Bovine Respiratory Pathology

University of Illinois Veterinary Diagnostic Laboratory - Bovine Respiratory Disease Workup

- Cost of workup - $95
- 1-4 animals
- Necropsy and histopathology
- Bacteriologic culture – lung, LN, etc
  - *Haemophilus somnus* with special media
- Mycoplasma – lungs – PCR and RFLP
- Virus isolation – lung, LN, trachea, spleen
  - IBR, BRSV, BVD, PI-3 and others as needed

Bovine Respiratory Disease Workup (cont)

- FA
  - Trachea for IBR
  - Lungs – BRSV and PI-3
- PCR – BVD
- IHC – lungs for BRSV
- Serologic examination – not included in standard package

Ruminant Respiratory Pathology

- **Upper Respiratory Diseases**
  - Noninfectious Disease
  - Infectious Diseases
- Lower Respiratory Tract (Lung)
  - Infectious Disease
  - Noninfectious Diseases

Bovine Respiratory Pathology

- **Upper Respiratory Diseases**
  - Noninfectious Disease
    - Atopic rhinitis
    - Laryngeal/tracheal edema
    - Laryngeal contact ulcers
  - Infectious Diseases
    - Viral
    - Bacterial
    - Mycotic

Nasal Granuloma (atopic rhinitis)

- Bovids in Australia (southeast), UK and S. Africa
- Polypoid nodules with eosinophils and mast cells
- Type I, III and IV hypersensitivity involved
- Infectious differentials
  - Mycetomas
  - Rhinosporidiosis
  - Schistosomiasis

Laryngeal/Tracheal Edema

- Laryngeal edema
  - Acute interstitial pneumonia
  - Obstructs lumen leading to asphyxiation
- Tracheal edema
  - "honker syndrome"/tracheal edema of feedlot cattle"
  - Unknown cause, usually summer
  - Edema and hemorrhages mid-cervical region and caudally to bifurcation
- Pharynx – drenching gun injury – capsule deposition

Laryngeal Contact Ulcers

- Common in feedlot cattle
- Cause – combination of stress (vocalization), environmental factors and viruses?
- Pathology
  - Circular uni- or bilateral ulcers
- Complications
  - Necrobacillosis
  - Papillomas
  - Chondritis

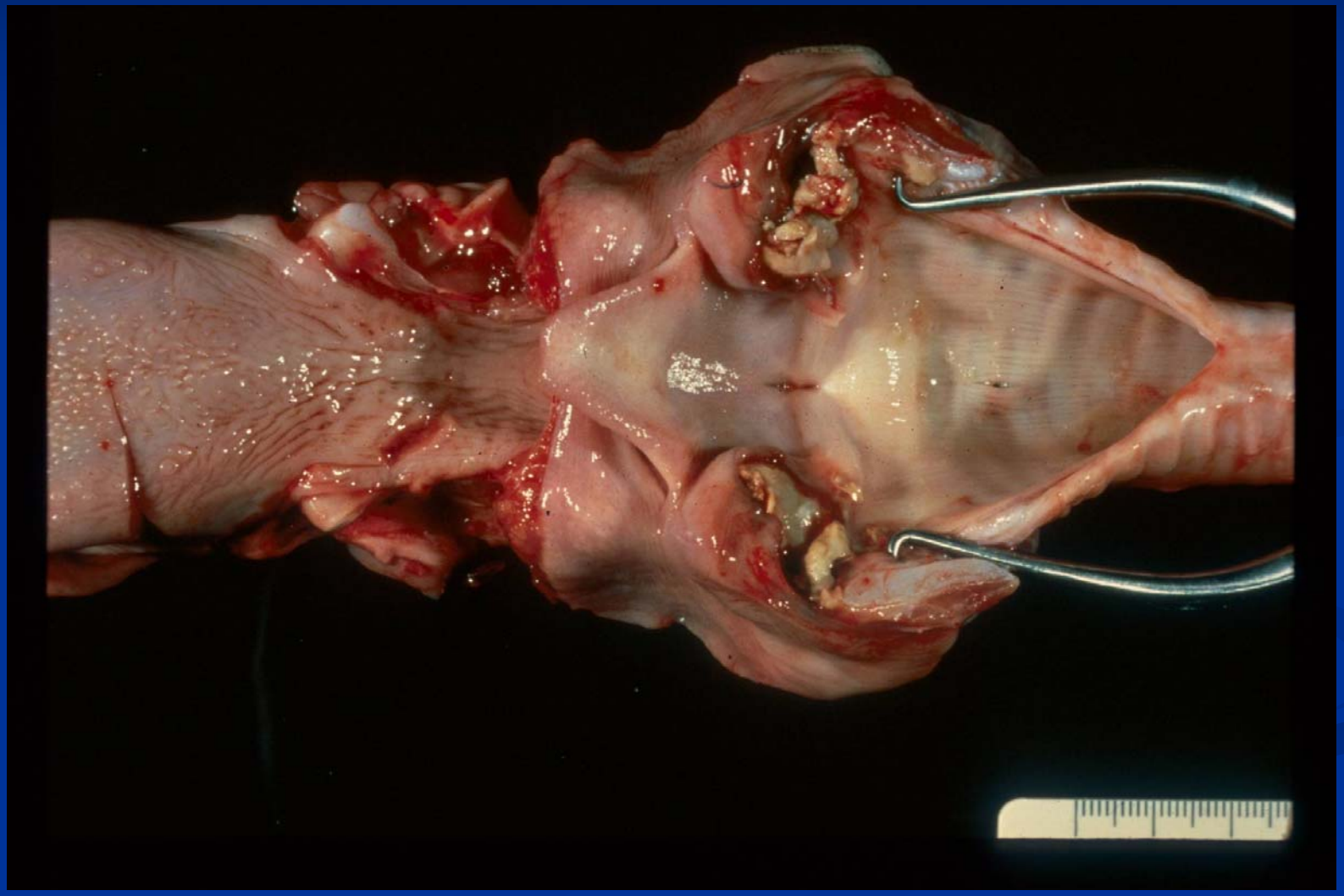
Bovine Respiratory Pathology

- **Upper Respiratory Diseases**
  - Infectious Diseases
    - Bacterial
    - Viral
    - Mycotic

Calf Diphtheria (Necrobacillosis)

- Feedlot cattle, sheep
- Secondary to viral infection or trauma
- Etiologic agent
  - *Fusobacterium necrophorum*
- Pathology
  - Tongue, larynx, pharynx, trachea
  - Elevated necrotic plaques, ulceration

Calf Diphtheria (Necrobacillosis)



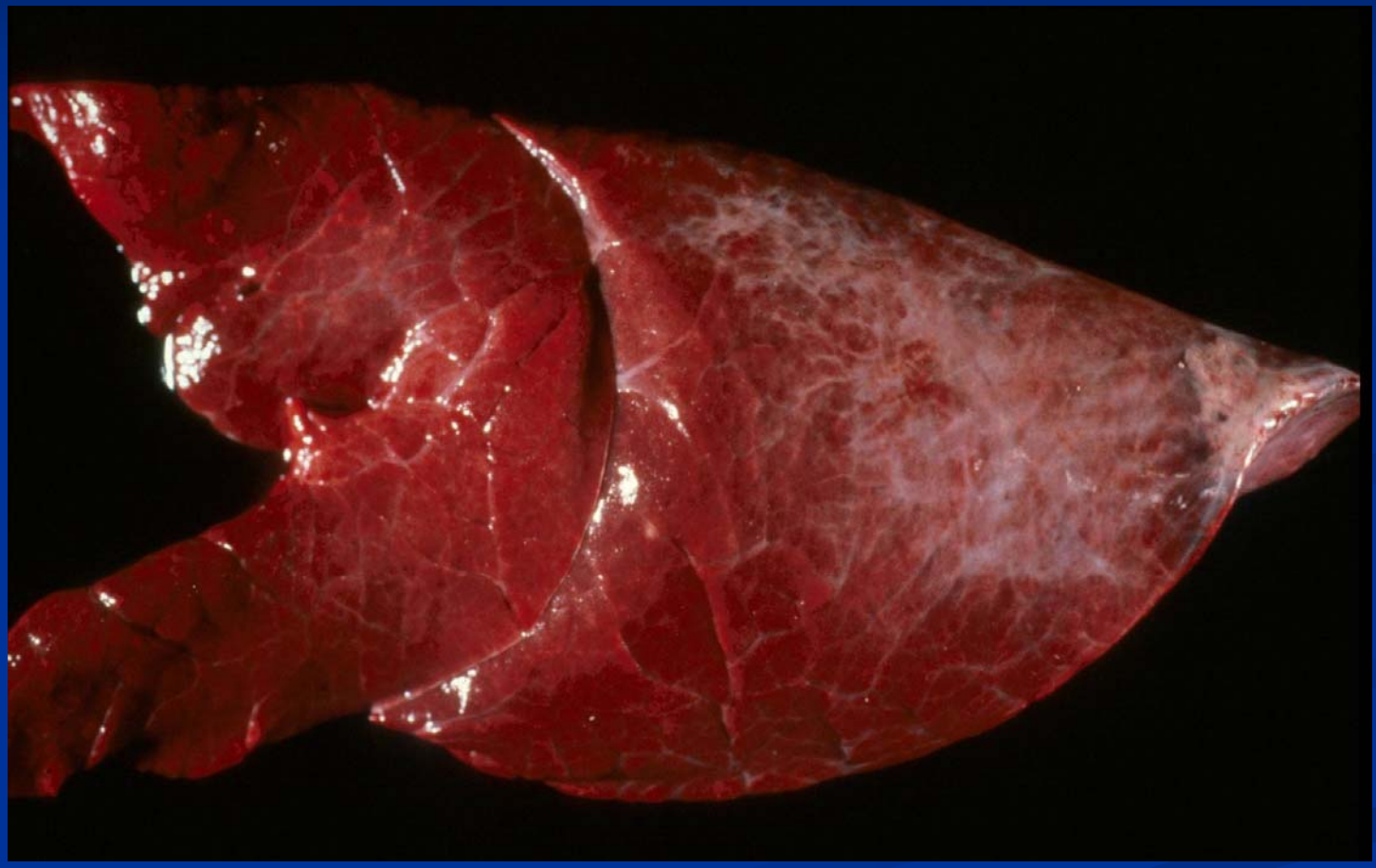
Calf Diphtheria (Necrobacillosis)

- Disease
  - Systemic disease
  - Respiratory – cough and inspiratory dyspnea
- Complications
  - Pneumonia secondary to aspiration
  - Toxemia or bacteremia
  - Asphyxiation

Bovine Respiratory Pathology

- **Lower Respiratory Tract Diseases**
  - Noninfectious Disease
    - Congenital
    - Emphysema
    - Immune Mediated Interstitial pneumonia
    - Toxic interstitial pneumonia
  - Infectious Disease
    - Viral Diseases
    - Bacterial Diseases
    - Parasitic Diseases

Normal Calf Lung (note fibrous pleura)



Congenital Disease

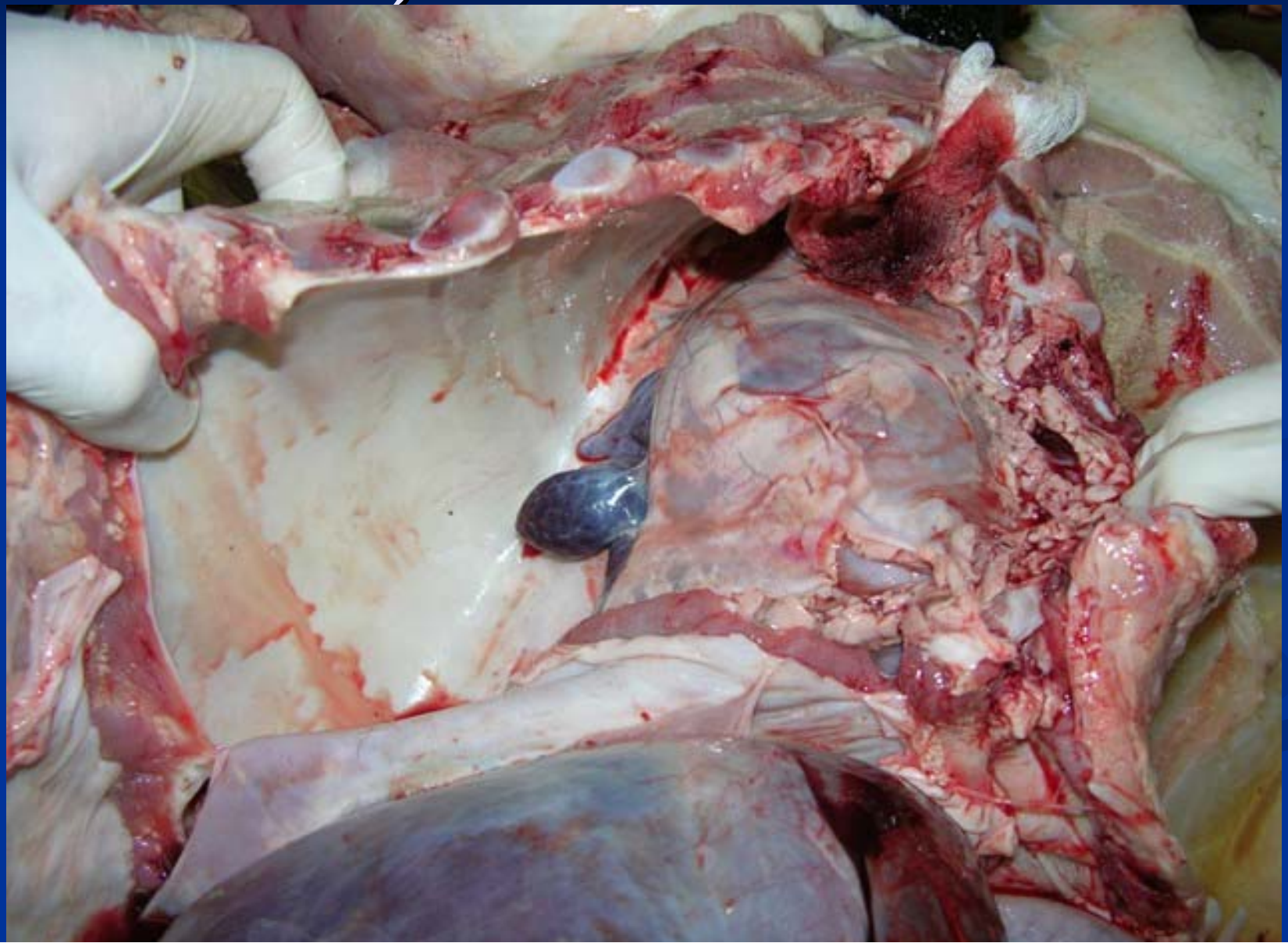
- Pulmonary hypoplasia
- Accessory lungs (dystocia possible)
- Congenital melanosis

Congenital Lung Defects

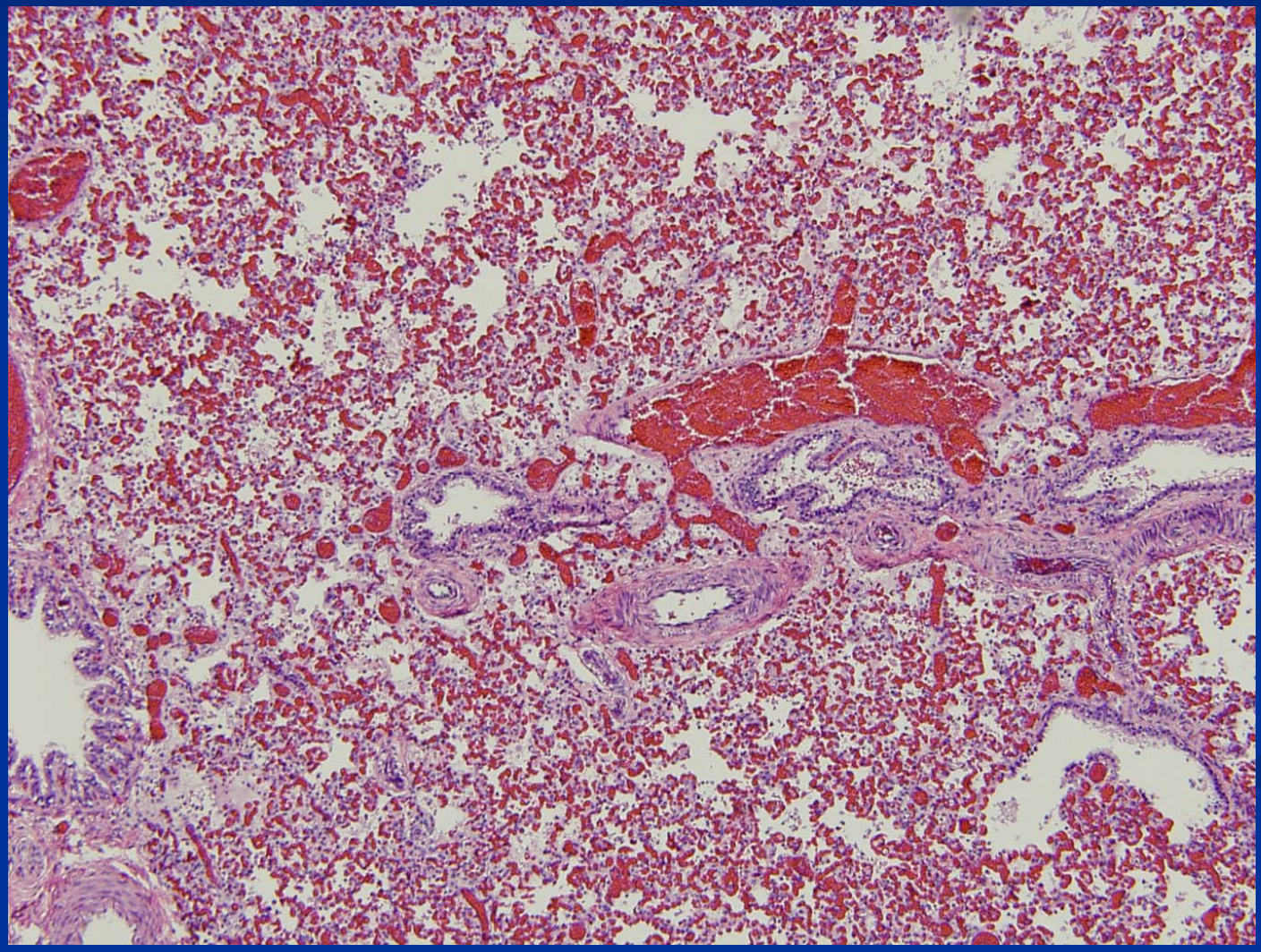
- Pulmonary hypoplasia and anasarca (HPA)
  - An emerging genetic disease in Shorthorn fetuses in US
  - Anjou-Maine? – one case seen in Illinois
  - In Australia, seen in Dexters (Peter Windsor)

Anasarca

Severe Pulmonary Hypoplasia – Anjou-Maine Fetus



Pulmonary Hypoplasia—
Normal Histology -Maine-Anjou Fetus



Bovine Respiratory Pathology

- Viral Diseases
  - Upper respiratory
    - Infectious bovine rhinotracheitis (IBR)
    - Bovine malignant catarrhal fever (BMC)
  - Pneumonia
    - Bovine respiratory syncytial virus (BRSV)
    - Retrovirus infections of goats and sheep

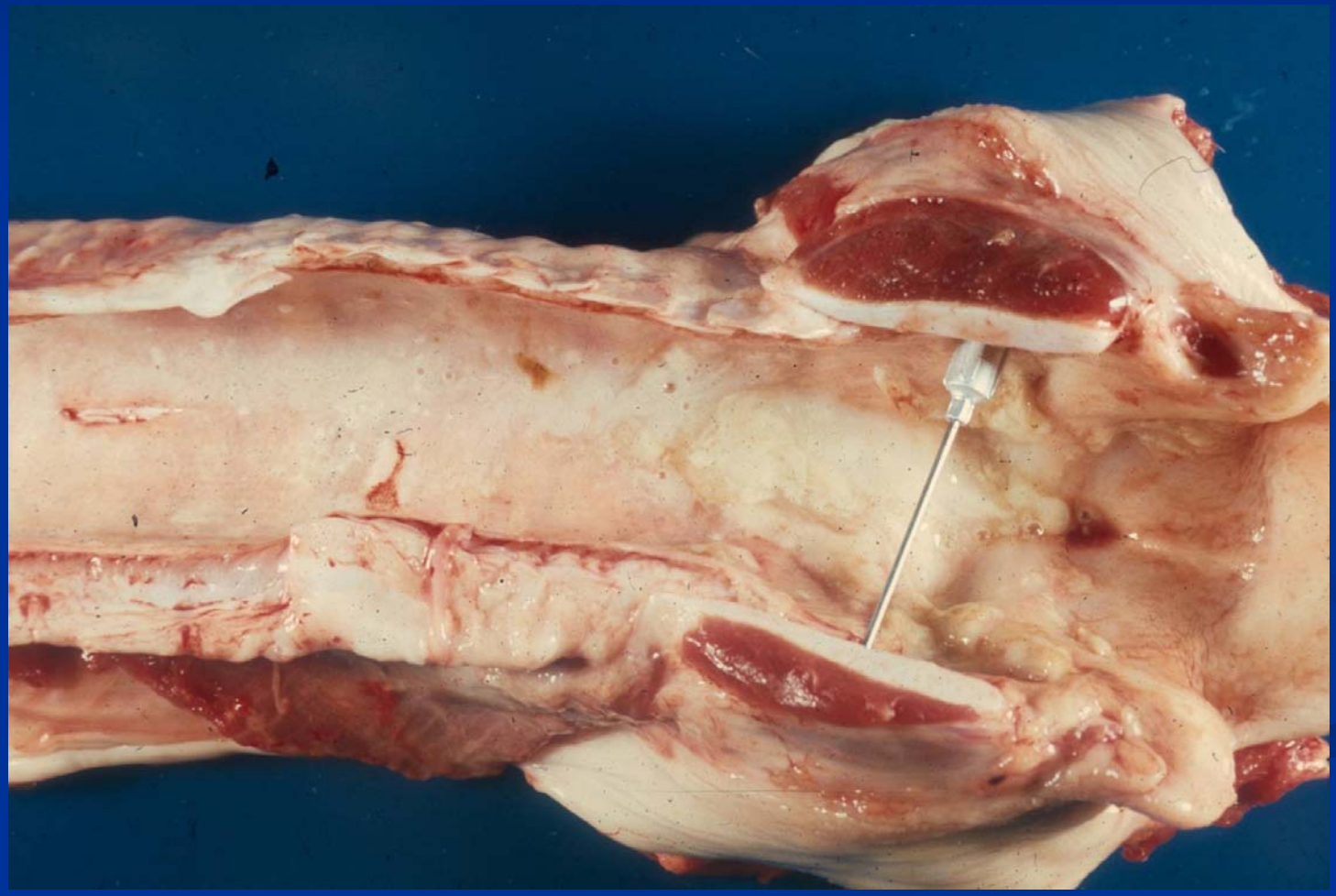
Infectious Bovine Rhinotracheitis (IBR, "rednose")

- Etiology: bovine herpesvirus I (BHV-I)
- Species: young cattle (feedlots)
- Diseases: respiratory, generalized, reproductive (IPV, IBP)
- Clinical signs: rhinitis, tracheobronchitis
- Differential: calf diphtheria

Infectious Bovine Rhinotracheitis (IBR)

- Pathology
  - Mucopurulent rhinotracheitis
  - Multifocal epithelial necrosis
  - Intranuclear inclusion bodies
- Importance
  - Predisposes to secondary bacterial infection especially *Mannheimia (Pasteurella) haemolytica*
- Diagnosis: virus isolation, IHC, PCR

Infectious Bovine Rhinotracheitis (IBR)



Bovine Malignant Catarrhal Fever

- Etiology: herpes virus (alphaherpes)
- Two types
  - Wildebeest derived
  - Sheep associated - worldwide
- Species: all bovines, deer
- Carriers are sheep, possibly infected deer
- Generally sporadic, with high mortality, but herd outbreaks may occur.
- Clinical signs
  - Fever, keratoconjuctivitis, rhinitis
  - Encephalitis
  - Death

Bovine Malignant Catarrhal Fever (BMC)

- Pathology
  - Digestive and upper respiratory tract erosions
  - Encephalitis
  - Lymphoid hyperplasia (lymphadenopathy)
  - Vasculitis with fibrinoid necrosis
- Differential diagnoses: Rinderpest, BVD, IBR

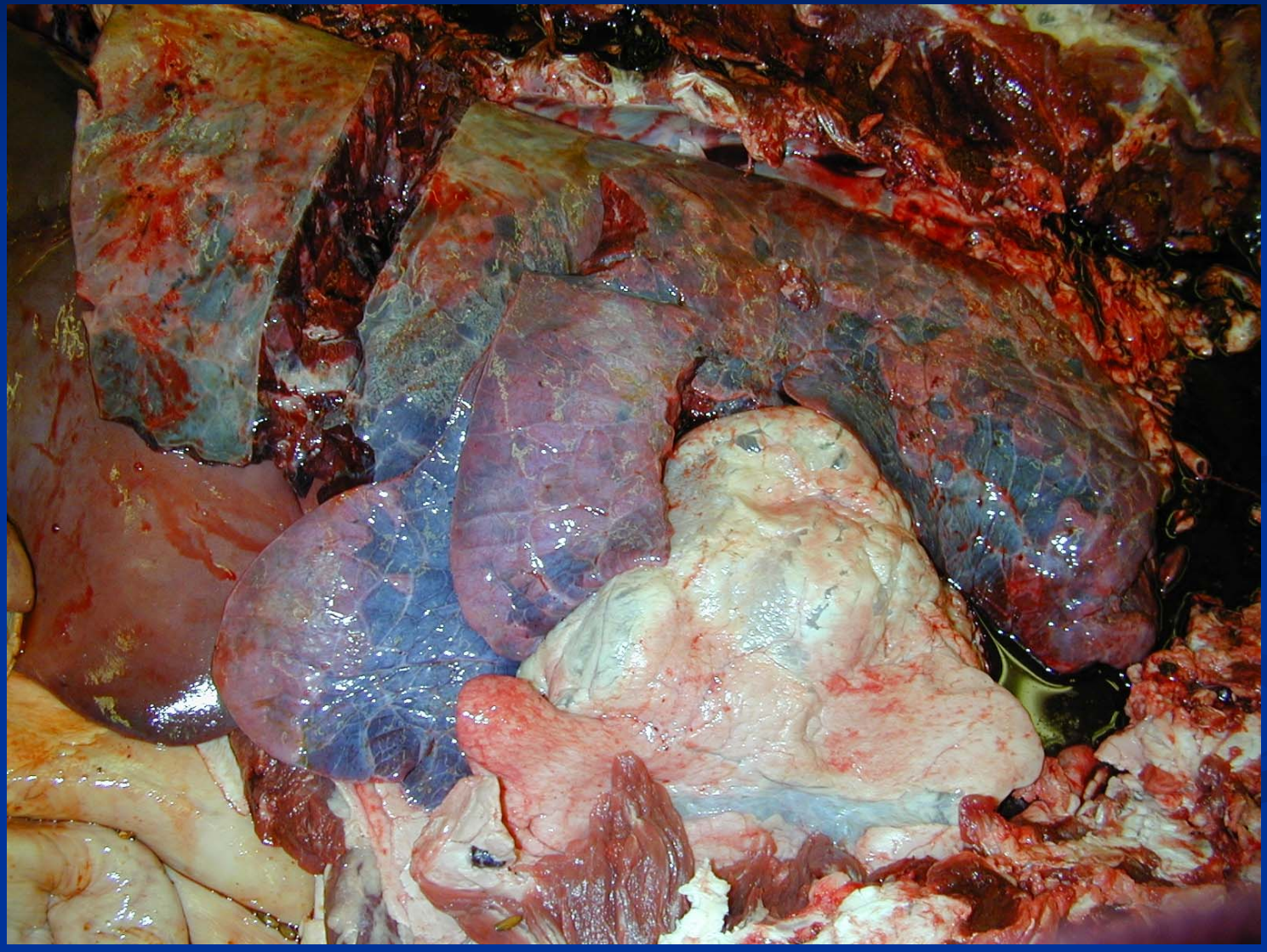
Bovine Respiratory Syncytial Virus (BRSV)

- Pneumovirus (paramyxoviridae)
- <1 year, beef calves
- Clinical signs
  - Fever
  - Anorexia
  - Nasal and lacrimal discharge
  - Increased respiratory rate
  - +/- Death

Bovine Respiratory Syncytial Virus

- Pathology
  - Bronchointerstitial pneumonia
  - Syncytial giant cells of bronchiolar epithelium
  - +/- Acidophilic cytoplasmic inclusion bodies
- Secondary bacterial infection
- Diagnosis – IHC, virus isolation
- In Australia mainly non pathogenic
- Differentials: other interstitial pneumonias

Bovine Respiratory Syncytial Virus (BRSV)



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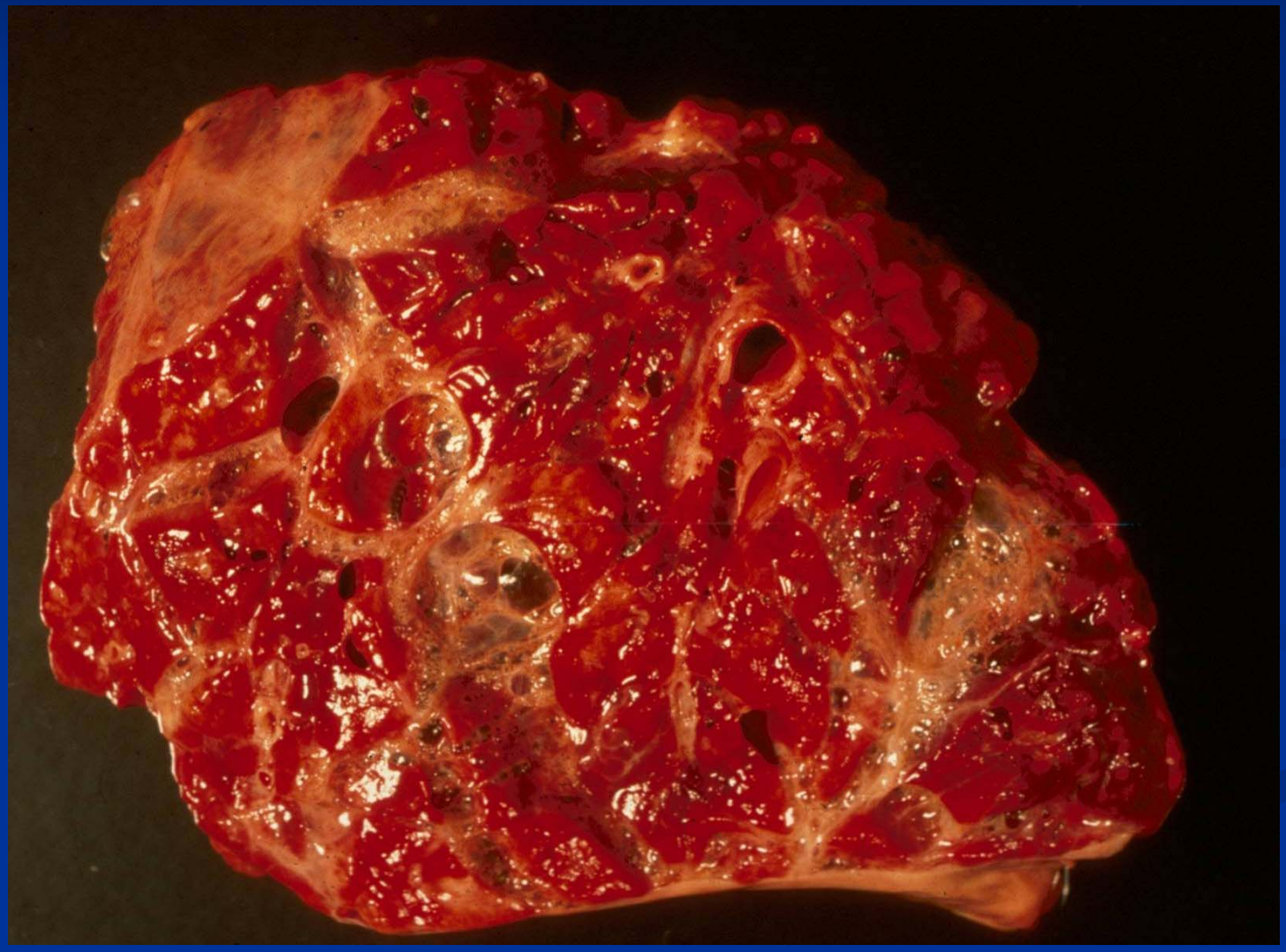
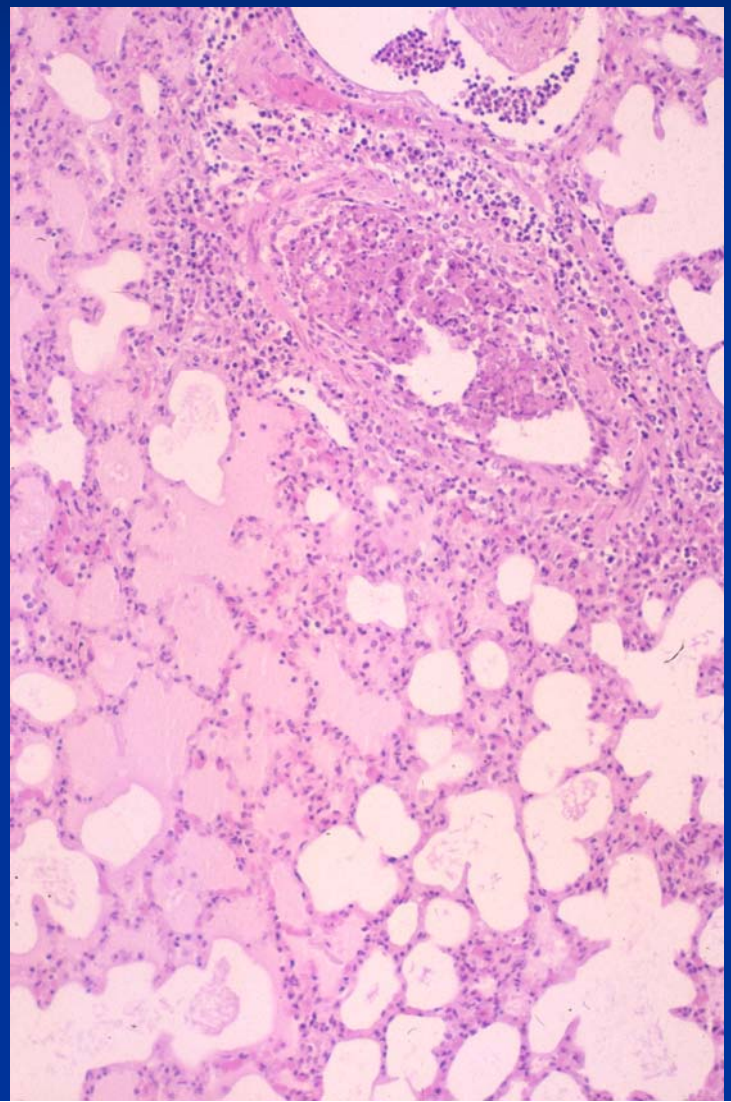
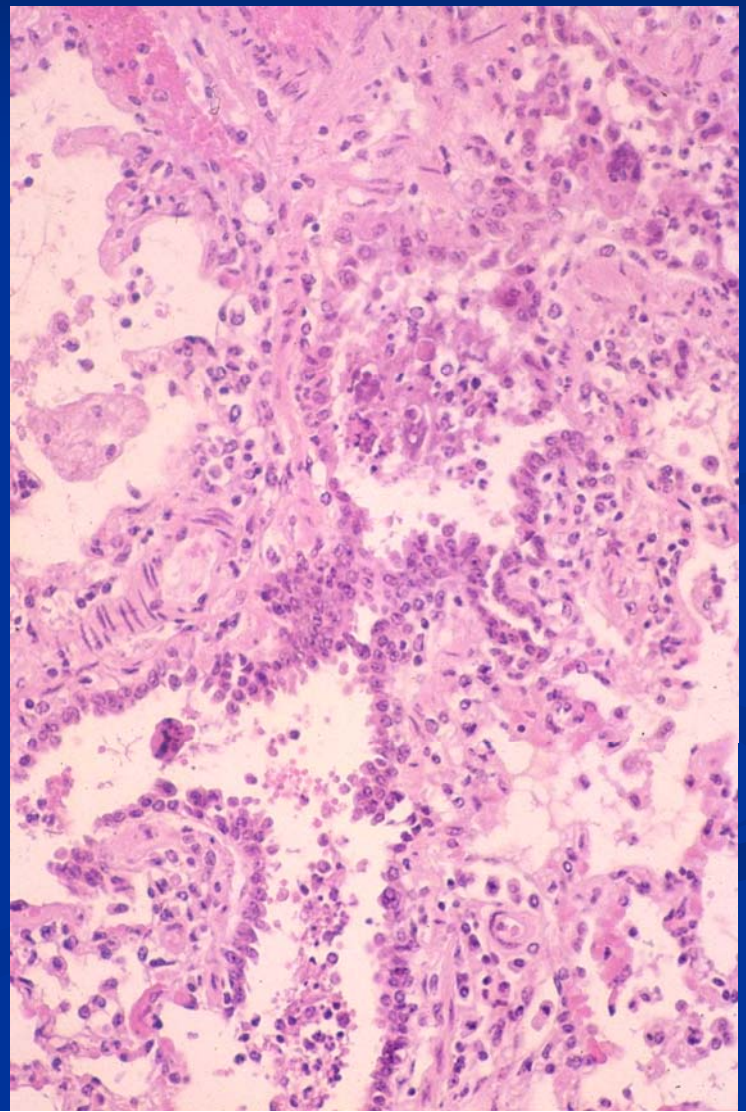
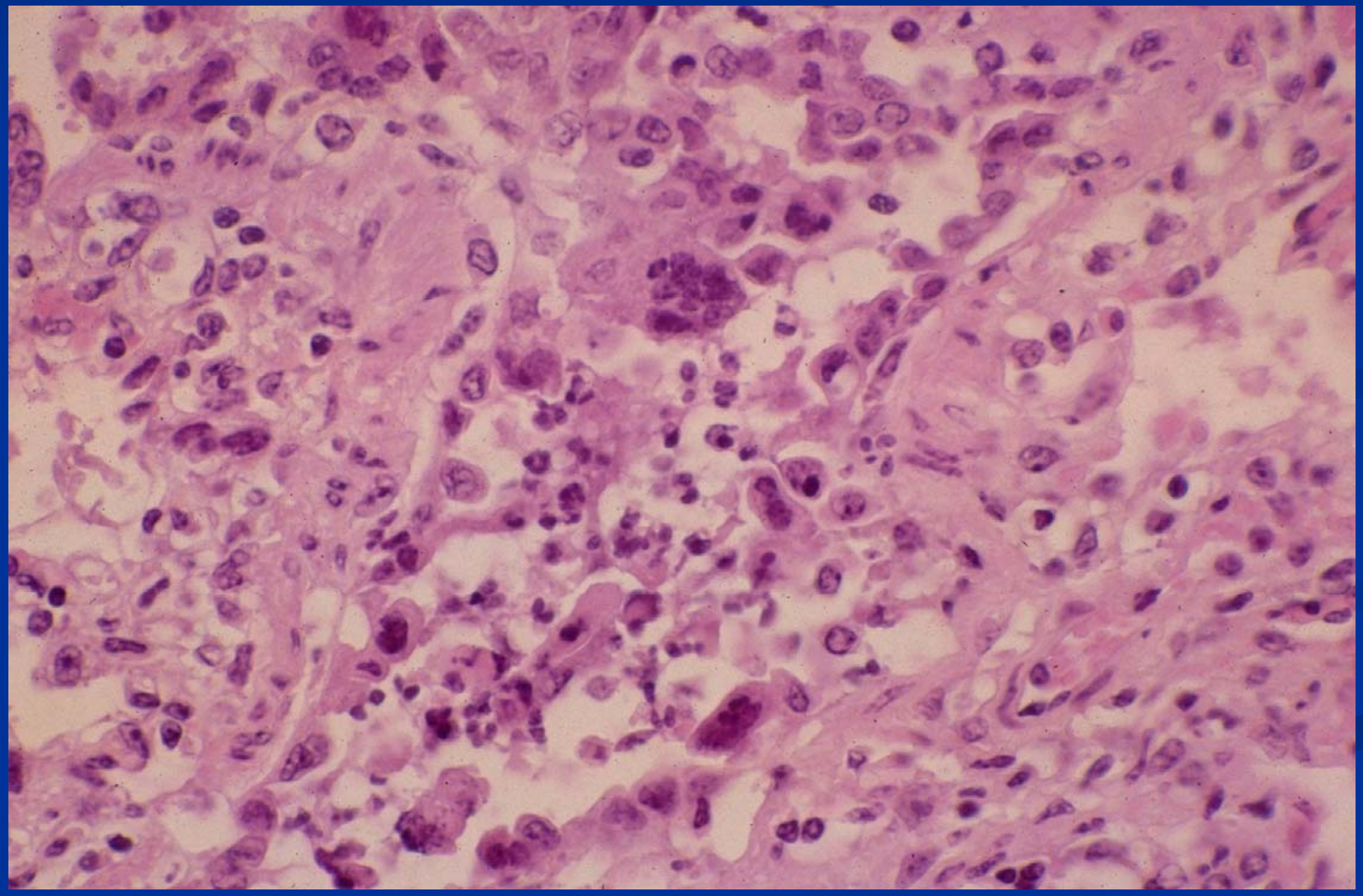


Bovine Respiratory Syncytial Virus (BRSV)





Bovine Respiratory Syncytial Virus (BRSV)



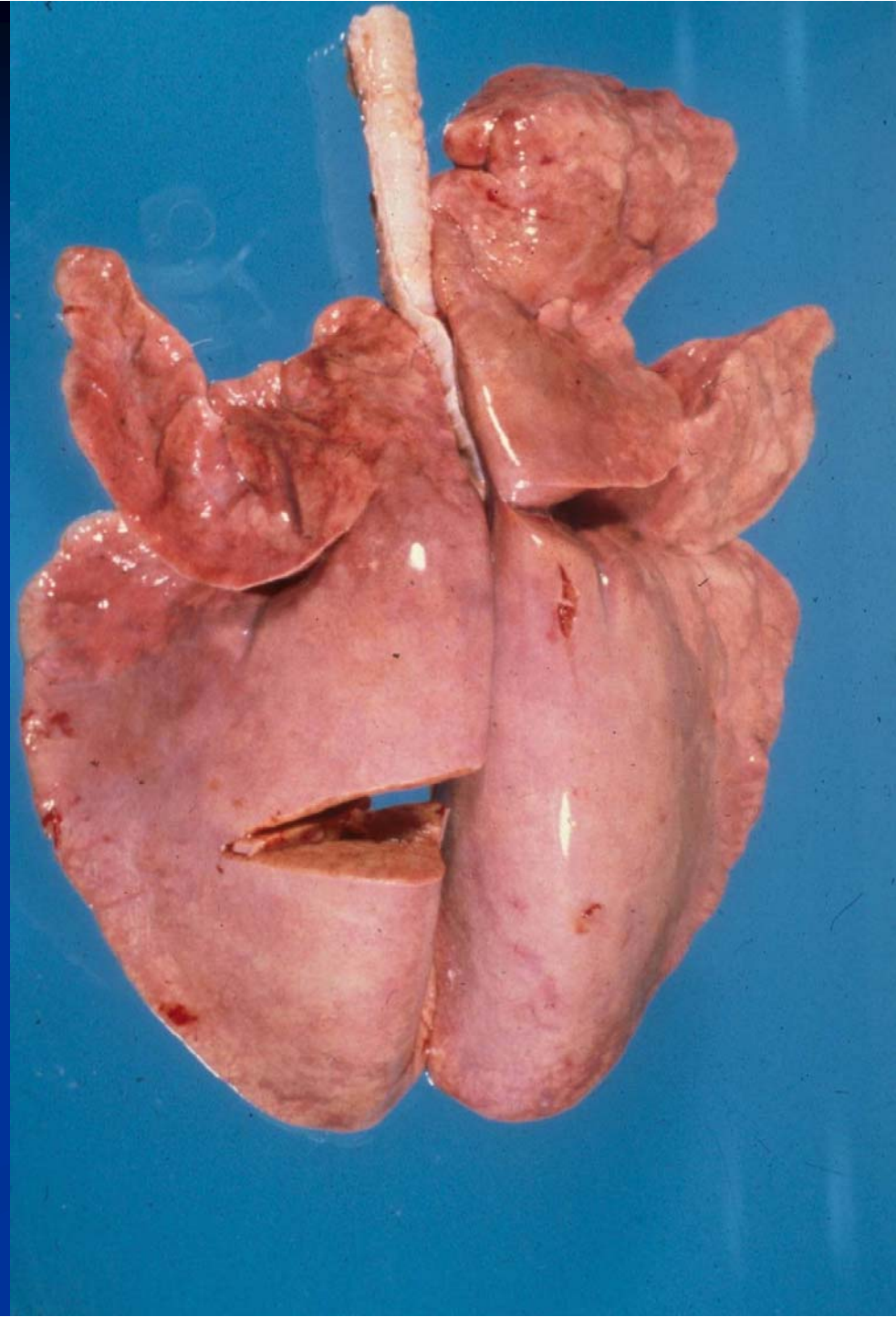
Retrovirus Infections of Goats and Sheep

- Ovine Progressive Pneumonia (Maedi)
- Caprine Arthritis- Encephalitis (CAE)
- Ovine Pulmonary Adenomatosis/Ovine Pulmonary Carcinoma (Jaagsiekte)

Ovine Lentivirus-Induced Lymphoid Interstitial Pneumonia (LIP)

- Etiology: Lentivirus, 'Slow' virus (2-3 yr incubation)
- Widespread infection but few clinical cases
- Most countries except Australia and New Zealand
- Pulmonary form also known as Maedi, ovine progressive pneumonia (OPP)
- Can affect CNS (Visna), mammary tissue, joints, etc
- Pathology
  - Severe chronic interstitial pneumonia
  - Marked BALT and smooth muscle proliferation
  - Tracheobronchial lymph nodes enlarged

Ovine Lentivirus-Induced Lymphoid Interstitial Pneumonia (LIP)



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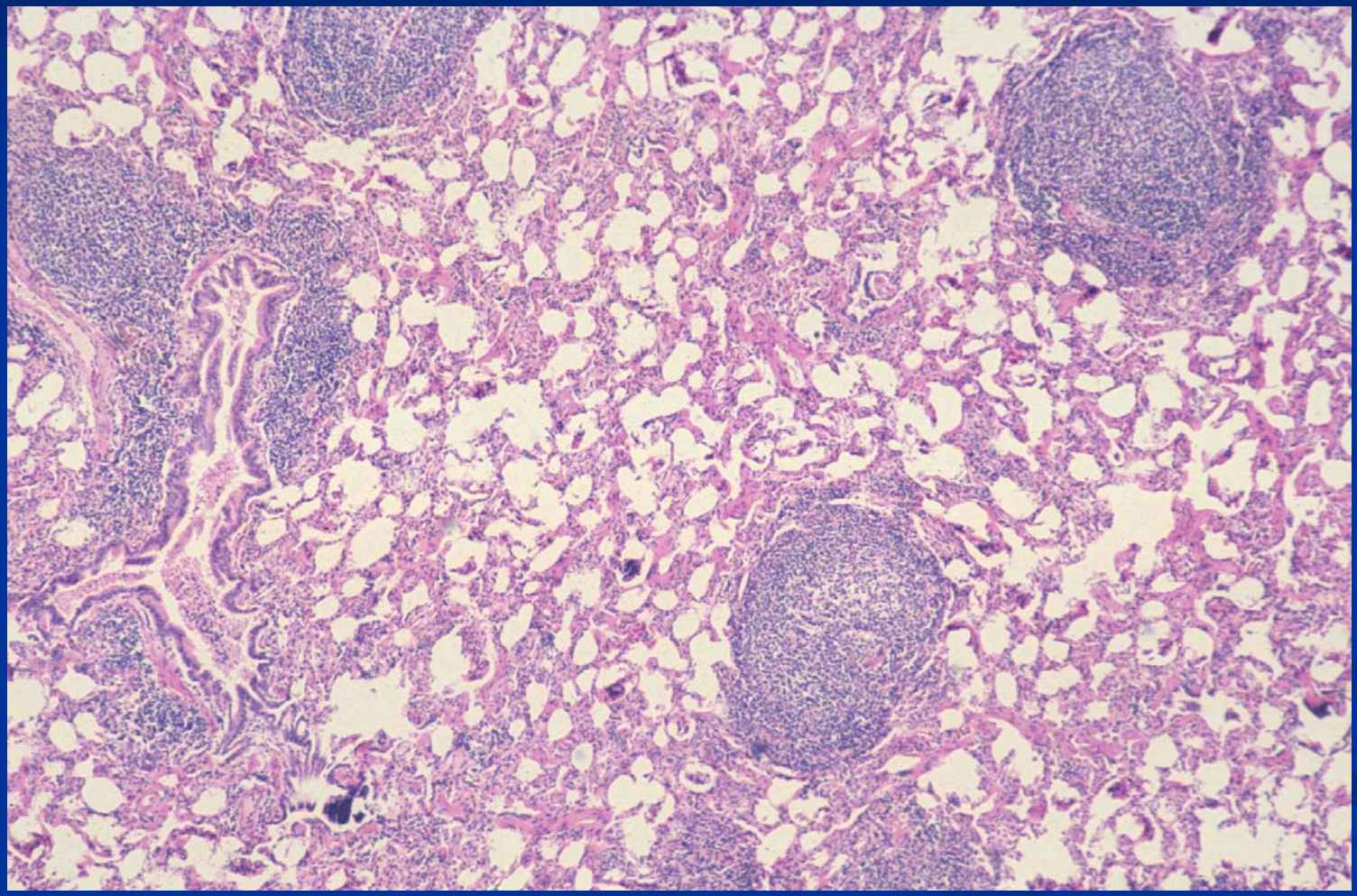

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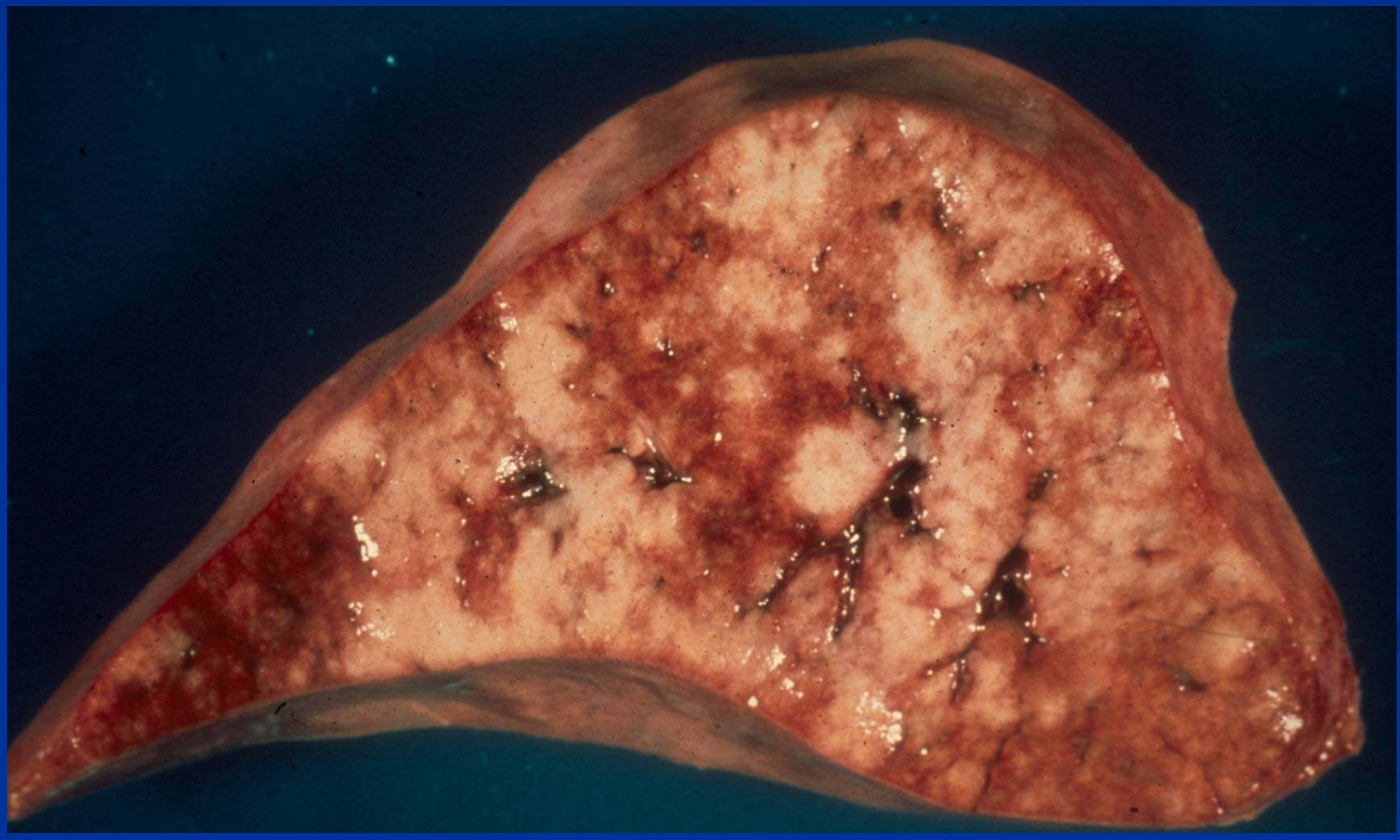

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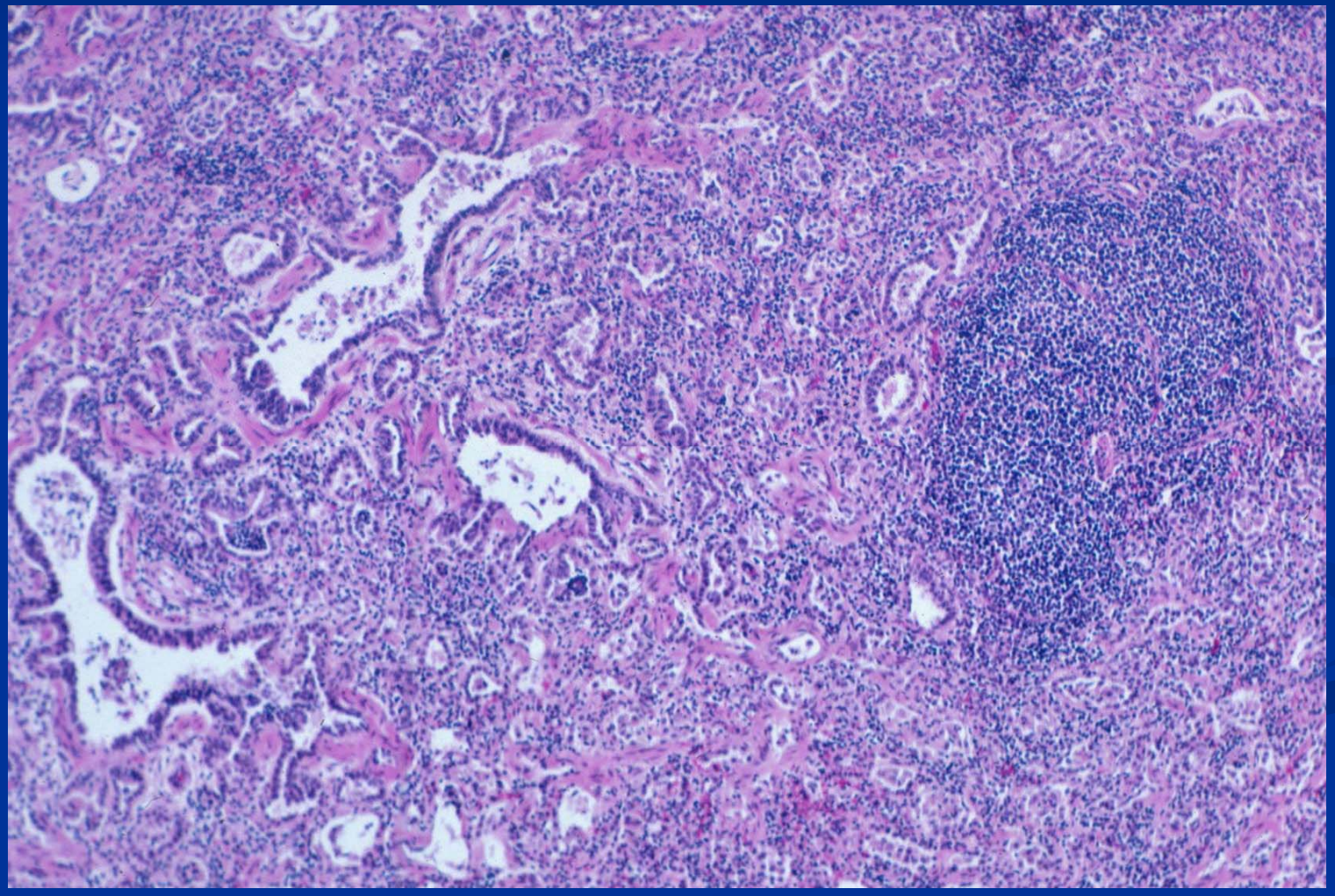
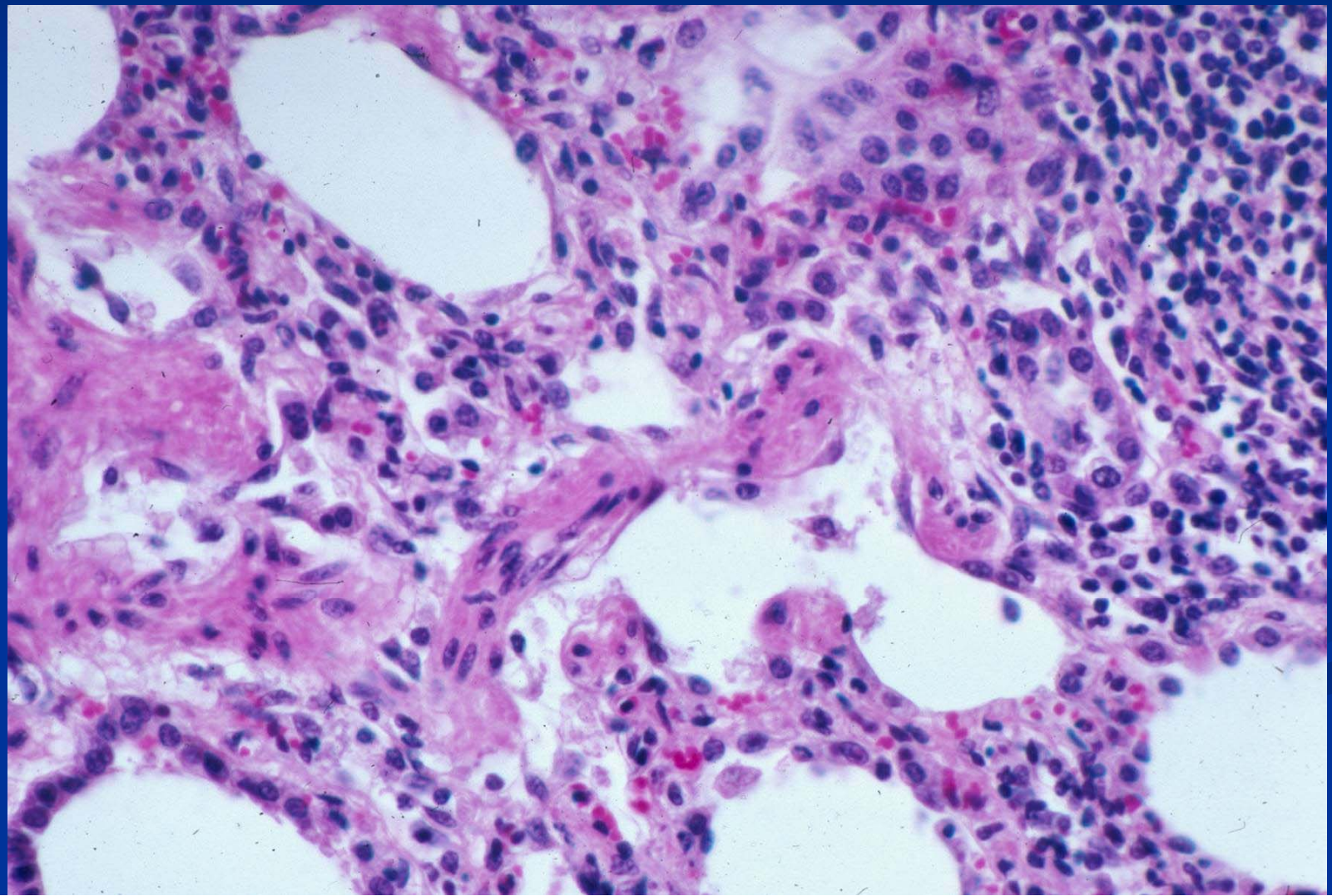


Ovine Lentivirus-Induced Lymphoid Interstitial Pneumonia (LIP)



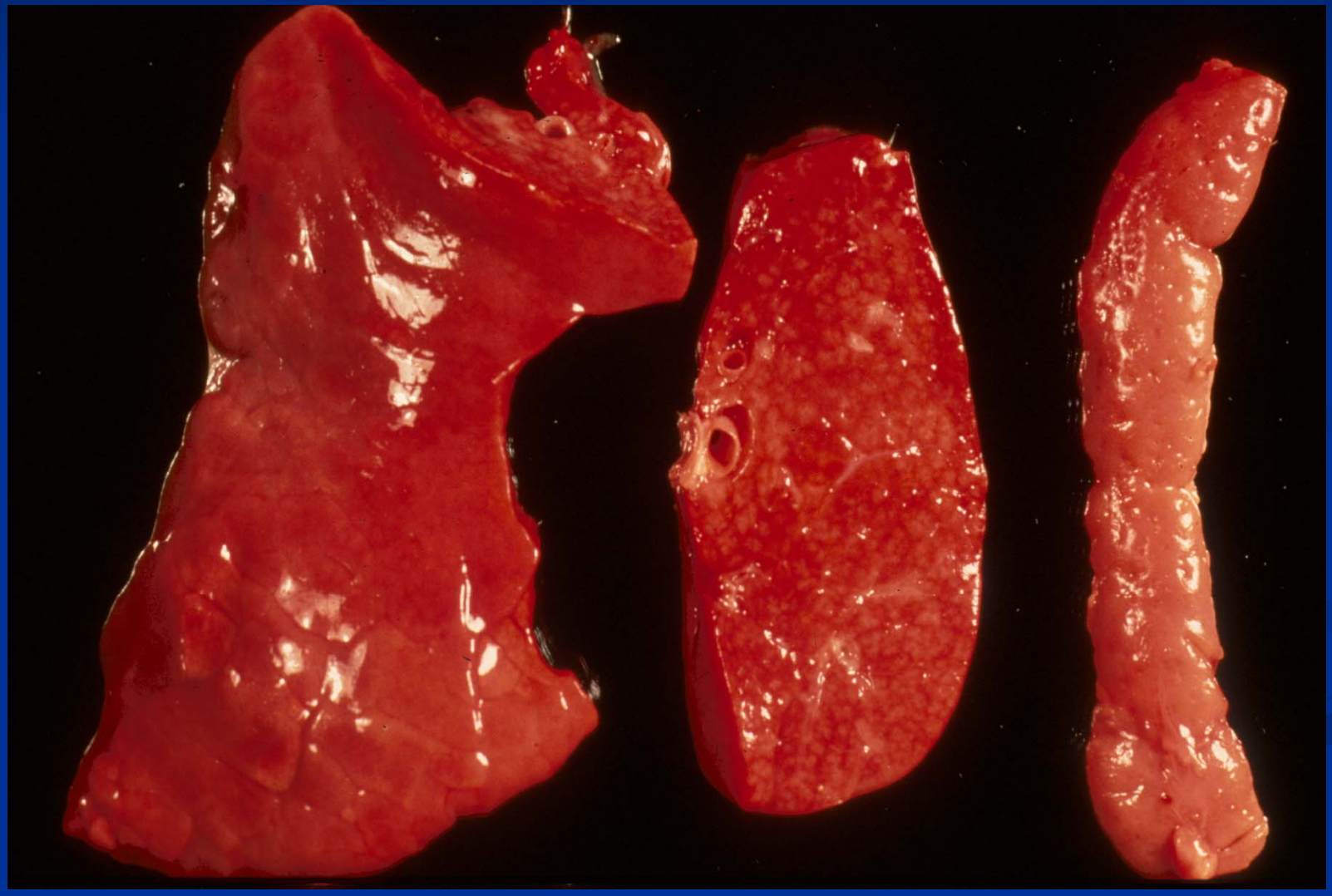
Barbary Sheep in Australia

- Interstitial pneumonia
- BALT hyperplasia
- Cause? LIP? Mycoplasma?

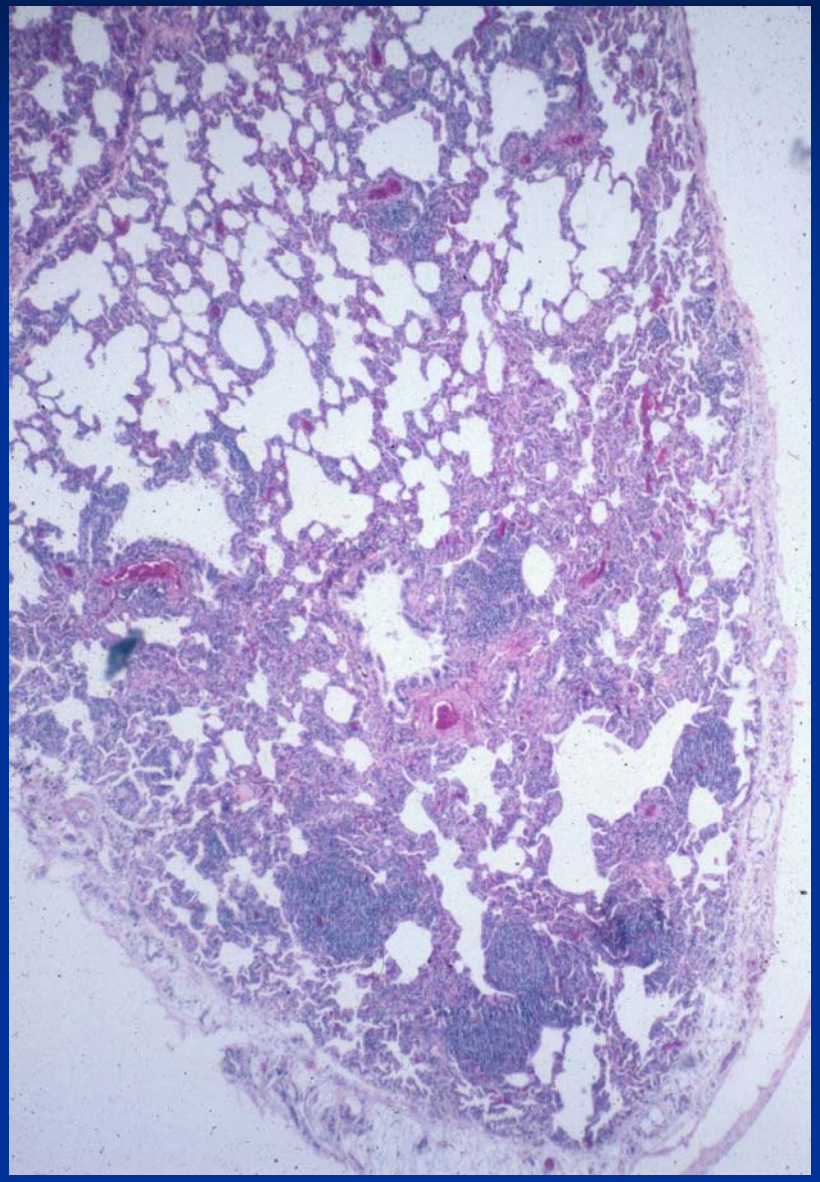
Caprine Arthritis- Encephalitis (CAE)

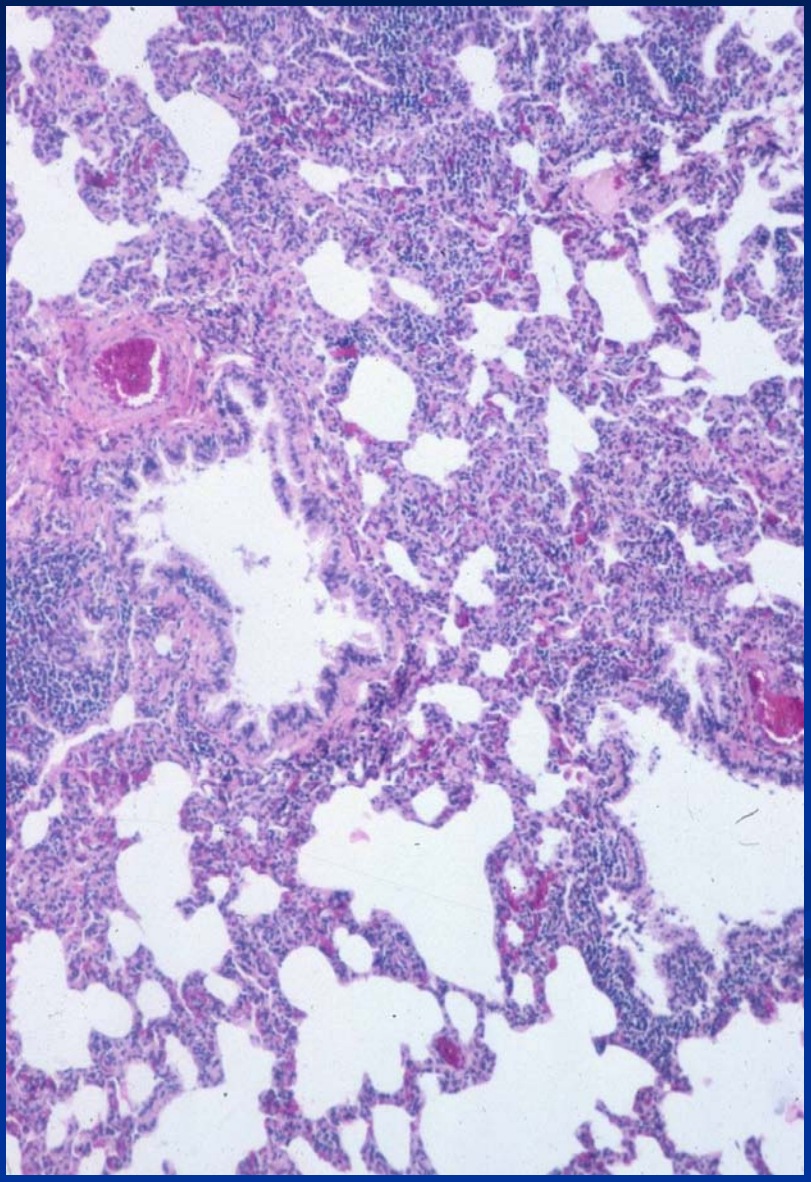
- Etiology: Lentivirus of goats
- Disease: similar to LIP in sheep
- Transmission horizontal and vertical: in utero, milk
- Australia, US, Canada, Europe
- Disease
  - Chronic interstitial pneumonia, lymphocytic (adult)
  - Tracheobronchial lymph nodes enlarged
  - Arthritis, mastitis (adult)
  - Encephalitis (2 - 4 mth old)

Caprine Arthritis- Encephalitis (CAE)



Caprine Arthritis- Encephalitis (CAE)





Bacterial Pneumonias

- Bacterial Agents
  - *Mannheimia (Pasteurella) haemolytica*
  - *Pasteurella multocida*
  - *Histophilum somni (Haemophuilus somnus)*
  - *Mycobacterium sp.*
  - *Mycoplasma mycoides* **ssp.** *Mycoides*
- Sheep and goats – pseudoglanders – *Burkholderia pseudomallei* – pulmonary abscesses

Bovine Respiratory Disease (BRD)

- "Shipping Fever Complex"
  - Acute disease
  - High mortality
- Enzootic pneumonia
  - Young calves that are intensively housed
  - High morbidity, low mortality
- Embolic pneumonia
  - Sporadic

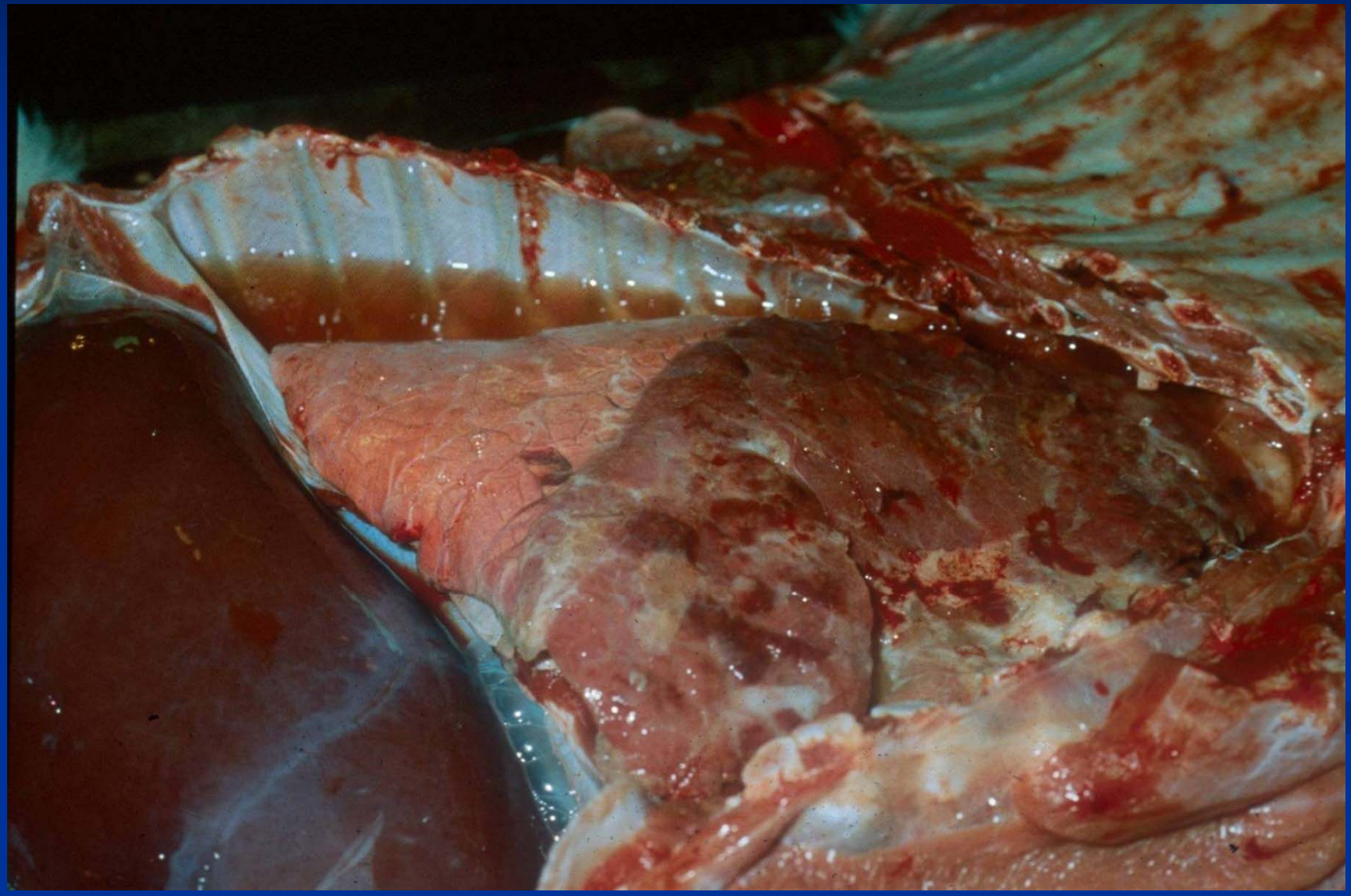
"Shipping Fever Complex"

- Predisposing factors
  - Shipping and other stressors (feedlot)
  - Viral infection (IBR, BRSV, **BVD**, PI-3)
- Etiology
  - *Mannheimia (Pasteurella) haemolytica* biotype A, serotype 1
  - *Pasteurella multocida (type A)*
  - *Histophilum somni (Hemophilus somnus)*
    - Respiratory hemophilosis
    - TEME – thrombo-embolic meningoencephalitis

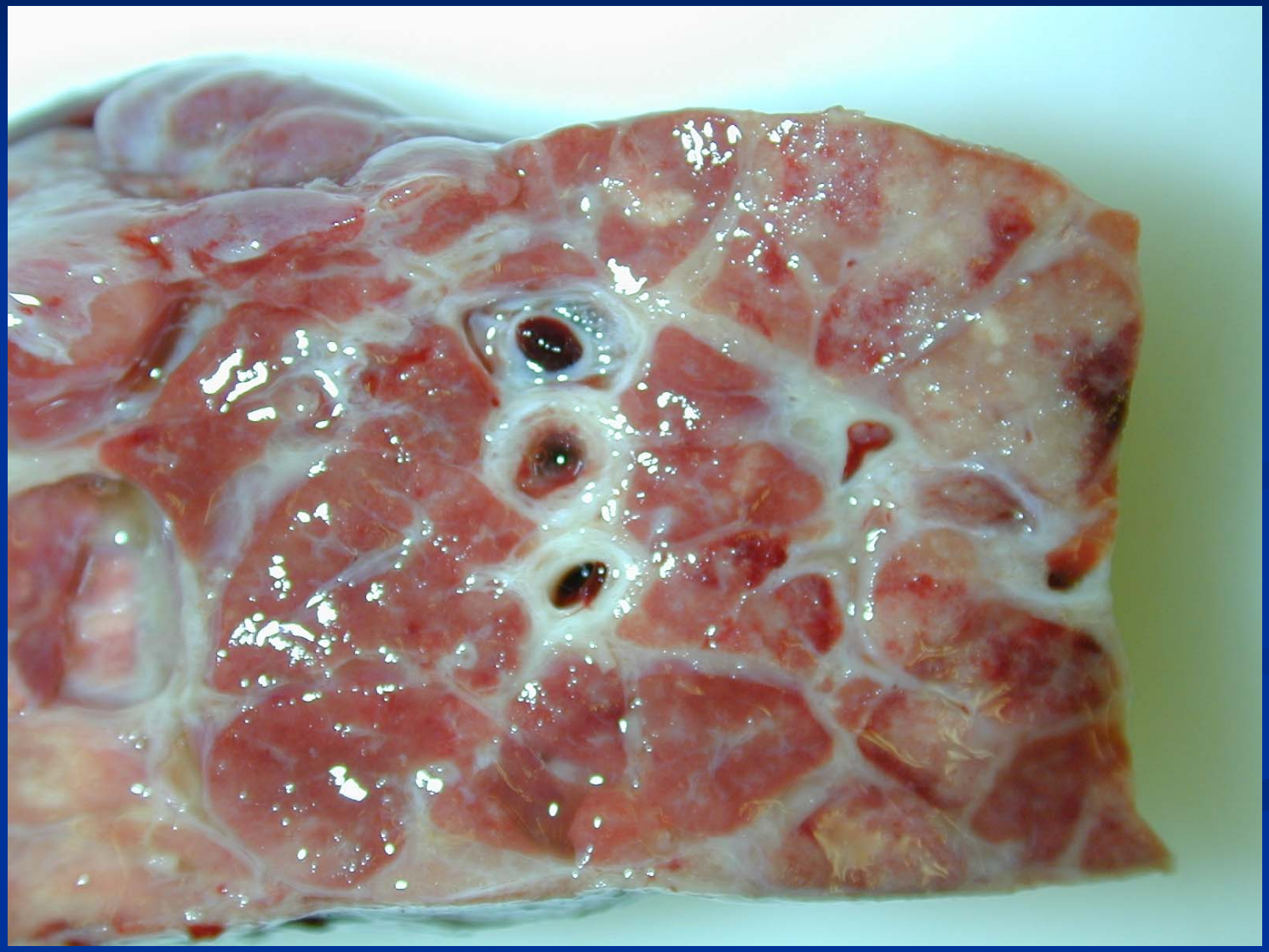
“Shipping Fever Complex”

- Disease
  - Few days to weeks after shipping
  - Systemic and respiratory clinical signs
- Gross Pathology
  - Severe fibrinous anteroventral bronchopneumonia
  - Fibrinous pleuritis and pleural effusion

“Shipping Fever Complex”



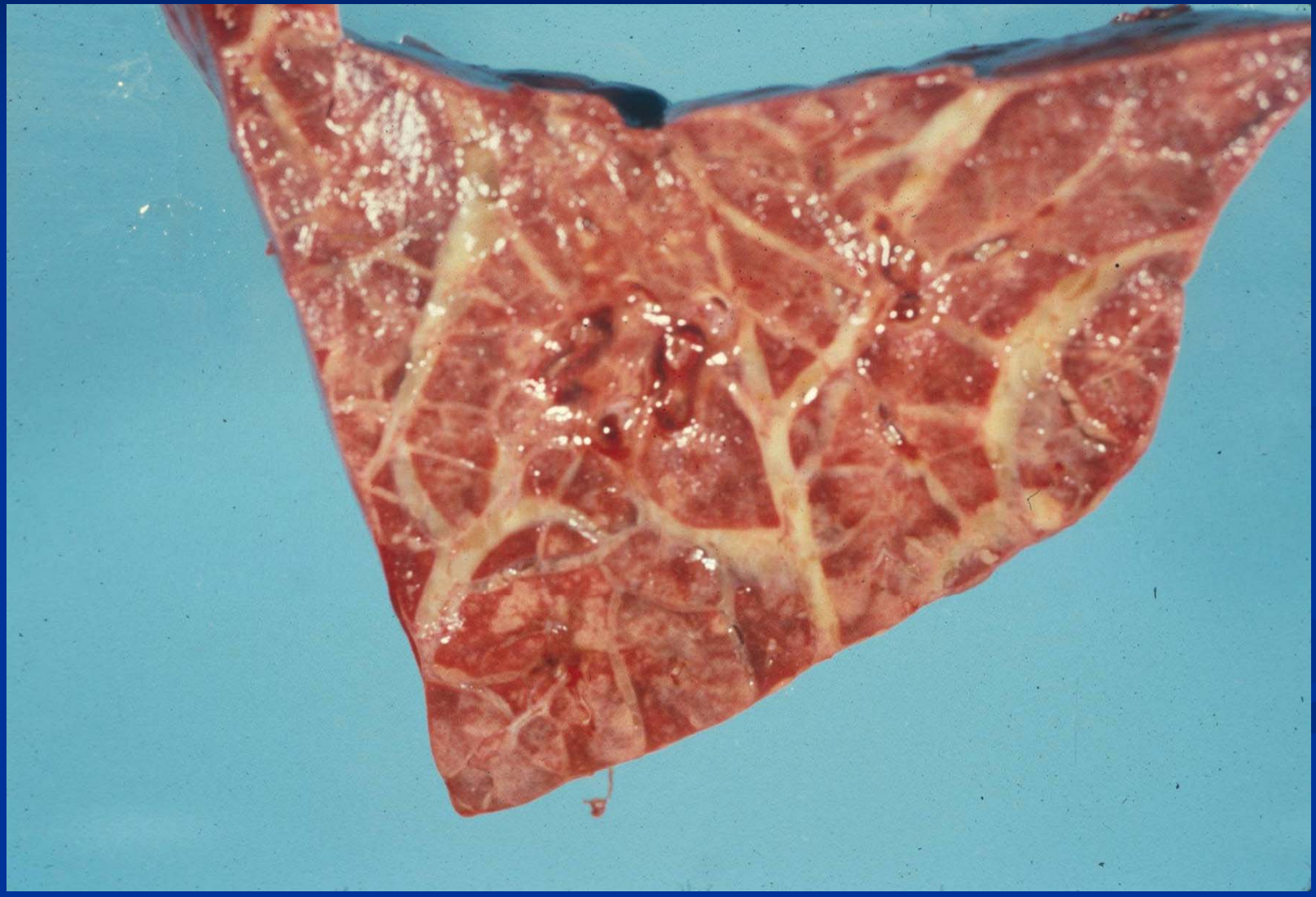
Bronchopneumonia—Fibrinous



Pneumonic Mannheimiosis

- *Mannheimia haemolytica*
- Virulence factors
  - Exotoxin –leukotoxin binds and kills ruminant neutrophils and macrophages which release proinflammatory cytokines, free radicals, etc
  - Endotoxin, LPS, membrane proteins
- Histopathology
  - Necrotic areas rimmed by degenerating and elongated neutrophils ("oat cells")

Pneumonic Mannheimiosis



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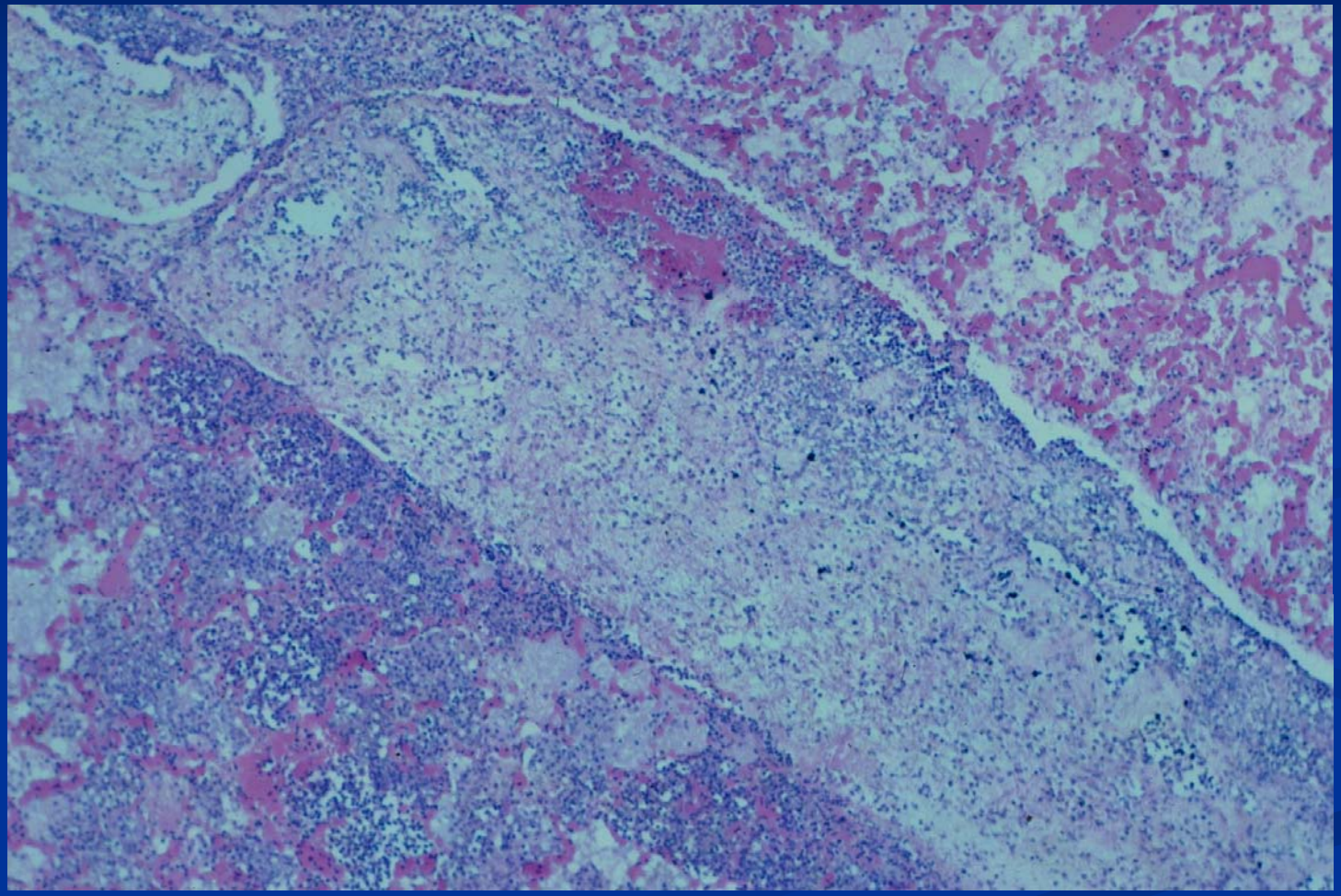
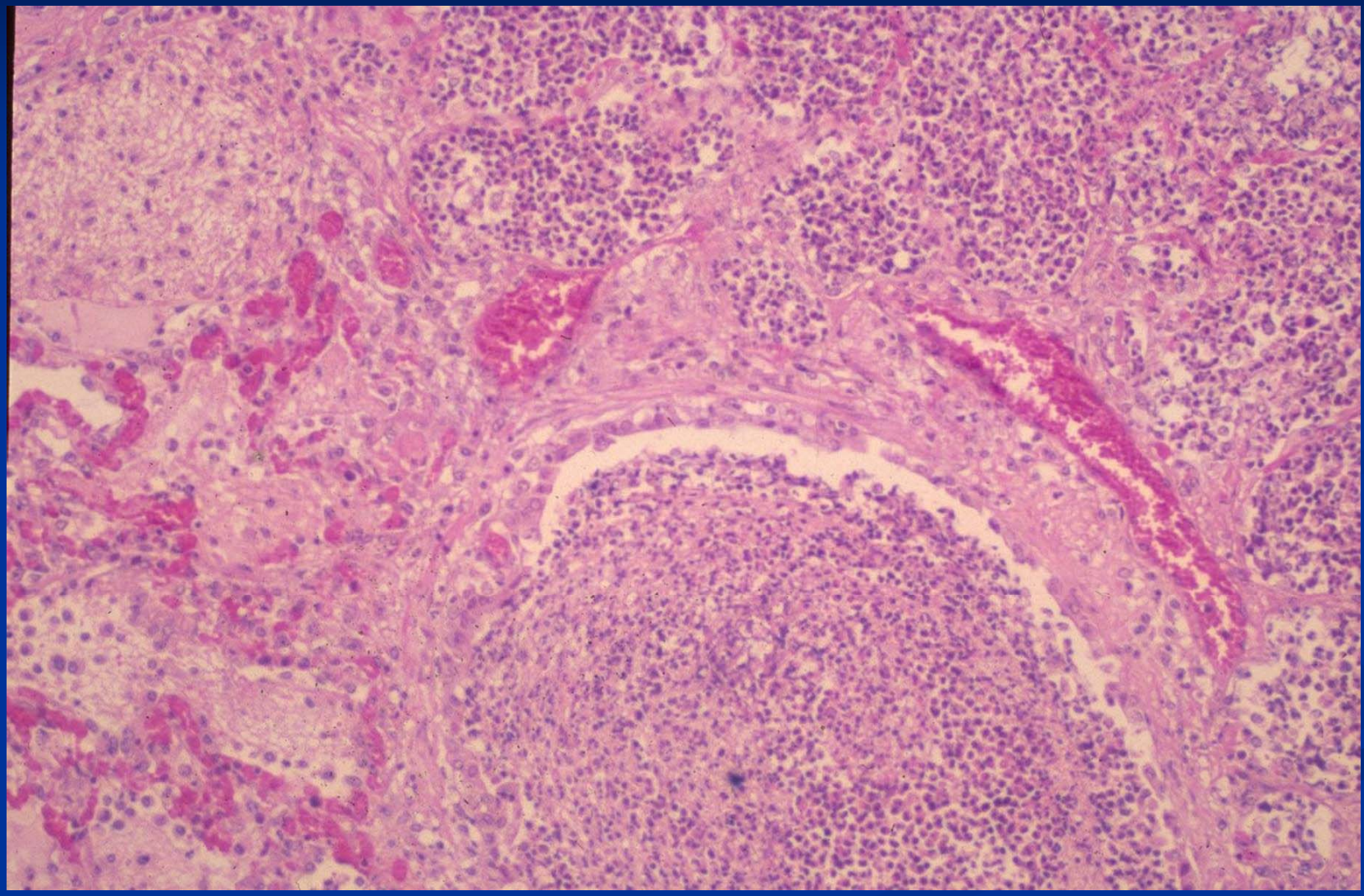


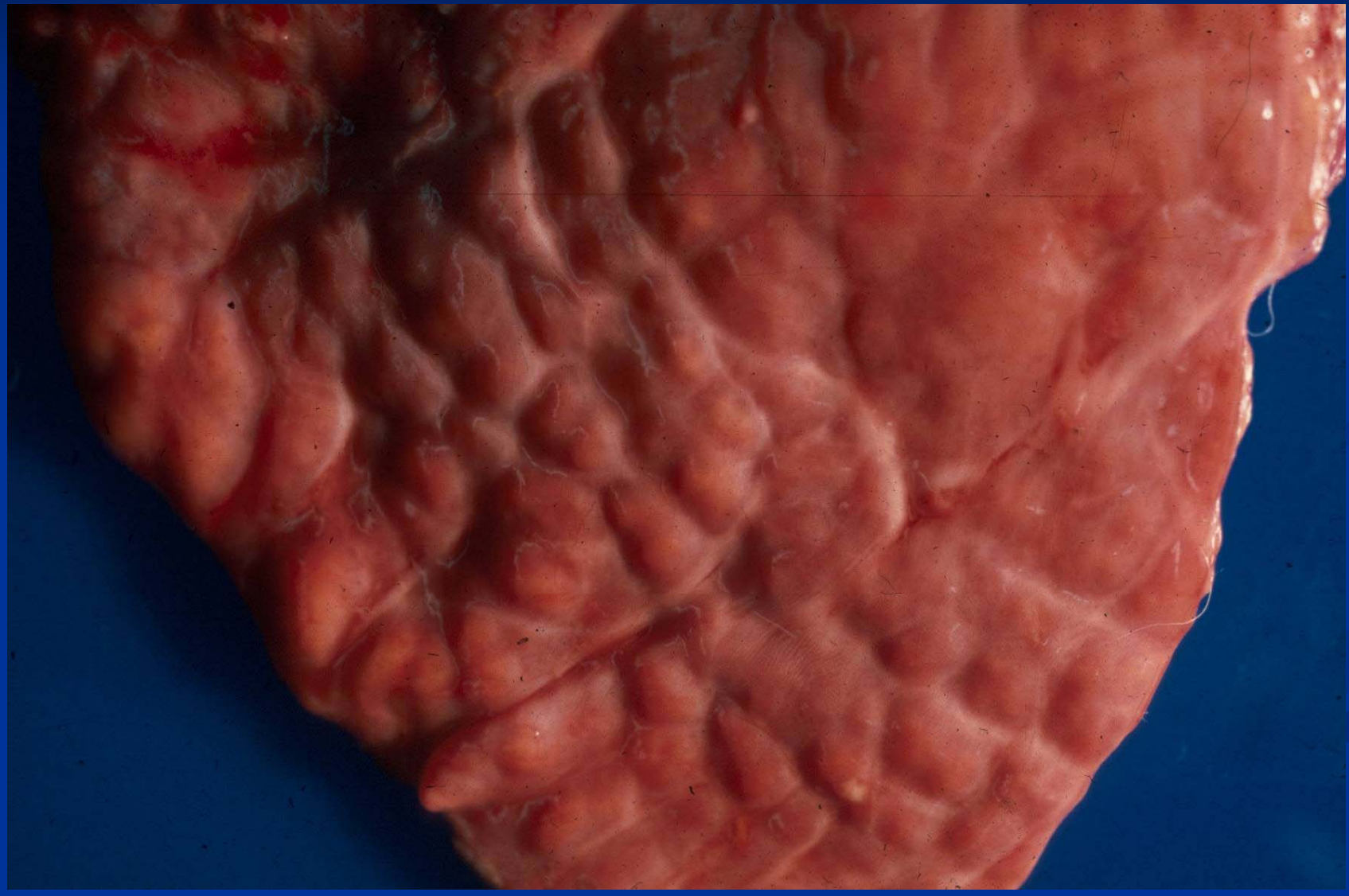
Pneumonic Mannheimiosis



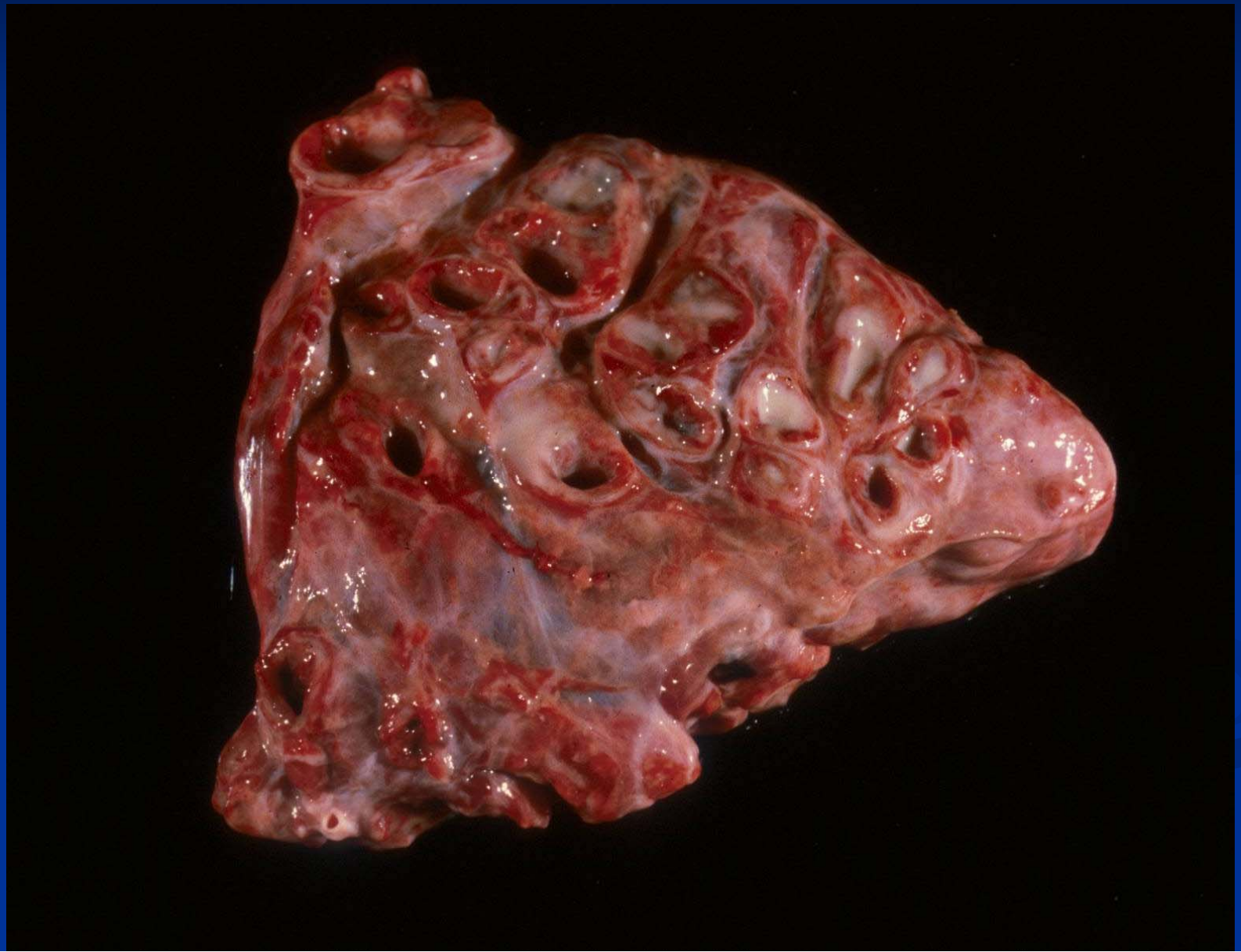
Pneumonic Mannheimiosis

- Sequella
  - Death due to toxemia
  - Abscesses
  - Sequestra
  - Chronic pleuritis with adhesions
  - Bronchiectasis

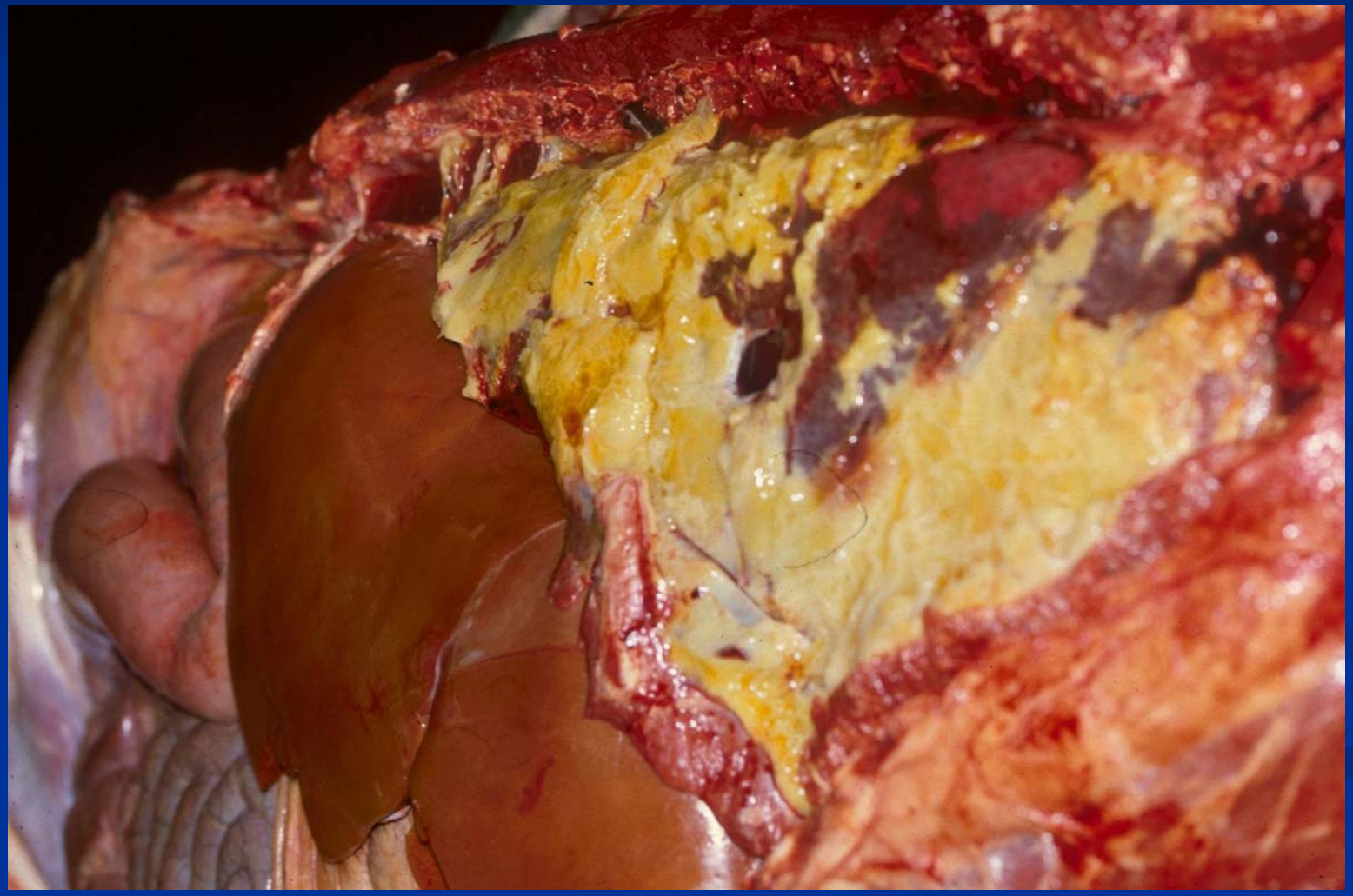
Bronchiectasis



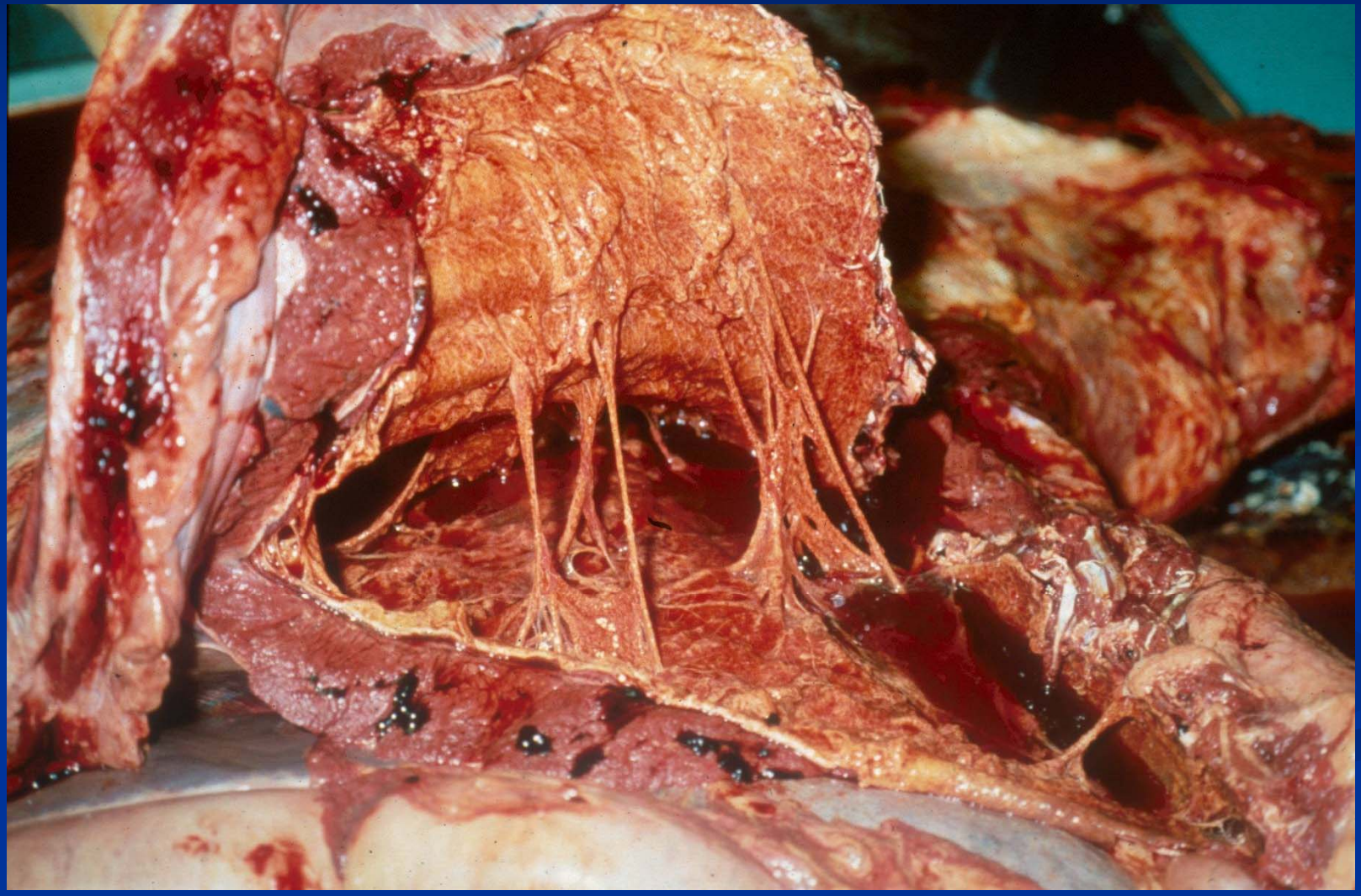
Bronchiectasis



Pleuritis - Sheep



Chronic Pleuritis - Cow



Pneumonic Pasteurellosis

- *Pasteurella multocida* (type A)
- Histopathology
  - Suppurative bronchopneumonia
- Sequellae
  - Similar to previous but not sequestra
- Differentiate from septicemic pasteurellosis/hemorrhagic septicemia - serotype B and E.

Sheep and Goat Pneumonias

- Sheep
  - *Pasteurella trehalosi* (biotype T)
  - *Mannheimia haemolytica* (biotype A) which can also cause mastitis
- Goats
  - *Mycoplasma mycoides* ssp. *mycoides* large colony type isolated from goats recently in Australia
- Note – this is an incomplete listing

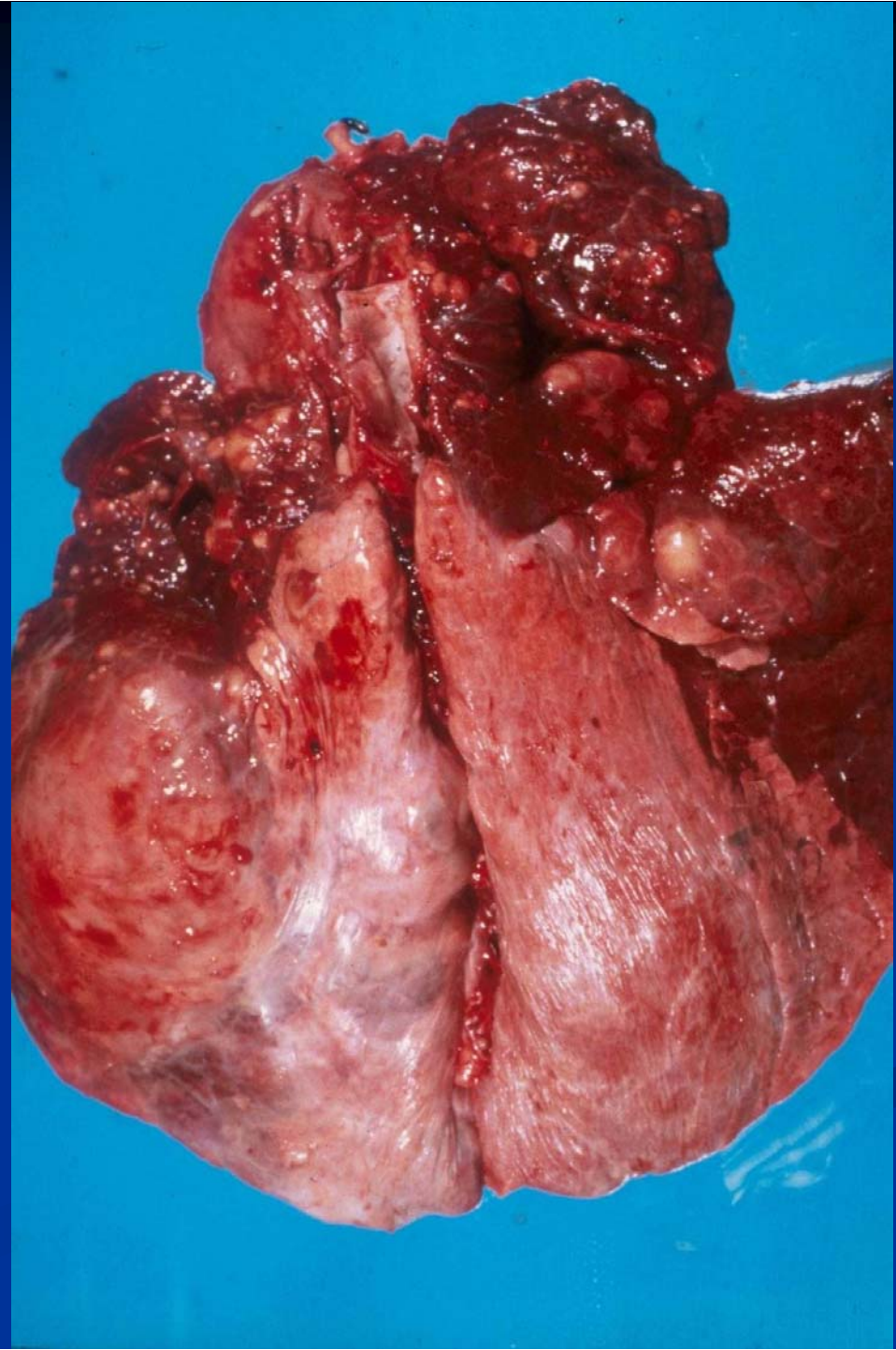
"Enzootic Pneumonia"

Predisposing factors

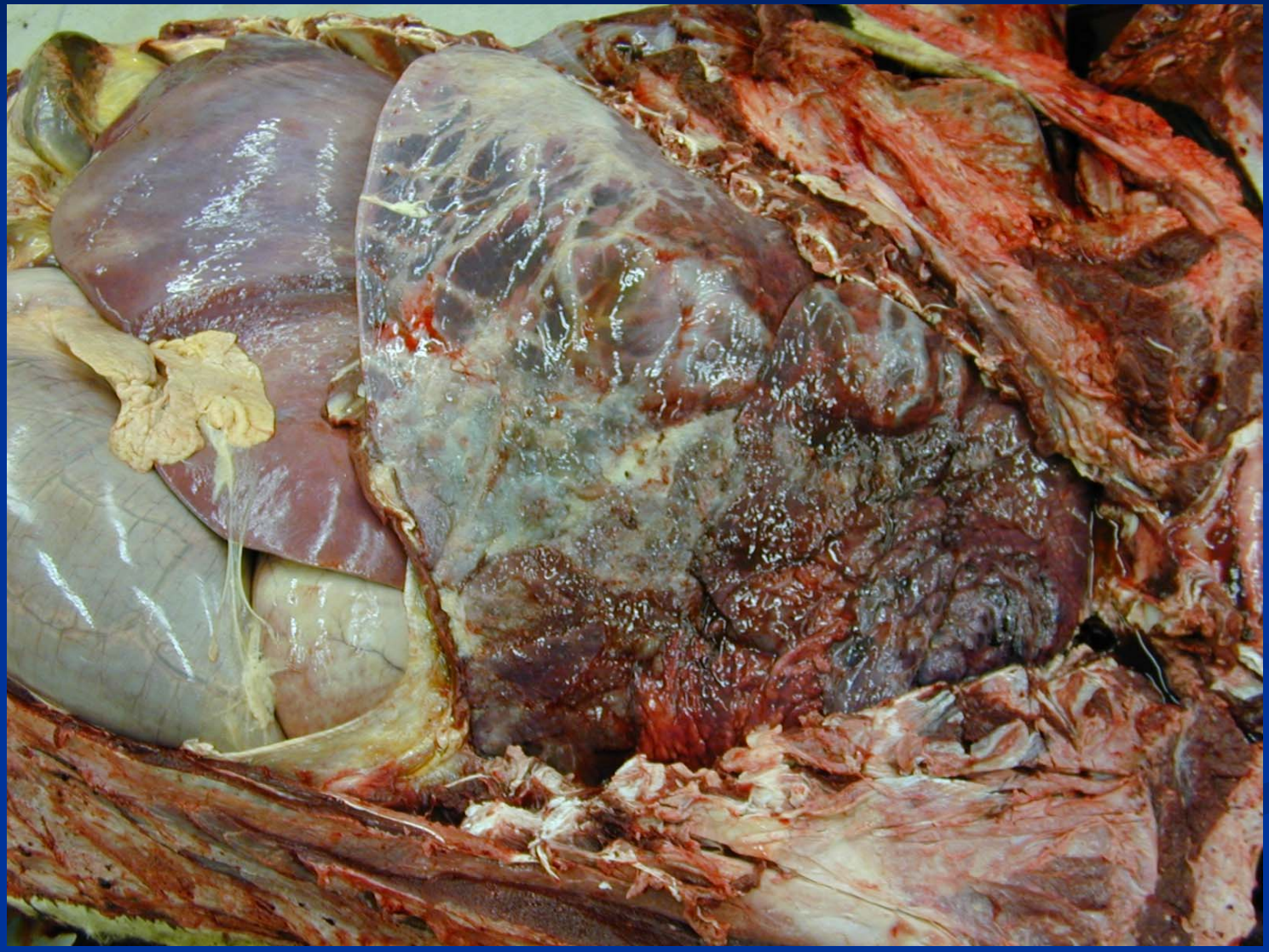
- Stress (temperature extremes, crowding)
- Viral infection (IBR, BRSV, BVD, PI-3 virus)
- Mycoplasmas (*M. bovis*), *Chlamydophila sp.*
- Bovine leucocyte adhesion deficiency (BLAD)

- Etiology (mixed)
  - *Mannheimia (Pasteurella) haemolytica*
  - *Pasteurella multocida (type A)*
  - *Histophilus somni (Hemophilus somnus)*
  - *Arcanobacterium (Actinomyces, Corynebacterium) pyogenes*
  - *E. coli*
- Acute or chronic forms
- Similar in lambs

“Enzootic Pneumonia”



Bronchopneumonia—*A. pyogenes*



Atelectasis - Sheep

Contagious Bovine Pleuropneumonia (CBPP)

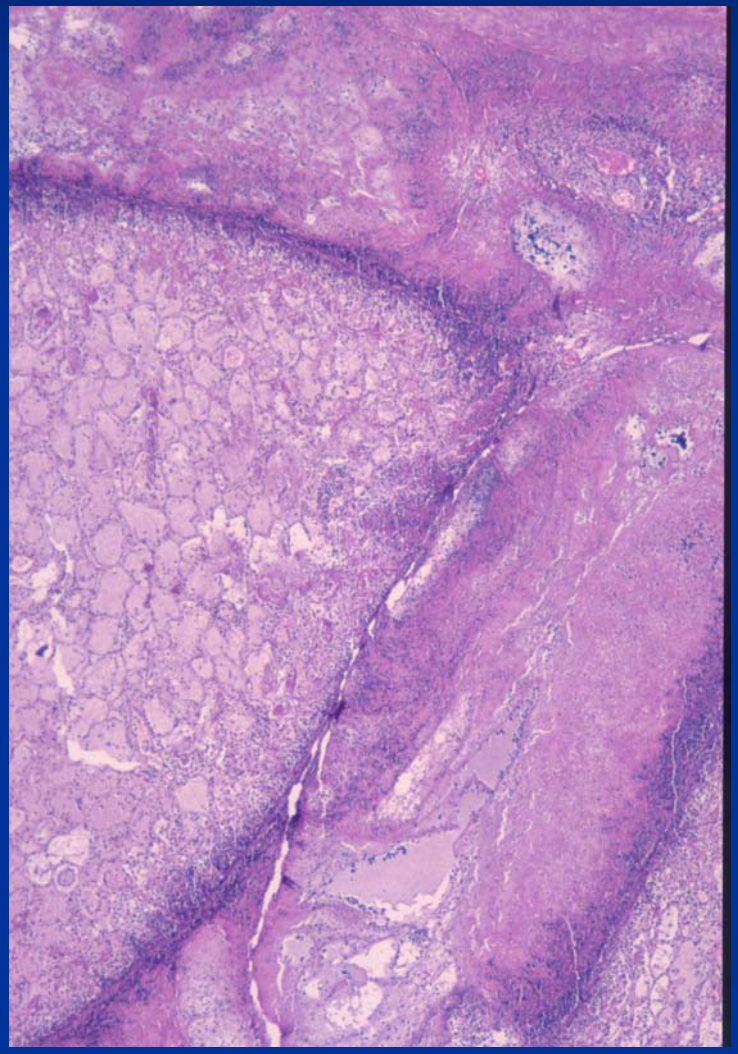
- Eradicated from Australia in 1970s, US in 1800s
- Enzootic in Africa, Asia and Eastern Europe
- Etiology
  - In cattle, *Mycoplasma mycoides* ssp. *mycoides* small colony type (note: large colony type isolated from goat pneumonias recently in Australia)
  - In goats, *Mycoplasma capricolum* ssp capripneumoniae

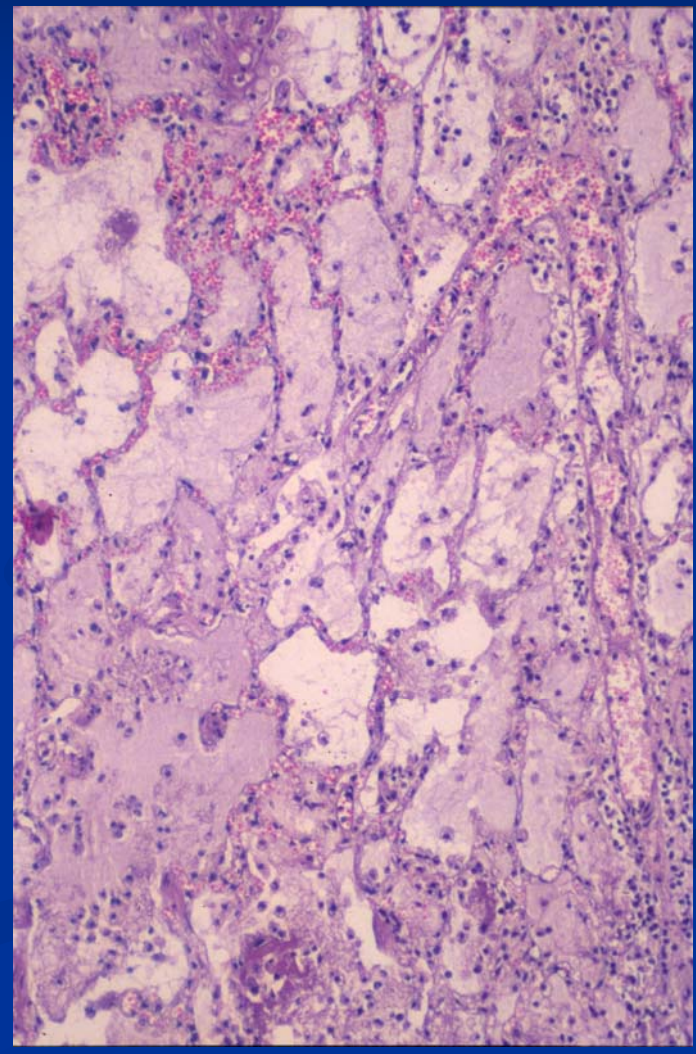
Contagious Bovine Pleuropneumonia

- Pathology
  - Extremely severe fibrinous bronchopneumonia/pleuritis (similar in nature to *M. hemolytica)*
  - Interlobular septa severely widened ("marbling") – edema and fibrin
  - Caudal lobes affected, not anteroventral distribution
  - Thrombosis and infarction
  - Sequestration prominent

  - NOTE: SEVERE EDEMA AND FIBRIN IN LUNG AND THORACIC CAVITY

Contagious Bovine Pleuropneumonia (CBPP)

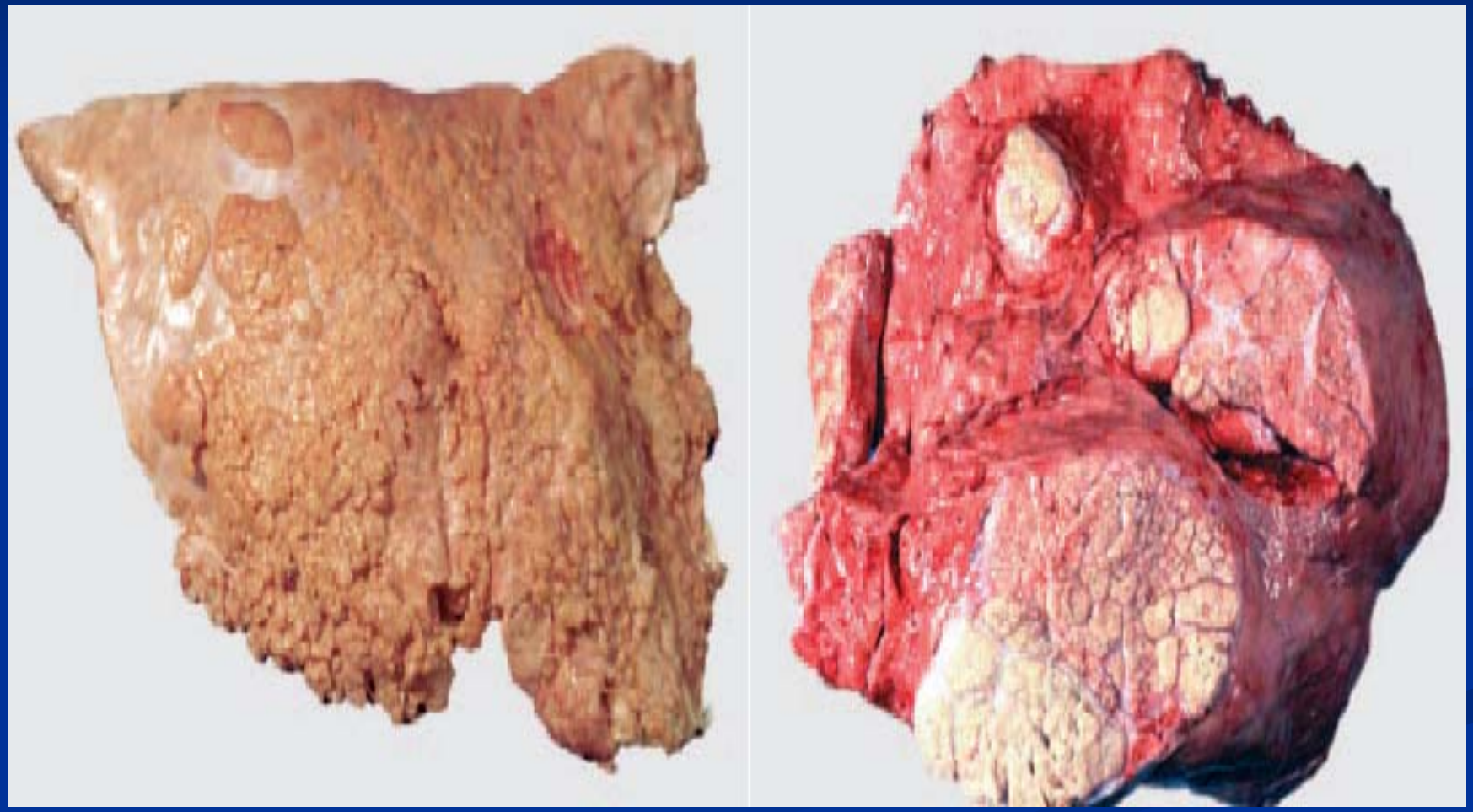




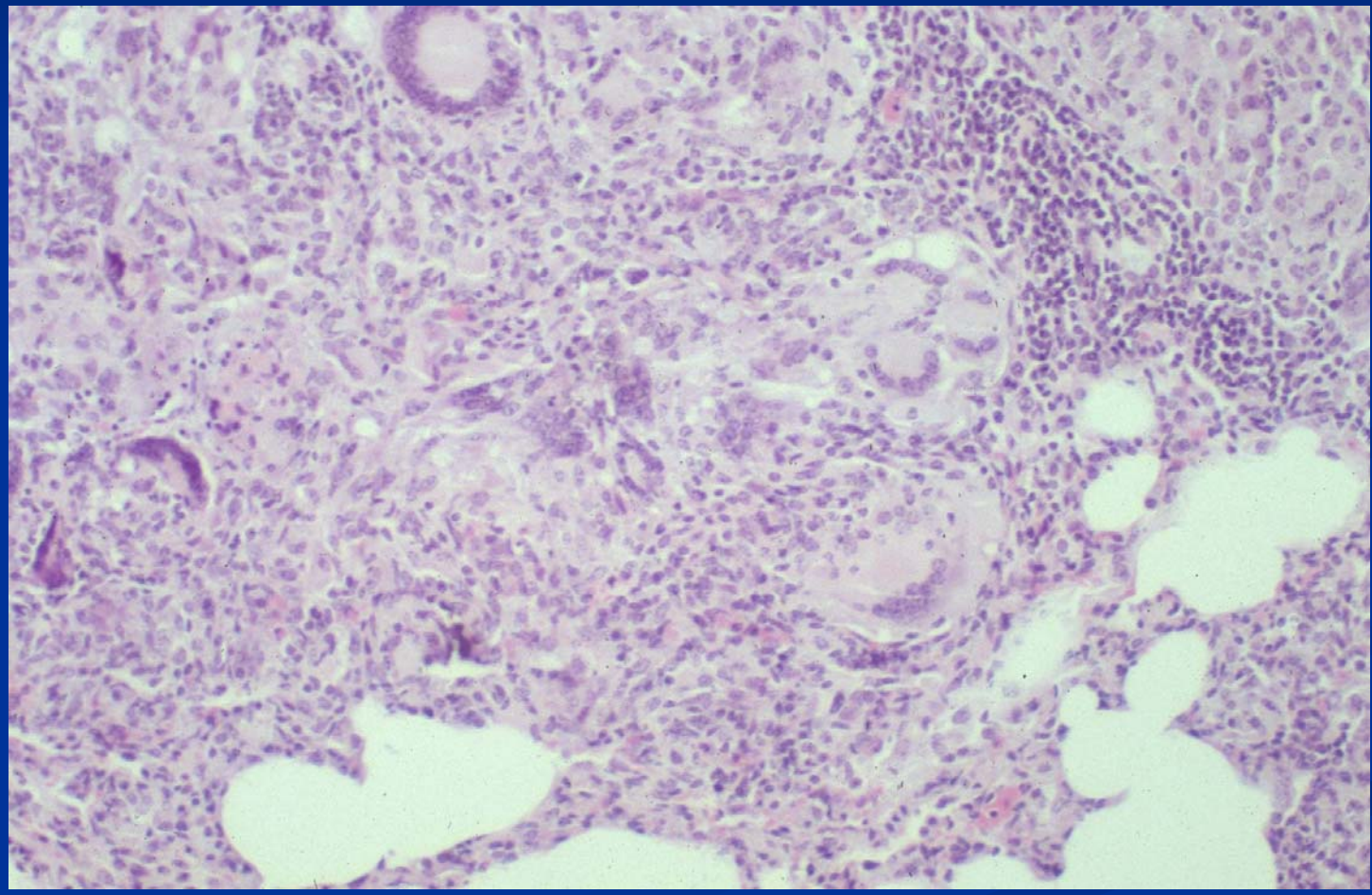
Mycobacterium sp Pneumonia

- Cattle – *M. bovis*
  - *M. bovis* eradicated from Australia
  - In US, *M. bovis* occurs sporadically – mainly transmitted from deer and occasionally from cattle south of the border.
  - Pulmonary granulomas
- *M. avium*
  - Occasionally in cattle, may see pulmonary granulomas
- Deer – both *M. bovis* and *M. avium*
  - Outbreaks in deer, especially in Michigan and adjacent states, related to feeding practices by hunters

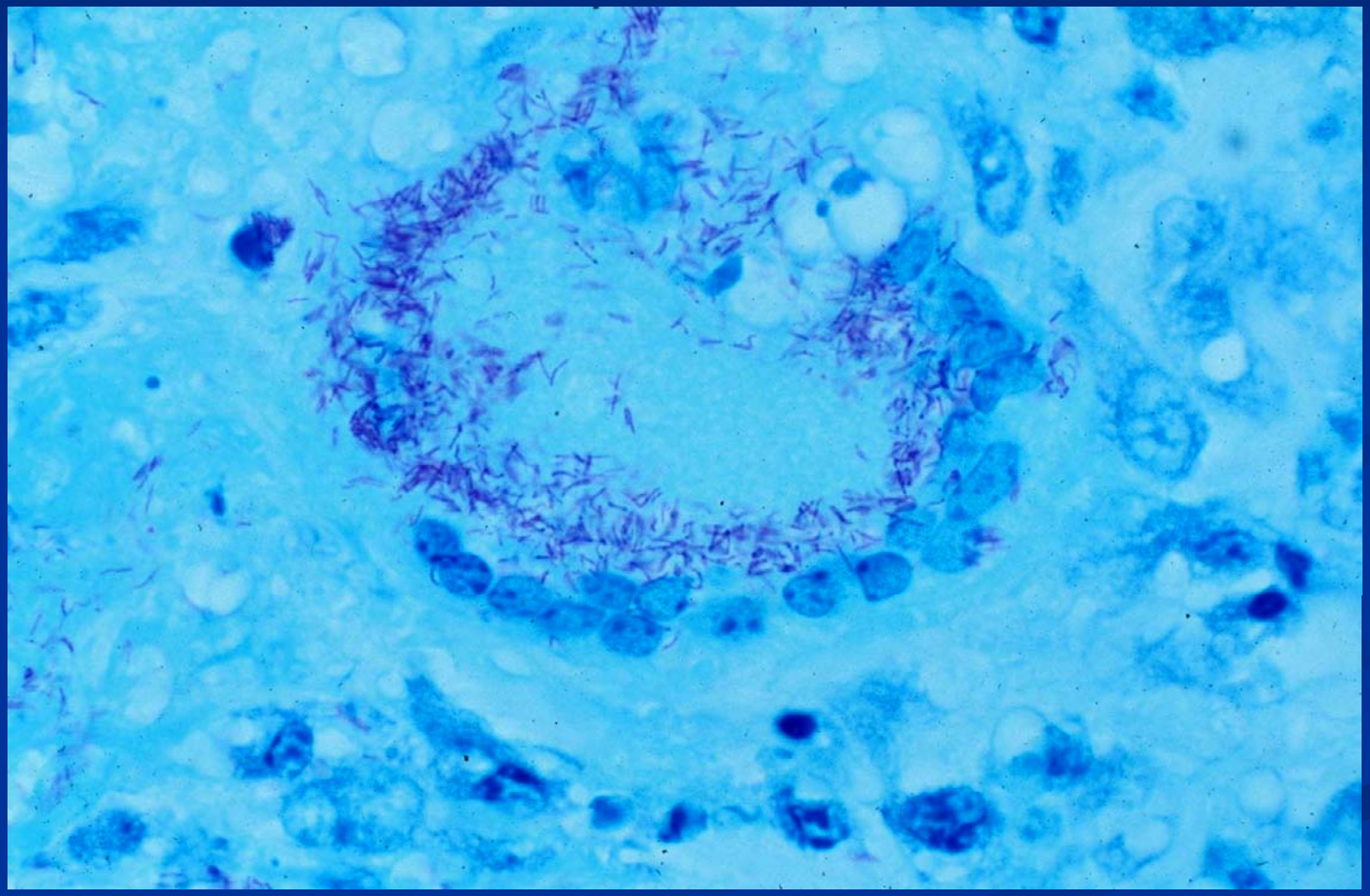
Mycobacterium sp. - Cow



Mycobacteriosis - Deer



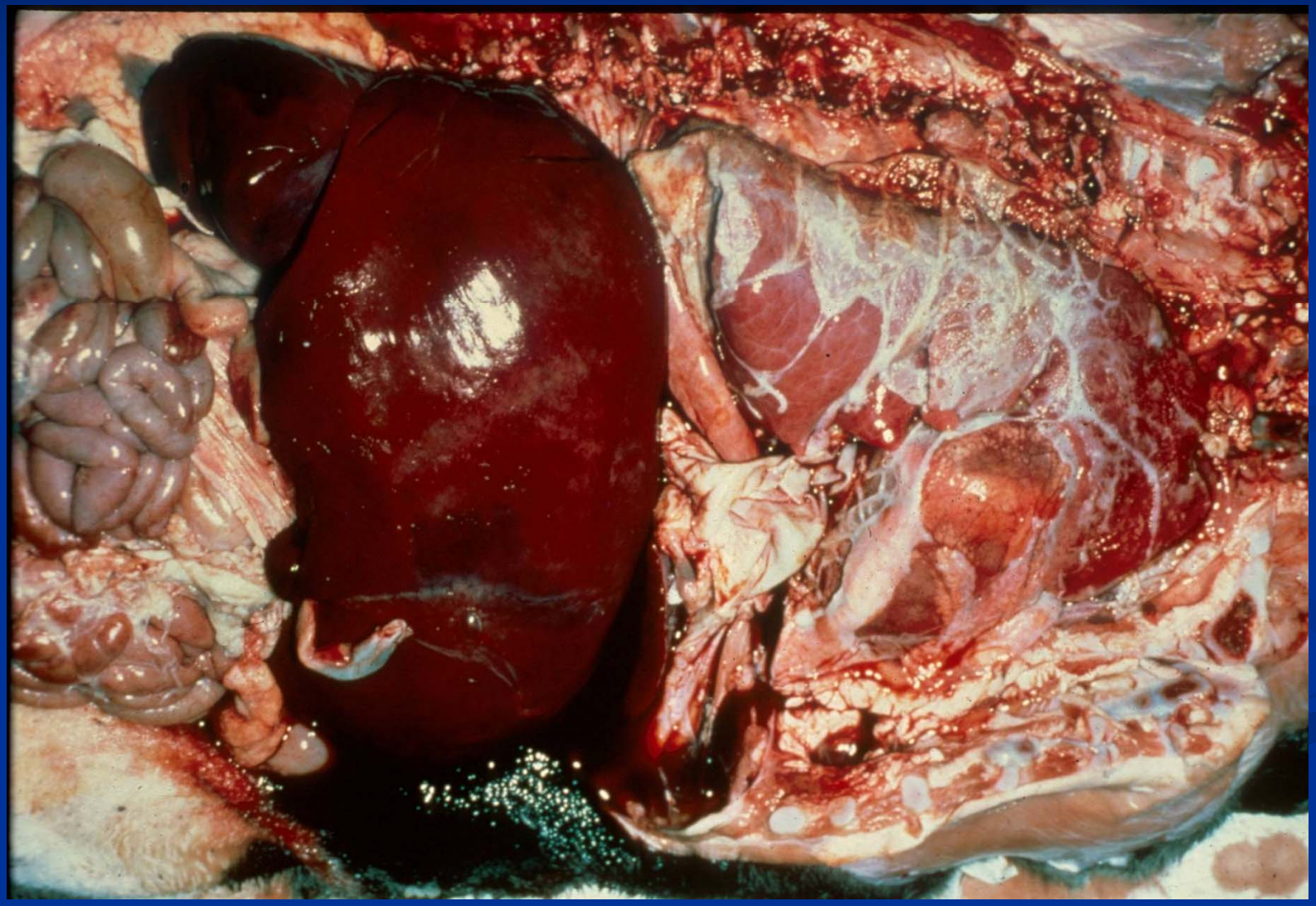
Mycobacteriosis (*M. avium*)- Deer (acid fast stain)



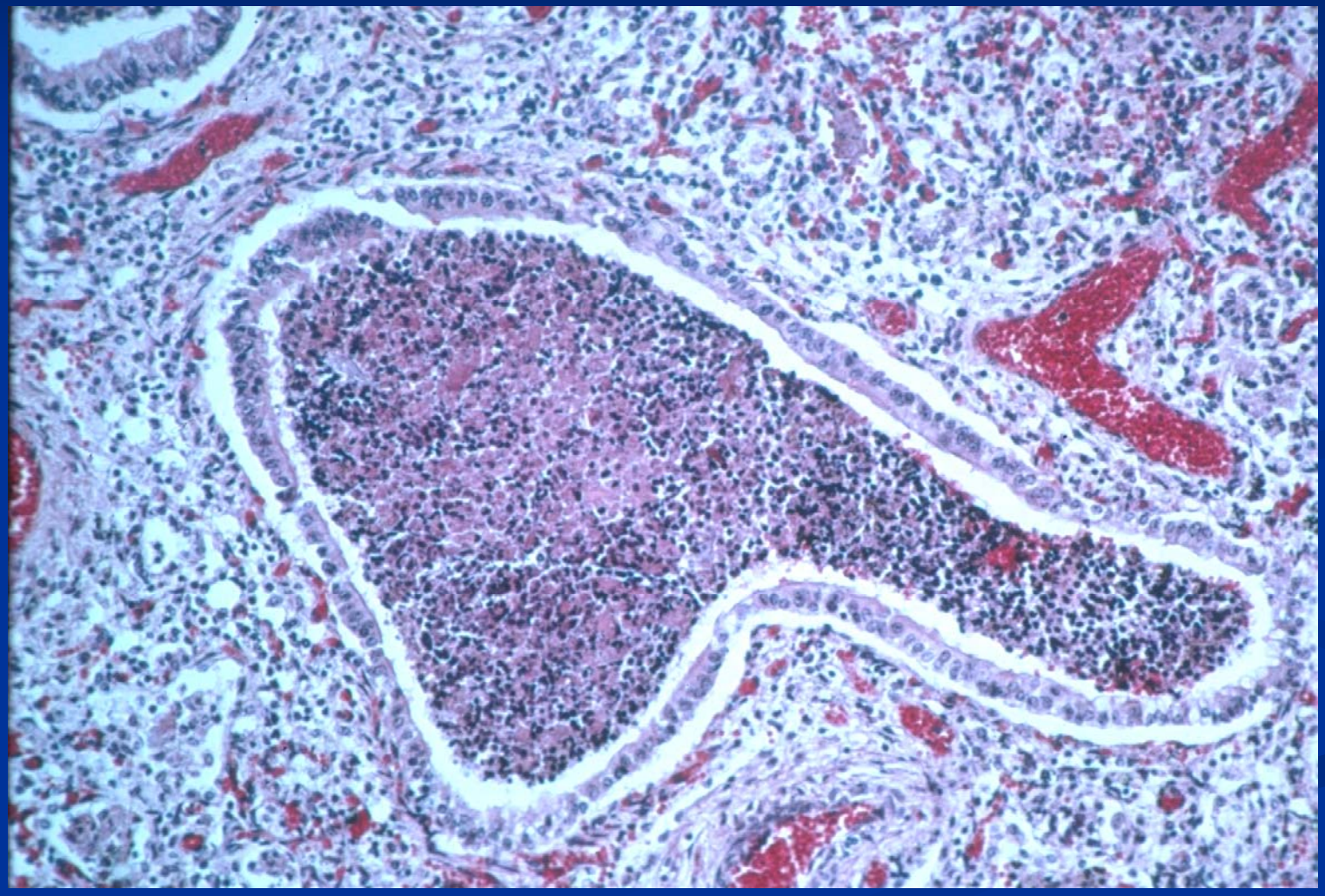
Brucellosis

- Brucellosis eradicated from Australia
- In US, reservoir in bison – occasionally "escapes" to cattle around national parks
- Affected cattle can abort and fetuses have a bronchopneumonia

Fetal Pneumonia - Brucellosis



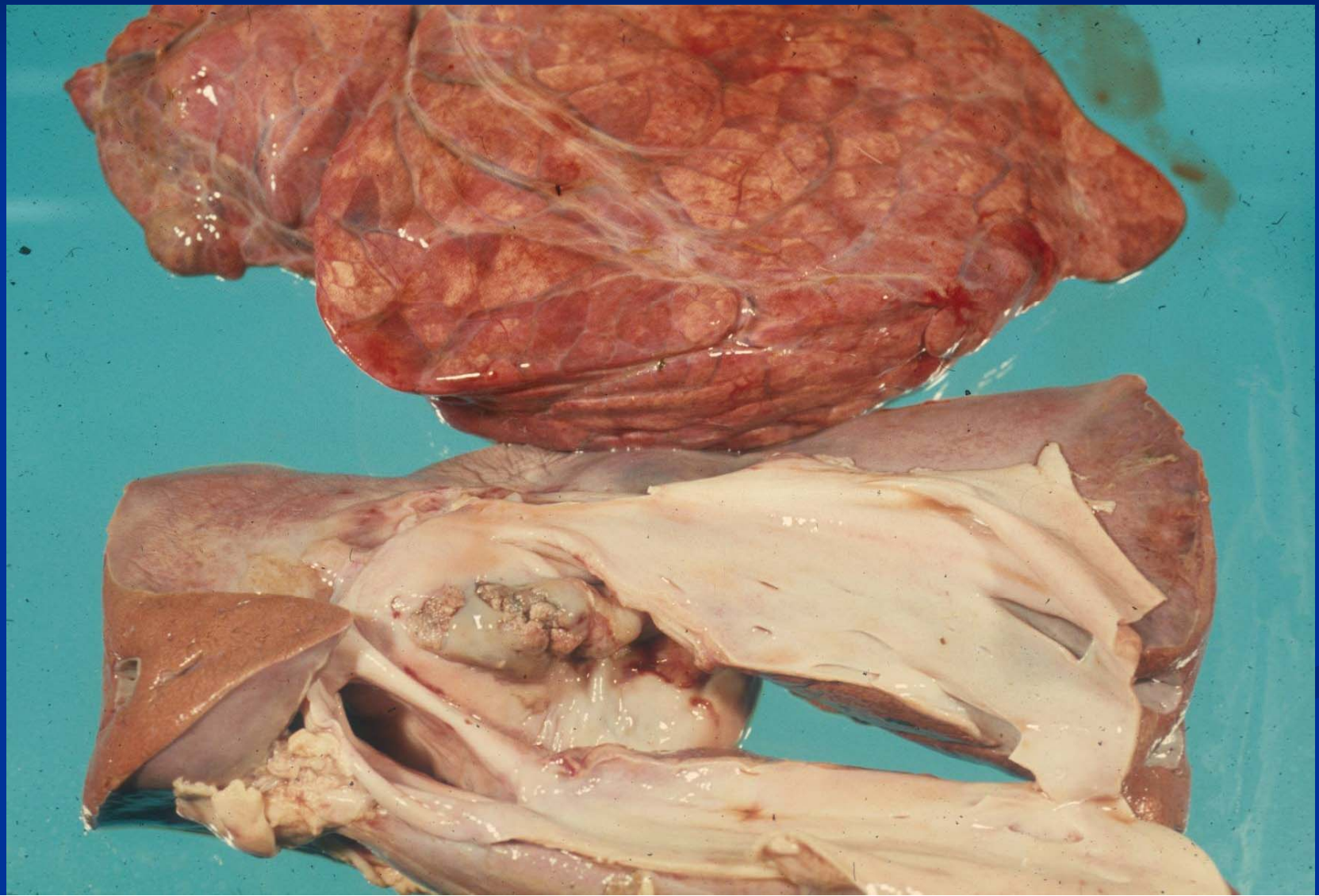
Fetal Pneumonia - Brucellosis



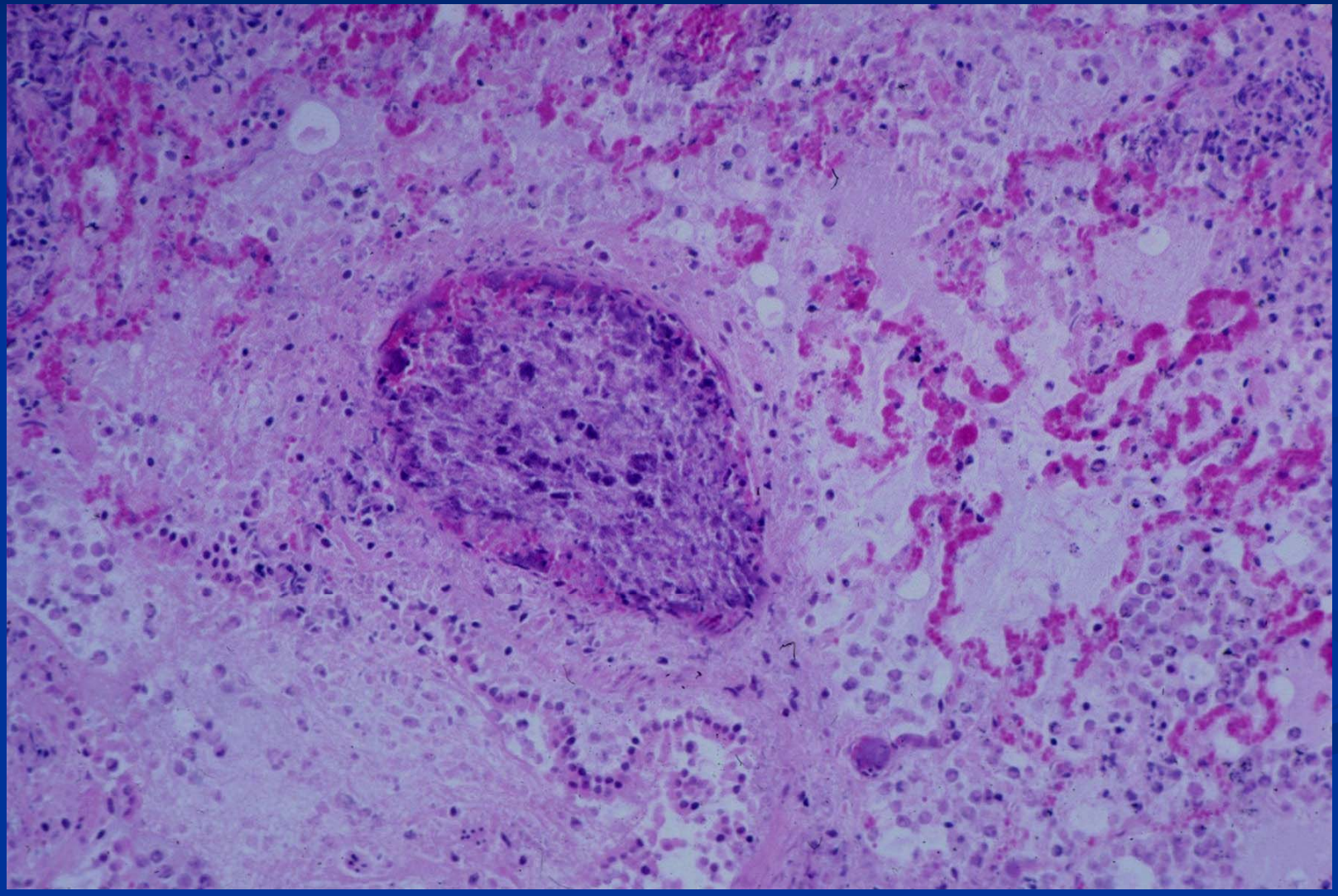
Embolic Pneumonia

- Etiology
  - Bacterial (abscesses)
    - Ruptured liver abscess
    - Hardware disease
    - Vegetative endocarditis
    - *C. pseudotuberulosis* in sheep
    - *B. holderia* (pseudoglanders) in sheep and goats
- Mycotic (granulomas)
  - Rumenal ulcers
  - Foreign body (iv injection)
- Sequella

Embolic Pneumonia – Ruptured Liver Abscess - Cow



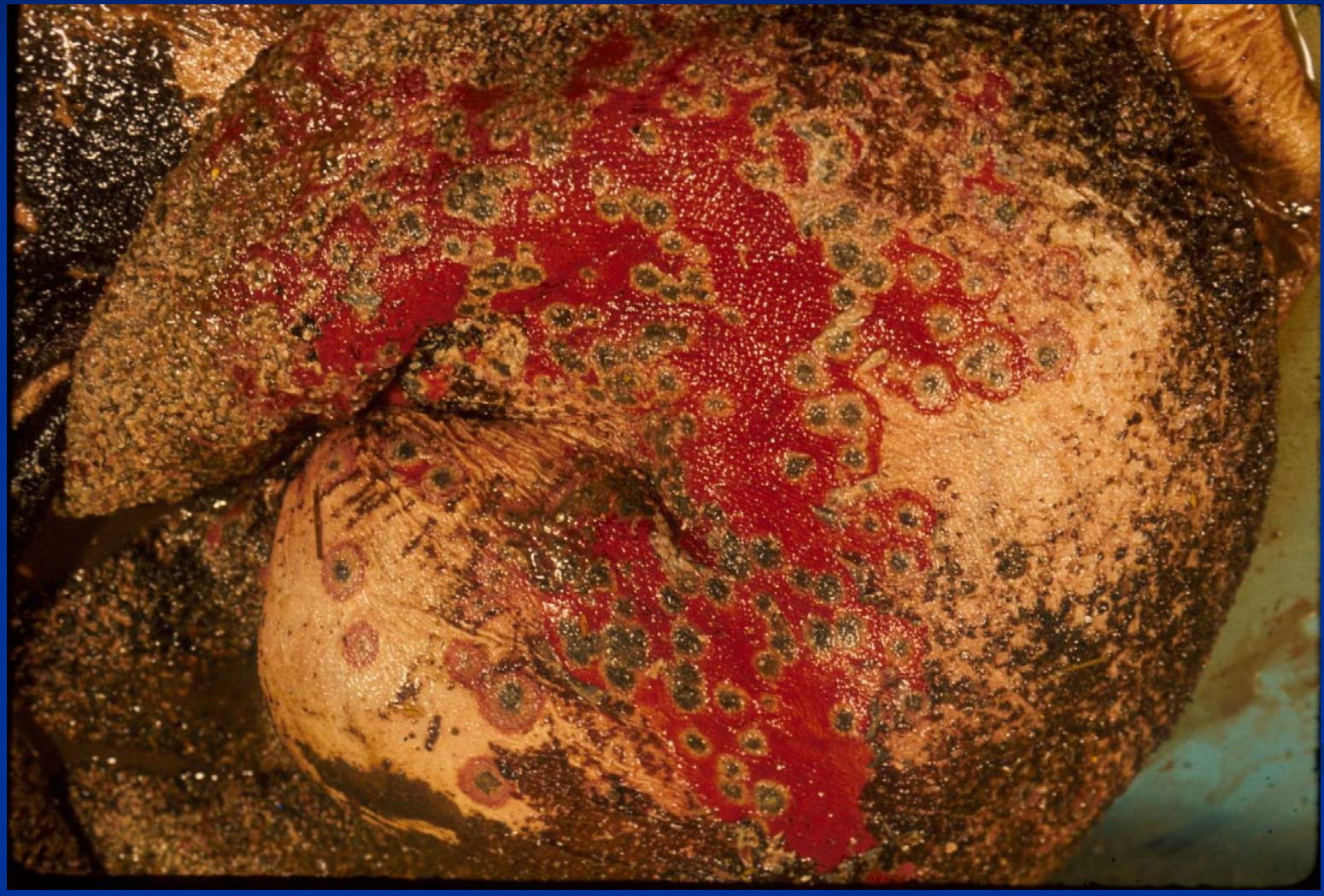
Embolic Pneumonia – Ruptured Liver Abscess - Deer



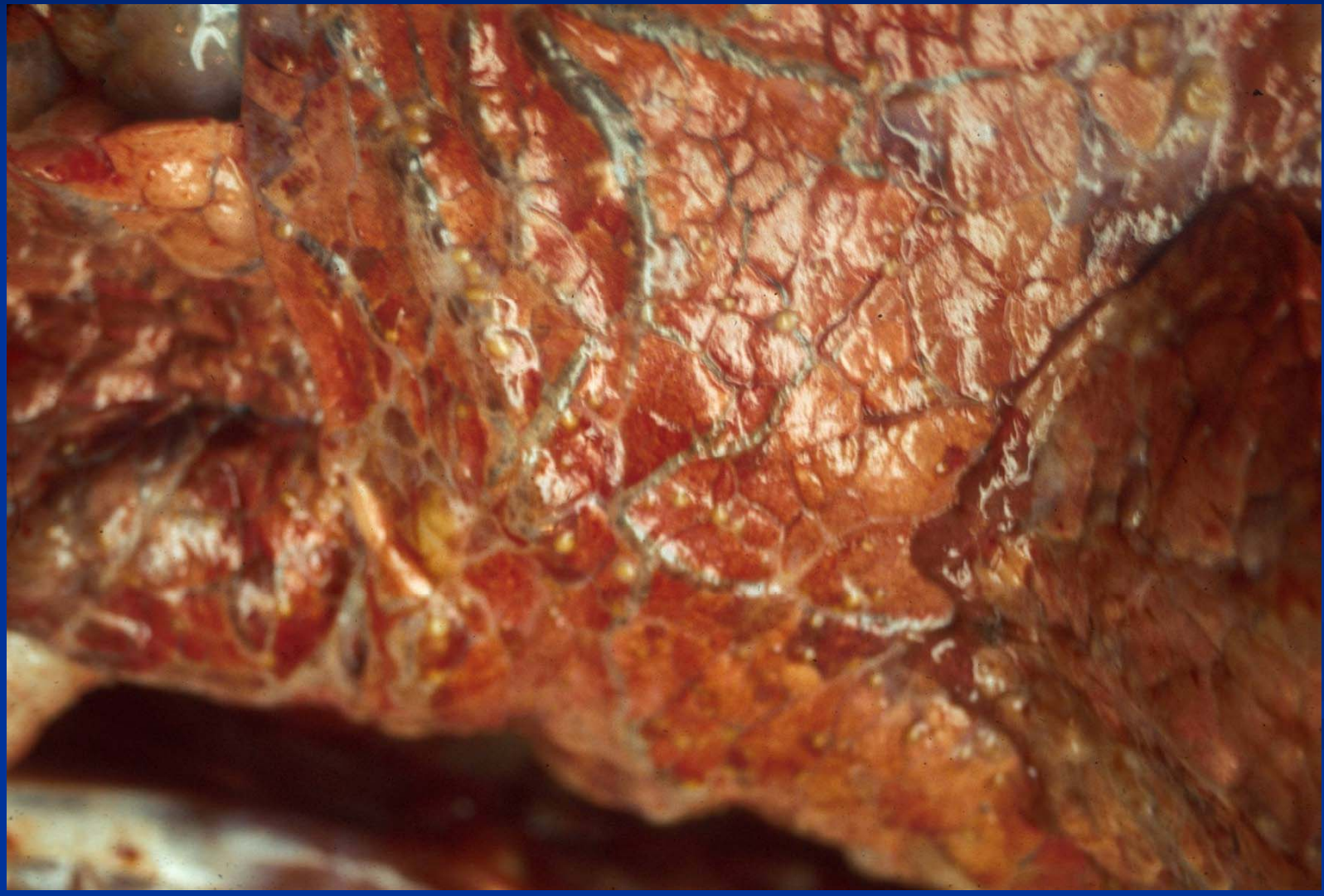
Mycotic Granulomas

- Pulmonary granulomas (embolic)
  - *Aspergillus spp.* most commonly
  - Usually rumenal ulcers allow invasion of blood vessels, may go to lung or to gravid uterus.

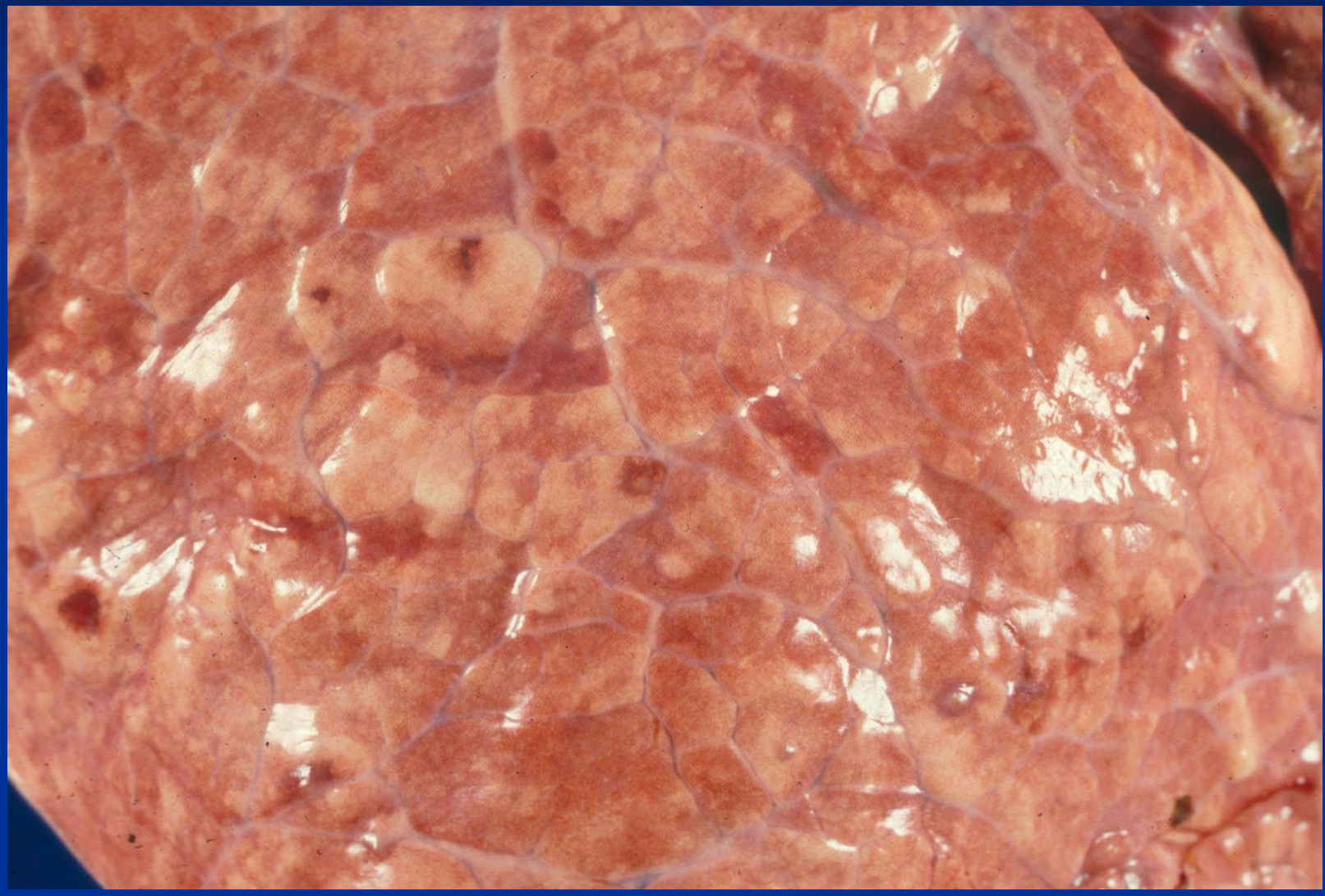
Rumen Ulcers - Cow



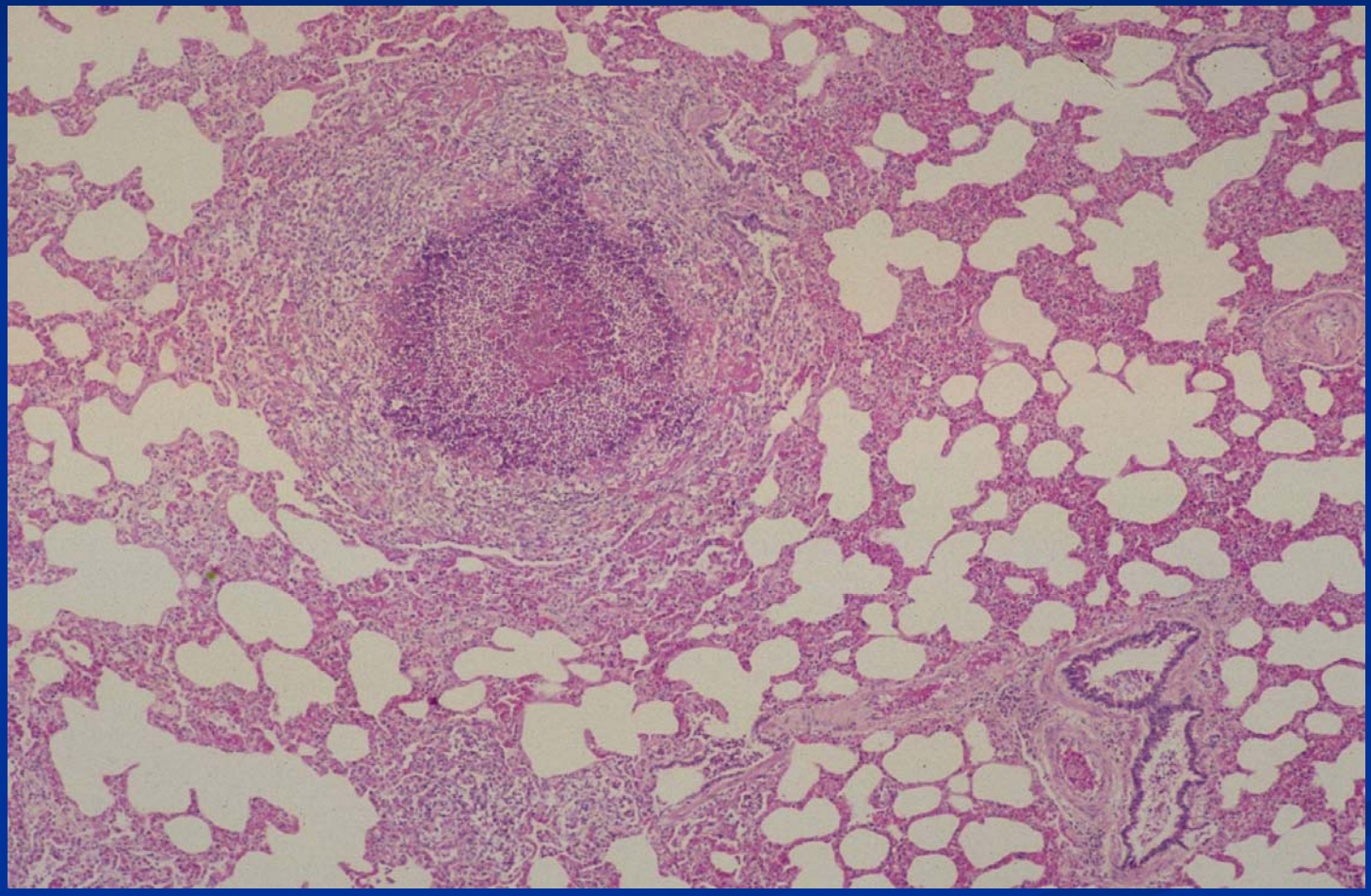
Embolic Pneumonia - Mycotic



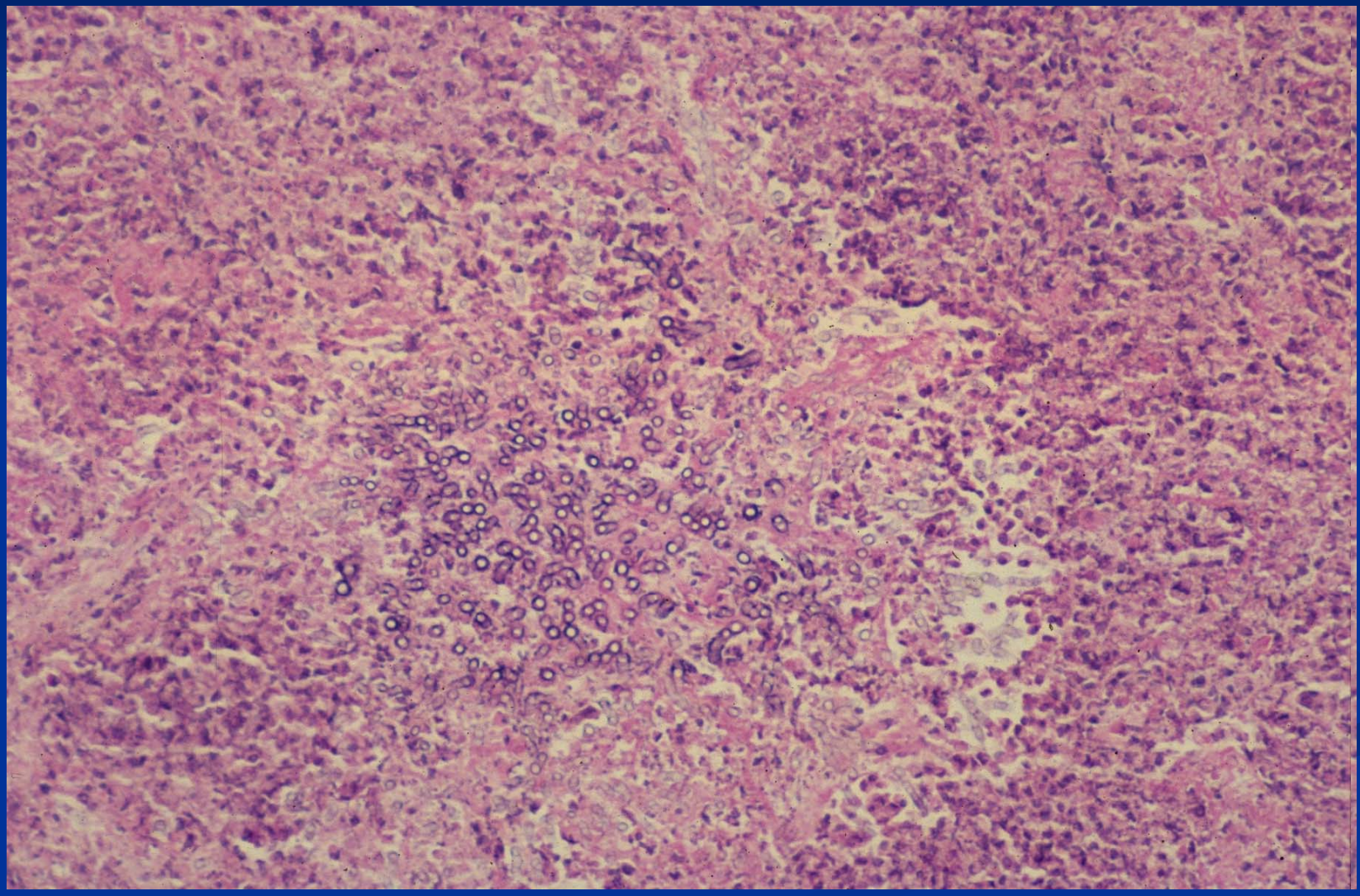
Mycotic Granulomas



Mycotic Granulomas



Mycotic Granulomas



Sheep - *Corynebacterium pseudotuberculosis* (Caseous Lymphadenitis - CLA) - Pulmonary Abscesses

Bovine Parasitic (Verminous) Pneumonia

- *Dictyocaulus viviparous* in cattle
  - Interstitial pneumonia (larval migration)
  - Bronchitis and airway obstruction (adults)
  - Multifocal atelectasis and emphysema
  - Granulomatous pneumonia (dead larvae, eggs)
  - Secondary bronchopneumonia
  - Hypersensitivity interstitial pneumonia on re-exposure ("reinfection syndrome")

Dictyacaulus viviparous (Verminous) Pneumonia

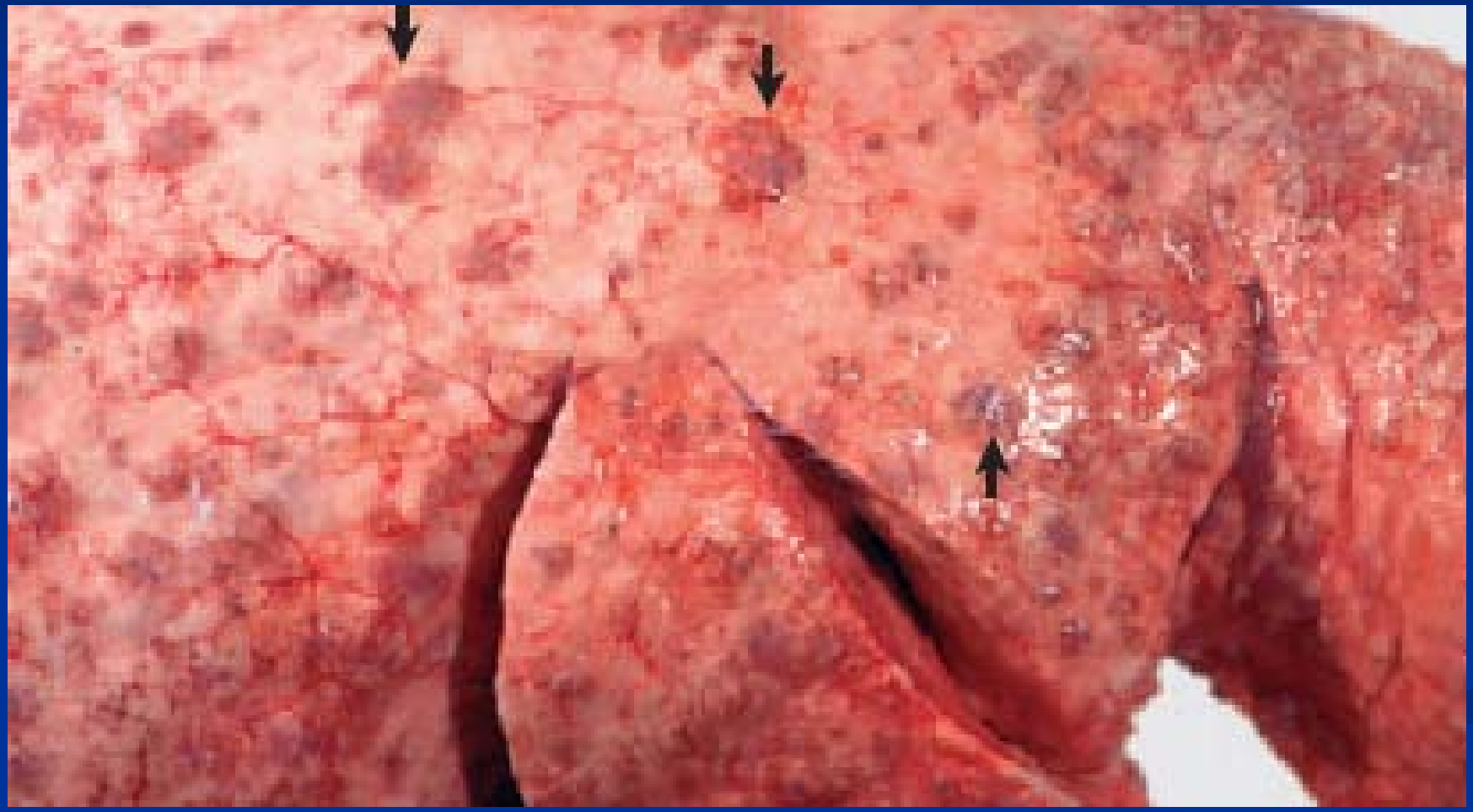
Bovine Parasitic (Verminous) Diseases

- *Echinococcus granulosus*
  - Hydatid cysts (lung, liver, etc)
  - Especially sheep
  - 5-15 cm diameter
  - Intermediate stage of canine tapeworm
  - Zoonosis

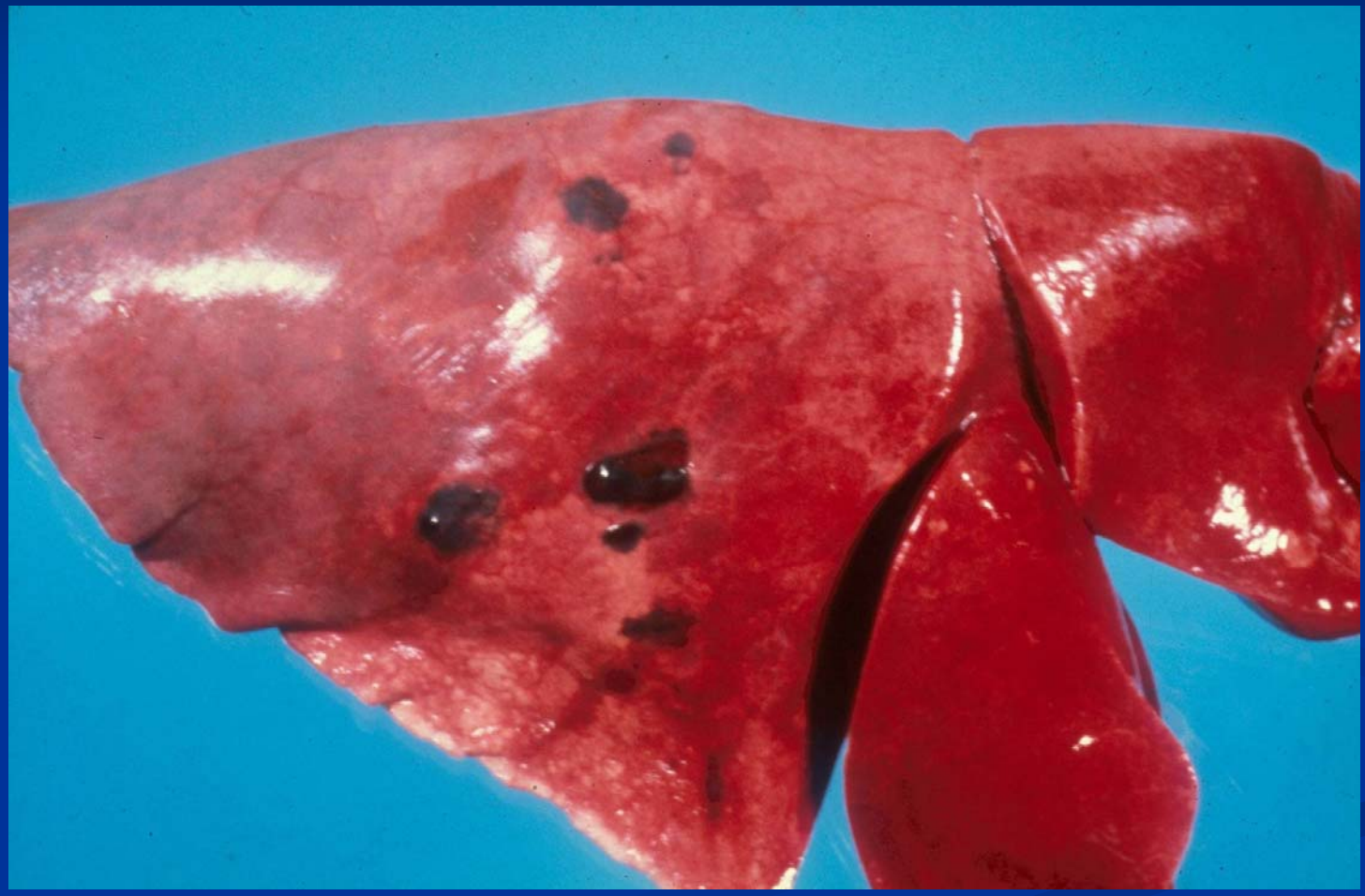
Parasitic (Verminous) Diseases in Sheep and Goats

- *Dictyocaulus filaria*
  - Mainly in lambs and kids, but also adults
  - Disease similar to that in bovids plus anemia
- *Muellerius capillaris* ("nodular lung worm")
  - Snails and slugs are intermediate hosts
  - Sheep: multifocal subpleural granulomas in caudal lobes
  - Goats: diffuse interstitial pneumonia
- *Protostrongylus rufescens*
  - Especially young
  - Adults live in airways
  - Nodules in lung

Muellerius spp - Sheep



Fasciola hepatica -
Fluke Migration in in Sheep



Bovine Respiratory Pathology

- **Noninfectious Pulmonary Disease**
  - Aspiration Pneumonia
  - Emphysema
  - Immune Mediated Interstitial Pneumonia
  - Toxic Interstitial Pneumonias

Aspiration Pneumonia

- Secondary to cleft palate, white muscle disease, force feeding in calves, lambs
- Medication
- Hypocalcemia
- Anesthesia – rumenal fluid
- Neurologic disease
- Amniotic fluid/meconium

Aspiration Pneumonia

- Lesion distribution: multifocal or locally extensive (e.g. anteroventral)
- Histopathology: suppurative/granulomatous to to gangrenous bronchopneumonia/abscesses/granulomas
- Look for plant material, lipid
- Look for meconium/squames in fetuses, neonates – can be diffuse lesion, may have syncytial cells

Aspiration Pneumonia – Calf

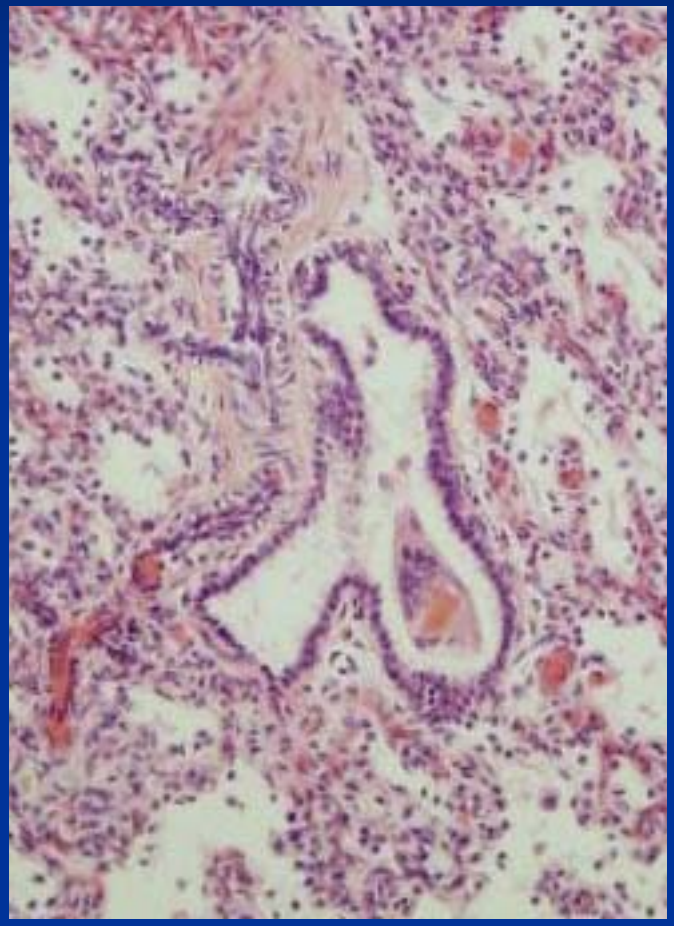
Multifocal, unilateral abscesses

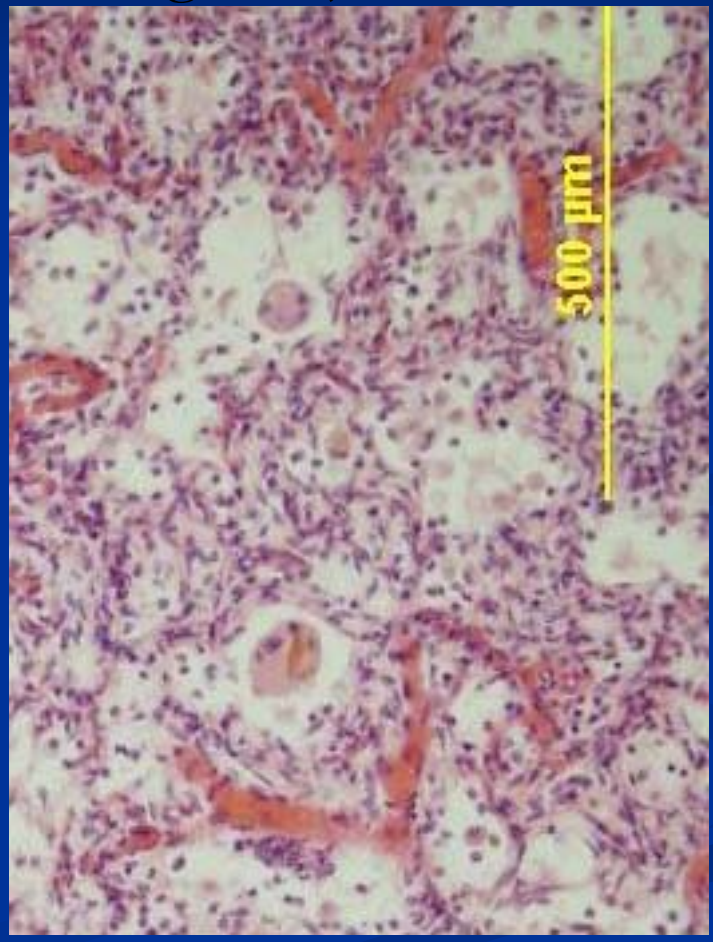
Aspiration Pneumonia

Rumen contents

Fetal Aspiration

Meconium with syncytial cells
(courtesy of Cor Lenghaus)

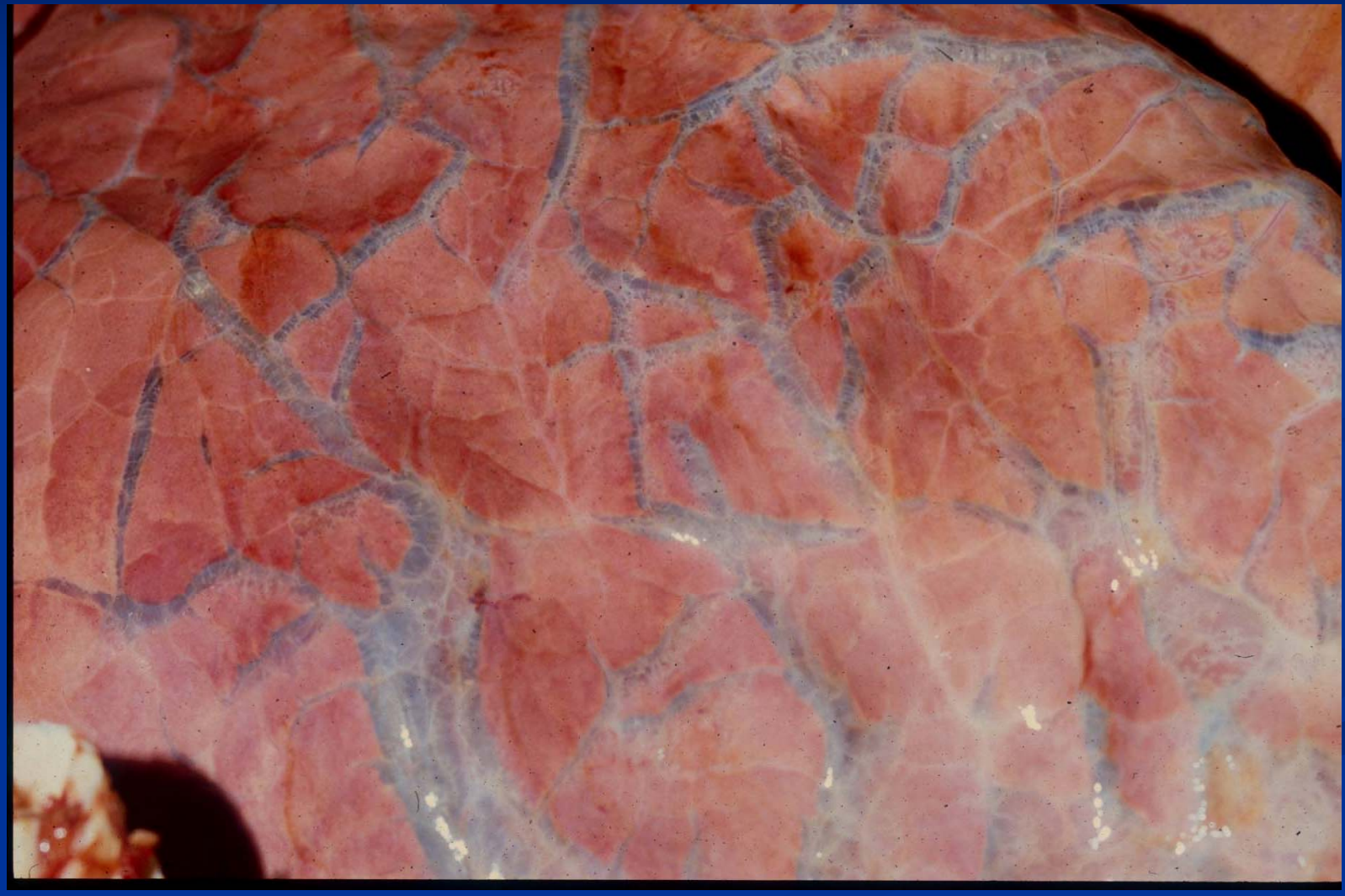




Interstitial Emphysema

- Air in interlobular septae and subpleurally, occasionally subcutaneous
- May extend into subcutaneous tissue
- Secondary to marked respiratory effort
- Generally terminal event
- Not a significant lesion

Interstitial Emphysema



Toxicant Induced Edema

- Damage to epithelium, endothelium
  - Inhalation – smoke, oxygen, ammonia
  - Blood borne – endotoxin, snake venom, paraquat, ANTU
- Anaphylaxis
- May be secondary to toxicant induced cardiac injury
- Differentiate from "dead ruminant lung" - autolysis

Anaphylaxis

- Type I hypersensitivity
- Etiology
  - Iatrogenic: antibiotic injection, vaccination
  - Ruptured liver abscess
  - Milk allergy – sensitization to own casein
- Pathology
  - Pulmonary edema with eosinophils
  - Airway constriction

Pulmonary Edema: Anaphylaxis

Etiology of NonInfectious Interstitial Pneumonias

- Inhaled Toxicants
  - Smoke – thermal and chemical injury
  - Organic dusts (hypersensitivity reaction)
  - Manure "pit" gases – H_2S, NH_3
  - NO_2 from silos
- Ingested Toxicants
  - Plant toxins
- Feed lot interstitial pneumonia – cause unknown

Hypersensitivity Pneumonia (extrinsic allergic alveolitis)

- Sporadic disease
- "Farmer's lung" in humans
- Affects housed adult dairy cows
- Type III hypersensitivity to inhaled organic antigens
- Fungal spores of *Saccharopolyspora rectivirgula (Micropolyspora faeni)* in moldy hay

Hypersensitivity Pneumonia (extrinsic allergic alveolitis)

- Disease - acute or chronic
- Clinical signs - dry cough, dyspnea, fever
- Gross pathology:
  - Mild – multifocal subpleural granulomas
  - Severe - AV to diffuse consolidation, emphysema
- Histopatholgy – proliferation alveolar epithelial cells, lymphocytic infiltrate, fibrosis

Parasitic Hypersensitivity

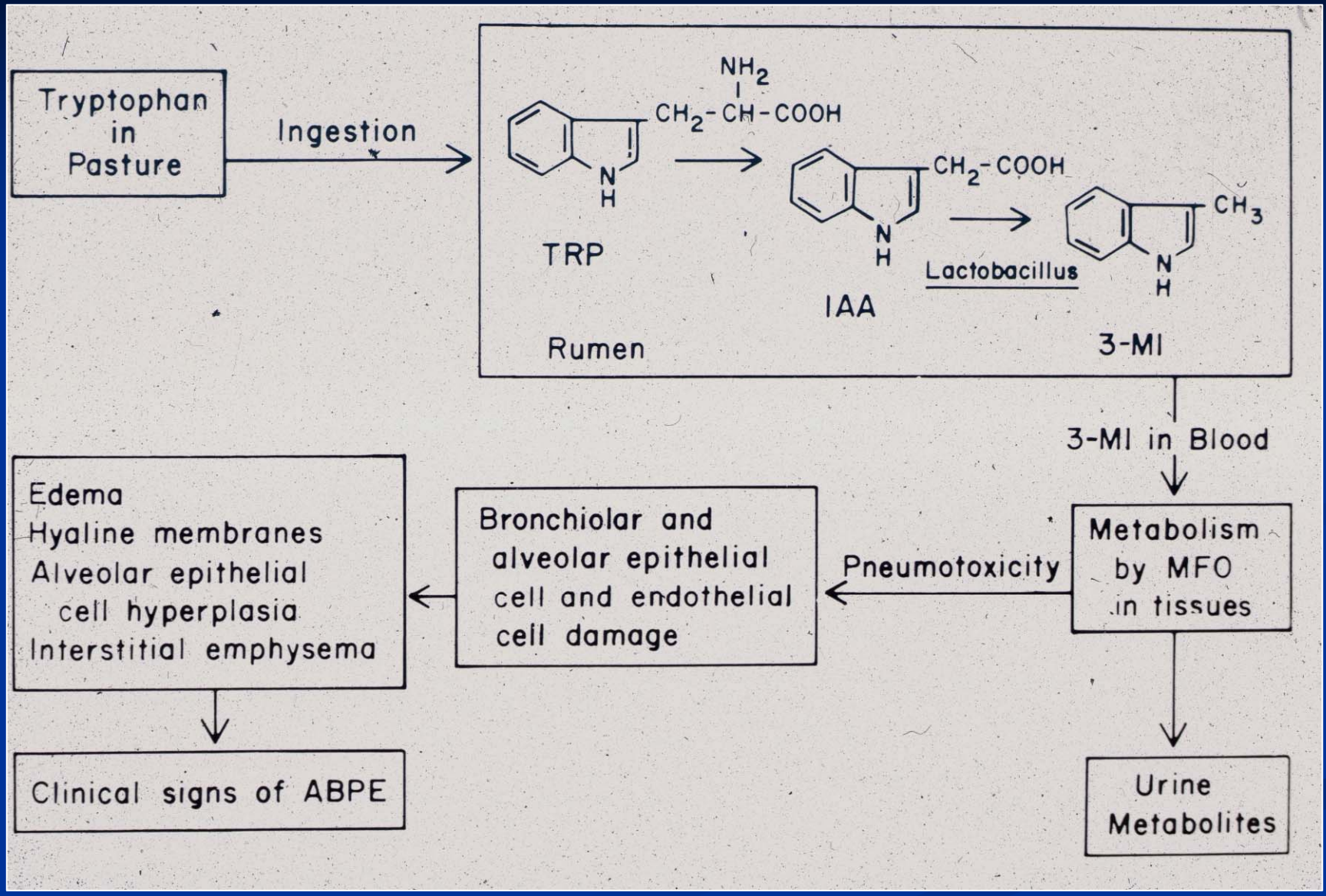
- Parasitic infection
  - *Dictyocaulus vivaparous* – "reinfection syndrome"
  - *Ascaris suis????*
  - *D. filariae* – sheep - levamisole treatment

Etiology of Interstitial Pneumonias: Ingested Toxicants

- L tryptophan, 3-methylindole
- 4-ipomeanol, moldy sweet potatoes – *Fusarium solani* – outbreaks reported in New Zealand
- Purple mint -*Perilla frutescens* ketone
- Stinkwood – *Zieria arborescens*
- Rapeseed, kale, canola reshoots (glucoscintilates)– *Brassica* spp.

Acute Bovine Pulmonary Edema/ Emphysema (ABPE) – Fog Fever

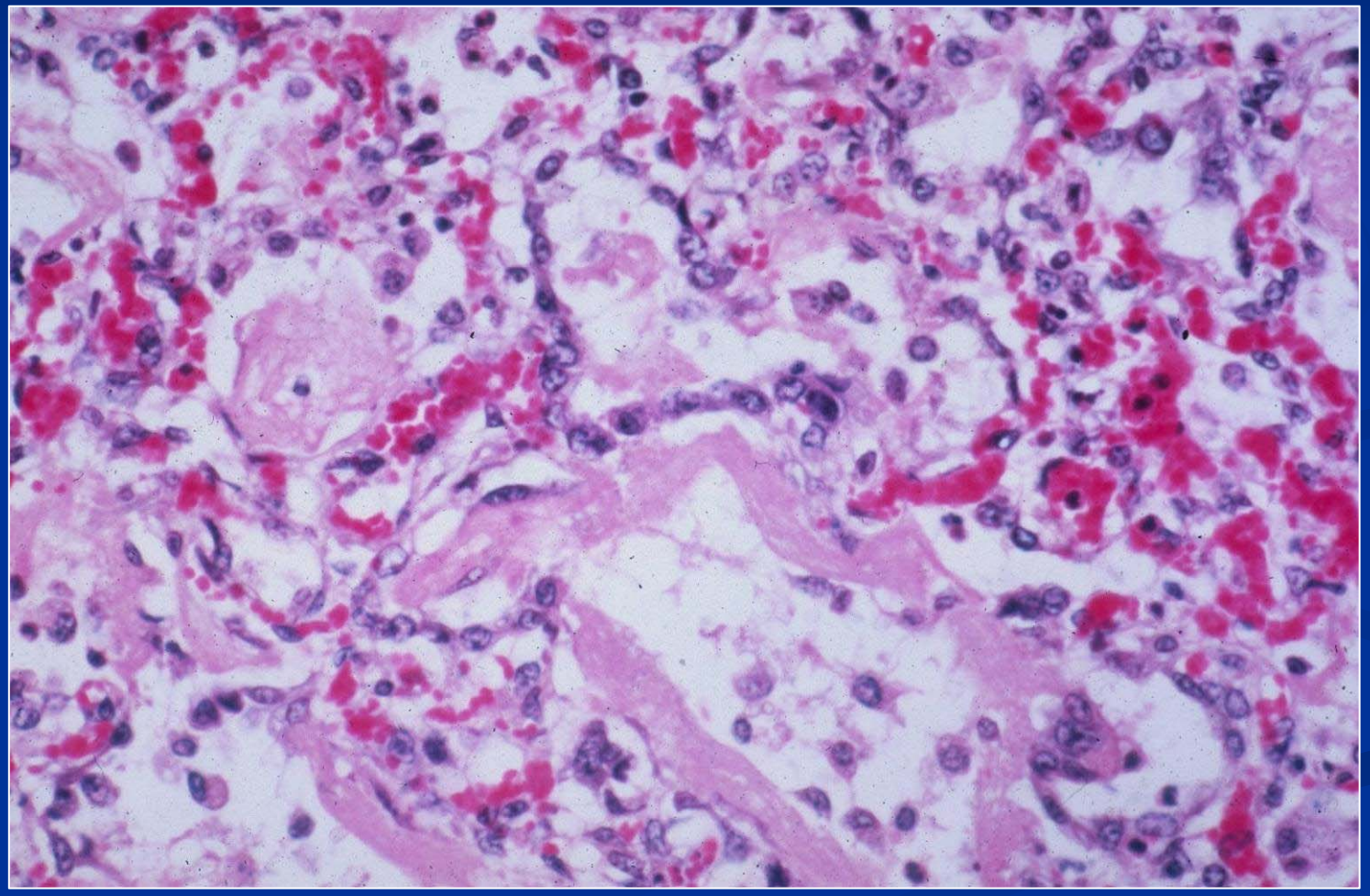
- Occurrence
  - UK, Europe, USA, Australia
  - Fall
  - Adult cattle >2 years old
  - Abrupt change to lush pasture (within 2 wks)
  - In Australia, where autumn growth largely grass rather than clover
  - Goats/sheep are susceptible experimentally


Tryptophan in Pasture
Ingestion
TRP
IAA
Lactobacillus
3-MI
Rumen
3-MI in Blood
Metabolism by MFO in tissues
Pneumotoxicity
Bronchiolar and alveolar epithelial cell and endothelial cell damage
Edema
Hyaline membranes
Alveolar epithelial cell hyperplasia
Interstitial emphysema
Clinical signs of ABPE
Urine Metabolites

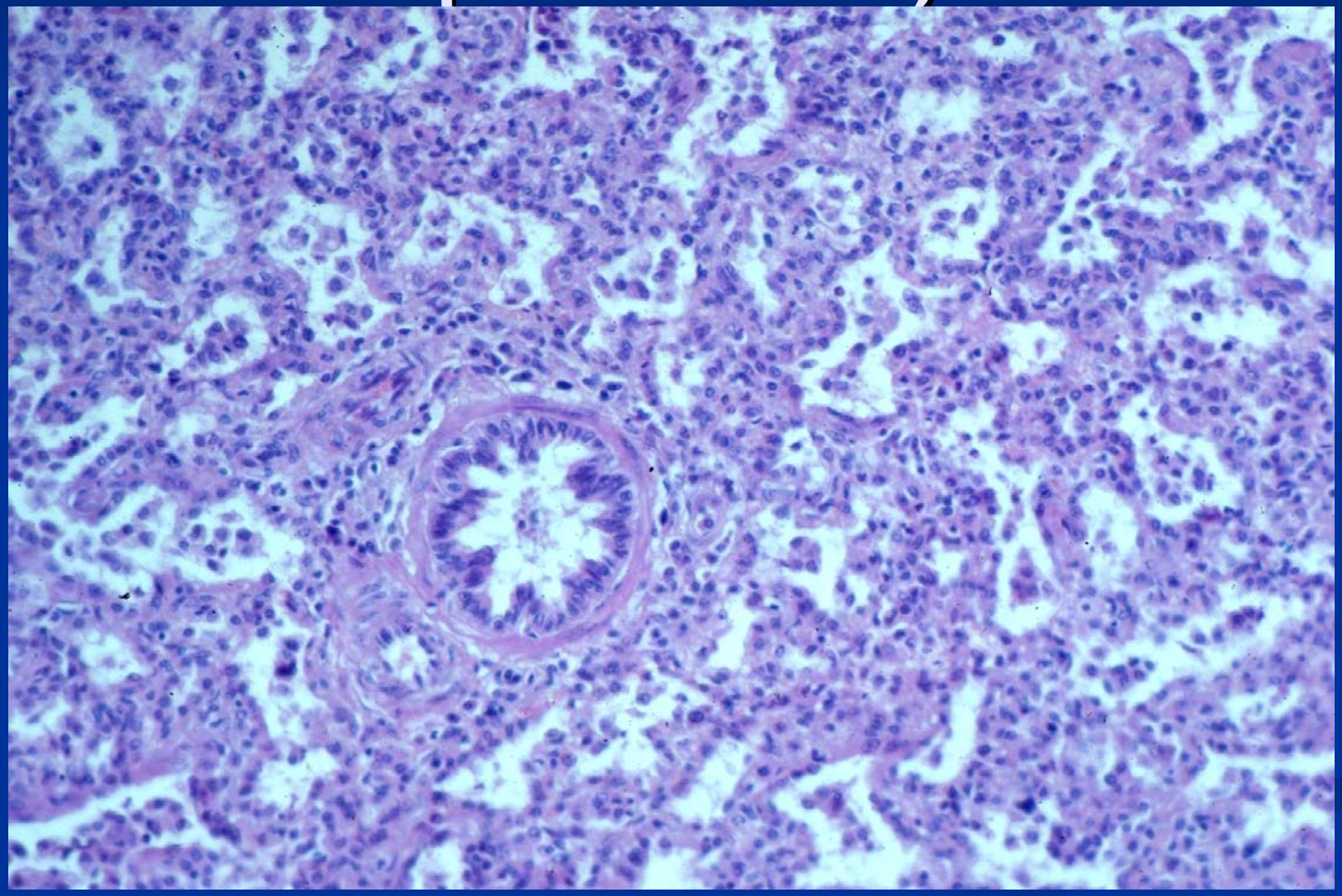
Acute Bovine Pulmonary Edema/ Emphysema (ABPE) – Fog Fever

- Gross lesion
  - Lungs do not collapse, heavy, wet, emphysema
- Histopathology: interstitial pneumonia
  - Hyaline membranes
  - Prominent type II cell hyperplasia
- Sequella
  - Interstitial fibrosis
  - May see bronchiolitis obliterans

Acute to Subacute Interstitial Pneumonia



Subacute to Chronic Interstitial Pneumonia ("proliferative" pneumonia)



Acute to Subacute Interstitial Pneumonia (type II cell proliferation)