Respiratory
Slide 1

Ethmoidal hematoma

9-12
Ethmoidal hematoma

Ethmoid hematoma
Older horses
Chronic progressive unilateral nasal bleeding
Gross appearance
Single, soft, tumorlike, pedunculated, expanse, dark red mass
Arises from the mucosa of the ethmoid conchae
Microscopic appearance
Epithelial lined capsule
Hemorrhagic stromal tissue
Macrophage infiltration
Siderophages
9-13
Suppurative rhinitis
Arrow- Large round ulcer in mucosa of the nasopharynx

Inflammation of the nasal cavity

Serous Rhinitis
Hyperemia
Increased serous gland production (nasal submucousa)
Catarrhal Rhinitis
Increased serous and mucous secretions
Microscopic
Goblet cell hyperplasia
Neutrophilic exudate
Suppurative rhinitis
Neutrophilic exudate
Mucosal necrosis, secondary bacterial infection
Nasal passages completely blocked
Microscopically
Neutrophils in mucosa and submucosa
Form plaques of exudate on the mucosal surface
Neutrophils commonly found attached to the vessels and between epithelial cells
Fibrinous Rhinitis
Increased vascular permeability
Exudates fibrinogen
Pseudomembrane
Intact mucous membrane with fibrin
Pseudodiphtheritic
Ulcerated mucous membrane
Diphtheritis
Fibrinonecrotic rhinitis
Aspergillosis
Granulomatous rhinitis
Infiltration of numerous activated macrophages
Mixed with lymphocytes and plasma cells
Associated with chronic allergic reactions, or systemic fungi, tuberculosis, rhinosporidium and foreign bodies
May lead to bronchopneumonia
Deformation of nasal turbinates
Osteomyelitis
Fibrinous rhinitis
IBR (BHV-1)
The nasal mucosa is covered by diphtheritic membrane

Fibrinous rhinitis
Nasal injury causes severe increase in vascular permeability
Abundant exudation of fibrinogen
Grossly
Fibrin- yellow, tan, gray, rubbery, mat on the mucosa
Film of fibrin is pseudomembrane
Pseudodiphtheritic rhinitis
Psudomembrane over intact mucosa
Diphtheritis or fibrinonecrotic rhinitis
Pseudomembrane over ulcerated mucosa, hard to remove
Microscopically
Perivascular edema with fibrin
Neutrophils in the mucosa
Superficial plaques of exudate consisting of fibrin with leukocytes and cellular debris
Ulcerated mucosa
Granulomatous rhinitis
Rhinosporidium seeberi

Granulomatous Rhinitis
Infiltrates of numerous activated macrophages
Few lymphocytes and plasma cells
Some cases form polypoid nodules that obstruct the nasal passage
Chronic allergic
Systemic mycoses
Tuberculosis
Rhinosporidiosis
Foreign Bodies
Adverse sequelae
Bronchoaspiration
Bronchopneumonia
Destruction of turbinates
Deviation of the nasal septum
Craniofacial deformation

Extension into sinuses → sinusitis

→ osteomyelitis

→ through cribiform plate → meningitis

→ otitis media and interna, and vestibular syndrome
Fibrinonecrotic sinusitis
Aspergillosis
Chronic granulomatous inflammation

9-16
Fibrinonecrotic sinusitis
Aspergillosis
Chronic granulomatous inflammation

Sinusitis
Sequela of rhinitis
Penetrating wounds
Dehorning
Frontal sinus
Tooth root abscess
Maxillary sinus
Paranasal sinuses have poor drainage
Exudate accumulates
Mucocoele
Accumulation of pus
Empyema
Osteomyelitis
Chronic sinusitis extending into adjacent bone
Meningitis and encephalitis
Through ethmoidal conchae

Equine Viral Rhinopneumonitis (EVR)
EHV-1, and EHV-4
Disease
Mild Respiratory Disease
Foals
Persist in trigeminal ganglia
Secondary bacterial rhinitis, pharyngitis, or bronchopneumonia

Equine Influenza
Type A Influenza
Equine Influenza -1 and 2
2-3 year old race horses
Occasionally causes severe bronchointerstitial pneumonia with pulmonary edema
Secondary bacterial bronchopneumonia
Streptococcus zooepidemicus
Staphylococcus aureus
Bacteroides spp

Other Equine Respiratory Diseases
Equine Rhinovirus
Equine Adenovirus
Equine Parainfluenza virus
Suppression of cell mediated immunity
Pneumocystic carinii
Adenovirus- pneumonia and enteritis
Strangles, Glanders, or Melioidosis
Systemic
Purulent rhinitis

Strangles
Streptococcus equi ssp equi
Highly contagious
Suppurative rhinitis and lymphadenitis
Not part of normal nasal flora
Pathogenesis
Exposure to feed/ exudate with the bacyerium □ Penetrates through
nasopharyngeal mucosa □ drains to regional lymph node
Gross Lesions
Mucopurulent rhinits
Purulent lymphadenitis
“Bastard” Strangles
Hematogenous spread
Metastatic abscesses
Lungs, liver, spleen, kidneys, brain, joints
Often fatal
Sequelae
Bronchopneumonia
Laryngeal hemiplagia
Facial paralysis and Horner’s syndrome
Compression of sympathetic nerves
Purpura Hemorrhagica
Vasculitis from deposition of anitgen-antibody complexes
Skin and mucous membranes
Paranasal sinuses
Gutteral Pouch empyema
Infects young horses and some become carriers
Glanders
Burkholderia mallei (Pseudomonas mallei)
Can be transmitted to carnivores through ingestion of horse meat
Potential biological warfare
Pathogenesis
Ingestion of contaminated feed → bacteria penetrate mucosa → spread via lymph vessels → LN → Blood → Lungs
Lesions
Nasal Cavity
Pyogranulomatous nodules in SM
→ ulceration → bacterial exudate in nasopharynx
Heal by scarring (star shaped)
Lungs
2-10 mm miliary nodules
Chronic granulomas
Necrotic centers surrounded by connective tissue infiltrated by macrophages, giant cells, and lymphocytes and some plasma cells

Melioidosis (Pseudoglanders)
Life threatening disease of humans, horses, and cattle, sheep and goats, pigs, dogs, cats, and rodents
Burkholderia pseudomallei (Pseudomonas pseudomallei)
Clinically and pathologically similar to glanders
Humans
Severe sepsis
Hematogenous abscessation
Brain, spinal cord, liver, lungs, spleen, nasal mucosa and joints, and lymph nodes
Focal adhesive pleuritis
Rhinocerous seberi
Nasal infection to humans, horses, mules, cattle, dogs, and cats

Gross Lesions
Barely visible granulomas
Large expansile polypoid nodules

Histology
Large 400 um oval sporangium containing thousands of endospores
9-17

Subacute fibrinous laryngitis and tracheitis
IBR (BHV-1)
Thick plaques of fibrinonecrotic exudate cover the laryngeal and trachea mucosa
Arrows- Intranuclear inclusions

Infectious Bovine Rhinotracheitis
Bovine Herpesvirus-1
Synergism with Mannheimia hemolytica
Forms
Mild febrile respiratory disease
Dyspnea caused by exudate
Ulcerative rumenitis
Multifocal hepatitis in neonatal calves
Non-suppurative meningoencephalitis
Infertility
Bovine abortion
Infectious pustular vulvovaginitis
Infectious balanoposthitis
Respiratory form
Severe hyperemia
Focal necrosis of nasal pharyngeal, laryngeal, and tracheal mucosa
Microscopically
Necrosis and exfoliation of ciliated epithelium
Secondary bacterial infectious
Fibrinonecrotic material (diphtheritis) overlying the necrotic areas
Intranuclear inclusion bodies (early stages)
Sequela
Pneumonia
Aspiration of exudate
Impaired pulmonary clearance
Mannhaimia hemolytica
Other bovine Rhinitis
Nasal granulomas
Unidentified inhaled antigens
Grossly
Multiple small pink or red polypoid nodules starting in the nasal vestibule
Nodules are composed of fibrovascular tissue mixed with lymphocytes (granulation tissue) and lined by hyperplastic epithelium with abundant mast cells and eosinophils in the lamina propria (nasal eosinophilia)
Type 1 hypersensitivity
Type 3 and 4 (immune complex and delayed)
DDX
Nasal mycetomas
Rhinosporidiosis
Nasal Schistosomiasis
Mycotic granulomas
Splendore-hoeplli materia
Thought to be localized antigen-antibody response
Oestrus ovis

Nasal Bot

1\textsuperscript{st} stage larvae in nostrils
- mature into bot maggots
- Spend life in nasal passages and sinuses
- cause irritation, inflammation and obstruction
- matured larvae drop to the ground and pupate into flies

Myiasis

Sporadically affects goats, dogs, and shepherds

Lesions

Mucopurulent rhinitis and sinusitis
Secondary bacterial meningitis
Infectious rhinitis in goats
Pasteurella multocida
Mannheimia hemolytica
Atrophic rhinitis

Top left: Normal
Top right: mild symmetric atrophy
Bottom Left: severe unilateral atrophy
Bottom right: Severe bilateral atrophy with complete loss of nasal conchae

Pig nasal diseases

Atrophic Rhinitis
Or Progressive Atrophic rhinitis
Inflammation and atrophy of nasal conchae (turbinates)
May cause facial deformity
Associated pathogens
Bordatella bonchiseptics
Pasteurella multocida
Haemophilus parasuis
Porcine cytomegalovirus (Herpes, inclusion body rhinitis)
Predisposing factors
Genetics
Environment
Nutritional deficiencies
Proposed pathogenesis
Bordatella → moderate tubinate atrophy → colonization of P. multocida types A and D → Cytotoxins → inhibit osteoblastic activity and promote osteoclastic reabsorption of nasal bones (Ventral nasal conchae)
Dx
Transverse section of snout between the 1\textsuperscript{st} and 2\textsuperscript{nd} premolars
Microscopic lesions
Osteopenia of the conchae
Mucopurulent exudate is variable
Hyperplastic or metaplastic glands and epithelium
Lyphoplasmacytic infiltrates
9-19
Inclusion body rhinitis
Cytomegalovirus
Nasal conchae 3 week old pig

Inclusion body rhinitis
Young pigs <5 weeks
Herpesvirus
Mild rhinitis
Hyperemia
Secondary mucopurulent rhinitis
Microscopic lesions
Necrotizing
Non-suppurative rhinitis
Giant basophilic intranuclear inclusion bodies in nasal epithelium and glands
Immunocompromised piglets
Sytemic cytomegalovirus infection
Necrosis of liver, lungs, and adrenal glands, and brain
Nasal carcinoma
Diffusely infiltrating the nasal conchae and obliterating the meatuses

Canine Nasal Diseases

Acute Rhinitis
Canine Distemper
Canine Adenovirus 1, 2
Canine parainfluenza virus
Reovirus
Canine herpesvirus
Secondary bacterial infections
Rhinitis
Sinusitis
Pneumonia
Bordatella bronchiseptica
E. coli
P multocida
Immotile Cilia syndrome
Ciliary dyskinesia
Congenital disease
Reduces mucociliary clearance
Causes recurrent rhinitis, sinusitis, bronchitis, bronchiectasis and pneumonia

Mycotic rhinitis
Aspergillus
Penicillium
Leisons
Necrosis of nasal epithelium
Fibrinopurulent exudate with many fungal hyphae
Cryptococcus neoformans
Rhinosporidium seeberi
Mucosal granulomas
PAS positive organisms
Mucopurulent nasal discharge

Linguatula serrata
Pentastomid parasite
From eating uncooked ruminant meat containing infective larvae
Adult parasite found throughout the nasal passages
Catarrhal inflammation
Epistaxis
Eggs leave host in exudate, and swallowed, exit in feces

Capillaria aerophila
Nematode
Trachea and bronchi of wild and domestic carnivores
May involve nasal passages and sinuses
Cough because of local irritation
Concurrent infection with Pneumonyssus caninum mites

Allergic rhinitis
Type 1 hyper sensitivity related to IgE mast cell degranulation
Rhinitis and conjunctivitis
Edematous mucosa
Eosinophils, neutrophils and some macrophages

Feline Nasal Diseases

Feline Viral rhinotracheitis
Feline Herpesvirus-1
Impairs pulmonary defenses
Predisposes to secondary bacterial infections
Pasteurella multocida
Bordatella bronchiseptica
Streptococcus suis
Mycoplasma felis
Chronic suppurative rhinitis and conjunctivitis
Latency in ganglia
Lesions
Nasal discharge
Bone lysis
Interstitial pneumonia
Ulcerative keratitis
Hepatic necrosis
Abortion

Feline calicivirus
Lesions
Mild oculonasal discharge
Severe rhinitis
Mucopurulent conjunctivitis
Ulcerative gingivitis and stomatitis
Acute diffuse interstitial pneumonia
Necrotizing bronchiolitis
Secondary bacterial infections
Bordatella bronchiseptica
Pasteurella multocida
Escherichia coli

Feline Chlamydirosis
Chlamydophila felis
Persistent respiratory infection
Conjunctivitis
Serous or mucopurulent rhinitis
Feline pneumonitis
Transient bronchointerstitial pneumonia

Other feline rhinitis and sinusitis
Mycoplasma felis
Mucopurulent conjunctivitis
FeLV
FIV
Bronchopneumonia via immunosuppression
Mycotic rhinitis
Cryptococcus neoformans
Discrete nasal granulomas
Large mucopurulent masses filling nasal cavity
Nasal adenocarcinoma
Neoplastic mass arising from ethmoidal conchae
Histo: Multiple clusters of neoplastic epithelial cells with abundant eosinophilic cytoplasm and prominent nucleoli

Nasal neoplasms
Most malignant
Locally invasive
Infiltrate sinuses
Brain
Olfactory nerves
Blood vessels → epistaxis
Carcinoma
Anaplastic to well differentiated
Adenocarcinoma
SCC
Sarcomas less common
Mesenchymal tumors
Osteoma or OSA
Chondroma (SRA)
Hemangioma (SRA)
Fibroma/SRA
Lymphoma most common metastatic tumor
Benign ones are
Papilloma
Adenoma
Well circumscribed nodules
Secondary bacterial infections
Nasal adenocarcinoma
Typical of retroviral induced “enzootic nasal carcinoma”

Endemic ethmoidal tumors (ENZOOTIC NASAL TUMORS)
SHEEP, GOATS AND CATTLE
Arise from surface epithelium and glands of the ethmoidal conchae
Caused by Oncogenic retrovirus
Invasive but do not metastasize

Nasal Polyps and Cysts
Horses and cats
Horses
Ethmoidal region
Ethmoidal hematomas
Nasal and paranasal sinus cysts
Cause deformation and destruction of the surrounding bone
Epithelial cell capsule filled with yellow or hemorrhagic fluid
Surgical excision is curative

Cats

Nasopharynx and Eustachian tubes

Polyps

Firm pedunculated nodules

Smooth or ulcerated surface

Hemorrhagic

Microscopically- core of well vascularized stromal tissue containing inflammatory cells and covered by pseudostratified or squamous epithelium
9-24
Tracheal collapse
Pony
The dorsal surface is flattened dorsoventrally
The dorsal ends of the C-shaped rings are widely separated and the dorsal ligament between the two ends is lengthened and thinned

Brachycephalic airway syndrome
Stenotic external nares
Elongated soft palate
Leads to laryngeal edema and upper airway obstruction
Epiglottic abnormalities
Epiglottic entrapment
Small epiglottis
Epiglottic cysts
Necrosis of the tip of the epiglottis
Also occurs in pigs
Dorsal Displacement of Soft Palate
Short epiglottis, or long soft palate
Subepiglottic and pharyngeal cysts
Horses
Cysts lined by squamous or pseudostratified epithelium
Contain thick mucous

Tracheal agenesis or Hypoplasia
English bulldogs
Boston terriers
Tracheal lumen decreased all along its length

Tracheal Collapse and Stenosis
Toy and Miniature Breeds
Called Tracheobronchial collapse or central airway collapse
Also occurs in cattle, and horses and goats
Dorsoventral flattening
Widening of the dorsal tracheal membrane which may prolapse into the lumen
9-25
Laryngeal hemiplegia
Larynx, dorsal surface
2 yr old horse
The left cricoarytenoideus dorsalis muscle is pale and atrophic

Laryngeal Hemiplegia
Atrophy of the dorsal and lateral cricoarytenoideus muscles (Left side)
Denervation of the recurrent laryngeal nerve (idiopathic axonopathy)
Can be secondary to guttural pouch inflammation
Mycosis
Retropharyngeal abscesses
LSA

Laryngeal and Tracheal Hemorrhages
Mucosal petechia
Coagulopathies, inflammation, sepsis, Especially in pigs with CSF or Salmonellosis
Severe dyspnea and asphyxia can cause congestion, ecchymoses and petechiae in the laryngeal and tracheal mucosa
Laryngeal edema
Larynx mature cow
Can cause respiratory distress due to the narrowing of the laryngeal lumen (rima glottidis)

Laryngeal edema
Edema disease
Purpura Hemorrhagica (horses)
Acute interstitial pneumonia (cattle)
Systemic anaphylaxis (cats)
Trauma
Smoke inhalation

Tracheal edema
Honker cattle
Guttural pouch empyema
The guttural pouch is filled with masses of inspissated purulent exudate (arrow)

9-27
Guttural pouch empyema
The guttural pouch is filled with masses of inspissated purulent exudate (arrow)

Pharyngeal perforation
Trauma
Balling gun
Foreign body
Pigs
Pharyngeal diverticulum
Located in the pharyngeal wall rostral and dorsal to the esophagus
Barley awns may lodge here

Equine Pharyngeal Lymphoid Hyperplasia
Partial upper airway obstruction
Chronic pharyngitis
Unexplained
Variable sized white foci

Inflammation of Guttural Pouches
Mycosis
Aspergillus fumigatus
Usually unilateral
Can cause erosion of internal carotid artery leading to exsanguination
Can lead to multiple cerebral infarcts
Dysphagia
Damage to vagus and glossopharyngeal nerve
Empyema
Follows suppurative inflammation of nasal cavities
Streptococcus equi- Strangles
Close proximity to Cranial nerves
VI, IX, X, XI, XII
Necrotic laryngitis
Calf diphtheria
Fusobacterium necrophorum
Plaques if fibrinopurulent exudate are on the arytenoids

Necrotic Laryngitis (Calf Diphtheria)
Fusobacterium necrophorum
Exotoxins
Endotoxins
Requires IBR, and exudative stomatitis, or trauma to damage epithelium
Well demarcated yellow/gray, thick crusted, fibrinonecrotic exudate

Microscopically
Necrotic foci surrounded by hyperemic borders and surrounded by leukocytes
Heal by granulation tissue and collagen (fibrosis)

Sequelae
Toxemia
Fusobacteria
Laryngeal Contact Ulcers

Grossly
Laryngeal mucosa reveals circular ulcers
Causative
Unknown
Predispose to Fusobacterium and laryngeal papillomas
Secondary infection
Arcanobacterium pyogenes (Actinomyces pyogenes, Corynebacterium pyogenes)
Parasitic tracheobronchitis
Oslerus osleri

Top- Large parasitic nodules on the mucosal surface of the distal trachea and main bronchi

Inset- Filarial forms of oslerus osleri can be seen in the LP of the tracheal mucosa

9-29
Parasitic tracheobronchitis
Oslerus osleri
Top- Large parasitic nodules on the mucosal surface of the distal trachea and main bronchi
Inset- Filarial forms of oslerus osleri can be seen in the LP of the tracheal mucosa

Tracheitis
Viral infections
IBR
Equine viral rhinopneumonitis
Canine distemper
Feline rhinotracheitis
Canine Infectious Tracheobronchitis (Kennel Cough)
Cough, rhinitis, pharyngitis, tonsillitis, conjunctivitis, secondary pneumonia
Bordatella bronchiseptica
Canine adenovirus -2 (Not CAV-1/Infectious canine hepatitis)
Canine Parainfluenza virus (CPV)
Gross
Absent
Catarrhal to mucopurulent tracheobronchitis, with enlargement of the tonsils, retropharyngeal and tracheobronchial lymph nodes.
With Bordatella bronchiseptica
Suppurative or mucopurulent rhinitis and tracheobronchitis and suppurative bronchiolitis
Viral diseases
Microscopic changes are focal necrosis and tracheobronchial epithelium

Besnoitiosis (Besnoitia benneti, and benotti)
Apicomplexan coccidian
Unknown life cycle
Lesions
Pedunculated lesions in skin, sclera, nasal cavity, larynx of horses, donkey, cattle, and wild animals
Grey pale, round, exophytic nodules protruding from the mucosal surfaces
Microscopically
Hyperplastic and sometimes ulcerated epithelium containing numerous thick walled parasitic cysts with little inflammation

Mammomanogamous laryngeus (Syngamus laryngeus)
Nematode
Attached to laryngeal mucosa of cattle
Gapeworm

Oslerus (filaroides) osleri
Dogs and other canidae
Protruding nodules into the lumen of the tracheal bifurcation
Microscopically
Mononuclear cell reaction when the parasites are alive, but when they die an intense foreign body reaction develops with giant cells and neutrophils
Pulmonary melanosis
This pigmentation extends into the lungs and is incidental

Collateral ventilation
Pigs and cattle- Poor
Dogs and cats- good
Via pores of Kohn

Congenital Anomalies
Ciliary Dyskinesia
Defect in microtubules
Affects all ciliate cells and spermatozoa
Often associated with situs inversus
Chronic rhinosinusitis, pneumonia, infertility
Congenital melanosis
Common in pigs and ruminants
No clinical significance
Uremic pneumopathy from chronic renal failure
Insert: calcification of alveolar septa

Pulmonary Calcification
Hypercalcemic states
Secondary to Vitamin D Toxicity
Solanum malacoxylon
Sequela to uremia and hyperadrenocorticism in dogs
Pulmonary necrosis (dystrophic calcification)
Grossly
Fail to collapse
Gritty texture
Microscopic
Calcification of alveolar basement membranes
Heterotopic ossification of the lungs
Multifocal neonatal atelectasis
Prominent mosaic pattern of normally inflated (light) and atelectatic, uninflated (dark) lobules
Aspiration of amniotic fluid, meconium, and squamous epithelial cells, causing obstruction of small bronchi and bronchioles.
This pattern suggests that the fetus was acidotic and aspirated amniotic fluid.

Atelectasis (Congenital and Acquired)
Incomplete distension of alveoli
Congenital- did not expand from birth
Can occur to abnormal production of surfactant by type 2 pneumocytes and Clara cells
Barkers, wanderers, cerebral hypoxia
Acquired- collapse of lung after they’ve been inflated
Compressive
Space occupying masses in the pleural cavity
Abscesses
Tumors
Bloat
Hydrothorax
Hemothorax
Chylothorax
Empyema
Pneumothorax
Massive atelectasis, or lung collapse
Obstructive (absorption) atelectasis
Reduce diameter of airway
Mucosal edema
Inflammation
Mucous plugs
Exudate
Aspirated foreign material
Lungworms
Complete obstruction → air trapped in lungs → trapped air becomes reabsorbed
Lobular pattern
More common in species with poor collateral ventilation (cattle/pigs)
Hypostatic Atelectasis
Blood-air imbalance
Shallow breathing
Airway obstruction
Inadequant surfactant
Paralysis of respiratory muscles
Prolonged mechanical ventilation
Atelectasis and hydrothorax
Lungs
Dog

9-34
Bovine pulmonary edema and emphysema (fog fever)
And interstitial pneumonia involving all pulmonary lobes

Pulmonary emphysema
Always secondary to obstruction of outflow
Agonal change
Bronchopneumonia
One way valve effect of exudate
Alveolar or interstitial
Alveolar
Distention and rupture of alveolar walls
Variably sized air bubbles
Interstitial
Mainly cattle
Wide interlobular septa
Lack of collateral ventilation
Accumulated air penetrates the alveolar and bronchiolar walls
Forces its way into interlobular connective tissue
Causes noticeable distention of interlobular septae
Bullous Emphysema
Bubbles of trapped air become confluent
Forms large pockets
Subcutaneous emphysema
Air from interlobular septa→ CT surrounding the mainstem bronchi → pneumomediastinum → cervical and thoracic subcutaneous tissue
9-36
Acute pulmonary congestion, lungs, dog
The lung parenchyma is red because of congestion of pulmonary vasculature and alveolar capillaries

Hyperemia
Active process
Acute inflammation

Congestion
Passive
Decreased outflow of venous blood
Congestive heart failure
May leak RBCs into alveoli
Erythrophagocytosis- Heart failure cells
Chronic passive congestion
Brown cytoplasm
Lungs have pathcy brown apperance
Hypostatic congestion
Gravity and poor circulation

Pulmonary Hemorrhage
Trauma
Coagulopathies
Pulmonary thromboembolism
Jugular thrombosis
Exudative emboli from hepatic abscess
DIC
Vasculitis
Sepsis
Atrifact: Aspiration of blood after slaughter
Rupture of pulmonary vessels
Massive hemorrhage
Growing abscess invades lung and disrupts the wall of a major artery or vein

Exercise Induced Pulmonary Hemorrhage
Following exercise
Epistaxis
Suggested etiologies
Laryngeal paralysis
Bronchiolitis
High pulmonary vascular pressures
Alveolar hypoxia
Pre-existing pulmonary injury
Gross Lesions
Large areas of dark brown discoloration in the caudal lung lobes
Microscopically
Alveolar hemorrhage
Abundant alveolar macrophages
Containing hemosiderin (Hemosiderophages)
Mild interstitial fibrosis
Chronic congestion and edema
Dilative cardiomyopathy.
The lungs have failed to collapse (fibrosis) and have a mottled and brownish appearance (hemosiderosis)
Inset: Macrophages containing hemosiderin
Pulmonary edema
Lungs pig
The lungs are distended by edema fluid which has resulted in rounded edges and edematous distention of the interlobular septa

Pulmonary Edema
Cardiogenic (Hydrostatic)
Increased vascular hydrostatic pressure
Decreased plasma oncotic pressure
Causes
Congestive heart failure
Iatrogenic fluid overload
Hypoalbuminaemia
Nephrotic syndrome
Neoplasia causing obstruction of lymphatics
Non-Cardiogenic (Permeability)
Excessive opening of endothelial gaps
Damage to blood air barrier
Causes
Inflammation
Leukotrienes
Platelet activating factor
Cytokines
Vasoactive amines
Type I pneumocyte damage
Influenza
BRSV
Toxic
Free radicals
Endothelial damage
Sepsis
DIC
Anaphylactic shock
Milk allergy
Paraquat toxicity
Adverse drug reactions
Protein in exudate
Inflammation → more protein
Hydrostatic → less protein
GrossLesions
Wet, heavy, red, variable amounts of foamy fluid
Oozes fluid like a wet sponge on cut section
ARDS
Humans
Pulmonary hypertension
Intravascular aggregation of neutrophils
Diffuse alveolar damage
Hyaline membranes
Pathogenesis
Damage to distant organs
Direct damage to lungs
Hyper-reactive macrophages
Relase overwhelming amounts of cytokines (TNF-a, IL-1, IL-6, IL-8)
Neurogenic pulmonary edema
Follows increased intracranial pressure
Presumable mass sympathetic stimulation
Jugular Thrombophlebitis and pulmonary thromboembolism, jugular vein and lung cut surface, cow

Left: The jugular vein has a large thrombus (arrow) attached to the wall at the site of prolonged catheterization.

Right: The pulmonary artery has a large thrombus (arrow) presumably a thromboembolus that has broken off the jugular mural thrombus. Note that the pulmonary thromboembolus is not attached to the wall of the pulmonary artery.

Pulmonary Embolisms
Thromboemboli
Sterile- no significance
Dirofilaria immitis
Angiostrongylus vasorum
Hyperadrenocorticism
Hypothyroidism
Glomerulopathies
Hypercoagulable states
Chronic IV catheter
Septic (bacterial) emboli
Valvular or mural thromboemboli
Bacterial
Jugular thrombophlebitis
Hepatic abscesses
Septic arthritis
Omphalitis
Fat emboli
Bone fractures
Surgery of bone
Brain emboli after trauma or stunning for slaughter
Tumor cell emboli
9-43
Lobe torsion, lung and heart, dog
The right middle Lung lobe is markedly congested and hemorrhagic from complete torsion.
Although the right middle lung lobe is most frequently affected other lobes can also rotate

Pulmonary Infarcts
Rare and generally asymptomatic
CHF + thromboembolus
Lung lobe torsion
Hemorrhage and necrosis
Chronic obstructive pulmonary disease (Heaves). Recurrent airway obstruction, goblet cell metaplasia, bronchiole, lung, horse.
This horse has a 3-year history of recurrent dyspnea and terminal pulmonary emphysema.
Numerous goblet cells (arrows) are discharging mucus (*) into the lumen, causing complete obstruction of the bronchiole.
Healthy bronchioles do not have goblet cells or mucus.
Granulomatous
Chronic Injury
Goblet cell hyperplasia
Chronic catarrhal
Obstructive bronchitis
Squamous metaplasia
Structural /functional loss of ciliary apparatus
Sequela
Bronchiectasis
Destruction of the walls
By enzymes of phagocytes
Gross lesions- bumps in the lungs, bosselated
Bronchioles
Epithelium
PI-3
Adenovirus
BRSV
Canine Distemper
Oxidant gases
Toxic (3-methylindole)
Pathogenesis
Hugh vulnerability to oxidants and free radicals
Clara cells rich in MFO’s
Accumulation of macrophages and leukocytes
Severe injury
Exudate cannot be removed
Fibroblast infiltration
Develop into microscopic polyp
External surface then becomes covered by ciliated epithelium
Bronchiloitis Obliterans
BALT hyperplasia is common
Mild Chronic Injury
Goblet cell metaplasia
Bronchiolar fluid becomes viscous and becomes obstructive
- Chronic obstructive pulmonary disease
- Pulmonary emphysema and atelectasis
COPD
Recurrent respiratory distress
Chronic cough (to clear bronchioles)
Poor athletic performance
Airway neutrophilia
Mucus hypersecretion
Genetic predisposition
TH2 allergic response
Hypereactive airway disease
9-46
Severe bronchiectasis with chronic bronchopneumonia in a calf
TOP: Note segmentally distended (Bosselated) bronchi supplying the ventral portion of the cranial lung lobe.
The lumens of the affected bronchi are filled with purulent exudate. The surrounding lung parenchyma supplied by these bronchi is atelectatic
Bronchiectatic bronchi resemble pulmonary abscesses, but unlike abscesses, which are lined by pyogenic membrane, the exudate in bronchiectasis is lined by the remnants of the bronchial wall.
Bottom: These distended bronchi are filled with purulent exudate

Feline asthma (feline allergic bronchitis)
Recurrent bronchoconstriction, cough and dyspnea
Type 1 hypersensitivity
Secondary bacterial pneumonia
Mild to moderate inflammation
Mucosal edema
Leukocytes, eosinophils
Chronic bronchoconstriction
Excess mucus production
Smooth muscle hyperplasia
Obstruction of the bronchi and bronchioles
Suppurative bronchopneumonia, enzootic pneumonia, lung, calf
Craniocentral consolidation of the lung involves about 40% of the pulmonary parenchyma
Most of the caudal lung is normal.
On cut surface, the consolidated lung is dark red and major bronchus contains purulent exudate

Suppurative exudate - >1.020, many cells
Cellulitis or phlegmonous inflammation - dense neutrophil infiltration of fascial planes or tissue layers and SQ CT
Blackleg - Clostridium
Staphylococcal infection
Streptococcus spp - S. equi
E.Coli
Listeria monocytogenes
Can also cause suppurative meningitis
Renal pelvis and tubules - Bronchopneumonia
Rhinitis and sinusitis
Prostatitis
Cholecystitis
Urinary bladder- urocystitis
Mastitis

Bronchopneumonia
Disease in bronchial, bronchiolar and Alveolar lumens
Cranioventral consolidation
Gravity
Frequency of organism invasion
Inadequate defense
Reduced vascular perfusion
Short and abruptly branching airways
Ventilation differences
May involve the entire cranial lobe, ventral portions of the middle and caudal lobes

Etiology
Bacteria
Mycoplasma
Aspiration
Acute injury
Mucosa of bronchioles
Exudate in bronchiolar, bronchial and alveolar airways
Interstitium unchanged
Acute vascular change
Engorged pulmonary vessels (red, hyperemia)
Permeability edema in alveoli
Neutrophil recruitment, and macrophage
Severe vascular change
Cytokines cause large endothelial gaps
Fibrin leakage into alveoli
Centrifugal spread
Through pores of Kohn
Adjacent alveoli are infected
Can affect whole lobule
Can then spread to other lobes
Via coughing
Chronic vascular change
Turns grey or yellow, or black
Suppurative Bronchopneumonia
Lobular pattern emphasized
Obvious in cattle and pigs
Acute phase
Hyperemic
Edematous
Sub-acute
Consolidation by exudate and fluid
Neutrophils exude
Chronic (5 days)
Less hyperemia
Bronchial. Bronchiolar and alveolar airways filled with neutrophils
Purulent exudate flows from cut section
Chronic (10 days)
Grey
Obstructive atelectasis
Purulent and catarrhal exudate
Mononuclear inflammation
Lymphoid hyperplasia
Early fibrosis
Late chronic
Fibrosis
Bronchiectasis
Atelectasis
Adhesions
Abscesses
Examples
Enzootic pneumonias of pigs and cows
Microscopically
Neutrophils
Macrophages
Cell debris in lumens and alveoli
Obliteration of lumens
Goblet cell hyperplasia if chronic
Hyperplasia of BALT
Bronchiectasis
Pleural adhesions from pleuritis
Suppurative bronchopneumonia, lung Pig
The bronchiole is plugged with purulent exudate
The alveoli are filled with leukocytes and some edematous fluid

9-49
Suppurative bronchopneumonia, lung Pig
The bronchiole is plugged with purulent exudate
The alveoli are filled with leukocytes and some edematous fluid
Fibrinous bronchopneumonia (Pleuropneumonia), right lung (Steer) 
Typical of Mannheimia hemolytica (Shipping fever)

9-50
Fibrinous bronchopneumonia (Pleuropneumonia), right lung (Steer)
Cranioventral distribution that extends into the middle and caudal lung lobes and effects 80% of the parenchyma.
The lung is firm, swollen, and covered with yellow fibrin (*).
The cut surface is dark and hyperemic
Typical of Mannheimia hemolytica (Shipping fever)
DDX
Mannheimia- fibrinosuppurative
3-methylindol (atypical interstitial pneumonia)
IBR-herpes virus
BRSV- mixed with necrotic debris-hyaline membrane
Fibrinous pseudomembrane- fibrin covers an ulcer
Heat and smoke inhalation- fibrinous tracheitis
Microscopically, the BV’s are dilated and congested with RBC’s (active hyperemia)
Interstitial pneumonia, lung feeder pig. The lung is heavy, pale and rubbery. It has prominent costal imprints (Arrows), a result of the hypercellularity of the section.

On cut section the parenchyma has a meaty appearance and some edema, but no exudate is present in airways or on the pleural surface. Highly suggestive of viral pneumonia in pigs.

Interstitial Pneumonia
Injury to 3 layers of alveolar wall
Endothelium
BM
Alveolar epithelium
And bronchiolar interstitium
Generally requires microscopic examination
Pathogenesis
Aerogenous injury to Type 1 and 2 pneumocytes
Toxic fumes
Smoke inhalation
Pneumotropic viruses
Influenza
IBR
EVR
Canine distemper
Hematogenous injury to alveolar capillary endothelium
Sepsis
DIC
Microembolism
Circulating larva migrans (Ascaris suum)
Endotoxin
3-methylindole
Paraquat
Free radicals in ARDS
Endothelial tropic viruses
Canine adenovirus
Classical swine fever
Migration of inhaled pathogens
Fungal spores
Type 3 hypersensitivity
Acute Interstitial Pneumonia
Injury to type 1 or 2 pneumocytes
Injury to capillar endothelium
Disrupts blood-air barrier
Exudation of proteins into alveoli
Hyaline membranes as plasma proteins mix with surfactant
Edema and neutrophils gather in alveolar intertitium and cause thickening of alveolar walls
Proliferative phase
Hyperplasia of type II pneumocytes
Causes more thickening of alveolar walls
Walls become rubbery and will not collapse
In severe cases animals may die of respiratory failure
Fatal pulmonary edema
Distribution
Diffuse
Failure of lungs to collapse
Rib impressions
Pale from fibrosis or destruction of blood vessels
Dorsocaudal emphysema
Chronic Interstitial Pneumonia
Fibrosis of alveolar walls, with or without, alveolar fibrosis
Accumulation of mononuclear cells in the interstitium
Persistence of hyperplastic type II pneumocytes
Desquamated epithelial cells and macrophages and mononuclear cells in the lumen of bronchioles and alveoli
Microscopic granulomas
Hyperplastic smooth muscle in airways and pulmonary vasculature
Ovine Progressive pneumonia
Hypersensitivity pneumonitis in cattle and dogs
Silicosis in horses
Pneumoconioses
Paraquat toxicity
Pneumotoxic chemotherapeutics
Extrinsic allergic alveolitis (Farmers Lung)
Massive pulmonary migration of ascaris suum larvae in pigs
Interstitial pneumonia, lung, aged ewe
The alveolar septa are notably thickened by severe interstitial infiltration of lymphocytes and mononuclear cells

9-53
Interstitial pneumonia, lung, aged ewe
The alveolar septa are notably thickened by severe interstitial infiltration of lymphocytes and mononuclear cells

Bronchointerstitial pneumonia
Combined type
Viruses that cause bronchoepithelial injury
Influx of neutrophils
Proliferation of type 2 pneumocytes
BRSV in cattle
Canine distemper
Influenza in pigs and horses
Interstitial pneumonia, edema and hemorrhage, lungs pig
This pig had migrating Ascaris suum larvae.
The lungs are wet and heavy and failed to collapse when the thorax was opened, due to pulmonary edema.
The mottled appearance of the lungs is due to the presence of numerous petechiae scattered in the pulmonary parenchyma.
Petechiae are likely alveolar hemorrhages caused by migrating larvae.
Larvae leave the blood stream to enter the alveoli by penetrating and rupturing alveolar capillaries and thus damage the blood-air barrier.
9-55
Embolic pneumonia, lungs, 6 week old puppy
Large hemorrhagic foci are scattered relatively uniformly throughout all pulmonary lobes (Arrows)
These hemorrhagic foci are the sites of lodgement of Pseudomonas aeruginosa emboli (Septic)
Which originated from necrotizing enteritis.
Note the multifocal distribution of the inflammatory foci which is typical of embolic pneumonia.
Septic emboli were also present in the liver

Embolic Pneumonia
Injury is hematogenous
Inflammation is centered in pulmonary arterioles and alveolar capillaries
Must escape phagocytosis by intravascular macrophages
Most by pass the lung and land in liver, spleen, joints
Once trapped in lung arterioles and capillaries via attaching to thrombi or to endothelium directly the bacteria disrupt endothelium and BM and spread from the vessels to the interstitium

Lesions
Multifocal random
Small white foci surrounded by a hemorrhagic halo
In massive numbers can cause fatal pulmonary edema
Can progress to pulmonary abscesses randomly distributed
Look for the source of the emboli

Sources
Hepatic abscesses
Omphalophlebitis
Chronic bacterial skin or hoof infections
Infected jugular catheters
Valvular or mural endocarditis in right side of the heart

Etiologies
Arcanobacterium (actinomyces) pyogenes
Fusobacterium necrophorum
Erysipelothrix rhusiopathiae
Streptococcus suis type II
Staphylococcus aureus
Streptococcus equi
Pulmonary tuberculosis, lung, aged cow
Multifocal, coalescing granulomatous pneumonia involves most of the lung, except for the dorsal portion of the caudal lung lobe
Transverse Sections: Large multifocal to copnfluent caseating granulomas are present in the pulmonary parenchyma.
Typical of Bovine tuberculosis

Granulomatous pneumonia
Aerogenous or hematogenous
Cannot be normally eliminated by phagocytosis
Evoke local inflammatory reaction
Presence of pulmonary granulomas
Pathogenesis
Similar to embolic and interstitial pneumonia
Unique- not by entry method or site of initial injury
Unique inflammatory reaction resulting in formation of granulomas
Agents are resistant to killing by phagocytic cells and the acute inflammatory response

Causes
Systemic fungal diseases
Cryptococcus neoformans
Coccidioides immitis
Histoplasma capsulatum
Blastomyces dermatitidis
Entry aeroginous
Bacteria
Mycobacterium bovis
Mycobacterium avium intracellulare
Rhodococcus equi
Foreign body
Starch
Parasites
Fasciola hepatica
Viruses
FIP
Lesions caused by deposition of antigen-antibody complexes and subsequent vasculitis
Lesions
Caseous or non-caseous granulomas, multifocal, random
Nodular character on palpation
Calicification may occur
Microscopic lesions
Center of necrotic tissue
Surrounded by a rim of macrophages (epithelioid cells) and giant cells
Outer layer of connective tissue infiltrated by lymphocytes and plasma cells
9-59
Granulomatous pneumonia (Rhodococcus equi), lungs foal.
Cranioventral consolidation of the lungs with subpleural granulomas.

Pneumonia of Horses
Pure viral infections
Mild to severe
Superimposed bacterial infections
Streptococcus spp
E. coli
Klebsiella pneumoniae
Rhodococcus equi
Anaerobic bacteria
Fibrinous or suppurative bronchopneumonia
Viral infections causing predispositions to hyper-responsive airways (COPD)
As yet unproven

Equine Influenza
Highly infectious, high morbidity
Explosive outbreaks
A/equi-1 and A/equi-2
Mild transient disease
Broncho-interstitial pneumonia
Secondary bacterial infections
Strep equi
Strep zoo

Equine viral rhinopneumonitis (EVR, Equine Herpesvirus Infection)
Young horses
EHV-1, EHV-4
Can cause abortion in pregnant mares
Can cause neurologic disease in all ages
Respiratory form
Bronchointerstitial pneumonia
Secondary bacterial infections
Strep equi
Strep zoo
Staph aureus
Abortions
Focal necrosis in liver, and lungs
INtranuclear inclusions

Equine Viral Arteritis
Pansystemic
Foals and horses
Infects macrophages and endothelial cells
Gross Lesions
Hemorrhage and edema
Pulmonary edema
Voluminous hydrothorax
Hydroperitoneum
Edema of intestinal walls and scrotum and periorbital tissues
Microscopic lesions
Fibrinoid necrosis and inflammation of vessel walls
Lymphocytic arteritis
Interstitial pneumonia
Type II pneumocyte hyperplasia
Vasculitis
Fluid in bronchoalveolar spaces
Signs
Respiratory distress, fever
Abortion
Diarrhea, colic
Edema of limbs

African Horse Sickness
Vector borne Orbivirus (Culicoides)
Dogs can be infected by eating horse flesh
Respiratory distress
Cardiovascular failure
High mortality
Pathogenesis
Tropism for pulmonary and cardiac endothelial cells, and mononuclear cells
Pulmonary form
Massive pulmonary edema
Sub-pleural lymph vessels are distended
Cardiac form
Heart failure
Subcutaneous and interfascial edema
Neck and periorbital
Mixed form
Combination of respiratory and cardiac forms
Mild form
Resemnbles Equine Influenza

Equine Morbillivirus (Hendra)
Fruit bats transmit
Lungs
Edema
Gelatinous distension of the pleura and sub-pleural lymph vessels
Diffuse alveolar edema
Vasculitis
Capillary thrombosis
Distention of lymphatic vessels
Multinucleated syncytial cells

Rhodococcus Equi
Facultative intracellular gram Pos bacterium
2 major diseases
Ulcerative enterocolitis
Bronchopneumonia
Rare to have intestinal lesions alone
Disease restricted to foals or immunocompromised
Survive in macrophages
Infections
Aeroginous bronchopneumonia → swallowed sputum → intestine
Oral → enteritis → bacteremia → lungs
Pathogenesis
Lung → Phagocytosis → survive and multiply in macrophages → Macrophage is destroyed
Easily killed by neutrophils
Caseous necrosis (cytokines, lysosomal enzymes, bacterial toxins)
Large numbers of neutrophils, macrophages, giant cells with intracytoplasmic organisms
Pulmonary Lesions
Suppurative bronchopneumonia
Granulomatous pneumonia with caseous necrosis
Young foals
Suppurative bronchopneumonia → pulmonary abscesses → pyogranulomatous nodules
Microscopically
Neutrophilic exudate → Macrophages in bronchoalveolar spaces → Large necrotic areas with fibrosis
Multifocal granulomatous pneumonia, tuberculosis (Mycobacterium avium intracellulare), lung cut surface, aged horse.
Note the large numbers of caseating granulomas scattered throughout the pulmonary parenchyma.
In horses, tuberculosis granulomas often resemble sarcomatous nodules.

Chlamyphila psittaci
Obligate intracellular pathogen
Keratoconjunctivitis
Rhinitis
Pneumonia- bronchointerstitial
Abortion
Polyarthritis
Enteritis
Hepatitis
Encephalitis
Mycobacterial pneumonia
Mycobacterium avium
Mycobacterium tuberculosis
Mycobacterium bovis
Infections
Intestinal tract and lymph nodes via ingestion
Lungs via hematogenous route
Lesions
Tubercles (Granulomas)
Smooth, grey, solid nodules
No visible caseous necrosis of calcification
Appear like sarcomas
Microscopically
Macrophages
Epithelioid cells
Multinucleate giant cells
Fibrosis

Adenovirus
Arabian SCID foals
Lack of B and T lymphocytes
Intranuclear inclusions, amphophilic
Bronchial, bronchiolar, alveolar, renal, intestinal epithelium

Pneumocystis carinii
SCID foals

Diffuse Proliferative interstitial pneumonia of undetermined causes
- pulmonary fibrosis

Parasitic Pneumonia of Horses
Parascaris equorum
Nematode
Larval stages migrate through the lungs
Eosinophils are prominent in the interstitium and airway mucosa
Focal granulomas caused by dead larvae
Dictyocaulus arnfieldi
Not very pathogenic
Donkeys are natural host
Does not become patent in horses\no fecal eggs
BAL\ eosinophils, not parasites
Obstructive bronchitis
Edema
Atelectasis
Dorsocaudal
Caused by adult nematodes
9-61
Suppurative bronchiolitis, bovine respiratory syncytial virus, 5-week old calf
This is the reparative stage of necrotizing bronchiolitis and is characterized by epithelial hyperplasia and exfoliation of necrotic cells into the bronchiolar lumen. Epithelial cells are swollen, and the cytoplasm of some cells contain eosinophilic inclusion bodies surrounded by a clear halo (Arrows). Many of the hyperplastic bronchiolar cells eventually undergo apoptosis during the last stage

Pneumonias of Cattle

Bovine Respiratory Disease Complex

**Enzootic Pneumonia of calves (multi etiology)**

Begins with acute PI-3 or BRSV, or adenovirus, IBR, reovirus, rhinovirus
Can begin with Mycoplasma dispar, Mycoplasma bovis, Ureaplasma, and Chlamyphila
Opportunistic bacteria cause secondary bronchopneumonia
Mannheimia hemolytica
Pasteurella multocida
Arcanobacterium pyogenese
Histophilus somni
E.coli
Suppurative bronchopneumonia
Environmental factors are important
Bovine leukocyte adhesion deficiency
Prevents migration of neutrophils from capillaries
Lesions
Variable, depending on the agent
Viruses
Bronchointerstitial pneumonia- mild
Necrotizing bronchiolitis
Necrosis type 1 pneumocytes
Mild interstitial and alveolar edema
Intracytoplasmic inclusion bodies (PI-3 and BRSV)
Large multinucleate syncytia- fusion of infected bronchiolar cells
Mycoplasmas
Bronchiolitis
Bronchiolar and alveolar necrosis
Interstitial reaction
Tends to progress to a chronic stage- peribronchiolar lymphoid hyperplasia
(cuffing pneumonia)
Secondary Bacterial bronchopneumonia
Change from bronchointerstitial to suppurative bronchopneumonia
Chronic- creamy-mucoid exudate in the airways and often pulmonary abscesses or bronchiectasis

**Pneumonic Mannheimiosis (Mannheimia hemolytica)**
Shipping fever
Severe fibrinous bronchopneumonia
Occurs in animals that have not been shipped as well
Similar lesions as Histophilus somni
Mannheimia hemolytica biotype A serotype 1
Rapidly cleared by normal lung defenses
Require stressors
Horizontal transmission of viruses and Mannheimia can occur during crowding and transport
Virus Predisposition
IBR, PI-3, BRSV and others
Virulence factors
Endotoxin
LPS
Outer membrane proteins
Leukotoxin (an exotoxin)- binds and kills macrophages and neutrophils (only Bovine)
Cytokines produced- by host cells- TNF-a, IL-1, IL-8, histamine, leukotrienes
Neutrophils release many injurious substances
Lesions
Fibrinous, lobar bronchopneumonia
Fibrinous pleuritis
Pleural effusion
Always cranioventral
Interlobular edema and fibrin
Marbling- necrosis and interlobular and interstitial edema
Necrotic areas surrounded by a rim of elongated cells, (swirling macrophages or oat shaped cells)
Sequelae are abscess and sequestra, chronic pleuritis, fibrous pleural adhesions, and bronchiectasis
Severe toxemia that can kill animals
Mucopurulent nasal exudate
**Hemorrhagic septicemia**
Septicemic Pasteurellosis
Serotypes B and E of Pasteurella multocida
Not in US
Not a lower respiratory disease
Lesions
Petechia of serosal surfaces
Superficial lymph nodes are swollen and hemorrhagic

**Respiratory Histophilosis (Histophilus somni)**
Complex
Septicemia
Encephalitis (TME)
Pneumonia (as above)
Suppurative and fibrinous bronchopneumonia (in some cases indistinguishable from mannheimia)
Requires predisposing factors
Virulence factors- Immunoglobulin binding proteins, antigenic variation, promote leukocyte apoptosis, evading phagocytosis, inhibition of intracellular killing, reduce transferrin concentrations, induce epithelial apoptosis
Mixed infections are common
Pleuritis
Myocarditis
Arthritis
Ophthalmitis
Conjunctivitis
Otitis
Abortion

**Contagious bovine pleuropneumonia**
Mycoplasma mycoides ssp mycoides Small colony type
Aerogenous portal of entry
Pathogenic mechanisms
Toxins
TNF-α
Ciliary dysfunction
Immunosuppression
Immune-mediated vasculitis
Vasculitis and thrombosis of blood vessels lead to lobar infarction
Lesions
Severe fibrinous bronchopneumonia (Pleuropneumonia)
Similar to Mannheimosis
Extensive lymphatic thrombosis and interlobular edema
Can extend to caudal lung lobes
Large pulmonary sequestra

**Bovine tuberculosis**
Mycobacterium tuberculosis
Mycobacterium bovis (most common in adults)
Mycobacterium avium-intracellulare complex
Mycobacterium avium ssp avium
Mycobacterium avium ssp sylvaticum
Mycobacterium avium ssp paratuberculosis
Mycobacterium avium ssp intracellulare
Inhaled bacteria reach alveoli and are phagocytosed by pulmonary macrophages
M. bovis is a facultative intracellular pathogen
Multiplies intracellularly and kills the macrophage
Bacilli spread aerogenously and via lymphatics to tracheobronchial and mediastinal lymph nodes
May disseminate to distant organs or lymph nodes via macrophages
Miliary tuberculosis
Host becomes hypersensitive and causes host tissue destruction (Caseous necrosis)
Macrophages surround necrosis and bacteria and become epithelioid
Multinucleate macrophages
Surrounded by fibroblasts and connective tissue
Lesions
Granulomatous pneumonia
Small granulomas in the dorsocaudal subpleural areas
Lesions become large and confluent
Calcification of granulomas is common
Young tubercles
Non-caseous necrosis surrounded by epithelioid and langhans type giant cells
surrounded by lymphocytes, plasma cells, and macrophages
Older tubercles
Caseous necrosis at the center
Enclosed by other cell types and fibrosis

**Mycoplasma bovis pneumonia**
M. bovis most common
Exacerbated by stress
Depresses pulmonary defense mechanisms
Lesions
Chronic necrotizing bronchopneumonia
Distinct areas of pulmonary necrosis surrouned by a rim of neutrophils,
macrophages, and fibroblasts
Arthritis, otitis, mastitis, abortion, keratoconjunctivitis

**Interstitial pneumonia of cattle (Atypical)**
Microscopically
Absence of exudate
Edema
Interstitial emphysema
Hyaline membranes
Hyperplasia of type II pneumocytes
Interstitial fibrosis with cellular infiltrates

Etiologies
Pulmonary edema (Fog Fever)
Allergy (hypersensitivity pneumonitis)
Reinfection syndrome (hypersensitivity to Dictyocaulus or BRSV)
Milk allergy
Moldy potato ingestions
Others

**Acute Bovine Pulmonary edema and Emphysema (FOG FEVER)**
Fog- aftermath or “foggage” after hay or silage has been cut
Change from short dry grass to lush pasture
L-Tryptophan in pasture converted to 3-Methylindole - Blood - lungs
Non ciliated bronchiolar epithelial (clara cells) metabolize 3-Methylindole into a pneumotoxic compound that causes necrosis of bronchiolar Type 1 cells
Increases alveolar permeability leading to edema, interstitial pneumonia and emphysema

Gross Lesions
Diffuse interstitial pneumonia with severe alveolar and interstitial edema and interlobular emphysema
Lungs are enlarged pale and rubbery, most notable in the caudal lobes

Other causes
4- ipomeanol- moldy sweet potatoe contaminated with fusarium
Purple mint (perilla frutescens)
Stinkwood (Zieria arborescens)
Rapeseed and kale (Brassica)

**Extrinsic Allergic Alveolitis**
Hypersensitivity pneumonia
Type III hypersensitivity
Fungal spores
Thermophilic actinomycete
Saccharopolyspora rectivirgula
Presumed dyregulation of IgG, interleukins, IFN-y, and T lymphocytes involved
Housed adult dairy cows in winter
Gross Lesions
Subtle grey subpleural foci (granulomatous)
Severe meaty lungs
Alveolar and epithelial hyperplasia
Lymphocytic inflammation
Interstitial fibrosis
Discrete non-caseous granulomas
Can progress to diffuse fibrosing alveolitis
Hypersensitivity to recurring Dictyocaulus viviparous- more eosinophils

**Milk Allergy**
Type I Hypersenistivity
Sensitized to their own casein and lactalbumin
Lesions
Acute pulmonary congestion, edema, hemorrhage and emphysema
Drug reactions can cause similar

**Inhalation of Manure pit gases (H2S and NH3)**
Necrosis of bronchiolar and Type I pneumocytes epithelium
Fulminating pulmonary edema, asphyxiation and rapid death
Bronchiolitis, interstitial pneumonia in survivors, and bronchiolitis obliterans

**Smoke inhalation**
Nasal, laryngeal and tracheal edema, pulmonary hemorrhage, and alveolar edema
Carbon particles microscopically
IBR (BHV-1)
PI-3
BRSV
Bovine pulmonary edema
Reinfection syndrome- Type I hypersensitivity to dictyocaulus viviparous
Suppurative bronchopneumonia, right lung calf
40% of the lung parenchyma is consolidated and includes most of the cranial lung lobe and the ventral portions of the middle and caudal lung lobes. Cross sections show bronchi filled with purulent exudate.

9-62
Suppurative bronchopneumonia, right lung calf
40% of the lung parenchyma is consolidated and includes most of the cranial lung lobe and the ventral portions of the middle and caudal lung lobes. Cross sections show bronchi filled with purulent exudate.
Fibrinous bronchopneumonia (pleuropneumonia)
Pneumonic mannheimiosis (Mannheimia hemolytica)
Right lung, steer
Cranioventral pneumonia (85%)
Firm and swollen and the pleura is covered with a thick layer of fibrin

9-63
Fibrinous bronchopneumonia (pleuropneumonia)
Pneumonic mannheimiosis (Mannheimia hemolytica)
Right lung, steer
Cranioventral pneumonia (85%)
Firm and swollen and the pleura is covered with a thick layer of fibrin
Pneumonic mannheimiosis (mannheimia hemolytica)
Lung steer
Interlobular septa (arrowheads) are notably distended by edema and fibrin
In the lung parenchyma are irregular areas of coagulative necrosis (Arrows) surrounded by a rim of inflammatory cells

9-64A
Pneumonic mannheimiosis (mannheimia hemolytica)
Lung steer
Interlobular septa (arrowheads) are notably distended by edema and fibrin
In the lung parenchyma are irregular areas of coagulative necrosis (Arrows) surrounded by a rim of inflammatory cells
Note a large area of Necrosis of the pulmonary parenchyma
Alveoli in the right bottom corner are edematous

9-64 B
Note a large area of Necrosis of the pulmonary parenchyma
Alveoli in the right bottom corner are edematous
Alveoli filled with fibrin (center) and with neutrophils and macrophages (top right)

9-64 C

Alveoli filled with fibrin (center) and with neutrophils and macrophages (top right)
Mannheimia hemolytica produces leukotoxin (cytotoxic for ruminant leukocytes) and LPS. Note the accumulation of neutrophils in the alveoli.
Note the active hyperemia of acute inflammation of alveolar capillaries

9-64 D. Mannheimia hemolytica produces leukotoxin (cytotoxic for ruminant leukocytes) and LPS. Note the accumulation of neutrophils in the alveoli.
Note the active hyperemia of acute inflammation of alveolar capillaries
Verminous pneumonia (Dictyocaulus viviparous)
Bronchus calf
Clear foamy fluid is Pulmonary edema

Parasitic Pneumonias of Cattle

Verminous Pneumonia (Dictyocaulus viviparous)
Interstitial (larval migration)
Bronchitis, chronic (adult intrabronchial parasites)
Granulomatous pneumonia (dead larvae, aberrant parasites, eggs)
Eosinophilic syndrome
Infiltrates of eosinophils in the pulmonary interstitium and bronchoalveolar spaces
Blood eosinophilia
Atelectasis and emphysema secondary to obstructive airways
Gross Lesions
Dark, grey depressed wedge shaped areas of atelectasis on the dorso-caudal aspect
Edematous foam and mucus mixed with white slender nematodes
Microscopically
Bronchial lumens filled with parasites admixed with mucus because of goblet cell hyperplasia
Squamous metaplasia of broncial and bronciolar epithelium
Alveolar edema
Hypertrophy of bronchial smooth muscle
Eosinophilic granulomas around eggs and dead larvae

**Ascaris suum**
If calves are kept where pigs were kept
Lesions
Diffuse interstitial pneumonia
With hemorrhagic foci
Interlobular edema
Microscopically
Focal hemorrhage (intra-alveolar)
Larvae in bronchiloes and alveoli
Mixed inflammation
Including eosinophils
Hydatidosis (echinococcosis),
Sheep Lung
A large Hydatid cyst containing fluid and larvae and often is enclosed by a fibrous capsule

**Hydatid Cysts**
Intermediate stage of echinococcus granulosus
Intestinal tapeworm of canids
5-15 cm cysts

**Aspiration Pneumonias**
Inhalation of regurgitated ruminal contents
Iatrogenic deposition of medicines or milk into trachea
Mineral oil
Mild suppurative or histiocytic bronchopneumonia
Ruminal contents
Fibrinous necrotizing bronchopneumonia
Right lung more severely affected
Right cranial bronchus is closest to the trachea
Gangrenous pneumonia caused by saprophytic organisms can complicate
Cleft palate predisposes animal
Hypocalcemia impairs swallowing
Encephalitis or encephalopathy predisposes
Acute fibrinous bronchopneumonia (pleuropneumonia) pneumonic mannheimiosis (mannheimia hemolytica) lungs lamb

The cranioventral aspects of the lungs are red swollen and very firm. The consolidated lung resembles liver, hence the previous name of “lung hepatization”

**Pneumonias of Sheep and Goats**

**Mannheimia hemolytica (biotype A)**
- Shipping fever (Ovine pneumonic mannheimiosis)
- Septicemia in young lambs
- Sporadic severe gangrenous mastitis in ewes
- Pasteurella trehalosi (formerly P. haemolytica T)
- Septicemia in lambs 5-12 months old
Ovine Pneumonic Mannheimiosis
Facilitated by stressors
Handling, deworming, PI-3, RSV, adenovirus, chlamydia, bordatella
Lesions
Severe fibrinous bronchopneumonia (lobar, cranioventral)
With pleuritis
Fibrino-purulent bronchopneumonia
Sequelae
Abscesses and fibrous pleural adhesions

Chronic Enzootic Pneumonia
Multifactorial
Mild to Moderate pneumonia
Younger animals affected <1yr
Also called
Atypical pneumonia
Chronic non-progressive pneumonia
Proliferative pneumonia
Chronic differentiates from the acute mannheimia disease
Acute stages
Cranioventral broncho-interstitial pneumonia
Moderate thickening of alveolar walls
Hyperplasia of type II pneumocytes
Secondary colonization by Pasteurella multocida
Progress to fibrinous or suppurative bronchopneumonia
Later stages
Hyperplastic bronchitis
Atelectasis
Alveolar and bronchiolar fibrosis
Severe peribronchial lymphoid hyperplasia (cuffing pneumonia)
**Septicemic Pasteurellosis**
Pasteurella trehalosi (Biotype T)
> 5 mo old
Mannheimia hemolytica (biotype A)
< 2mo old
Both commensal in tonsils and pharynx of sheep
Stress causes septicemia or colonization lower in the respiratory tract
Gross Lesions
Necrotizing pharyngitita, tonsilitis
Severe congestion and edema of the lungs
Focal hepatic necrosis, infarcts and petechiae
Disseminated intravascular thrombosis with bacterial colonies in the capillaries of affected tissues

**Contagious caprine pleuropneumonia**
Sheep do not get disease
Three Mycoplasmas
Mycoplasma mycoides ssp mycoides large colony type (north america)
Mycoplasma mycoides ssp capri (north america)
Mycoplasma capricolum ssp capripneumoniae (Primary agent in Mid east and asia)
Gross Lesions
Severe fibrinous bronchopneumonia and pleuritis
Fibrinous polyarthritis, septicemia, meningitis, mastitis, peritonitis, abortion
IgG antibodies directed against ovine mycoplasmal antigens cross-react with ciliary proteins causing inflammation and ciliary dysfunction (coughing syndrome)
Acute fibrinosuppurative bronchopneumonia (pasteurella multocida)
Sheep Lung
The ventral portion of the cranial middle and caudal lung lobes are consolidated (50%)
The dorsal portions are multifocally congested and edematous

9-69
Acute fibrinosuppurative bronchopneumonia (pasteurella multocida)
Sheep Lung
The ventral portion of the cranial middle and caudal lung lobes are consolidated (50%)
The dorsal portions are multifocally congested and edematous
Acute fibrinosuppurative bronchopneumonia (pasteurella multocida)
Sheep Lung
The ventral portion of the cranial middle and caudal lung lobes are consolidated (50%)
The dorsal portions are multifocally congested and edematous

9-70
Interstitial pneumonia (unknown etiology)
Sheep lung
Heavy and rubbery and shows costal imprints on the pleural surface.

**OPP-ovine progressive pneumonia -Maedi-visna (icelandic for shortness of breath)**
Lifelong persistent virus
Ovine lentivirus-induced lymphoid interstitial pneumonia
Lymphoid interstitial pneumonia (LIP)
Non-oncogenic retrovirus- related to Caprine arthritis-encephalitis
Virus is widespread/ disease is rare
Transmission by infected colostrum and close contact
Remains within macrophages and monocytes
Clinical signs develop in 2 years or more
Lesions
Severe interstitial pneumonia
Lungs fail to collapse
Notable rib imprints
Pale and mottled lungs
Tracheo-bronchial lymph nodes enlarged
Microscopic lesions
BALT hyperplasia
Thickening of alveolar walls, and peribronchial interstitial tissue by lymphocyte infiltration
Largely T lymphocytes
Some fibrosis and smooth muscle hypertrophy
Secondary bacterial infections often seen
Enlargement of lymph nodes is because of severe lymphoid hyperplasia (B lymphocytes)
Other lesions
Non-suppurative encephalitis (visna)
Lymphocytic arthritis
Lymphofollicular mastitis
vasculitis
Interstitial pneumonia with alveolar proteinosis
Lung, cut surface, sheep
Note the gray nodules, arrows, and meaty appearance of the lung.
These lesions are seen in sheep with Caprine Arthritis-encephalitis pneumonia disease complex.

Caprine Arthritis encephalitis (CAE)
Lentivirus of goats similar to Maedi visna
2 forms
Kids
CNS
Non-suppurative leukoencephalomyelitis
Adults
Joints
Chronic, non-suppurative arthritis, synovitis
Chronic lymphocytic interstitial pneumonia
Infection early in life, disease later
Replicates in monocytes-macrophages

Gross
Diffuse interstitial pneumonia
Severe in caudal lobes
Grey pink lobes, firm
1-2 mm grey white foci when cut
Tracheobronchial lymph nodes enlarged

Microscopically
Thickening of alveolar walls
Lymphocyte infiltration
Type II pneumocyte hyperplasia
Difference between Maedi and CAE
Proteinaceous material in alveoli (surfactant)
Pulmonary form of CAE can be mistaken for parasitic pneumonia (Muellerius capillaris)

Tuberculosis
Mycobacterium bovis or avium
Uncommon
Granulomatous pneumonia
Multiple large caseous calcified, well encapsulated
Multifocal granulomatous pneumonia, lungworms (Muellerius spp)
Sheep Lungs
Multiple gray nodules (arrows, granulomas) are scattered throughout the pulmonary parenchyma
Lungs have a nodular texture on palpation

Parasitic pneumonias
Dictyocaulus filaria
Lambs and kids
Microscopically
Catarrhal
Eosinophilic bronchitis
Peribronchial lymphoid hyperplasia
Type II hyperplasia
Focal lymphocyte infiltration
Bronchioles and alveoli contain edematous fluid, eosinophils, larvae, and eggs
Muellerius capillaris
Nodular lungworm
Requires slugs or snails as intermediate hosts
Gross-sheep
Multifocal subpleural nodules
Soft and hemorrhagic early
Later are hard and calcified, gray, green
Most numerus dorso-caudally
Gross-goats
Diffuse interstitial reaction (not nodular)
Microscopically
Interstitial pneumonia
Mononuclear cells
Resembles CAE or mycoplasma

Protostrongylus rufescens
Sheep and goats
Needs snail for intermediate host
Subclinical infection
Adults live in bronchioles
Pulmonary nodules similar to Muellerius
9-73
Pneumocystosis (Pneumocystis carinii)
Lung, Pig
Alveoli are filled with a foamy eosinophilic proteinaceous material in which numerous punctiform organisms (Arrows) are present.
Inset: Silver stained oval bodies typical of Pneumocystis carinii
Does not cause remarkable gross lesions

Swine influenza
Adaptation of type A influenza
Can infect humans
Enzootic worldwide
Pathogenesis
Epithelial cell infections (oral, nasal, GI) \(\Rightarrow\) nasal, tracheal, bronchial mucosa \(\Rightarrow\) intrapulmonary airways, when severe \(\Rightarrow\) secondary infection with Pasteurella multocida, Arcanobacterium pyogenes, or Haemophilus spp.
Lesions
Catarrhal, mucopurulent inflammation
Grossly similar to mycoplasma
Fatal cases
Severe alveolar and interstitial pulmonary edema
Microscopic
Uncomplicated cases
Necrotizing bronchitis-bronchiolitis, which can extend to alveoli as broncho-interstitial pneumonia
Thickening of alveolar wall with mononuclear cells
Aggregates of macrophages, mucus, neutrophils and necrotic cells in alveolar lumen
Abortion of pregnant sows, weight loss

**PRRS (Porcine Reproductive and Respiratory System)**
Arterivirus
Late-term abortions, still-births
Respiratory problems in young pigs
Induce apoptosis as a mechanism of cell destruction
Gross Lesions
Mild- failure of lungs to collapse
Severe- consolidation of lungs in complicated cases
Tracheobronchial and mediastinal lymph nodes are enlarged
Microscopically
Interstitial pneumonia
Thickening of alveolar walls by infiltrating macrophages and lymphocytes
Mild Type II hyperplasia
Necrotic cells scattered in alveolar lumens
Diagnosis- PCR, IHC

**PMWS (Postweaning Multisystemic Wasting Syndrome)**
PCV-2 associated disease
Gross Lesions
Poor body condition
Enlargment of lymph nodes
Mild interstitial pneumonia
Microscopically
Necrosis of lymphoid follicles
Lymphocyte depletion
Proliferation of follicular macrophages
Syncytial cells (MNGC)
Granulomatous lymphadenitis
Basophilic inclusions in cytoplasm of macrophages

**Pneumocystis carinii**
Secondary to PMWS and PRRS
Microscopic
Alveoli filled with foamy exudate with clear staining organisms

**Porcine Enzootic Pneumonia (Mycoplasma hyopneumonia)**
Mycoplasma hyopneumoniae
Suppurative or catarrhal bronchopneumonia
Mild to moderater bronchopneumonia
Complications
Pasteurella multocida
Arcanobacterium pyogenes
Bordatella bronchiseptica
Haemophilus parasuis
Mycoplasma hyorhinis
Other mycoplasma and ureaplasma
Pathogenesis
Mycoplasma hyopneumoniae adheres to cilia of bronchi ⊗ ciliastasis ⊗ firmly attaches to epithelium of trachea and bronchi ⊗ provokes neutrophilic infiltrates
causes excess loss of cilia
lymphocyte hyperplasia of BALT
attracts mononuclear cells into interstitium
Reduces phagocytic activity of neutrophils
Changes mucus to predispose for bacterial colonization
Lesions
Bronchointerstitial pneumonia
Mononuclear infiltrates in alveolar walls and a few macrophages and neutrophils in the alveoli abd bronchioles
Secondary bacterial pathogens then progress to suppurative or mucopurulent bronchopneumonia
Secondary fibrinous pleuritis
Mycoplasma hyorhinis, Pasteurella multocida, Actinobacillus pleuropneumoniae

Porcine Pasteurellosis
Pasteurella multocida alone or as secondary invader
May cause acute fatal septicemia
Secondary pathogen to:
Porcine influenza
PRRS
Porcine circovirus-2
PSeudorabies
CSF
Enzootic pneumonia (Mycoplasma hyopneumonia)
Severe suppurative bronchopneumonia
Multiple abscesses and sometimes pleuritis
Other lesions
Pharyngitis with subcutaneous cervical edema
Fibrinohemorrhagic polyarthritis
Focal lymphocytic interstitial nephritis
Sequelae
Fibrous pleuritis
Pericarditis
Pulmonary abscess
9-74

Chronic Suppurative bronchopneumonia (enzootic pneumonia)

Pig lung

Top: Craniovental consolidation of 50% of the parenchyma

Bottom: The bronchiole and alveoli contain numerous neutrophils and macrophages

Alveoli are edematous and alveolar septa are also widened by inflammation
9-74
Chronic Suppurative bronchopneumonia (enzootic pneumonia)
Pig lung
Top: Cranioventral consolidation of 50% of the parenchyma
Bottom: The bronchiole and alveoli contain numerous neutrophils and macrophages. Alveoli are edematous and alveolar septa are also widened by inflammation
Porcine pleuropneumonia (Actinobacillus pleuropneumoniae), pig lung.

Peracute: Locally extensive lesions in the dorsal aspects of the caudal lung lobes. There is lobular congestion, consolidation, and interlobular edema.

Acute to subacute: The lesions expand in size and severity. Note the large area of hemorrhagic necrotizing fibrinous bronchopneumonia. Fibrin is abundant on the pleural surface and interlobular septa.

The cut surface has numerous discrete and coalescing zones of lobular inflammation and necrosis which are pale pink to white and often surrounded by a white margin (inflammation).

Histo: Alveoli are filled with fibrin, edema fluid, and neutrophils. Capillaries in alveolar septa are congested (active hyperemia) and in many cases there is necrosis of alveolar septa.

**Porcine Pleuropneumonia**

Actinobacillus pleuropneumoniae

Fibrinous bronchopneumonia with extensive pleuritis

Sever often fatal
Respiratory transmission
Sporadic septicemia, otitis media and interna
Virulence factors
Capsular factor
Fimbriae
Adhesins
LPS
Hemolysins
Cytotoxins
Permeability factors
Gross lesions
Acute form
Fibrinous bronchopneumonia - consolidation and fibrinous pleuritis
Dorsal caudal lobes
Thickened interlobular septa
Well circumscribed areas of coagulative necrosis
Except for location the lesions are identical to Mannheimia in cattle
Chronic form
Sequestra
Pulmonary abscesses
Microscopic lesions
Areas of necrosis surrounded by thick streaming leukocytes
Distention of interlobular septa
Severe edema and lymph vessel thrombosis

Haemophilus pneumonia
Haemophilus parasuis (Agent of Glassers Disease and polyserositis)
Suppurative bronchopneumonia
Requires stress to cause disease (commensal)

Streptococcal pneumonia
Strep suid type II
Zoonotic
Septic shock, meningitis, deafness
Enters via oropharyngeal mucosa
Carried in tonsil, lymph nodes
Septicemia in neonates, with arthritis, polyserositis, myocarditis, valvular endocarditis, embolic pneumonia
Other serotypes may reach the lung aeroginously
Suppurative bronchopneumonia (in combo with Pasteurella multocida, E coli, Mycoplasma hyopneumoniae)
Fibrinous bronchopneumonia (combo with Actinobacillus pleuropneumoniae)

Tuberculosis
Mycobacterium bovis
Mycobacterium avium-intracellulare
Granulomas in LN
Rare in lungs

Other Pneumonias
Porcine Respiratory Coronavirus
Mild, and recover, sporadic cases
Bronchointerstitial pneumonia
Necrotizing bronchiolitis

Septicemia
Petechial hemorrhages
Pulmonary Edema
African Swine Fever
Classical Swine Fever (Hog Cholera)
PSEudorabies
Interstitial pneumonia
Salmonella
E coli
Listeria monocytogenes

Necrotizing fibrinous Pneumonia
Salmonella cholerasuis

Chronic Suppurative Bronchopneumonia
Salmonella Typhisuis

Foreign Body Granulomatous Pneumonia
Inhalation of dusty feed
9-75
Porcine pleuropneumonia (Actinobacillus pleuropneumoniae), pig lung.
Peracute: Locally extensive lesions in the dorsal aspects of the caudal lung lobes
There is lobular congestion, consolidation, and interlobular edema
Acute to subacute: The lesions expand in size and severity. Note the large area
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The cut surface has numerous discrete and coalescing zones of lobular
inflammation and necrosis which are pale pink to white and often surrounded by
a white margin (inflammation).
Histo: Alveoli are filled with fibrin, edema fluid, and neutrophils. Capillaries in
alveolar septa are congested (active hyperemia) and in many cases there is
necrosis of alveolar septa.
9-76

Acute vermonous bronchitis (Metastrongylus apri), bronchus, cross section, pig. Several sections of nematodes admixed with mucus, neutrophils, and eosinophils are present in the lumen of the bronchus.

Parasitic Pneumonias of pigs
Metastrongylus spp
Earthworms are intermediate hosts
May transmit Swine Influenza
Gross Lesions
Small grey nodules
Grossly visible in bronchi
Microscopic lesions
Catarrhal inflammation with eosinophils
Lobular atelectasis

Ascaris suum
Migrate through lungs
Edema
Subpleural hemorrhages
Interstitial inflammation
Hemorrhages in liver, fibrosis (milk spots)
Interstitial pneumonia, canine distemper, lungs, dog

The lungs are heavy, edematous, and rubbery, with costal imprints on the pleural surface.

Inset: the bronchial epithelium contains intracytoplasmic eosinophilic inclusion bodies.

Immunoperoxidase stain reveals canine morbillivirus antigen in the cytoplasm and apical borders of bronchial epithelial cells.

Pneumonias of dogs

**Canine Distemper**

Morbillivirus (related to measles, rinderpest, peste des petit ruminants)

Invades upper respiratory tract

Proliferates in regional lymph nodes

Becomes viremic

Infests all tissues without an adequate immune response—particularly epithelial tissues
Down-regulates cytokine production
Causes pneumonia directly or indirectly by making the lungs susceptible to bacterial infections
Gross Lesions
Acute
Nasopharyngitis, serous to catarrhal, to mucopurulent
Conjunctivitis
Lungs edematous
Diffuse interstitial pneumonia
Microscopic lesions
Necrotizing bronchiolitis
Necrosis and exfoliation of pneumocytes
Mild alveolar edema
Thickening of alveolar walls
Interstitial mononuclear infiltrate
Hyperplasia of Type II pneumocytes
Secondary infection with Bordatella bronchiseptica and mycoplasma
Life threatening suppurative bronchopneumonia
Viral induced lympholysis
Eosinophilic inclusions (nuclear, cytoplasmic) in epithelial cells of lungs, stomach, bladder
Secondary effects
Enamel hypoplasia when teeth are developing (ameloblasts affected)
Neurologic disease
Hard-pad disease
Pneumonia
Toxoplasma and sarcocystis due to immunosuppression

**Canine Adenovirus 2**
Transient Respiratory disease
Replicate in pneumocytes
Bronchointerstitial pneumonia  
Hyperplastic bronchitis  
Neutrophilic and lymphocytic  
Necrosis of pneumocytes  
Type II pneumocyte hyperplasia  
Basophilic intranuclear viral inclusions

**Canine Herpesvirus 1**  
Necrotizing rhinotracheitis  
Secondary bronchopneumonia  
Latent in ganglia  
Abortion or stillbirths if cross placenta

**Canine Influenza**  
Influenza type A  
H3N8  
Severe cough  
Mild transient pulmonary lesions  
Necrotizing bronchitis with neutrophils and macrophages

**Bacterial Pneumonia of Dogs**  
Pasteurella multocida  
Streptococcus spp  
Escherichia coli  
Klebsiella pneumoniae  
Bordatella bronchiseptica  
All can be secondary to Distemper  
Streptococcus zooepidemicus  
Hemorrhagic pleuropneumonia with hemorrhagic effusion  
Death by sepsis or bacterial emboli  
Mycoplasma uncertain
Tuberculosis uncommon
Dogs susceptible *Mycobacterium tuberculosis*, *bovis*, and *avium*
Lesions
Firm calcified nodules
Diffuse granulomatous pleuritis and pericarditis
Sero fibrinous or serosanguinous effusion
Aspiration pneumonia, bronchopneumonia, right lung, dog

The cranioventral portions of the lung are firm and contain purulent exudate (yellow)

Aspiration pneumonia starts as an acute necrotizing bronchitis and bronchiolitis
The aspirate contains pathogenic bacteria and damage of the mucociliary apparatus prevents clearing and promote a fibrinosuppurative bronchopneumonia

Aspiration pneumonia in dogs
Low gastric pH makes it more severe
Septic shock and ARDS
Diffuse alveolar damage, protein rich pulmonary edema, neutrophilic alveolitis, hyaline membranes
Sequelae of cleft palate, megaesophagus, myashtenia gravis or PRAA, anesthesia

Toxic Pneumonia in Dogs
**Paraquat**

Broad spectrum herbicide

Interstitial pneumonia (pneumonitis)

Ingestion or inhalation

Selectively accumulates in lungs

Metabolites produced by Clara cells

Local release of free radicals

Injure Clara cells and blood air barrier

Lipid peroxidation of Type I and II pneumocytes

Lesions

Heavy edematous (acute)

Fail to collapse (chronic)

Interstitial emphysema, bullous emphysema

Pneumomediastinum

Necrosis of Type I pneumocytes, interstitial and alveolar edema

Intra-alveolar hemorrhages, proliferation of Type II pneumocytes

Intra-alveolar fibrosis (Chronic)

**Uremic Pneumonopathy**

Chronic uremia

Pulmonary edema

Calcification of vascular smooth muscle and alveolar BM

**Parasitic pneumonia of dogs**

**Toxoplasmosis**

Triggered by immunosuppression

Focal necrosis of epithelial cells

Necrotizing interstitial pneumonia

Proliferation of Type II pneumocytes

Macrophages and neutrophils
Focal necrotizing hepatitis, myocarditis, splenitis, myositis, encephalitis, ophthalmitis
3-6 micrometer basophilic cysts

**Pneumocystis carinii**
Chronic interstitial pneumonia in dogs with compromised immune system

**Filaroides hirthii**
Lungworm of alveoli and bronchioles of dogs
Lesions
MF subpleural nodules
Eosinophilic granulomas associated with larvae or dead worms

**Crenosoma vulpis**
Foxes and dogs
Intermediate hosts are snails
Adults live in small bronchi and bronchioles, causing eosinophilic and catarrhal bronchitis
Bronchiolar goblet cell metaplasia and mucous obstruction

**Paragonimus kellicotti**
Asymptomatic flukes in fish eating species
Lesions
Pleural hemorrhage
Multifocal eosinophilic pleuritis
Cysts – 7mm- containing pairs of adult flukes

**Aleurostrongylus vasorum and Dirofilaria Immitis**
Parasites of pulmonary arteries and right ventricle
Adult parasites
Chronic arteritis leading to pulmonary hypertension
Interstitial (eosinophilic) pneumonia
Pulmonary interstitial fibrosis
Congestive RHF
Caudal vena caval syndrome
Diffuse pulmonary hemosiderosis, parasitic granulomas, pulmonary infarcts
9-79

Systemic (deep) mycoses

Top Left: Blastomyces dermatitidis 8-25 um diameter, broad based budding spherical yeastlike organisms

Top right: Cryptococcus neoformans, spherical 2-10um in diameter, usually surrounded by a thick mucus capsule which can increase the overall diameter up to 30 um, intracellular or extracellular location. The mucus capsule does not stain with H&E but is stained by mucicarmine. The capsule shrinks and distorts in conventional preparation.

Bottom left: Histoplasma capsulatum: Located intracellularly, is a spherical to slightly elongated 5-6 um in diameter

Bottom right: Coccidioides immitis, spherules 20-30 um containing endospores, intracellular or extracellular location.

Mycotic pneumonias

Aspergillus

Multifocal, nodular, pyogranulomatous, granulomatous pneumonia

Fungal hyphae
Necrosis
Vasculitis
Neutrophilic infiltrate
Macrophages, fibroblasts, encapsulates

**Deep Mycoses**
Blastomyces dermatitidis
Histoplasma capsulatum
Coccidioides immitis
Cryptococcus neoformans
Virulence factors favor hematogenous dissemination and evasion of immune system

**Blastomycosis**
Dimorphic
Dogs and cats
Lungs—to blood—to bone, skin, eyes, brain
Lesions
MF to coalescing granulomatous pneumonia, or pyogranulomatous pneumonia
Epithelioid macrophages, MNGC’s, thick walled yeasts 5-25 micrometers

**Coccidiomycosis**
Dimorphic
Aeroginous infection—to disseminates
Focal granulomas or pyogranulomas with suppurative or caseated centers
Double walled refractile spherules 10-80 micrometer

**Histoplasmosis**
Dimorphic
Inhalation
Well encapsulated granulomas
Diffuse lung involvement
Granulomatous tissue with many macrophages filled with small (1-3 micrometer) punctiform intracytoplasmic dark oval bodies (yeasts)
Granulomatous pneumonia, blastomycosis (*Blastomyces dermatitidis*), dog

The lung contains large numbers of small granulomas distributed throughout all pulmonary lobes.

The cut surface of the lung shows multiple discrete and coalescing gray-white granulomas distributed randomly throughout the lung.

9-80

Granulomatous pneumonia, blastomycosis (*Blastomyces dermatitidis*), dog

The lung contains large numbers of small granulomas distributed throughout all pulmonary lobes.

The cut surface of the lung shows multiple discrete and coalescing gray-white granulomas distributed randomly throughout the lung.
Acute hemorrhagic bronchopneumonia, acute respiratory distress syndrome (ARDS) in 4wk old puppy
The lungs did not collapse when the thorax was opened.
The cranioventral aspects are consolidated with diffuse hemorrhage
Histo: Alveolar capillary congestion, thick hyaline membranes along the alveolar septa (arrows), and intra-alveolar hemorrhage.

9-81
Acute hemorrhagic bronchopneumonia, acute respiratory distress syndrome (ARDS) in 4wk old puppy
The lungs did not collapse when the thorax was opened.
The cranioventral aspects are consolidated with diffuse hemorrhage
Histo: Alveolar capillary congestion, thick hyaline membranes along the alveolar septa (arrows), and intra-alveolar hemorrhage.
Fibrinopurulent bronchopneumonia, lungs, kitten, 5 mo old
History of conjunctivitis, rhinitis, and bacterial pneumonia.
Cranioventral consolidation, firm and when cut some exudate is present in the major bronchi

9-82
Fibrinopurulent bronchopneumonia, lungs, kitten, 5 mo old
History of conjunctivitis, rhinitis, and bacterial pneumonia.
Cranioventral consolidation, firm and when cut some exudate is present in the major bronchi

**Pneumonias of cats**
Herpes and calicivirus do not generally cause pneumonia, but may cause secondary bronchopneumonia with immunosuppression

**Feline Pneumonitis**
Chlamydophila (psittaci) felis
Conjunctivitis
Rhinitis
Bronchointerstitial pneumonia
Neutrophilic bronchiolitis
Thickening of alveolar septae- edema, infiltration of neutrophils and mononuclear cells
Type II pneumocyte hyperplasia
Alveolar histiocytosis

**Bacterial Pneumonias of Cats**
Secondary Organisms
Pasteurella multocida etc
Also causes otitis media and meningitis
Pyothorax
Mycobacterial infections
Classical tuberculosis
Mycobacterium bovis, tuberculosis, Avium
Rare
DDX pulmonary neoplasms
Gi disappointment lungs, skin
Feline leprosy
Mycobacterium lepraeurium
Focal skin granulomas
Atypical mycobacteriosis
Mycobacterium avium –intracellulare complex
Contamination of skin wound

**Mycotic pneumonias in cats**
Cryptococcus neoformans
Cats harbor it in their nasal cavities
Immunocompromised cats develop disease (FIV, FeLV)
Granulomatous rhinitis, sinusitis, otitis, pneumonia, ulcerative dermatitis, meningoecephalitis,
Multifocal granulomatous pneumonia with small gelatinous white foci
Lesions contain numerous fungi (4-10 micrometers without capsule) and only a few macrophages, lymphocytes, and MNGC. Large halo around yeasts.
Other Pneumonias of Cats

Endogenous Lipid Pneumonia
Lipids from pulmonary surfactant accumulate in alveolar macrophages
Gross
Multifocal, white firm nodules, scattered throughout the lungs
Microscopically
Alveoli filled with foamy lipid-laden macrophages with interstitial inflammation of
lymphocytes and plasma cells and fibrosis, and alveolar epithelialization.
Occurs frequently in the vicinity of cancer lesions in lung

Exogenous Lipid Pneumonia
Mineral oil for hairballs

Aspiration pneumonia
Vomiting, regurgitation, dysphagia, anesthetic complications, iatrogenic.

Parasitic pneumonias of cats
Aleurostrongylus abstrusus
Snail or slug is intermediate host
Toxoplasma gondii
Paragonimus kellicotti
Dirofilaria immitis

Fetal Pneumonias
Aspiration of amniotic fluid and bacteria from placentitis
Secondary to fetal hypoxia and acidosis (fetal distress)
Microscopically
Bronchoalveolar spaces contain variable numbers of neutrophils, macrophages
and meconium
Involves all pulmonary lung lobes
Cattle
Brucells abortus
Arcanobacterium pyogenes
Both present in large numbers of cattle bacterial placentitis
Inflammation of placenta interferes with oxygen exchange
Aspergillus spp
Ureaplasma
Both sporadic cases of placentitis
Interstitial Pneumonia in fetus (Hematogenous)
Listeria monocytogenes
Salmonella spp
Chlamydia psittaci
Microscopic lesions
Focal necrotizing interstitial pneumonia
Focal necrosis of the liver, spleen, or brain
Broncho-interstitial pneumonia in fetus
Viruses
IBR
PI3
EVR

Neonatal Pneumonias and septicemias
Newborns lacking passive immunity
Inhalation of bacteria
Histophilus somni
Pasteurella multocida- cattle
Streptococcus spp - foals
E coli
Listeria
Strep suis - pigs
Meconium Aspiration Syndrome
Same pathogenesis as fetal pneumonia, but can occur after delivery before nasopharynx is cleared
Accompanied by neonatal hypoxia and acidosis
Pulmonary hypertension and airway hyperreactivity
Gross lesions
Focal patchy atelectasis
Micro
Meconium and keratin exfoliated from skin in bronchi, bronchioles, and alveoli
Mild alveolitis- leukocytes, macrophages
Ovine pulmonary carcinoma (pulmonary adenomatosis, jaagskiekte), 3yr old sheep

Neoplastic cell infiltration involving the cranial and ventral portions of the lung and mainly sparing the dorsal portions of the caudal lung lobe (N).

The affected lung is enlarged and firm.

Inset: Papillary proliferation of cuboidal epithelial cells (presumed type II pneumocytes)

Transverse section: Solid appearance of the ventral portion of the lung and the frothy edema that originates in the alveolar walls.

Neoplasia of the lungs
Primary
Benign
Pulmonary adenomas
Bronchiolar-alveolar adenoma
Hemangioma
Malignant
Adenocarcinoma
SCC
Bronchiolar-alveolar carcinoma
Anaplastic carcinoma
Carcinoid tumor (neuroendocrine)
Ovine (retroviral) pulmonary carcinoma
Osteosarcoma
Chondrosarcoma
Hemangiosarcoma
Malignant histiocytosis
Lymphomatoid granulomatosis
Granular cell tumor
Mesothelioma
Secondary tumors (metastatic)
OSA
Uterine carcinoma in cattle
Malignant melanoma in horses

Ovine pulmonary carcinoma (pulmonary adenomatosis)
Transmissible retrovirus induced neoplasia
Behaves like chronic pneumonia
Affects mainly mature sheep
Death is inevitable
Similar to MAedi
Gross Lesions
Enlarged heavy, wet
Many firm grey nodules
Mucoid secretion
Microscopically
Papillary proliferation of cuboidal epithelial cells (type II, and clara cells)
Sequelae
Secondary bronchopneumonia
Abscesses
Fibrous pleural adhesions
Metastasis does occur to LN
DDX
Copious mucoid fluid drains from nose when held from hind legs (Neoplasm) but not from Maedi

Carcinoid (neuroendocrine tumor)
Sporadic in dogs
Polygonal cells with finely granular eosinoiphilic cytoplasm, small nuclei
Arise around main stem bronchi

Lymphomatoid granulomatosis
Rare
Nodules or large soild masses in one lung lobe
Pleomorphic mononuclear cells
Grow around blood vessels and destroy vascular walls
Mixed population of plasma cells, B and T lymphocytes and Histiocytes

Secondary Neoplasms of Lungs
Epithelial
Mammary
Thyroid
Uterine carcinomas
Mesenchymal
Hemangiosarcoma
Malignant melanoma
Lymphosarcoma
Vaccine associated fibrosarcoma
Osteosarcoma
Metastatic thyroid carcinoma, lungs, adult dog
The lungs contain multiple randomly distributed metastatic nodules which originated from the enlarged and neoplastic left thyroid gland.

9-85
Metastatic thyroid carcinoma, lungs, adult dog
The lungs contain multiple randomly distributed metastatic nodules which originated from the enlarged and neoplastic left thyroid gland.
Lung dog: Metastatic sarcoma (primary site unknown). Large numbers of metastatic nodules are randomly distributed throughout all lung lobes.

9-86a

Lung dog: Metastatic sarcoma (primary site unknown). Large numbers of metastatic nodules are randomly distributed throughout all lung lobes.
Lung dog: Metastatic hemangiosarcoma. Note the dark red masses throughout the lung parenchyma.

9-86b
Lung dog: Metastatic hemangiosarcoma. Note the dark red masses throughout the lung parenchyma.
Metastatic lymphoma (LSA), lungs, cow. Note the numerous discrete and confluent metastatic nodules with the smooth texture and gray color characteristic of lymphoma.
Hydrothorax (hepatic hydrothorax) and hepatic cirrhosis, pleural cavity, 8 yr old dog. The pleural cavity contains a large amount of dark yellow transudate (*). The lungs show focal lobular atelectasis. (Also not the nodular surface of the cirrhotic liver)

Pleura and thoracic cavity

Anomalies

Cysts
Thymic branchial cysts
Perinephric pseudocysts
Brocnhi
Branchial pouch remnants

Degenerative Disturbances
Pleural calcification
Chronic uremia
Linear white streaks in parietal pleura
Vitamin D toxicity
Hypercacemic substances

**Pneumothorax**
Humans have thick complete mediastinum
Mediastinum is variable in dogs
Generally less complete

**Pleural effusion**
General term for any fluid in pleural cavity

**Hydrothorax**
Transudate, clear, does not clot
Causes pleural hyperplasia and fibrosis

**Chylothorax**
Mostly idiopathic in dogs

**Pleuritis**
Can lead to pyothorax
Can result in severe toxemia
Can be extension of pneumonia
Pneumonic Mannheimiosis
Pleuropneumonia
Can be solitary
Polyserositis in pigs
Pleural empyema in cats
Caused by bacteria
HAemophilus parasuis (glassers disease)
Streptococcus suis type II
Pasteurella multocida in pigs
Streptococcus equi
Strep zoo
E coli in calves
Mycoplasma
Haemophilus in sheep and goats
Nocardia , Actinomyces, Bacteroides in cats and dogs
Pyogranulomatous pleuritis, with blood stained pus with sulfur granules

FIP- dry and wet forms

Horses
Nocardia asteroides, brasiliensis
Mycoplasma felis

**Neoplasms**

**Mesothelioma**
Congenital in calves
Pleural effusion with respiratory distress, cough and weight loss
Morphologically similar to reactive mesothelial cells
Reactive mesothelial cell can be multinucleated and pleomorphic and mistaken for carcinoma
Grossly
Multiple discrete nodules, or arborescent, spreading growths on the pleural surface
Microscopically
Neoplastic component can be either epithelial or the supporting CT
Carcinomatous or Fibrosarcomatous
Rarely metastasize
Hemothorax, right pleural cavity, dog. The right pleural cavity is filled with a large clot of blood from a ruptured thoracic aortic aneurysm, which caused unexpected death. Canine aortic aneurysms are associated with migration of Spirocerca lupi larvae along the aortic wall before their final migration into the wall of the adjacent esophagus.
Chylothorax (cause unknown), thoracic (pleural) cavity, mink. Lymph fills both the left and right pleural cavities.
Large amounts of purulent exudate cover the visceral and parietal pleurae. The lesion is referred to as pleural empyema.
Fibrinous pleuritis, right pleural cavity, horse
Large masses of yellow fibrin cover the visceral and parietal pleurae. The lungs are normal
A. Chronic pleuritis (Nocardia asteroides), pleural cavity, cat. The pleural cavity holds abundant red-brown exudate (“tomato soup”). The fluid contains granulomatous cells and sulfur granules.

Nocardiosis.

A. Chronic pleuritis (Nocardia asteroides), pleural cavity, cat. The pleural cavity holds abundant red-brown exudate (“tomato soup”). The fluid contains granulomatous cells and sulfur granules.
B. Chronic pleuritis (Nocardia asteroides), visceral pleura, dog. The thickened pleura has a granular appearance because of granulomatous inflammation and the proliferation of fibrovascular tissue of the pleura.

9-93

Nocardiosis. B. Chronic pleuritis (Nocardia asteroides), visceral pleura, dog. The thickened pleura has a granular appearance because of granulomatous inflammation and the proliferation of fibrovascular tissue of the pleura.
C. Chronic pleuritis (Nocardia asteroides), thoracic cage, dog. The pleura has been thrown up into villouslike projections composed of abundant fibrovascular tissue and granulomatous inflammation. Leakage from the neocapillaries of the fibrovascular tissue is responsible for the hemorrhagic appearance of the pleural exudate.

9-93

Nocardiosis.

C. Chronic pleuritis (Nocardia asteroides), thoracic cage, dog. The pleura has been thrown up into villouslike projections composed of abundant fibrovascular tissue and granulomatous inflammation. Leakage from the neocapillaries of the fibrovascular tissue is responsible for the hemorrhagic appearance of the pleural exudate.
9-93a

Nocardiosis. D. Chronic pleuritis (Nocardia asteroides), parietal pleura, cat. Large pieces of exudate, which contain sulfur granules, are present on the thickened pleura.
Mesothelioma (M), lungs and heart, horse. The tumor has proliferated and extended over the ventral parietal pleura and pericardium. The pericardial sac has been opened, and the epicardium appears essentially normal, indicating that the tumor did not invade the pericardial sac.