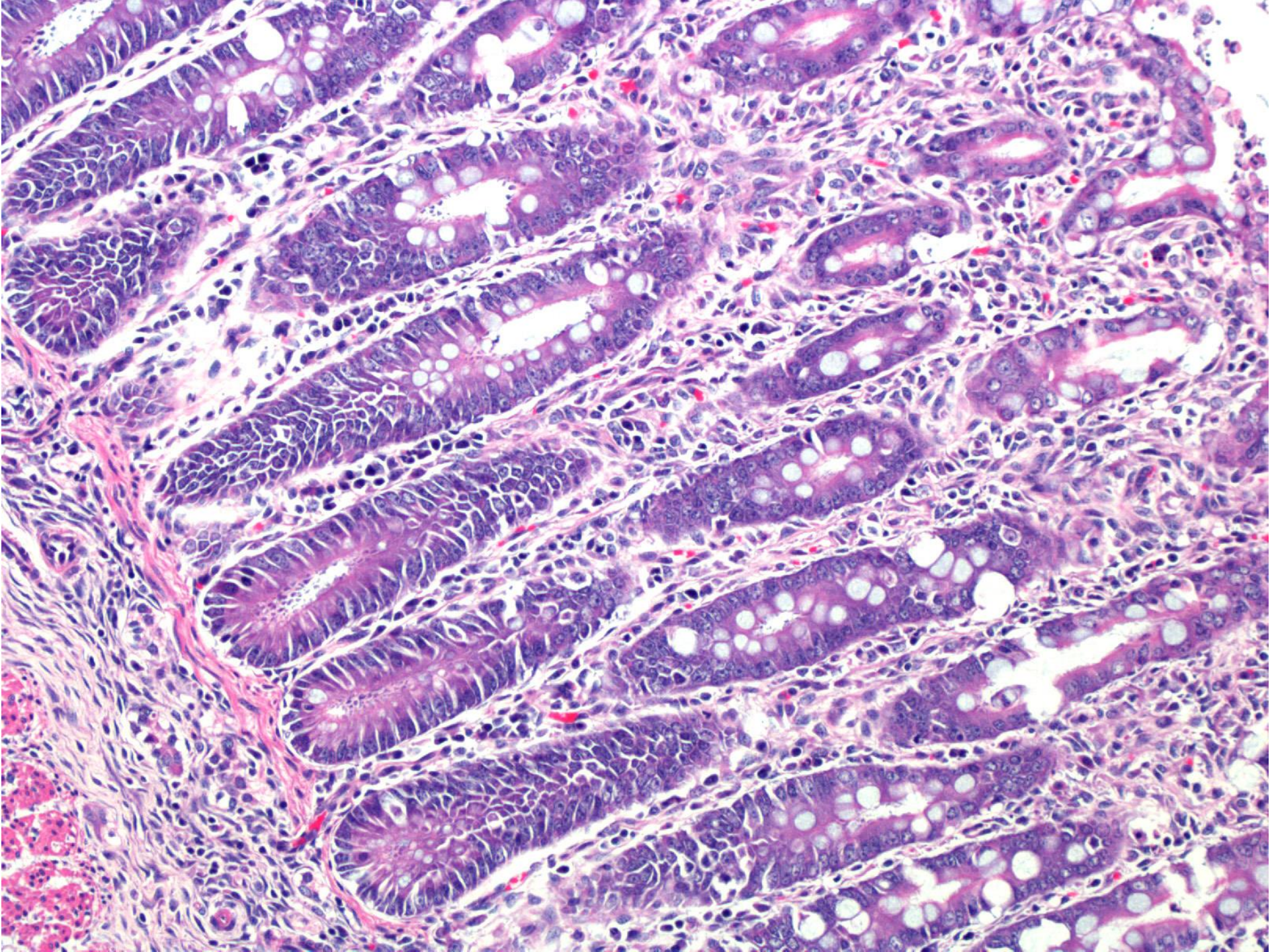
Various

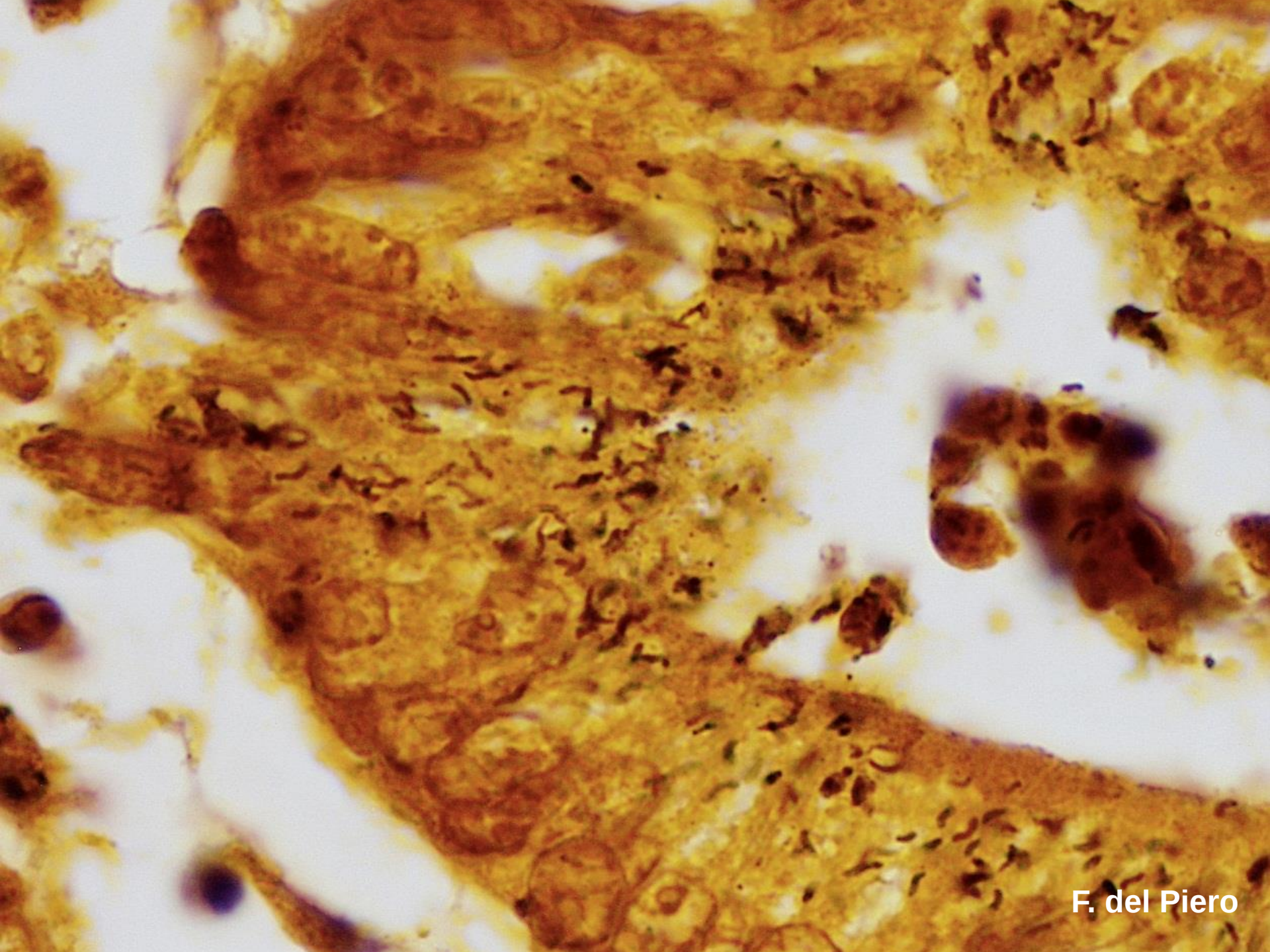


Robert Heines



Robert Heines





Bacterial

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Salmonella spp.

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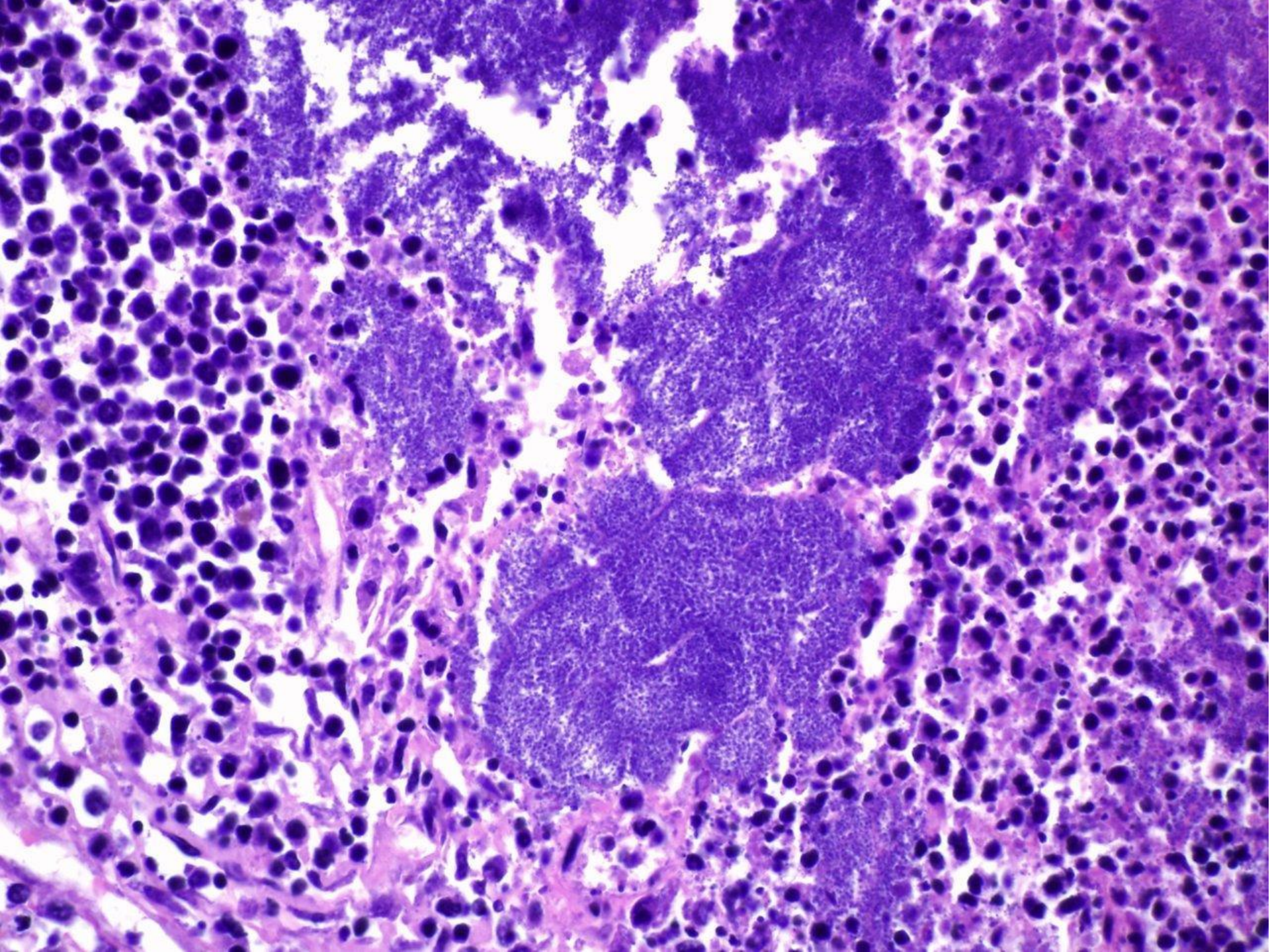
Fungal

Various

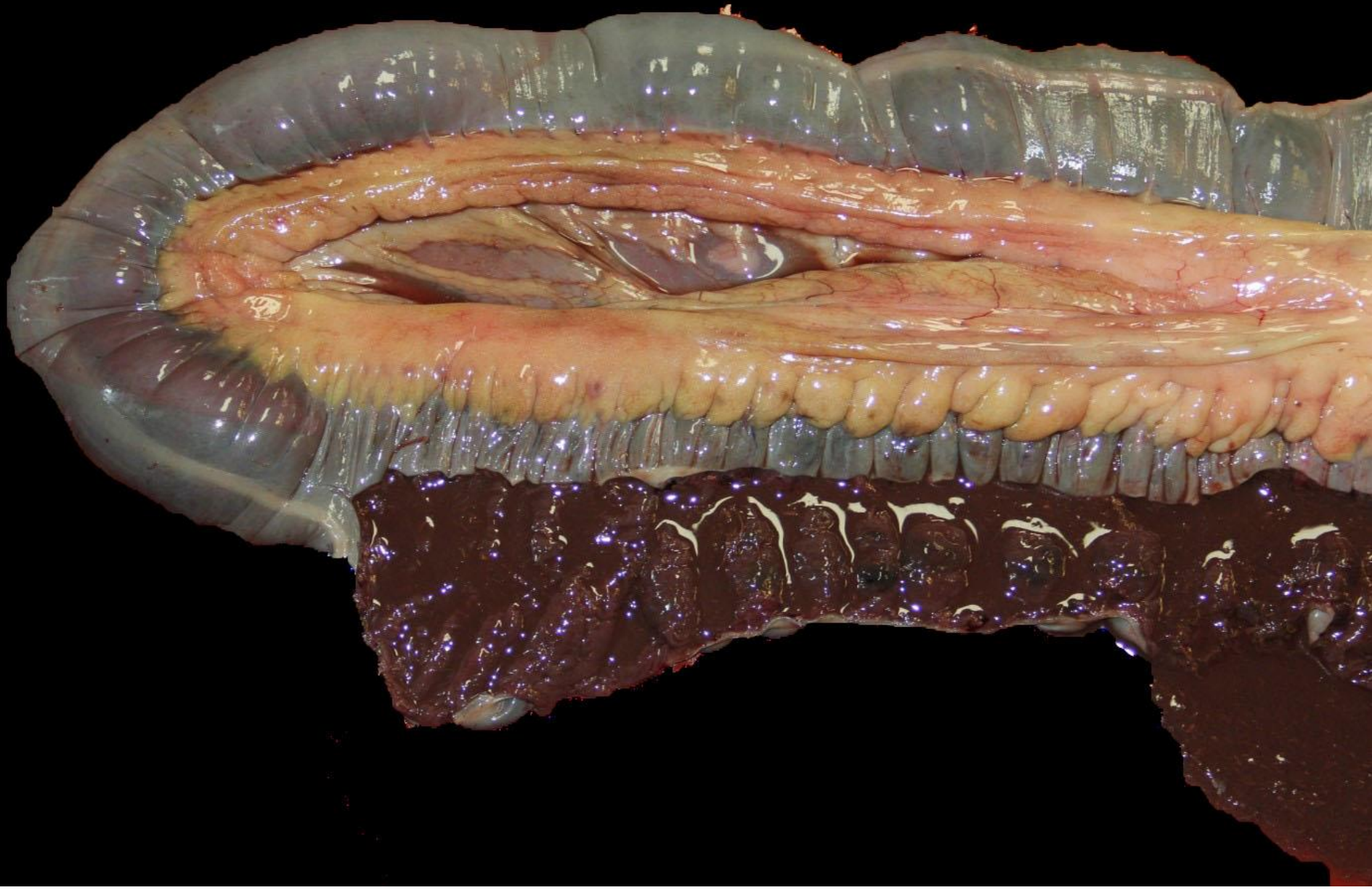
Actinobacillus equuli

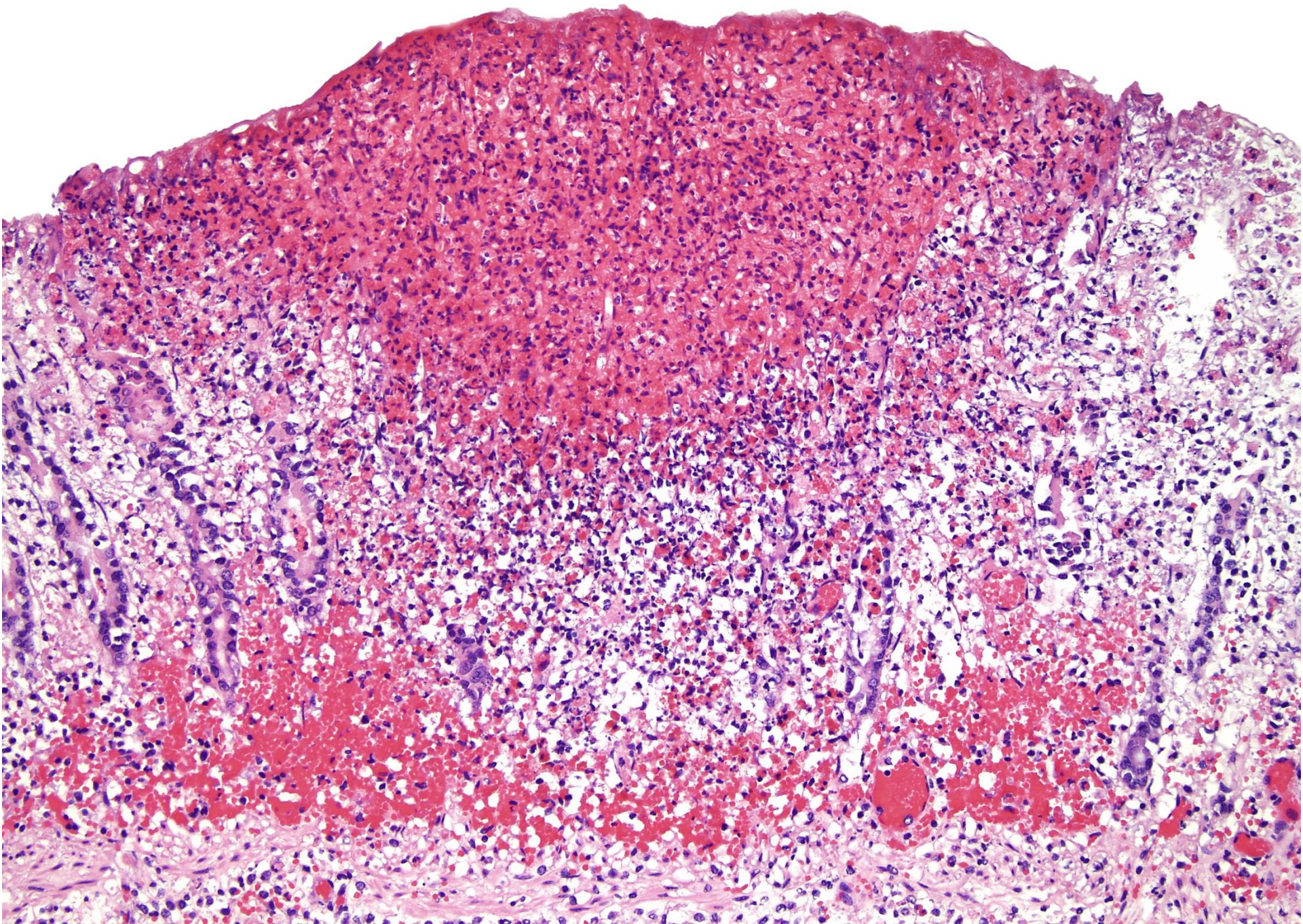


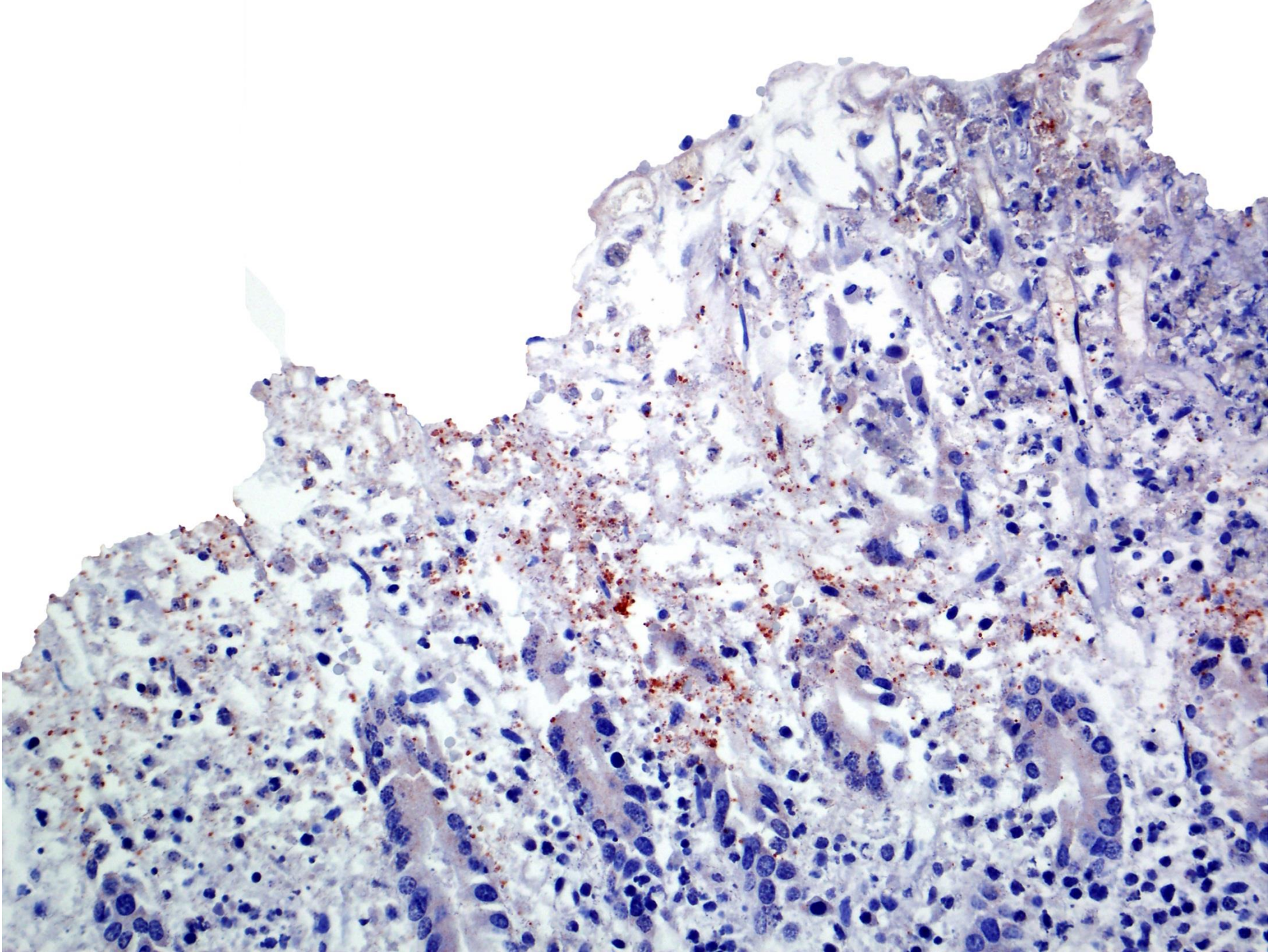




Streptococcus equi, *Klebsiella* spp., *Listeria* spp.







DIAGNOSIS

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

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Salmonella spp.

Rhodococcus equi

Ehrlichia risticii

Lawsonia intracellularis

Others

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Strongylus spp.

Parascaris equorum

Others

Viral

Rotavirus

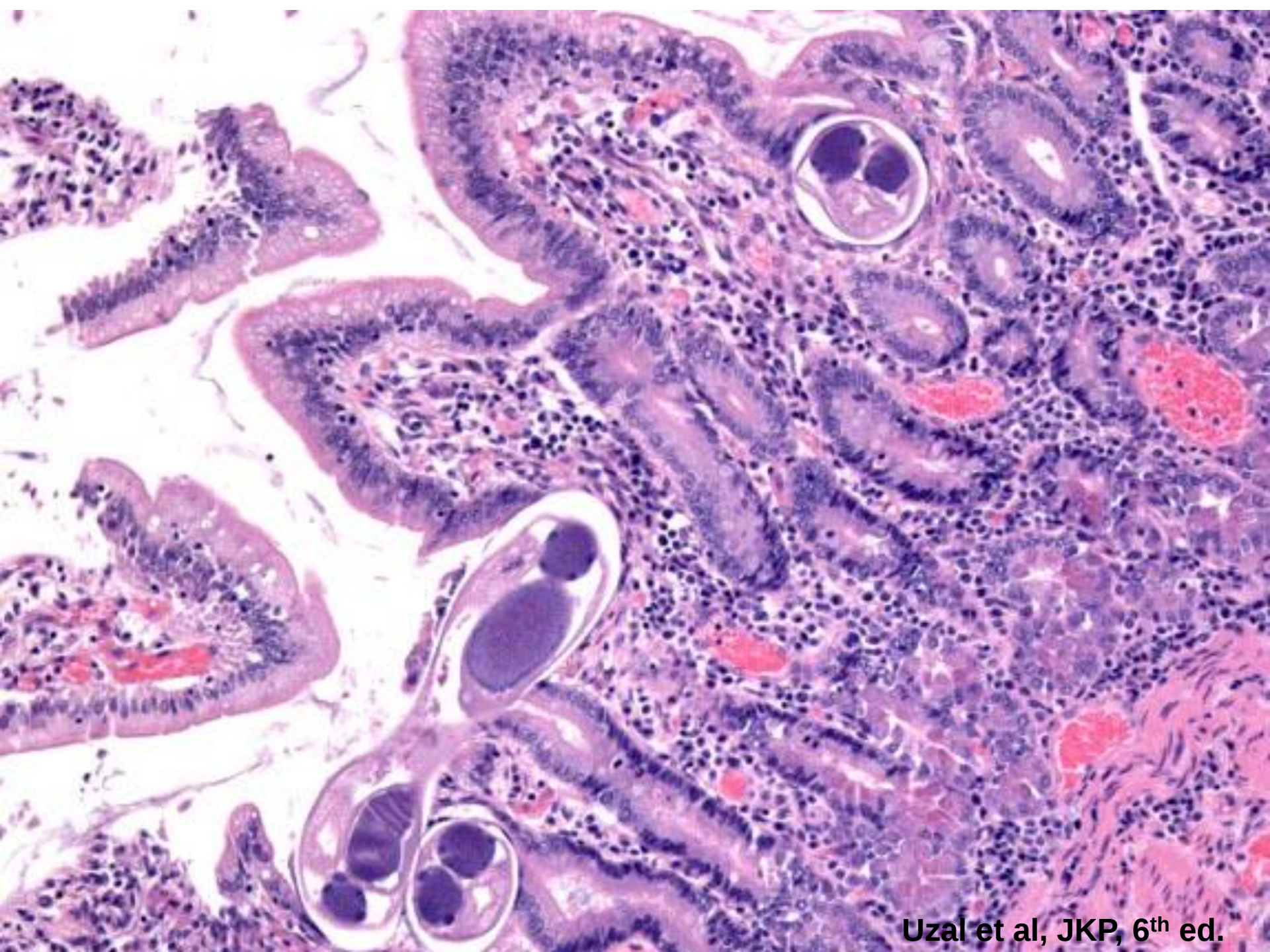
Coronavirus

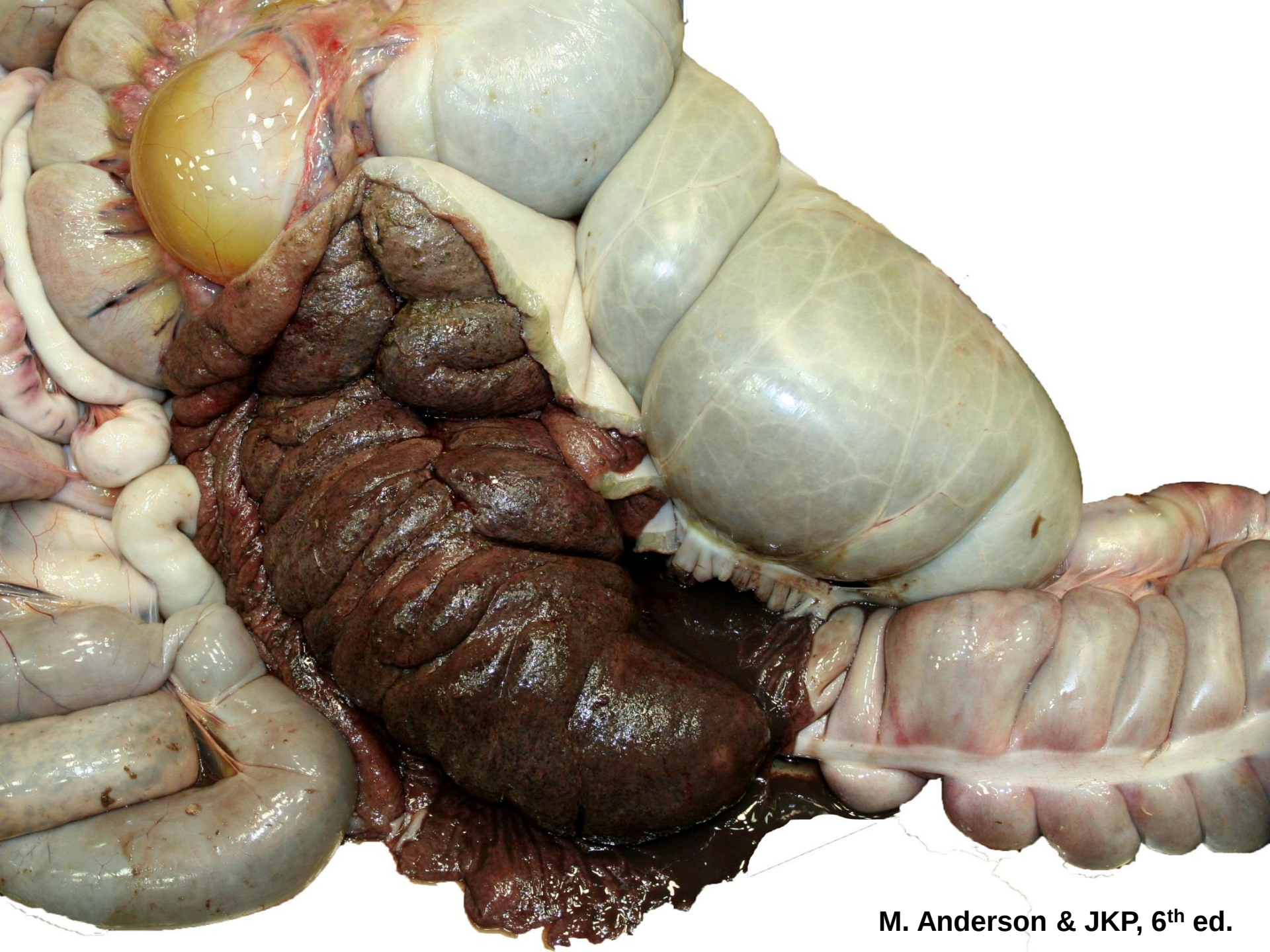
Fungal

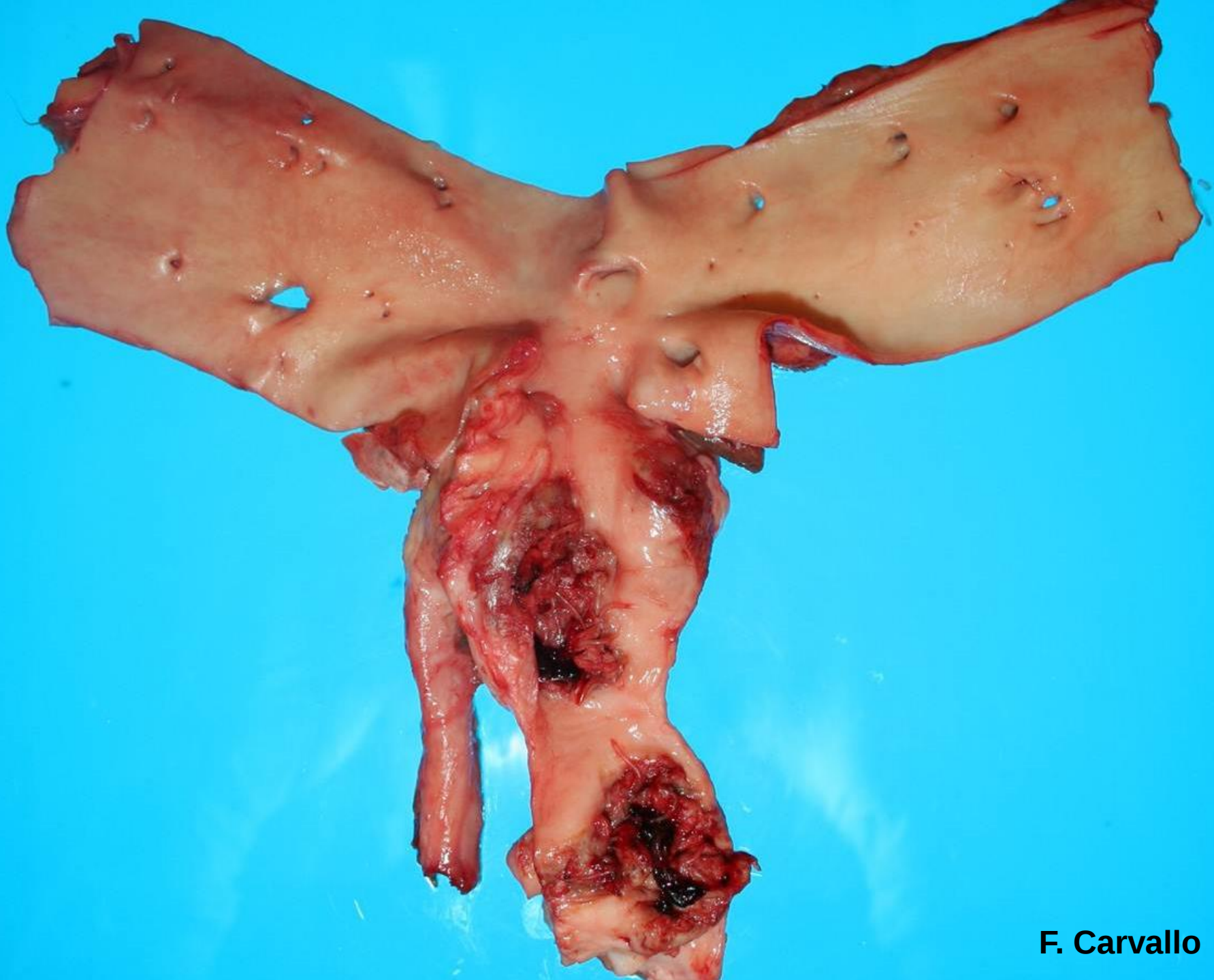
Various



M. Anderson







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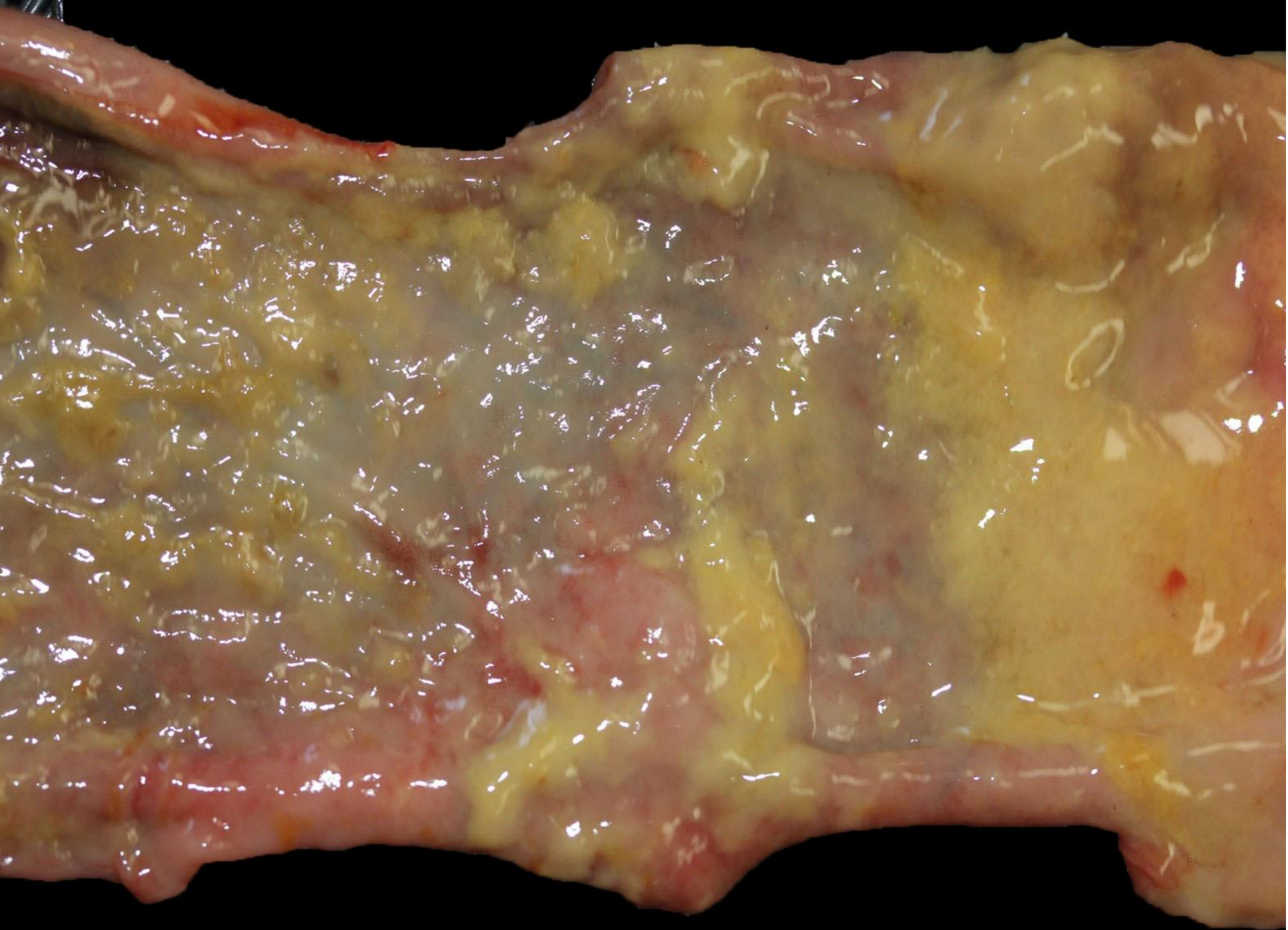
Viral

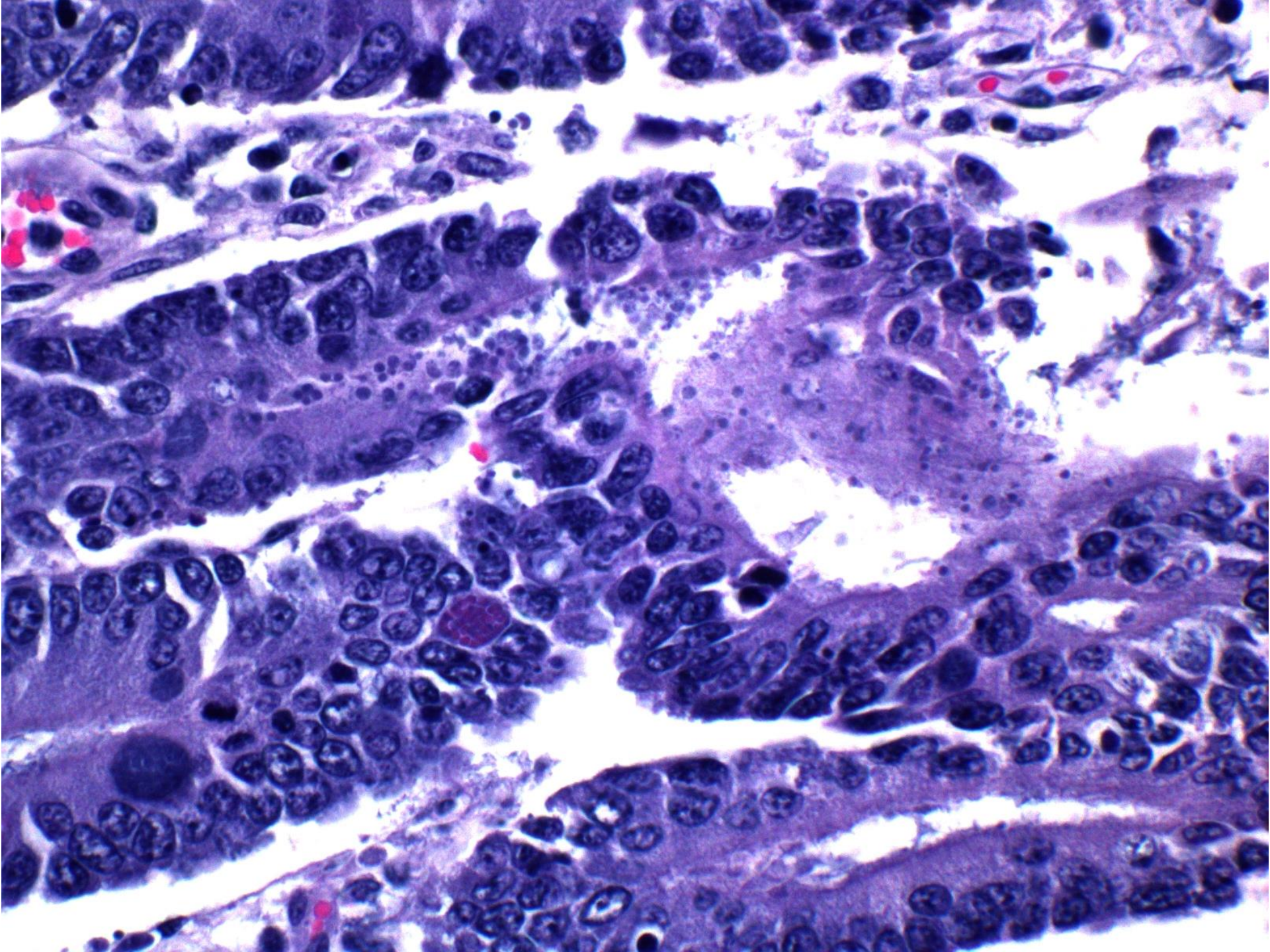
Rotavirus

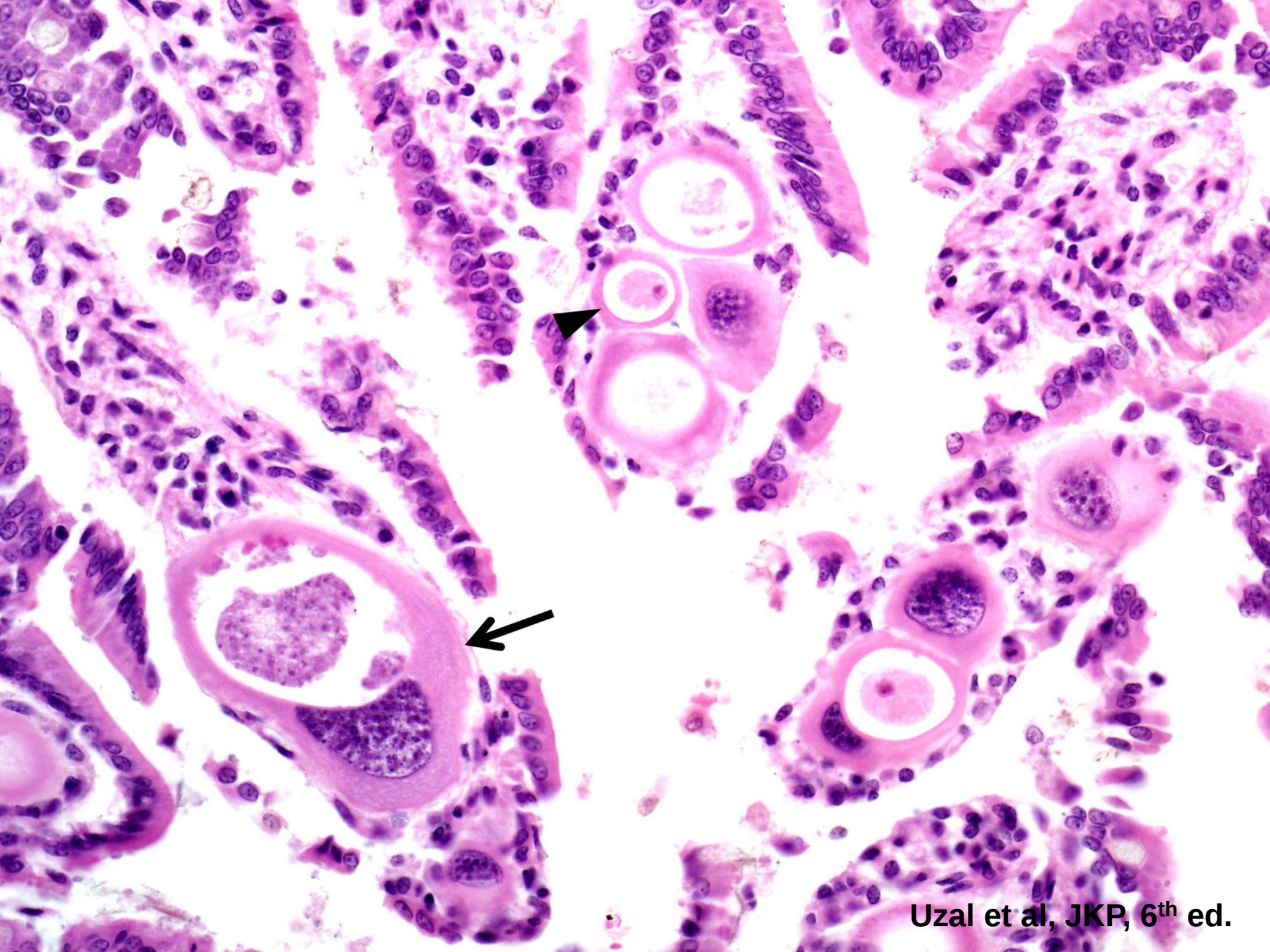
Coronavirus

Fungal

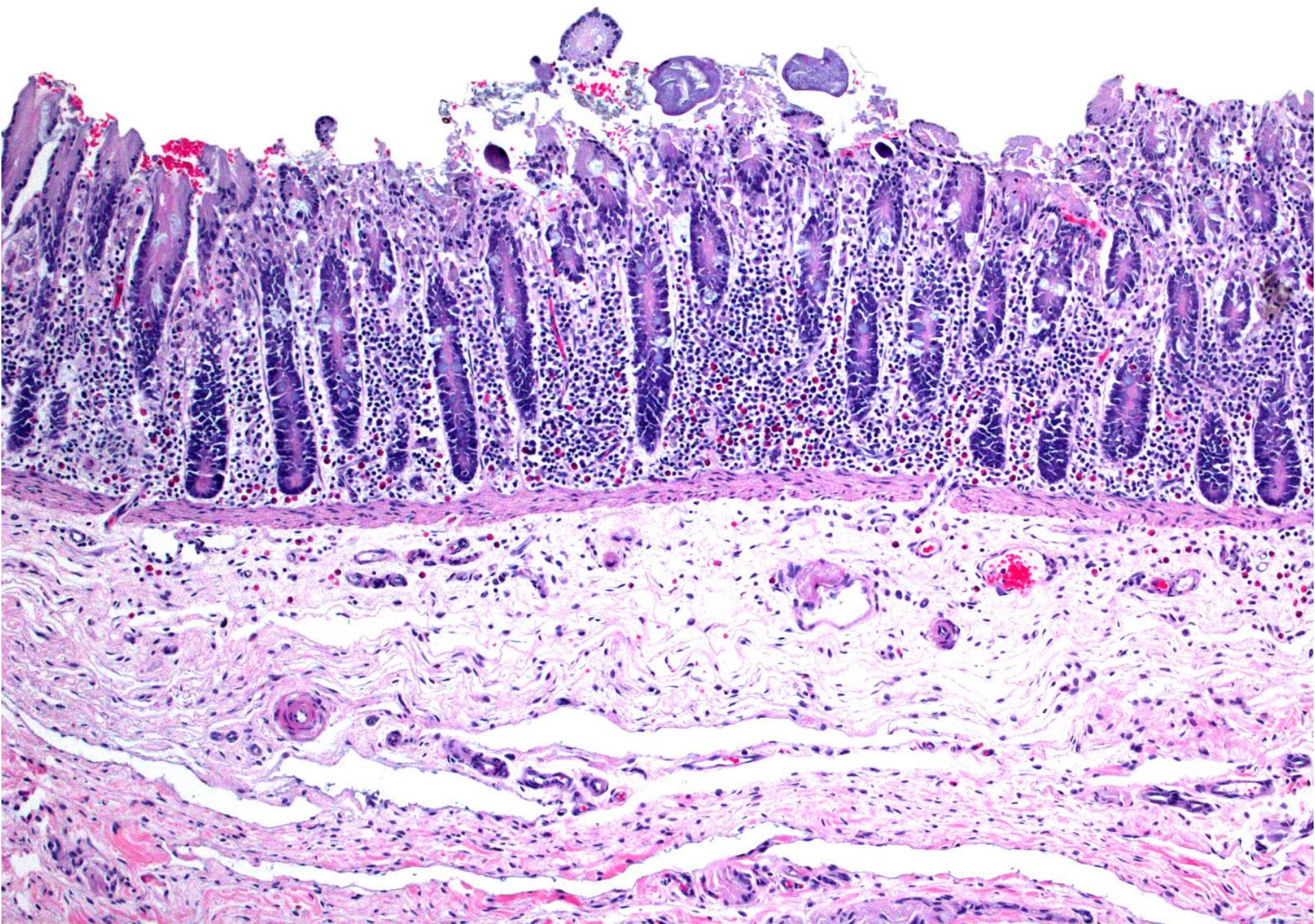
Various

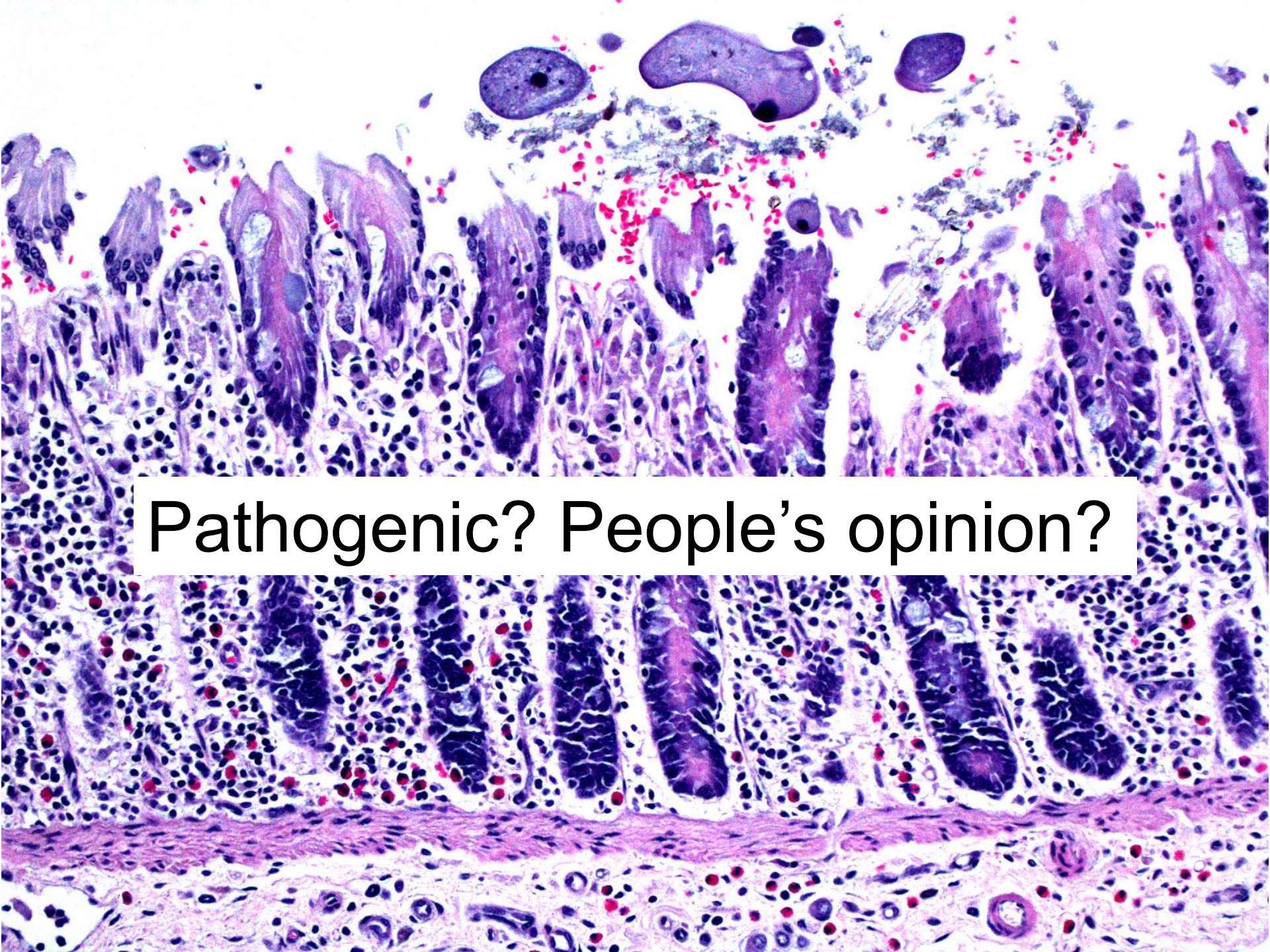












Pathogenic? People's opinion?

Bacterial

Clostridium spp.

Salmonella spp.

Rhodococcus equi

Ehrlichia risticii

Lawsonia intracellularis

Others

Parasitic

Strongylus spp.

Parascaris equorum

Others

Viral

Rotavirus

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Fungal

Various

Rotavirus diarrhea

Never seen one of these in the PM room

Clinician's opinion?

Bacterial

Clostridium spp.

Salmonella spp.

Rhodococcus equi

Ehrlichia risticii

Lawsonia intracellularis

Others

Parasitic

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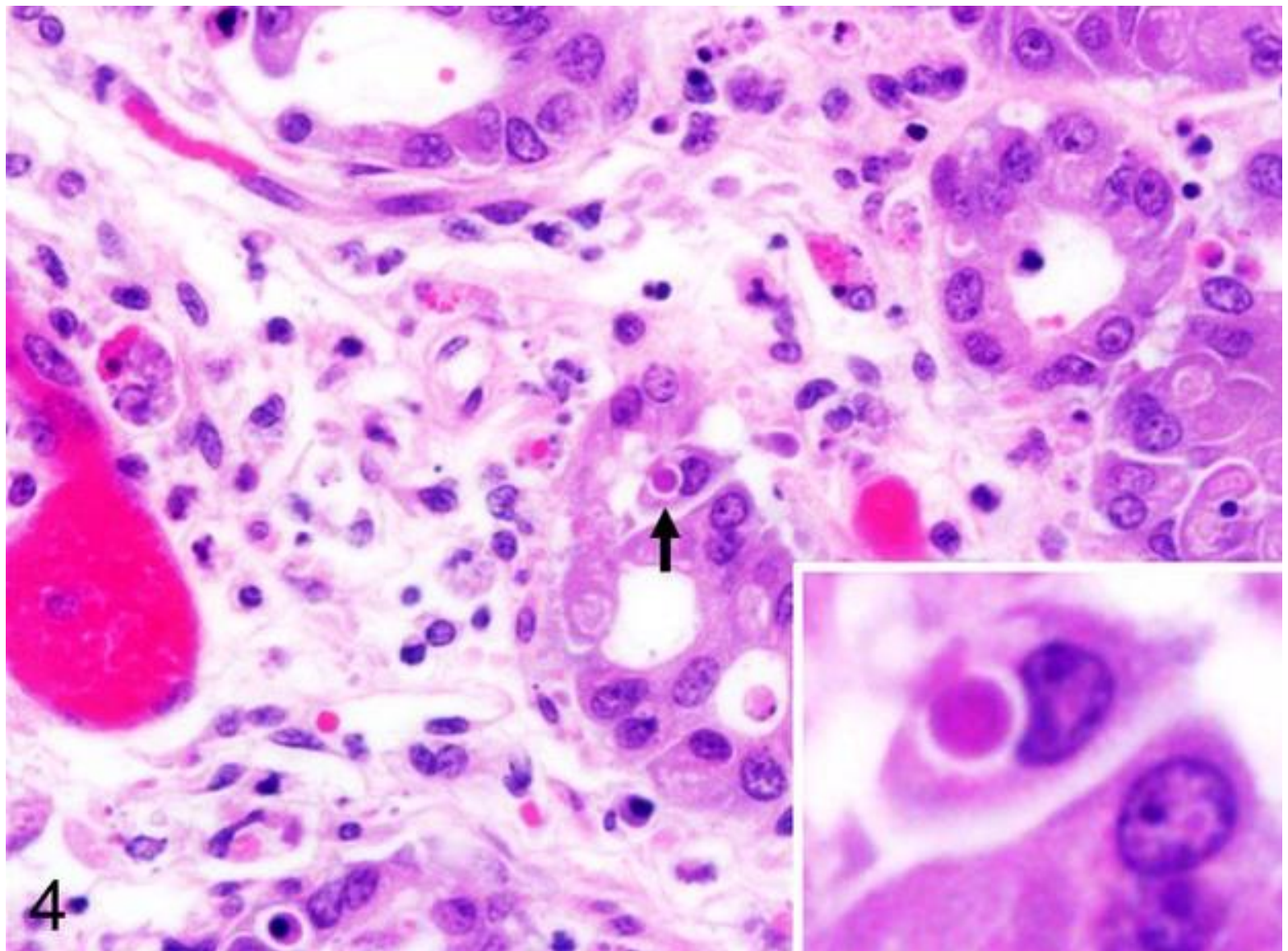
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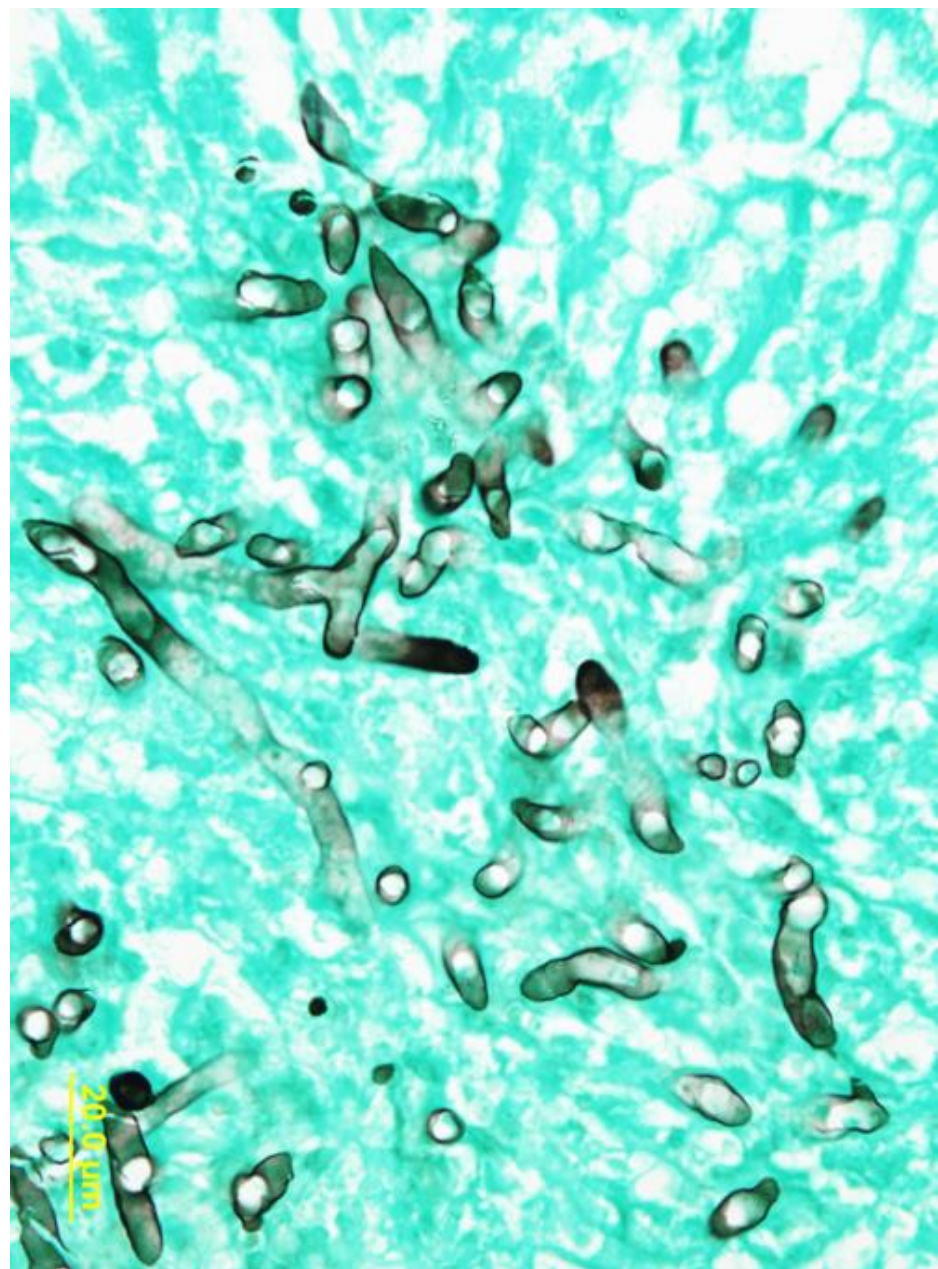
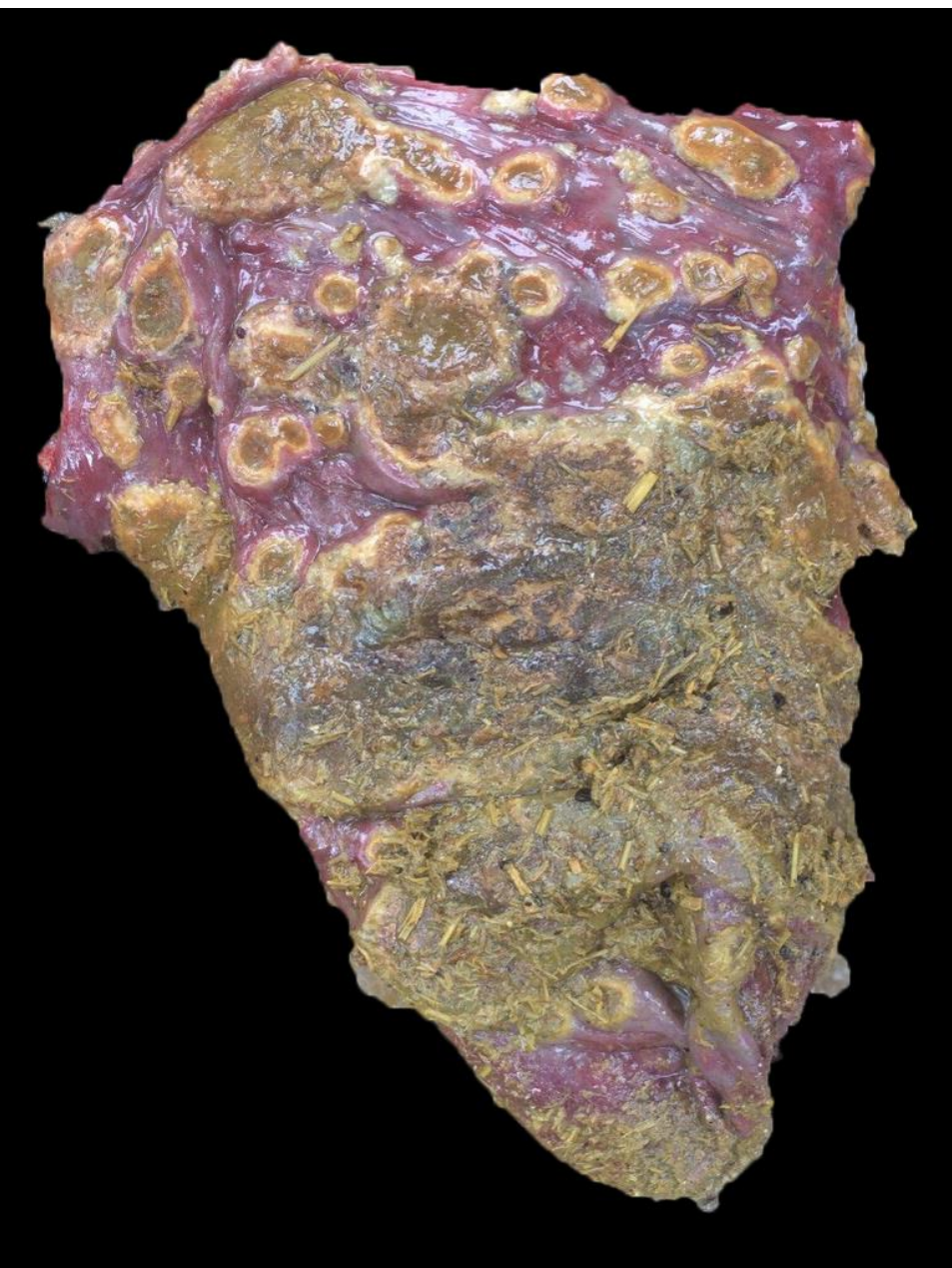
Viral

Rotavirus

Coronavirus

Fungal

Various



THANKS TO

M. Navarro

D. Read

P. Blanchard

F. Giannitti

J. King

M. Anderson

L. Minatel

J. Heines

J. Davis

F. del Piero

F. Carvallo

S. Diab

P. Chu

J. Hostetter

B. Plattner

P. Loukopoulos

P. Stromberg



Thank you



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)

* Salmonella PCR/culture

- Small/large intestine; liver

* Culture *C. difficile*

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

* desired

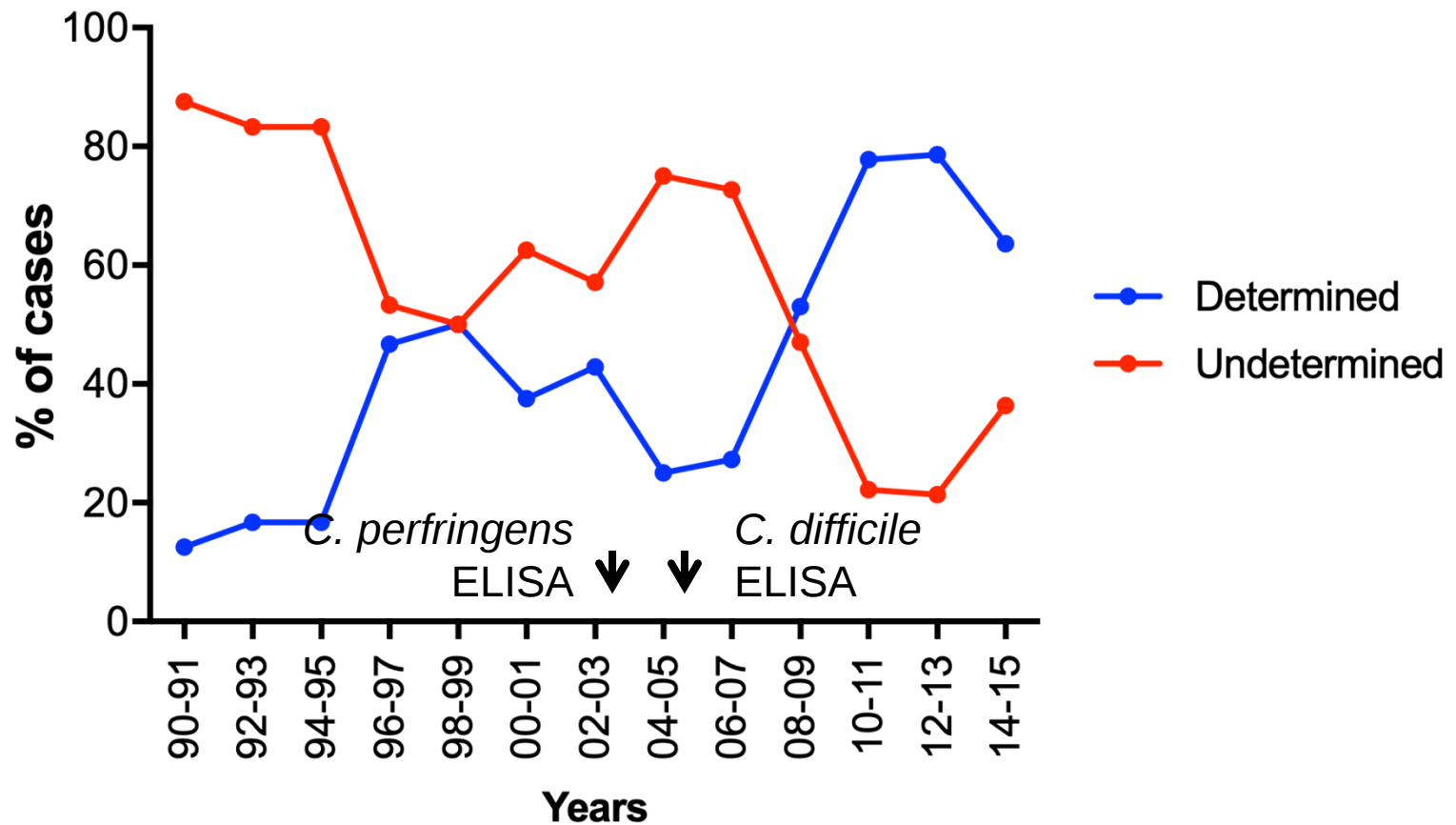
CAHFS Diagnostic work up (3)

- * *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)