

FERRET HEALTH ADVANCEMENT AT MICHIGAN STATE UNIVERSITY



Personnel

Collaborators

Research

Diagnostics

Publications

Presentations

Ferret Diseases

How Can I Help?

Contact Us

Ferret Health Advancement Home

Welcome to Ferret Health Advancement at Michigan State University



Ferret medicine has a long standing history within the College of Veterinary Medicine at Michigan State University. Compassionate and expert treatment of ill ferrets is provided at the Veterinary Teaching Hospital (VTH), the service unit of the College of Veterinary Medicine. It is the primary referral center in the state, accepting challenging cases from veterinary practitioners throughout Michigan, neighboring states, and Canada. The hospital staff includes specialists in anesthesiology, cardiology, dentistry, dermatology, emergency medicine/critical care, internal medicine, nutrition, oncology, ophthalmology, orthopedics, radiology, soft-tissue and orthopedic surgery, theriogenology, and zoo and wildlife medicine.

Working in close collaboration with the VTH is the Diagnostic Center for Population and Animal Health (DCPAH). In the more than 30 years since its inception, DCPAH has become one of the country's

premier veterinary diagnostic laboratories. Its 11 sections provide state-of-the-art, trusted and comprehensive veterinary diagnostic services, encompassing diseases of ferrets. Together, the CVM-MSU team of internationally recognized clinicians, diagnosticians and scientists focuses its efforts on the advancement of ferret health at MSU by treating sick animals, diagnosing ferret diseases and investigating the mechanisms and potential cures for ferret diseases.

This web page not only provides information about clinical and diagnostic testing available for ferret diseases, but also highlights the current research at MSU on ferret diseases and attempts to raise the funds necessary to create an endowment for a specialist position to support ferret research. We must raise a total of at least \$300,000.00 to fund the endowment. At this endowment level we can then adequately support this specialist position. We greatly appreciate your support towards the advancement of the health of ferrets.



FERRET HEALTH ADVANCEMENT AT MICHIGAN STATE UNIVERSITY



Personnel

Collaborators

Research

Diagnostics

Publications

Presentations

Ferret Diseases

How Can I Help?

Contact Us

Ferret Health Advancement Home > Presentations

Infectious Diseases

- [Enteric and Systemic Coronavirus Infections in Ferrets](#)
- [Epizootic Catarrhal Enteritis \(ECE\)](#)
- [Molecular Techniques for the Diagnosis of Epizootic Catarrhal Enteritis](#)
- [Identification of a Novel Coronavirus in Ferrets with Epizootic Catarrhal Enteritis](#)
- [Viral Causes of Enteric Disease in Ferrets](#)
- [Distemper](#)
- [Coccidiosis](#)
- [Laboratory Diagnosis of Coronavirus Infections in Ferrets](#)
- [Mycoplasmosis in Ferrets](#)



Neoplastic Diseases

- [Adrenal Cortical Carcinomas with Myxoid Differentiation](#)
- [Malignant Lymphoma](#)
- [Condroid Chordoma](#)
- [Pelioid Hepatocellularcarcinoma](#)

Other Conditions

- [Disseminated Idiopathic Myofascitis](#)

<http://www.ferrethealth.msu.edu>

FERRET HEALTH ADVANCEMENT AT MICHIGAN STATE UNIVERSITY



Personnel

Collaborators

Research

Diagnostics

Publications

Presentations

Ferret Diseases

How Can I Help?

Contact Us

Ferret Health Advancement Home > Diseases

Diseases

Pathology of Ferret Diseases

- [Introduction and Neuropathology](#)
- [Endocrine and Hematopoietic Pathology](#)
- [Gastrointestinal Pathology](#)
- [Urogenital, Skin, Special Senses, and Muskuloskeletal Pathology](#)
- [Notes](#)



**FERRET HEALTH ADVANCEMENT
AT MICHIGAN STATE UNIVERSITY**



Personnel
Collaborators
Research
Diagnostics
Publications
Presentations
Ferret Diseases
How Can I Help?
Contact Us

Ferret Health Advancement Home > Publications

Infectious Diseases



Coronavirus-associated epizootic catarrhal enteritis in ferrets.
Williams BH, Kiupel M, West KH, Raymond JT, Grant CK, Glickman LT. J Am Vet Med Assoc. 2000 Aug 15;217(4):526-30.

Development and Evaluation of Molecular Techniques for the Diagnosis of Epizootic Catarrhal Enteritis Infection of Ferrets.
Wise A, Kiupel M, Isenhour C, Maes R. Verh. ber. Erkr. Zootiere. 2003, 41: 427-432.

Molecular characterization of a novel coronavirus associated with epizootic catarrhal enteritis (ECE) in ferrets. Wise AG, Kiupel M, Maes RK. Virology. 2006 May 25;349(1):164-74. Epub 2006 Feb 24.

Clinicopathologic features of a systemic coronavirus-associated disease resembling feline infectious peritonitis in the domestic ferret (Mustela putorius). Garner MM, Ramsell K, Morera N, Juan-Sallés C, Jiménez J, Ardiaca M, Montesinos A, Teifke JP, Löhr CV, Evermann JF, Baszler TV, Nordhausen RW, Wise AG, Maes RK, Kiupel M. Vet Pathol. 2008 Mar;45(2):236-46. Erratum in: Vet Pathol. 2008 Jul;45(4):598.

Comparative sequence analysis of the distal one-third of the genomes of a systemic and an enteric ferret coronavirus.
Wise AG, Kiupel M, Garner MM, Clark AK, Maes RK. Virus Res. 2010 Apr;149(1):42-50.

Ferret coronavirus-associated diseases.
Murray J, Kiupel M, Maes RK. Vet Clin North Am Exot Anim Pract. 2010 Sep;13(3):543-60. Review.

Detection of group C rotavirus in juvenile ferrets (Mustela putorius furo) with diarrhea by reverse transcription polymerase chain reaction: sequencing and analysis of the complete coding region of the VP6 gene.
Wise AG, Smedley RC, Kiupel M, Maes RK. Vet Pathol. 2009 Sep;46(5):985-91. Epub 2009 May 9.

Neoplastic Diseases

Adrenal cortical carcinomas with myxoid differentiation in the domestic ferret (Mustela putorius furo).
Peterson RA 2nd, Kiupel M, Capen CC. Vet Pathol. 2003 Mar;40(2):136-42.

Transcription factor GATA-4 is a marker of anaplasia in adrenocortical neoplasms of the domestic ferret (Mustela putorius furo).
Peterson RA 2nd, Kiupel M, Bielinska M, Kliveri S, Heikinheimo M, Capen CC, Wilson DB. Vet Pathol. 2004 Jul;41(4):446-9.

Cytochrome b5 expression in gonadectomy-induced adrenocortical neoplasms of the domestic ferret (Mustela putorius furo).
Wagner S, Kiupel M, Peterson RA 2nd, Heikinheimo M, Wilson DB. Vet Pathol. 2008 Jul;45(4):439-42.

Peliod hepatocellular carcinoma in a domesticated ferret (Mustela putorius furo).
Jones Y, Wise A, Maes R, Kiupel M. J Vet Diagn Invest. 2006 Mar;18(2):228-31.

Multicentric squamous cell carcinoma in situ associated with papillomavirus in a ferret.
Rodrigues A, Gates L, Payne HR, Kiupel M, Mansell J. Vet Pathol. 2010 Sep;47(5):964-8. Epub 2010 May 13.

Intestinal lymphoma of granular lymphocytes in a fisher (Martes pennanti) and a Eurasian otter (Lutra lutra).
Bartlett SL, Imai DM, Trnpekiewicz JG, Garner MM, Ogasawara S, Stokol T, Kiupel M, Abou-Madi N, Kollas GV. J Zoo Wildl Med. 2010 Jun;41(2):309-15.

Other Conditions

Myofasciitis in the domestic ferret.
Garner MM, Ramsell K, Schoemaker NJ, Sidor IF, Nordhausen RW, Bolin S, Evermann JF, Kiupel M. Vet Pathol. 2007 Jan;44(1):25-38.

Surgical oncology of exotic animals.
Mehler SJ, Bennett RA. Vet Clin North Am Exot Anim Pract. 2004 Sep;7(3):783-805, vii-viii. Review.

<http://www.ferrethealth.msu.edu>

Mycoplasmosis in Ferrets



**Matti Kiupel¹, C. A. Johnson-Delaney²,
A. Lim¹, C. Bolin¹, S. Bolin¹,
M. M. Garner³**

- ¹ Diagnostic Center for Population and Animal Health, Michigan State University, East Lansing**
- ² Eastside Avian and Exotic Animal Medical Center, Kirkland, WA**
- ³ Northwest ZooPath, Monroe, WA**

History

- **Since 2006 vendor importing 6 week old kits from a single breeder in Manitoba, Canada**
- **Shipped in groups of 150-200 kits every 2-3 weeks**
- **Remained at vendor 1 week before distribution to pet stores**



PANDORA'S BOX

It was filled with Ferrets.

Clinical Presentation

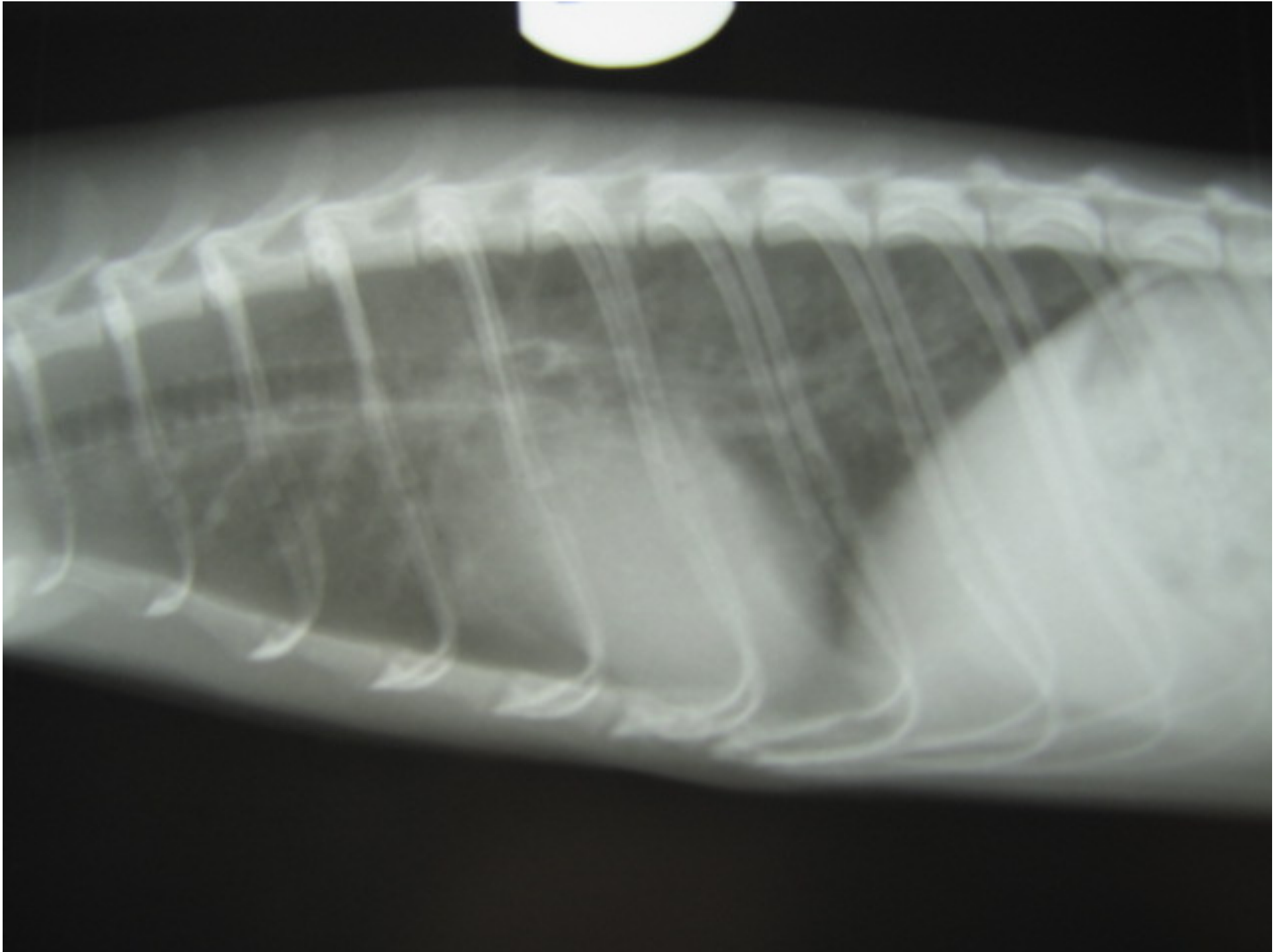


- **Each shipment: kits with non-productive cough and/or conjunctivitis**
- **95% Morbidity, almost no mortality**
 - **Conjunctivitis would resolve with eye wash, tetracycline ophthalmic ointment**
 - **Coughs were dry, intermittent with no other symptoms or signs**
 - **Treatment with broad spectrum antibiotics, bronchodilators, nonsteroidal anti-inflammatory**
 - **Temporarily decreased clinical symptoms, failure to alleviate recurrence of dry cough**

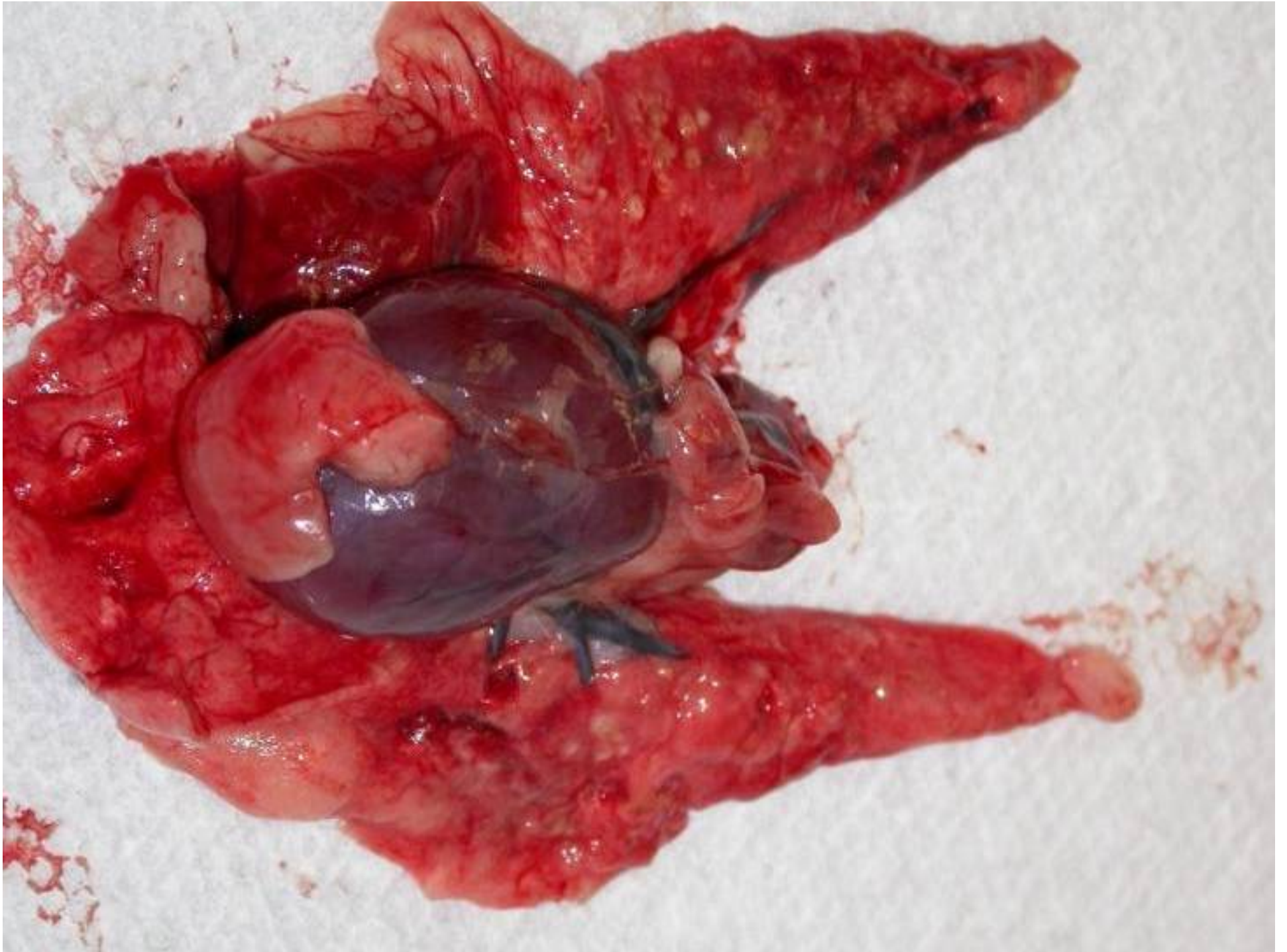
Differentials

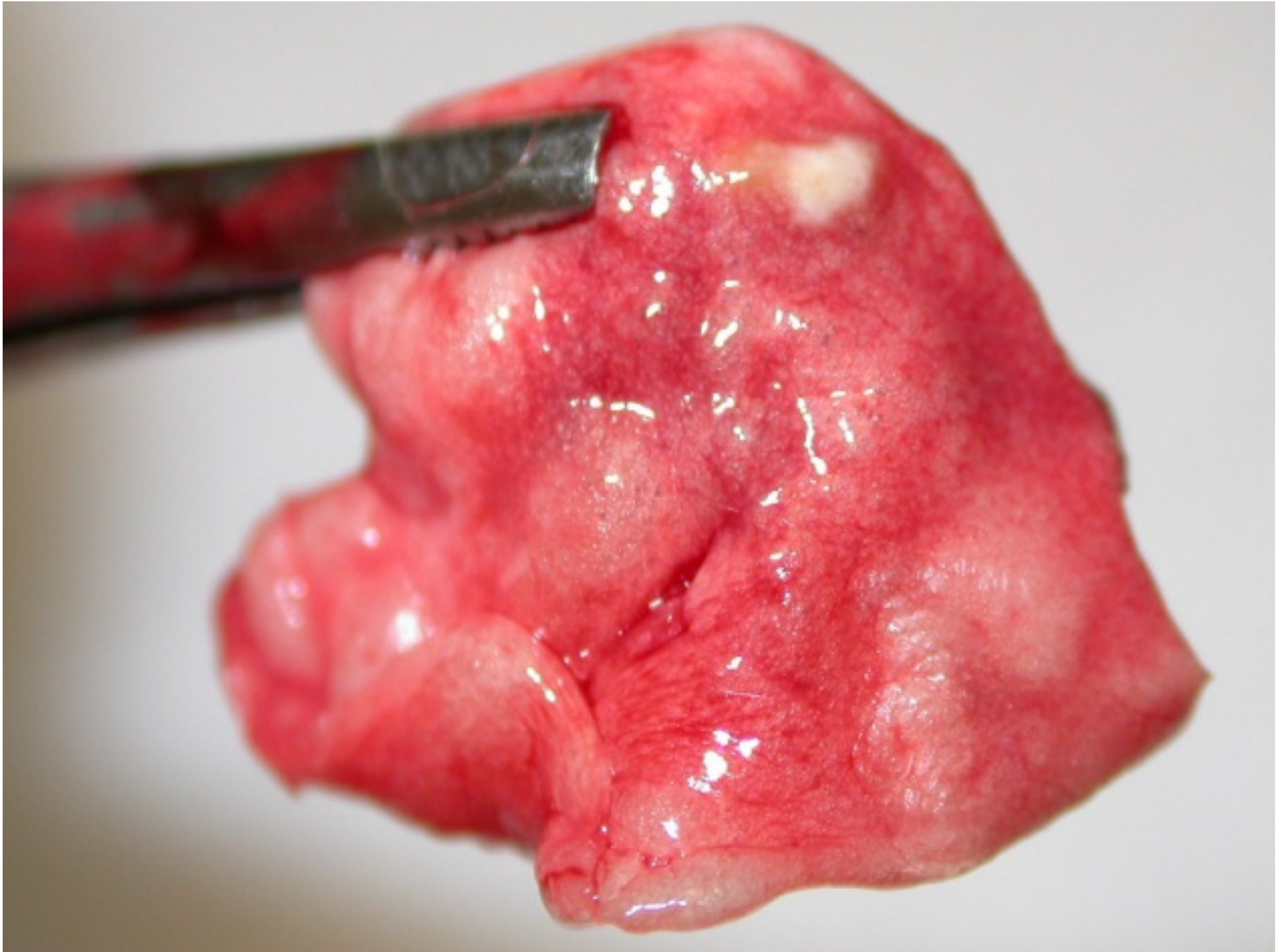


- **Heartworm**
- **Heart disease (pulmonary edema)**
- **Asthma-Allergies**
- **Bacterial/Viral (influenza, CD)/Fungal bronchitis/pneumonia**
- **Neoplasia**
- **Aspiration pneumonia**

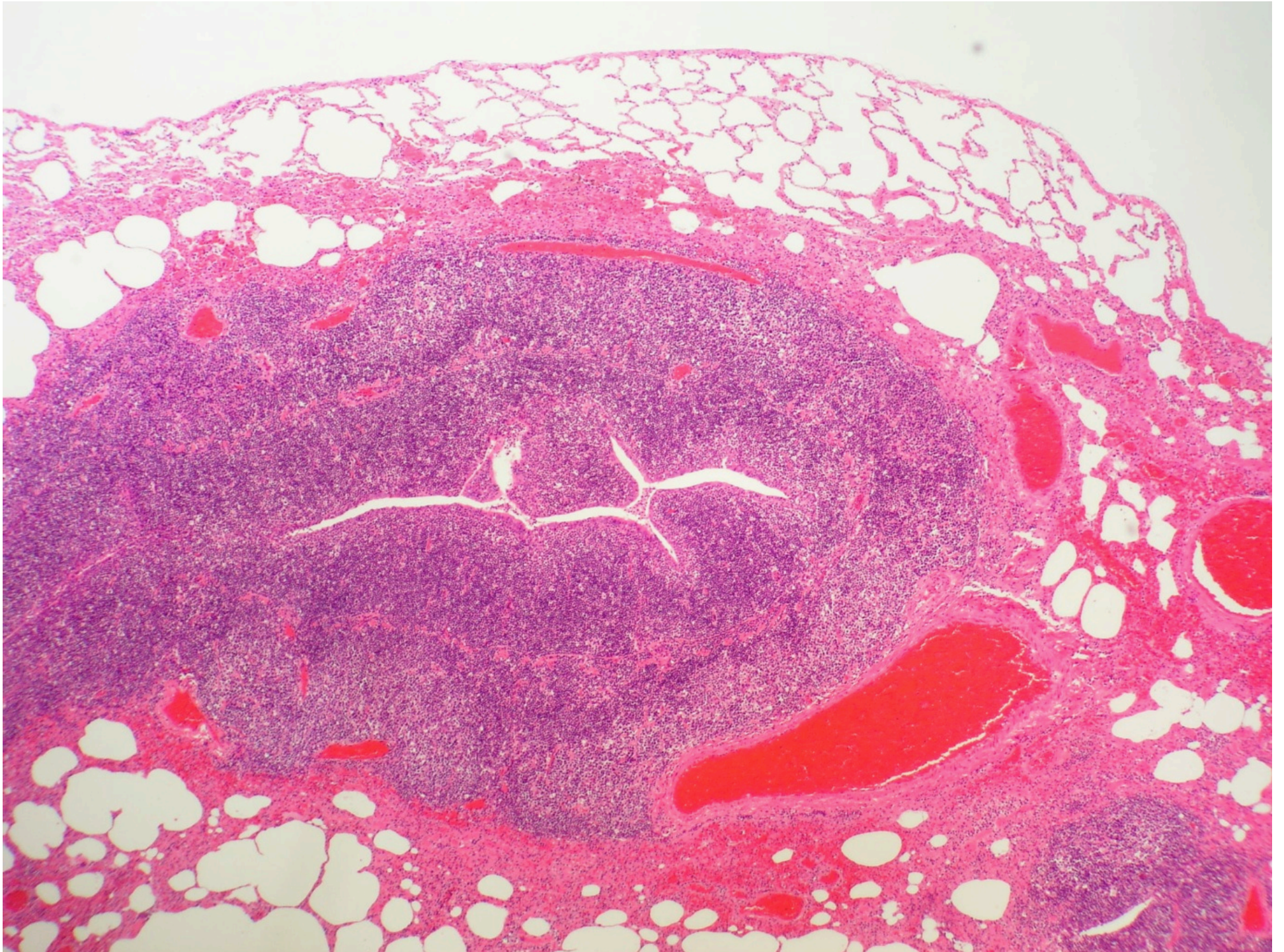


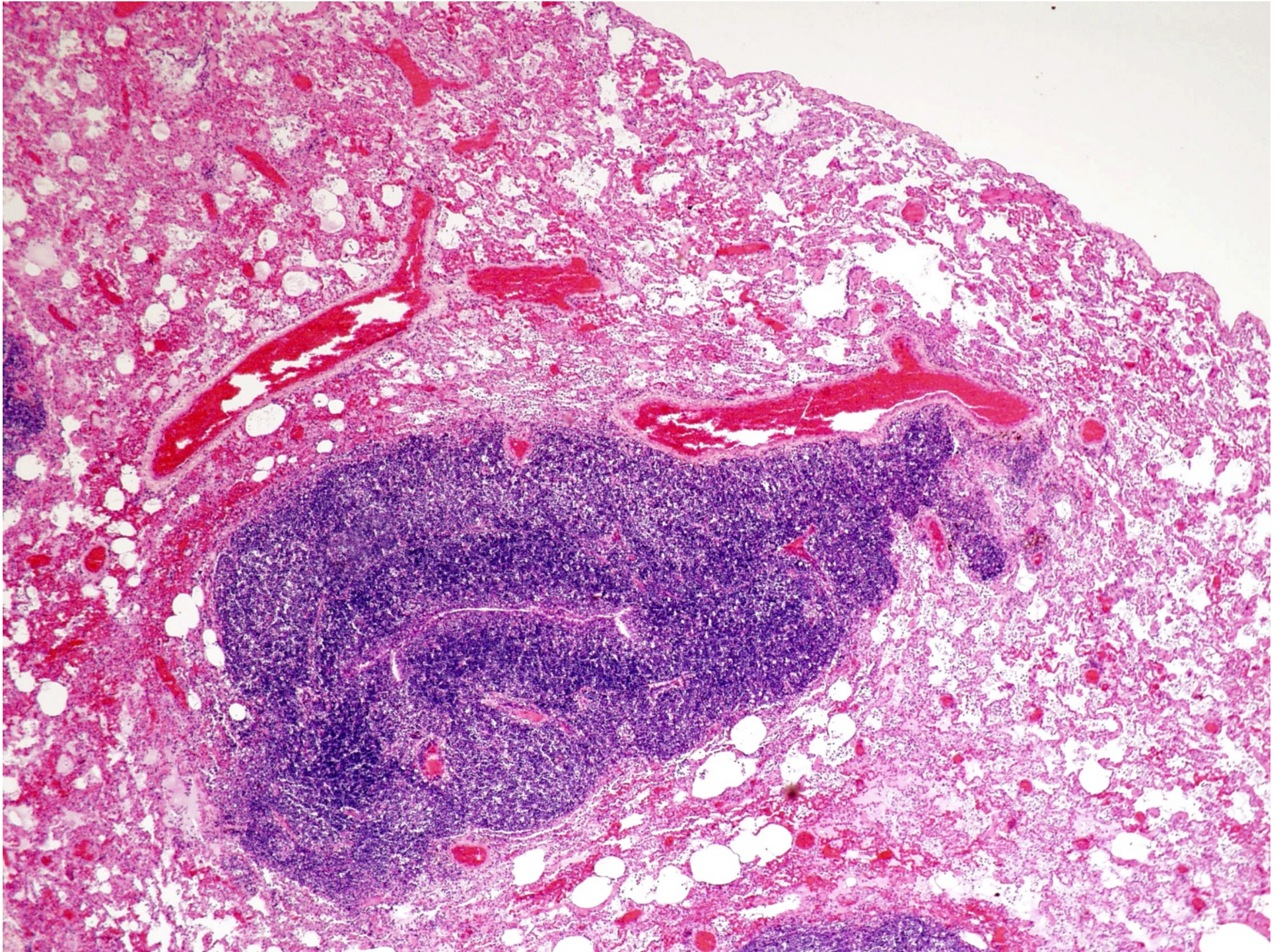


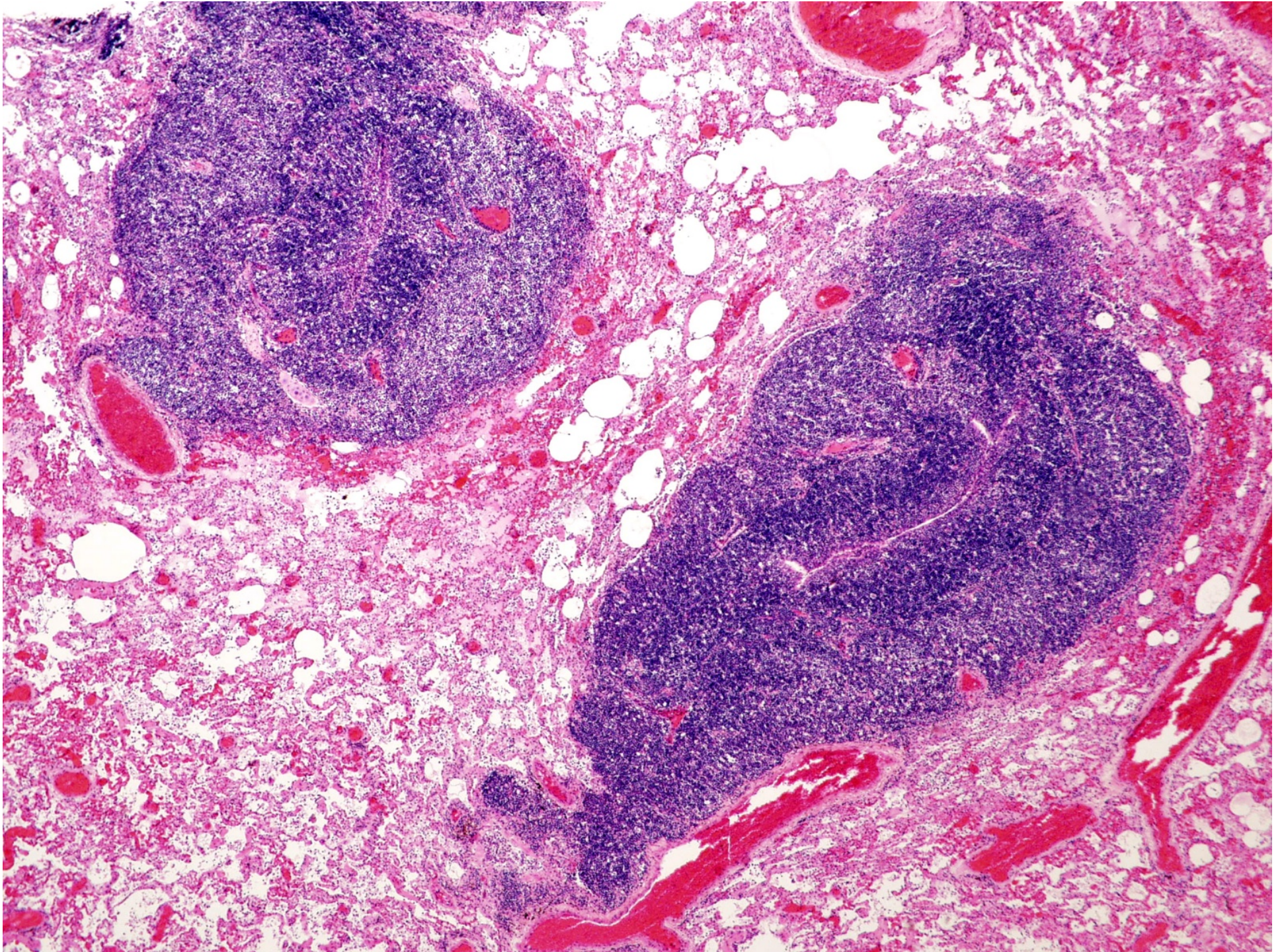


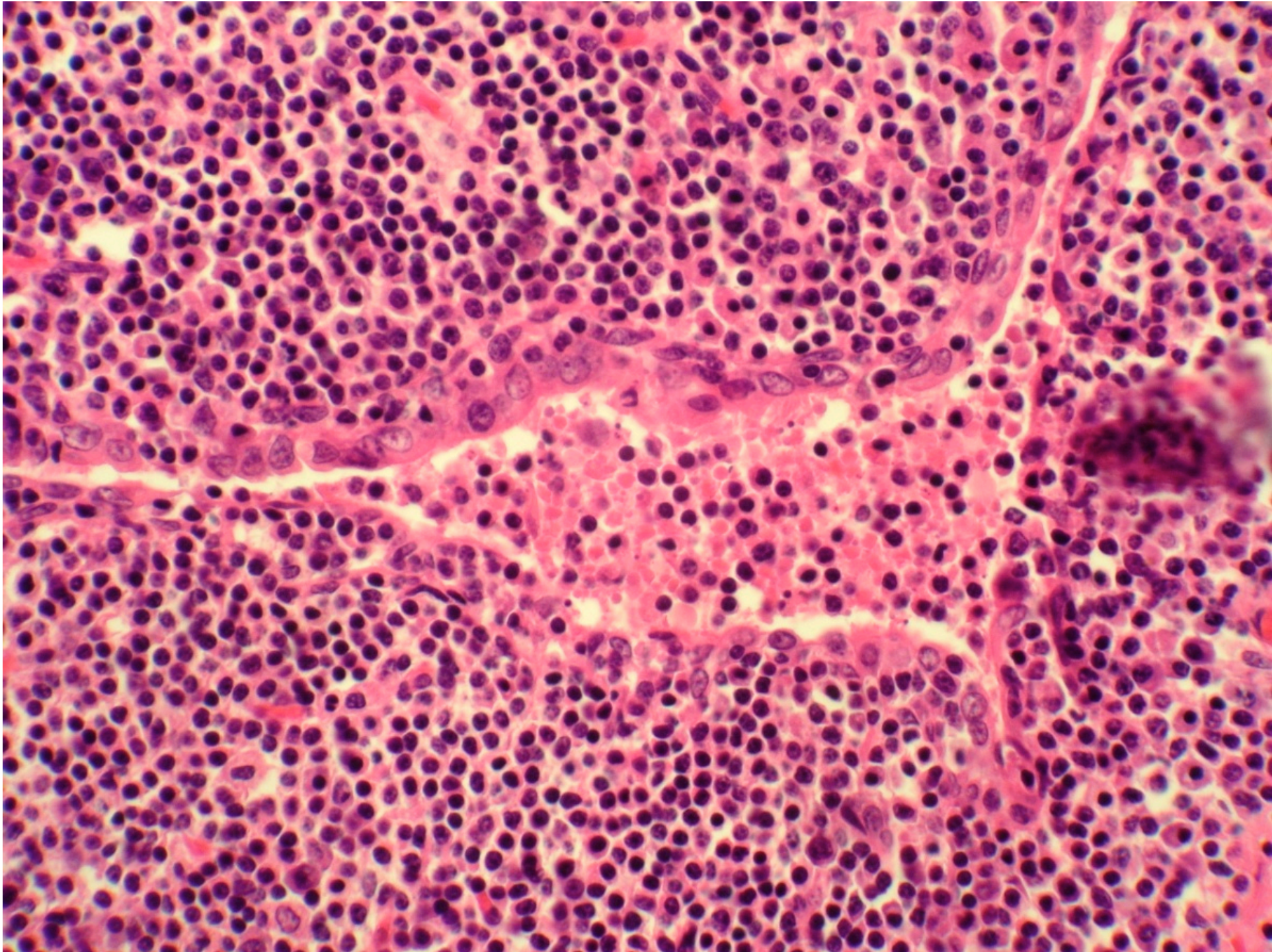












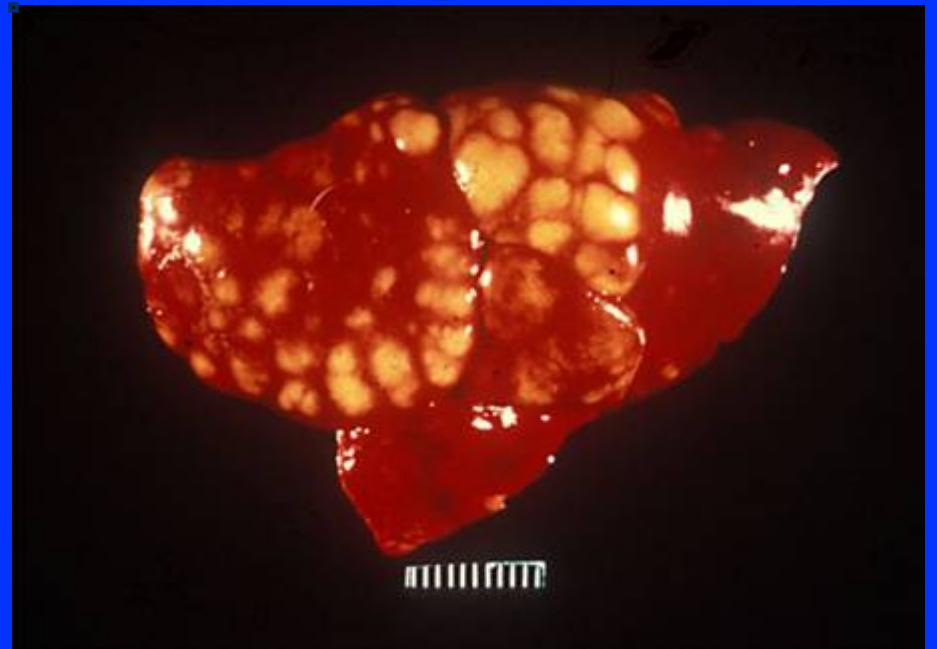
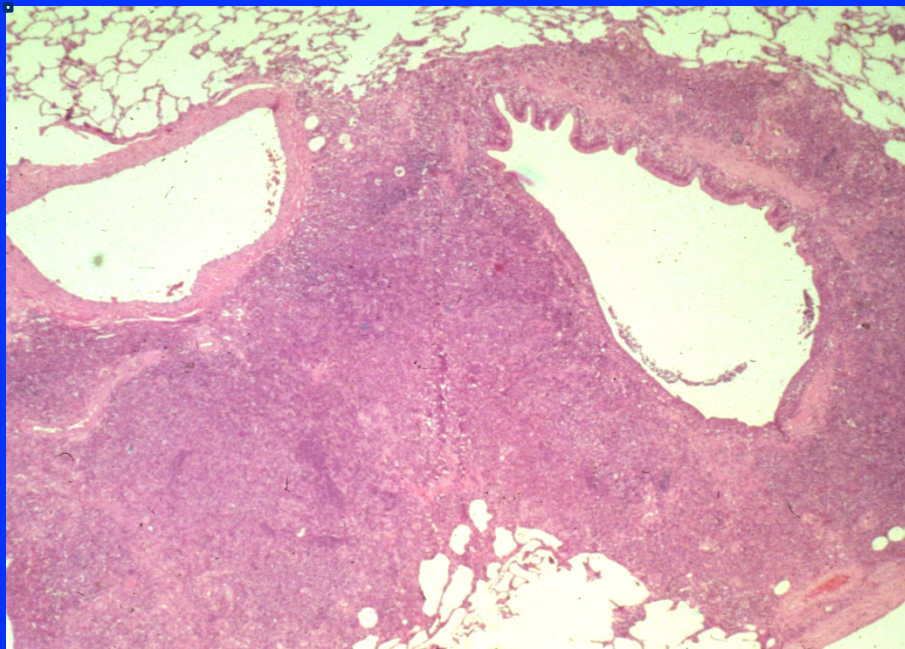
Morphologic Diagnosis



**Lung, BAL hyperplasia and
catarrhal bronchitis**

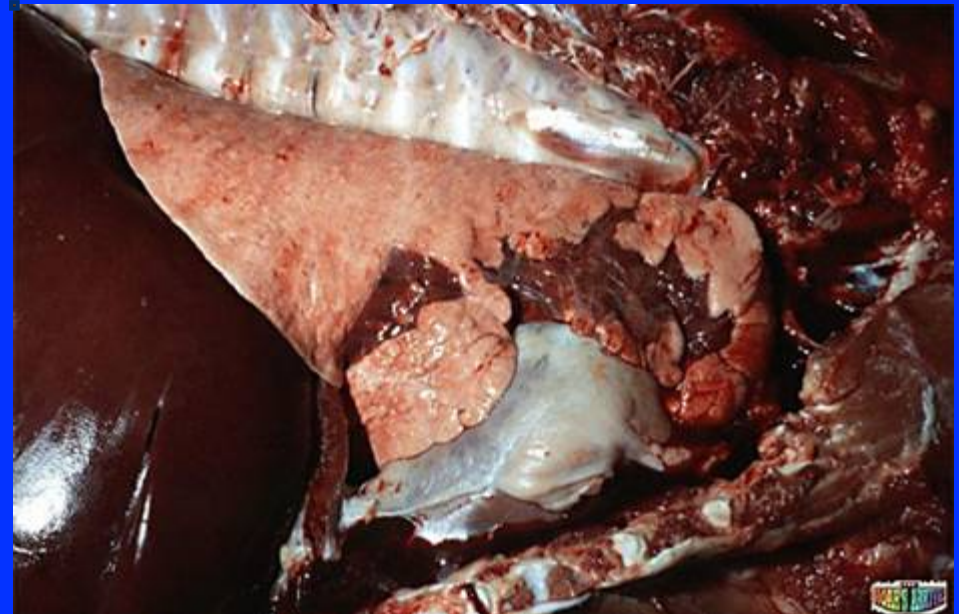
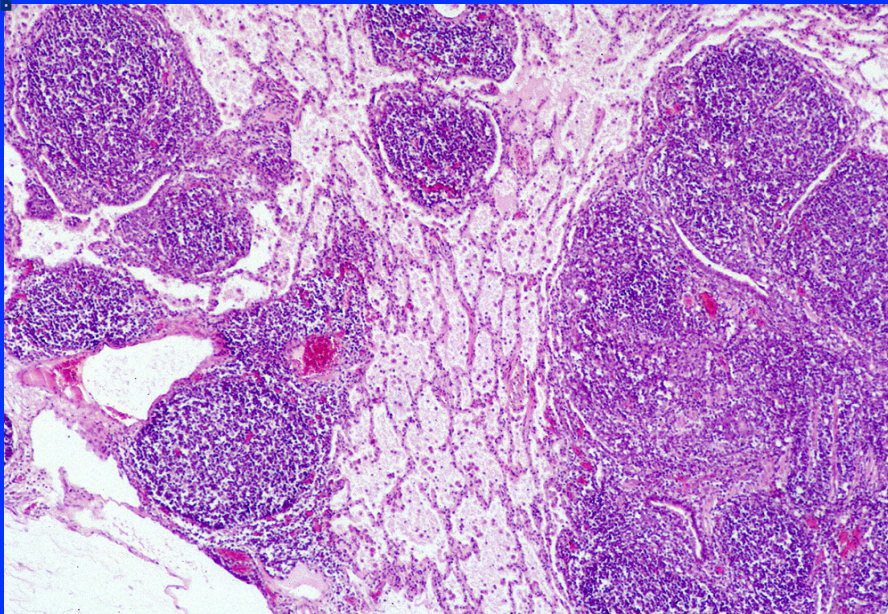
Comparative Pathology

- *M. pulmonis*
 - Rodents
 - Otitis media, bronchopneumonia, tracheitis, rhinitis, salpingitis



Comparative Pathology

- *M. hyopneumoniae*
 - Grower-finisher pigs
 - Bronchopneumonia, bronchitis, BALT hyperplasia



Comparative Pathology



- *M. cyanos, M. canis*
- untyped *Mycoplasma spp.*
 - Young dogs
 - Bronchopneumonia, bronchiectasia, BALT hyperplasia, some brochiolitis obliterans

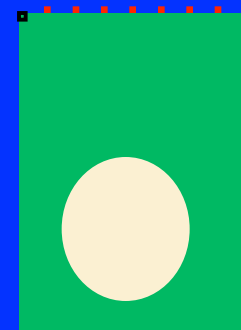
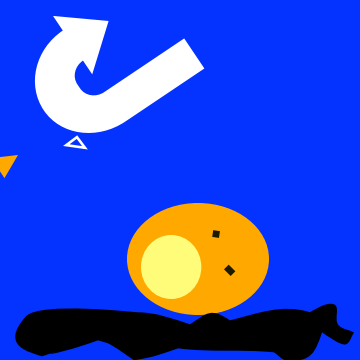
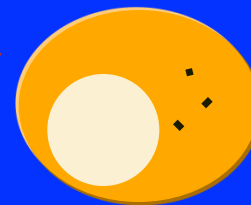
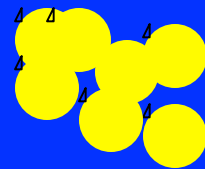
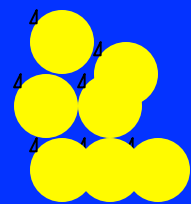
Lung Defenses

Native

Mucociliary Apparatus
Alveolar macrophages
Inflammation

Acquired

IgA
CMI
IgG



Damage to Lung Defenses

Mucociliary Apparatus

Mycoplasma

CDV

HIV

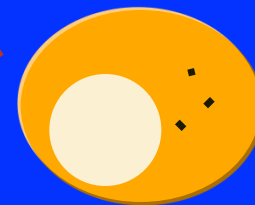
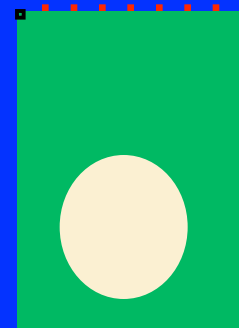
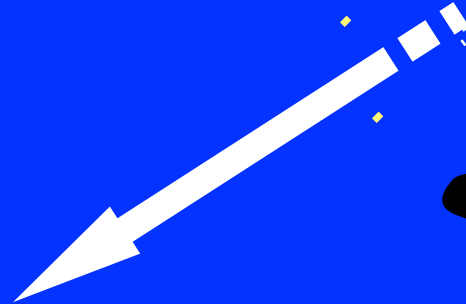
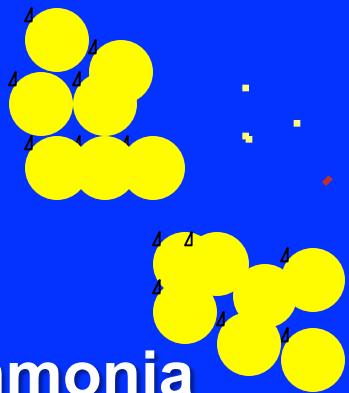
Chilling

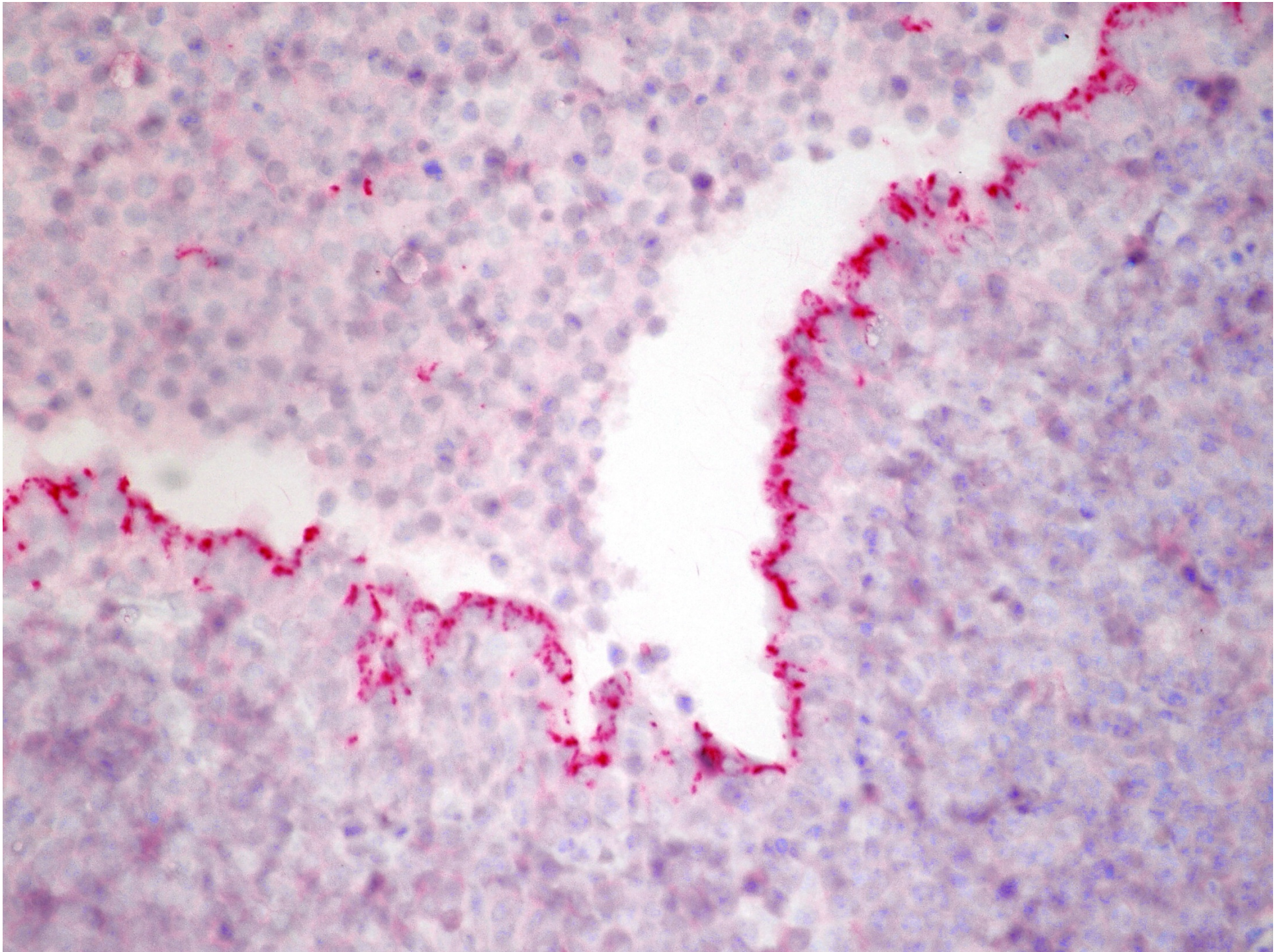
High levels of ammonia

Macrophages

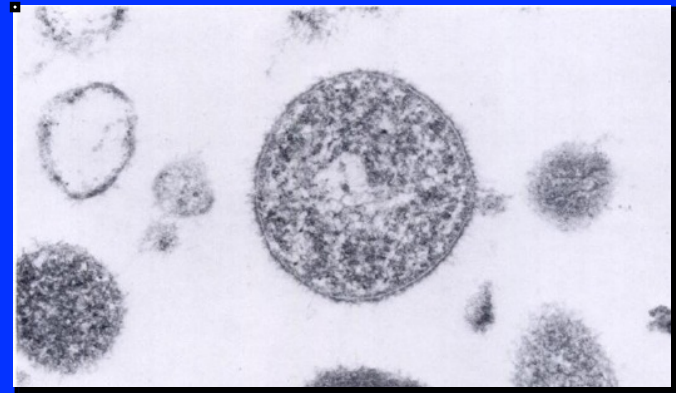
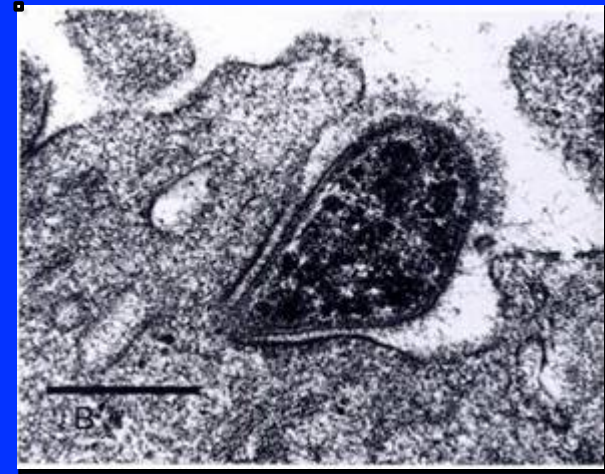
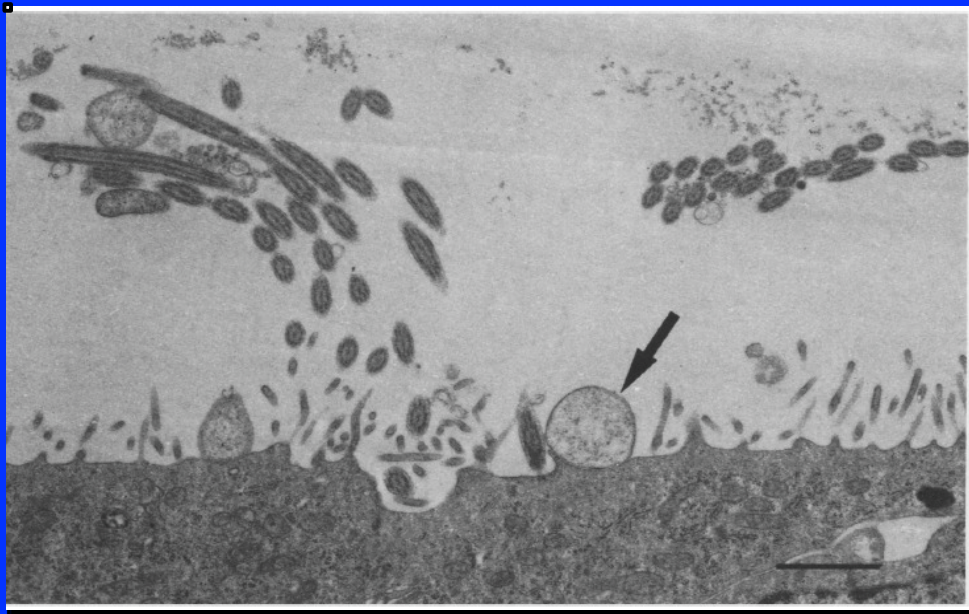
CDV

Stress, endogenous steroids

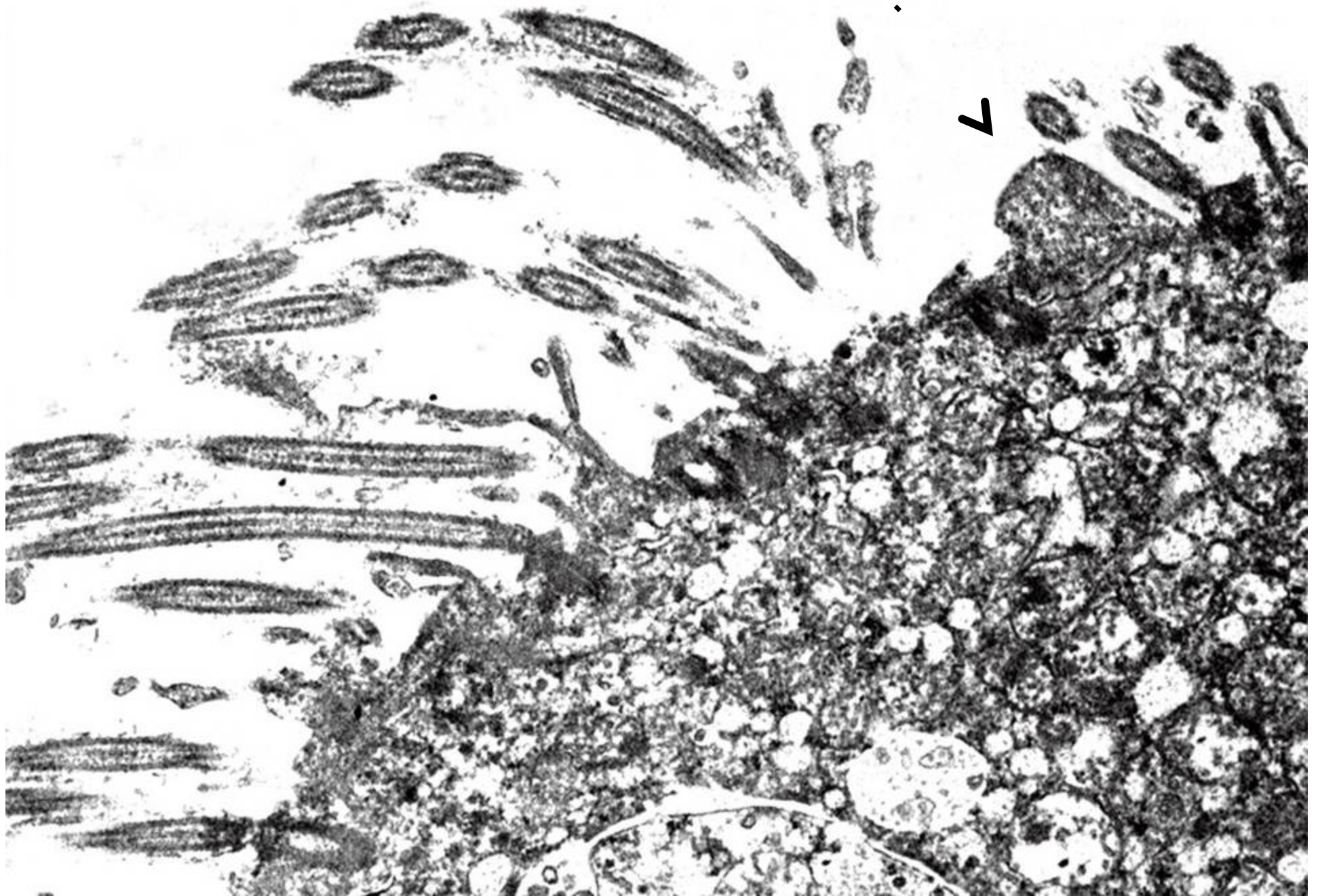




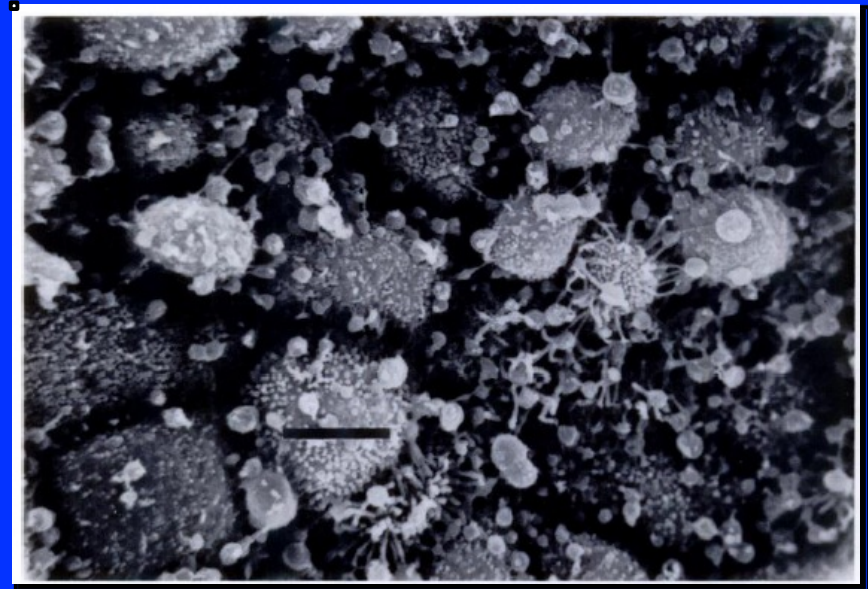
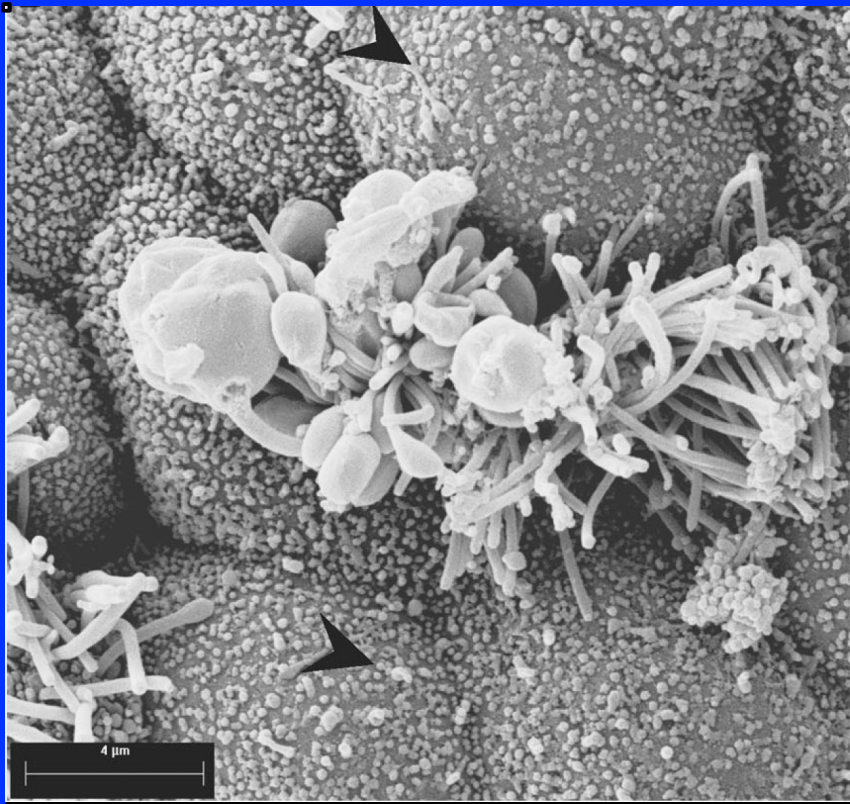
Transmission-Electronmicroscopy of Mycoplasmosis



Dennis F.K., et al. Pathogenicity of mycoplasma pulmonis in ependymal Organ Culture, *Infection and Immunity*, May 1980, 28(2).
Jacobson E.R., et al. CHRONIC UPPER RESPIRATORY TRACT DISEASE OF FREE-RANGING DESERT TORTOISES (*XEROBATES AGASSIZII*) *Journal of Wildlife Diseases*, 1991, 27(2).

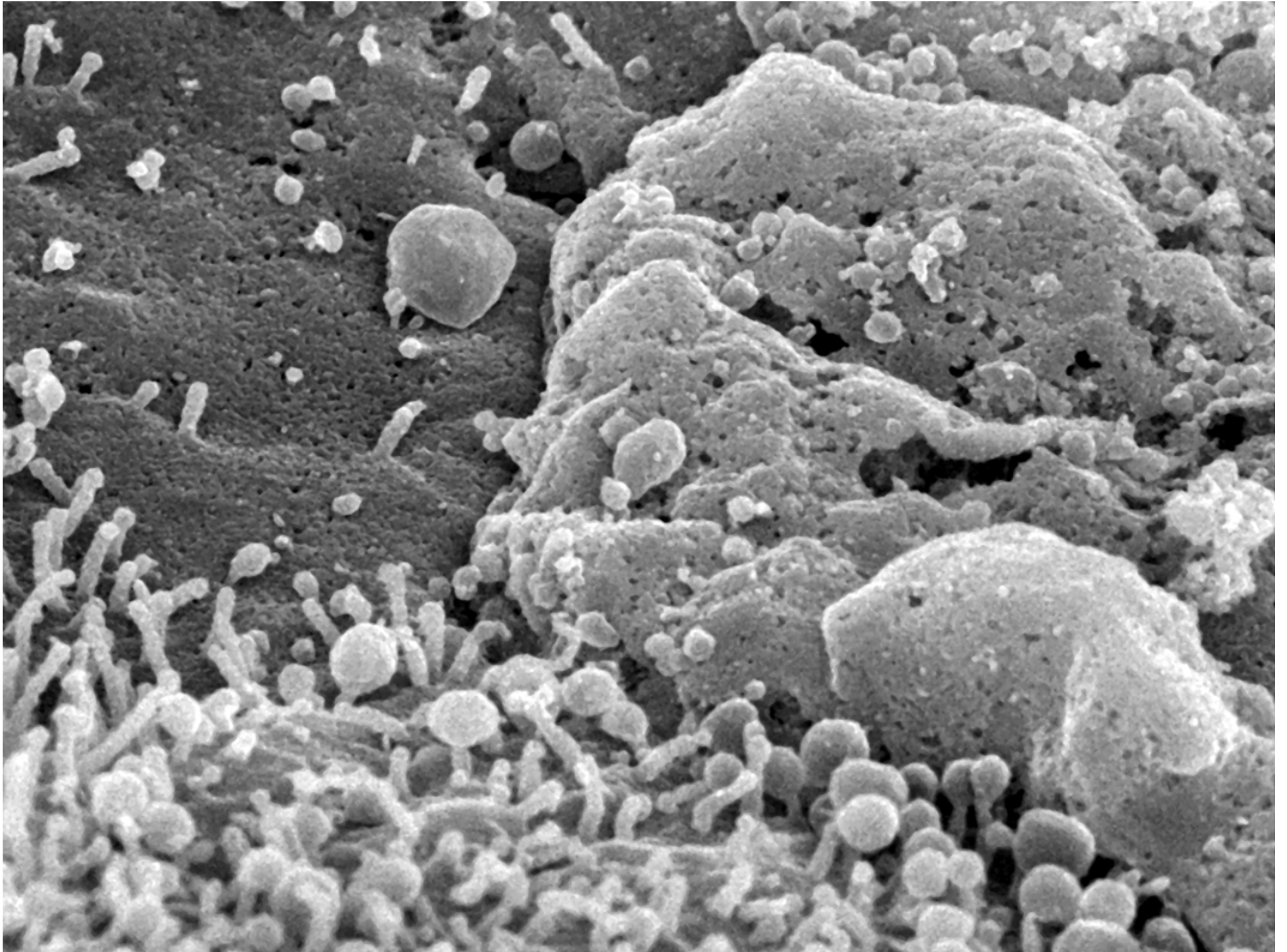


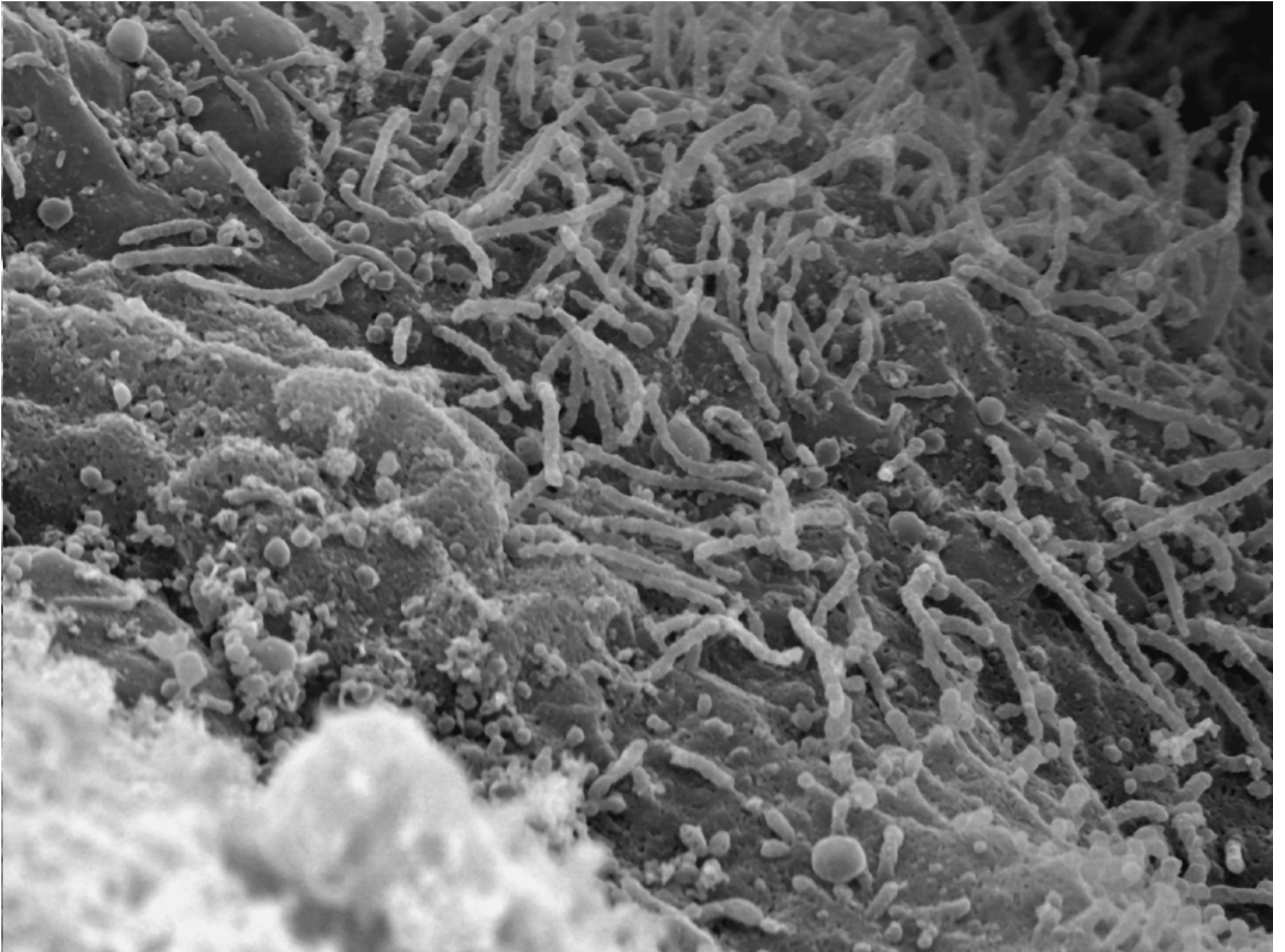
Scanning-Electronmicroscopy of Mycoplasmosis

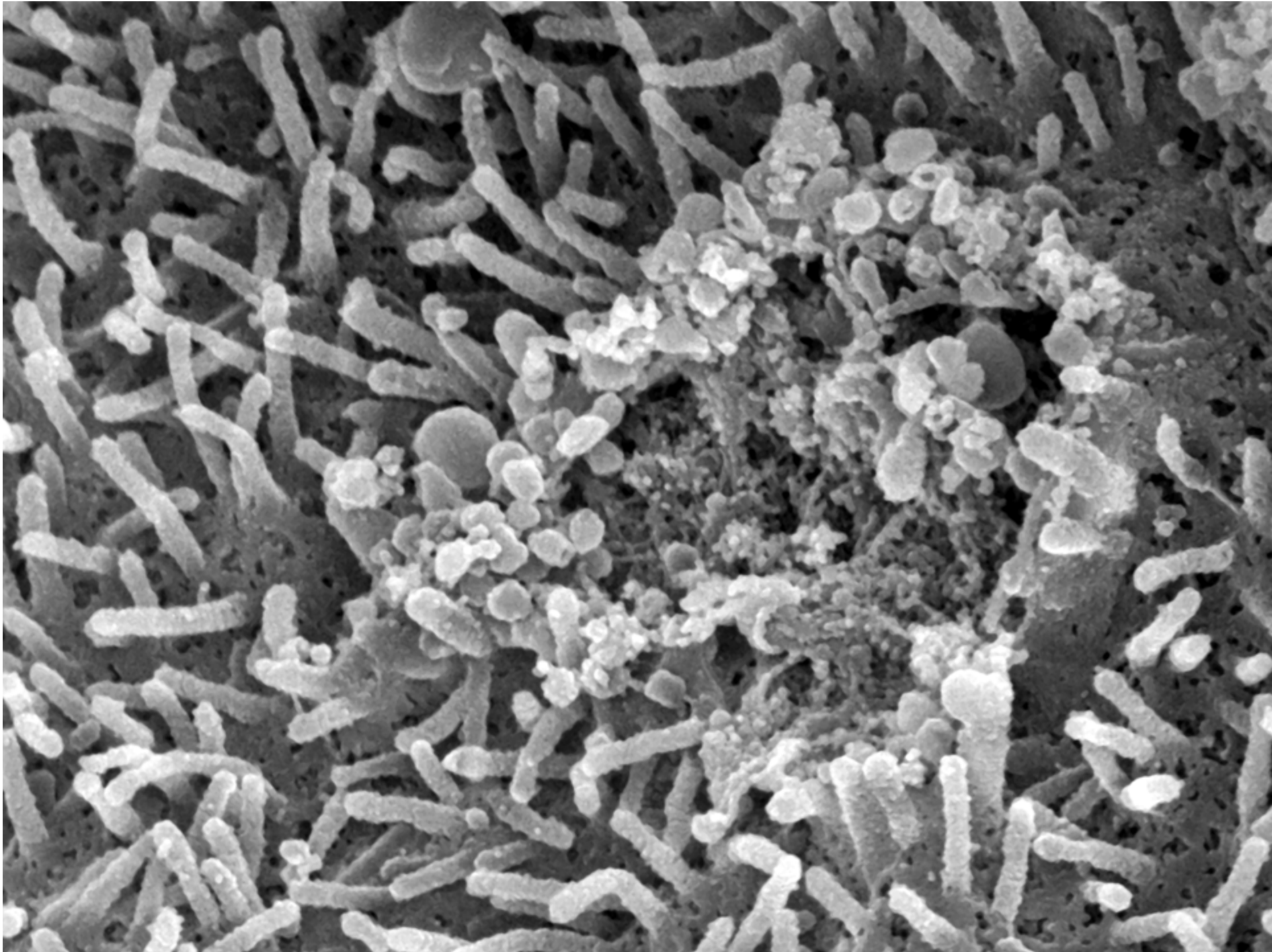


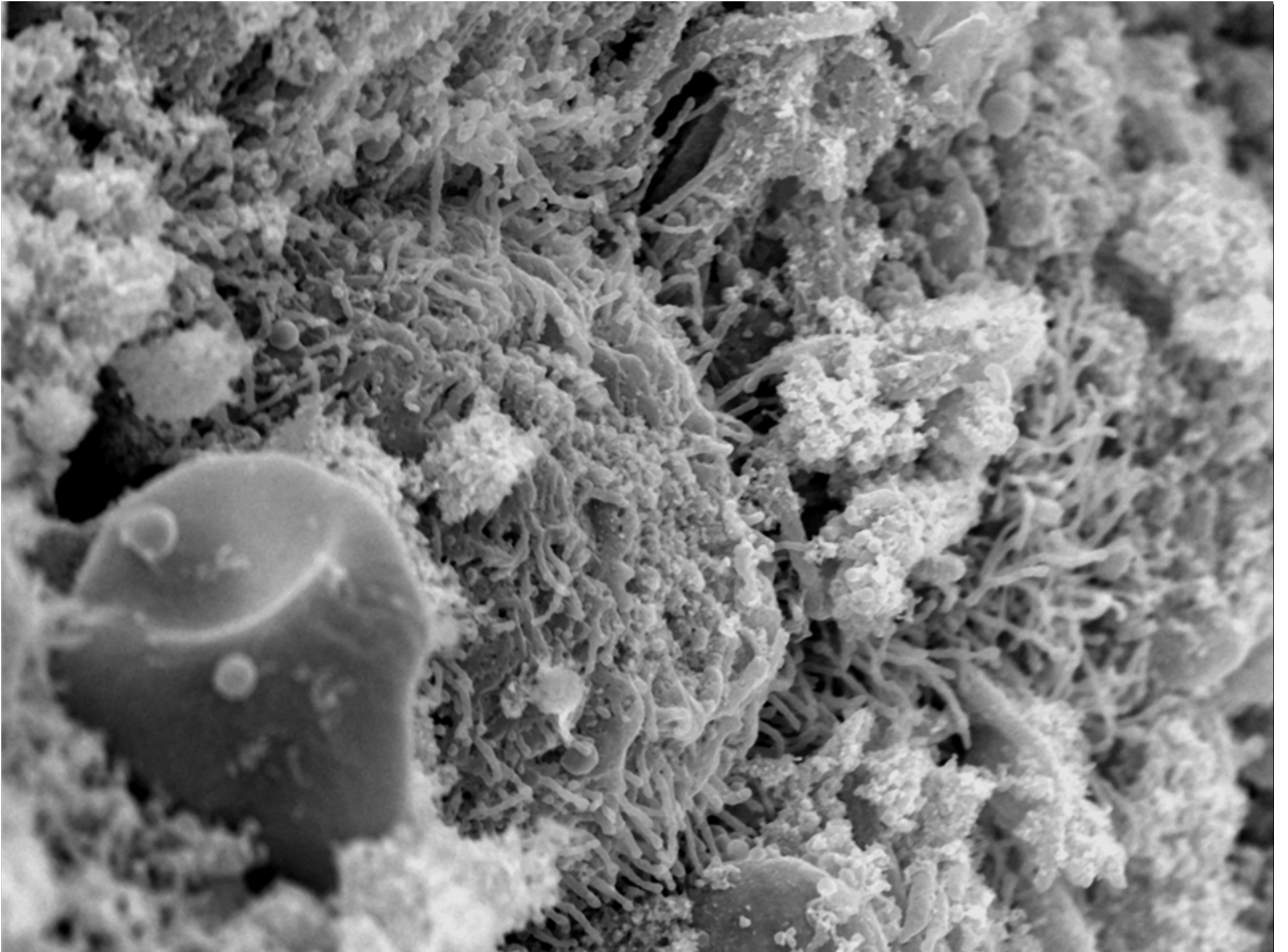
Baczynska A. et al., Morphology of human Fallopian tubes after infection with *Mycoplasma genitalium* and *Mycoplasma hominis*—in vitro organ culture study. *Human Reproduction*, 22(4) 2007.

Jacobson E.R., et al. CHRONIC UPPER RESPIRATORY TRACT DISEASE OF FREE-RANGING DESERT TORTOISES (*XEROBATES AGASSIZII*) *Journal of Wildlife Diseases*, 1991, 27(2).









Additional Laboratory Testing

- Bronchioalveolar lavage (BAL) samples from 12 affected ferrets (6 weeks to 4 years of age)
- Culture for Mycoplasma, PCR, sequencing
 - All 12 BAL samples yielded a fast growing, glucose-fermenting *Mycoplasma spec.*
 - PCR (16s ribosomal RNA) amplicons (1,000 bp): 95-96% sequence identity with *Mycoplasma molare* and *Mycoplasma lagogenitalium*.
 - PCR (rpoB gene of mycoplasma) amplicons (710 bp): 84-86% sequence identity with *Mycoplasma molare* and *Mycoplasma lagogenitalium*

Mycoplasma in Mustelids



- **No *Mycoplasma spec.* previously associated with clinical disease in ferrets**
- **Isolation of *Mycoplasma spec.* from oral cavities of 80% of healthy ferrets in 1982 in Japan**
- **Isolation of *Mycoplasma mustelea* from lungs of healthy mink kits in 1983 in Denmark**

Causation ?

- **Commensal or Pathogen**
- **Determining causal relationship**
 - **Isolation of Mycoplasma and failure to isolate other pathogens**
 - **Identification of Mycoplasma within the site of characteristic lesions**
 - **Demonstration of same lesions in experimentally challenged animals, and re-isolate Mycoplasma from them**



Epidemiology

- **Source: environment, adult breeding stock?**
- **Disease dynamics**
 - **Transmission: vertical? direct contact?**
 - **Host factors – age, immune status, specific defect in host defense mechanisms in RCF?**
 - **Non-host factors – environment, time of year, close proximity, closed air system**
- **Incubation period: < 6 weeks in kits (6 d – 6 wk)**
- **Infectious period: limited information from cases**
- **No sex predispositions**
- **Morbidity/Mortality: Kits: 95% / <<1%, Adults: unknown**

Conclusions

- Identification of unknown *Mycoplasma spec.*
- Good evidence for causal relationship between *Mycoplasma* isolates and pulmonary disease
- Experimental reproduction in process
- No *Mycoplasma spec.* previously associated with clinical disease in ferrets or mink
- Breeder sells to US, Eastern Canada, Japan
- Redefine cause of bedding cough, differential for pulmonary disease
- Best diagnosed on tracheal/bronchial washes, conjunctival or nasal swabs provided no results
- Radiographs may help for the diagnosis
- Treatment: alleviates symptoms, doesn't cure

FERRET HEALTH ADVANCEMENT AT MICHIGAN STATE UNIVERSITY



Personnel
Collaborators
Research
Diagnostics
Publications
Presentations
Ferret Diseases
How Can I Help?
Contact Us

Ferret Health Advancement Home > Donate

How Can I Help?

Give a Gift TODAY!

We need your help to support research into important and emerging ferret diseases. Funds will be used for personnel, supplies, basic research, pathogenesis studies and clinical trials with the ultimate goal to better understand ferret disease mechanisms and to develop tools to more accurately diagnose, to successfully treat and to prevent these diseases.



Diseases currently studied include ferret coronaviruses (ECE and FIP like disease), intestinal diseases (rotavirus, coccidiosis, staphylococcosis), neoplastic diseases (adrenal cortical neoplasms) and inflammatory conditions (disseminated idiopathic myofascitis).

These are just a few of the activities our team of researchers and clinicians participates in. They are representative of the clinical services, and research projects that your dollars help fund. We also need support to better teach our students and graduate students ferret diseases and medicine. Every gift matters, because every gift gives us the chance to enrich minds, hone skills, cultivate character, and make a difference in the community and the world.

Every gift matters. Make yours today.

There are many ways to support Ferret Health Advancement at MSU Today!

- [Make a gift online](#) enter "Ferret Health Advancement" as the fund name on the bottom of the page
- [Make a gift by mail or telephone](#) call the development office at (517) 353-4937
- [Make an honorary or memorial gift](#)
- [Make a gift of securities](#)
- [Make a planned gift \(also referred to as estate or deferred gifts\)](#)
- [Make a gift of personal property or real estate](#)

Interested in doubling your gift to CVM? [Click here](#) to find out if your company participates in our matching gift program.

Thank you for considering a tax deductible donation to Michigan State University College of Veterinary Medicine to support ferret health. All contributions are tax deductible to the full extent of IRS law.

You can also print the form below, fill it out and mail it together with your check to:

Dr. med. vet. Matti Kiupel, BS, MS, PhD, DACVP
Fachtierarzt für Veterinär Pathologie
Associate Professor, Section Chief Anatomic Pathology
Michigan State University
Department of Pathobiology and Diagnostic Investigation
Diagnostic Center for Population and Animal Health
4125 Beaumont Road, Room 152A
Lansing, MI 48910
USA



<http://www.ferrethealth.msu.edu>

