Inflammation and infectious etiologies: General overview and Case presentations
Reema Patel, DVM, DACVP
rtpatel@vet.upenn.edu

These notes are intended as an overview of a very broad topic and distributed for your reference, the presentation will focus on several of these etiologic agents.

Inflammation

<table>
<thead>
<tr>
<th>Type of inflammation</th>
<th>Predominant Cell Type</th>
<th>Common Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute (Neutrophilic/Suppurative)</td>
<td>Neutrophils</td>
<td>Bacterial infection, neoplasia, immune-mediated disease</td>
</tr>
<tr>
<td>Pyogranulomatous/Chronic suppurative</td>
<td>Macrophages (multinucleated giant cells and epithelioid macrophages, neutrophils, +/- lymphocytes and plasma cells.)</td>
<td>Foreign bodies, fungal infection, mycobacterial infection, some neoplasia</td>
</tr>
<tr>
<td>Granulomatous/Histiocytic/Chronic</td>
<td>Macrophages ( +/- fewer lymphocytes and neutrophils)</td>
<td>Similar causes as pyogranulomatous as well as Resolving/continued inflammation</td>
</tr>
<tr>
<td>Eosinophilic</td>
<td>Eosinophils</td>
<td>Parasitic infection, allergic/hypersensitivity disease, or neoplasia</td>
</tr>
<tr>
<td>Lymphocytic-plasmacytic</td>
<td>Lymphocytes, plasma cells</td>
<td>Injection site reaction, feline stomatitis/gingivitis, pododermatitis, viral infection, immune-mediated disease, neoplasia</td>
</tr>
</tbody>
</table>

Infectious Agents
- Bacteria, fungi, parasites, viral inclusions, protozoa
- Important to distinguish between opportunistic, contaminant, and pathologic agents.

Pathogenic Bacteria
With routine staining (Diff-Quik, Wright-Giemsa etc.) non mycobacterial bacteria stain blue to purple (basophilic). When bacteria are noted intracellularly within neutrophils or in certain cases macrophages (e.g. Rhodococcus) cytologic findings indicate a primary or secondary bacterial infection.

Oftentimes bacteria are noted both extracellularly and intracellularly with bacterial infections. If no intracellular organisms are detected this may reflect bacterial contamination or infection.

Assess type of bacteria -
- Cocci
- Bacilli/rods
- Filamentous/Beaded rods (Actinomyces or Nocardia) ¹ *
- Monomorphic population
- Pleomorphic/Mixed population
Actinomyces-facultative anaerobe creates sulfur granules, acid-fast negative
Nocardia-aerobic, no sulfur granules, partially acid-fast

Important for laboratory to be aware of suspicion of these organisms so that adequate culture techniques may be employed. Specialized media are not required for culture of members of either group but the use of semi-selective media may increase isolation rates in the presence of more rapidly growing organisms.

*Also of note Nocardia is not susceptible to Penicillin/Ampicillin as opposed to Actinomyces.
Treatment requires a combination of appropriate surgical drainage or debridement and long term antibiotic treatment.
Nocardia does require susceptibility testing given several species high rate of antibiotic resistance.

Mycobacteria sp. *

These organisms have a lipid cell wall and hence are negative staining using routine stains. All members of the genus are aerobic, acid-fast, non-spore forming, nonmotile rods. They cover the range from saprophytes to opportunists to obligate pathogens.
**Tuberculous forming** - in animals commonly *M. Bovis, M. Avium ssp. avium*

**Rapid-growers** (*M. fortuitum* group) produce colonies in less than 7 days and slow growers (*M. tuberculosis* complex, *M. avium* spp.) require 7-14 days or longer (in some cases several months).

**Feline leprosy** - chronic nodular ulcerative mycobacterial infection of the skin, organism has not been successfully cultured in vitro.

**Canine leproid granuloma** - condition affects the skin most commonly of dorsal pinnal fold followed by the face and body extremities. It is frequently self-limiting usually cured through complete surgical excision though some will require antibiotic therapy for complete resolution.

Rapidly growing mycobacteria can cause nodular draining skin lesions of cats (frequently occurs on the abdomen of cats) -
- Need to rule out Nocardia, Actinomyces, and feline ventral abdominal angiosarcoma.
- Most common isolate is *M. fortuitum* in N. America.

**Tests available:** include culture, qPCR, skin testing.

**Nonpathogenic Bacteria**

![Image of mycobacteria](image.png)

**Simonsiella sp.** - contaminants from oral cavity, they are noted free within the background or adhered to squamous epithelial cells. Bacilli that replicate lengthwise and line up as parallel rows (stack of pancakes)
**MYCOTIC INFECTIONS:**

**Subcutaneous Mycoses**

**Sporotrichosis** *
*Caused by:* *Sporothrix schenckii*

**Where to find it:** Worldwide distribution, especially tropical & subtropical regions. It is a saprophyte so on dead/senescent vegetation (rose thorns, timber, hay, straw, certain moss)

**Pathogenesis:** Sporotrichosis is a chronic cutaneous or lymphocutaneous disease; rarely becomes generalized. Dissemination can be seen in immunocompromised individuals.

**Feline**—Nodular skin lesions on limbs, head, and tail. Secondary nodules can form along lymphatics. Nodules ulcerate and drain; severe ulceration can expose underlying structures (muscle, bone). Abundant yeast in lesions—potential human health hazard?? Sodium iodide in food +/- ketoconazole. ZOONOTIC Potential of feline disease—CATS WILL SHED high numbers of fungi in lesion exudates and feces and it has been isolated in cats without clinical signs of sporotrichosis.

**Canine**—Lymphocutaneous predominant syndrome. Lesions begin at point of entry and consist of subq nodules that ulcerate and heal. With disease progression follow lymphatic vessel and +/- LN involvement. Lesions usually are neither painful or pruritic. Dissemination rare (recent report in a hunting dog). Similar treatment to cats. Minimal zoonotic importance due to few organisms present in tissues of most affected dogs.

**Horse**—Lymphocutaneous most common manifestation. Spores enter through skin abrasions on lower limbs. Nodules eventually develop and ulcerate and drain (yellow exudate). Subcutaneous edema can follow from obstruction of lymphatics. Treatment: Inorganic iodide added to feed.
Microscopic identification:
- Cytologic examination of exudate material—easiest in cats as numbers of organisms reportedly less in exudates from other species.
- Cytologic appearance: 2-4 um length, cigar-shaped to ovoid/elongate, basophilic, surrounded by thin (<0.5 um) negative-staining capsule-like structure
- Histology

Other methods of Diagnosis:
Fungal isolation - samples need to be deep from within the draining tract and ALERT the laboratory that sporotrichosis is being considered.

**There is a new ELISA that has been validated for detecting sporotrichosis infection in the feline. Two different kinds of antigens were used: "SsCBF", a specific molecule from *S. schenckii* that consists of a Con A-binding fraction derived from a peptido-rhamnomannan component of the cell wall, and a *S. schenckii* crude exoantigen preparation. SsCBF showed 90% sensitivity and 96% specificity in ELISA; while crude exoantigens demonstrated 96% sensitivity and 98% specificity.

Systemic Mycoses
True pathogens (e.g. Histoplasma, Coccidioides) have the ability to elicit disease in a normal host when the inoculum is of sufficient size. Obviously, 'normal' is relative to tests available and our understanding on the host’s immune system.

The second group is considered opportunistic, meaning the organisms are of low virulence but the host's diminished resistance or immune function results in clinical disease.

<table>
<thead>
<tr>
<th>TRUE PATHOGENS</th>
<th>OPPORTUNISTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DISEASES</strong></td>
<td></td>
</tr>
<tr>
<td>Histoplasmosis *</td>
<td>Aspergilus *</td>
</tr>
<tr>
<td>Blastomycosis *</td>
<td>Candidiasis</td>
</tr>
<tr>
<td>Coccidiomycosis *</td>
<td>Zygomycosis</td>
</tr>
<tr>
<td>Paracoccidioidomycosis</td>
<td>Cryptococcus *</td>
</tr>
<tr>
<td></td>
<td>Pneumocystis *</td>
</tr>
<tr>
<td><strong>Host</strong></td>
<td></td>
</tr>
<tr>
<td>'Normal'</td>
<td>Compromised immunity</td>
</tr>
<tr>
<td><strong>Portal of entry</strong></td>
<td></td>
</tr>
<tr>
<td>Respiratory (primarily)</td>
<td>Respiratory, skin</td>
</tr>
<tr>
<td><strong>Prognosis</strong></td>
<td></td>
</tr>
<tr>
<td>Subclinical to severe/fatal</td>
<td>Depends on host immune response</td>
</tr>
<tr>
<td>- Host &amp; fungus factors</td>
<td>-- exploit break in host line of defense</td>
</tr>
<tr>
<td><strong>Host response</strong></td>
<td>Similar—pyogranulomatous to granulomatos but depends on immune system</td>
</tr>
<tr>
<td><strong>Morphology</strong></td>
<td></td>
</tr>
<tr>
<td>Thermal dimorphism</td>
<td>Morphology mostly uniform</td>
</tr>
<tr>
<td>-- appearance &amp; biological behavior depends on temperature</td>
<td>-- optimal growth at body temperature</td>
</tr>
<tr>
<td><strong>Distribution</strong></td>
<td>Often geographically limited</td>
</tr>
</tbody>
</table>

![Diagram of Dimorphic and Opportunistic Fungi](image-url)
Blastomycosis *

Caused by: *Blastomyces dermatitidis*

Where to find it:

![Map showing areas of blastomycosis](image)

Assumed to be a soil saprophyte, exact niche still a mystery. Southeastern and south central states bordering Mississippi, Missouri and Ohio River valleys, upper Midwest, Canadian provinces near the great lakes, sporadically throughout US, Europe, Africa, Asia

How to get it:

- Live within 400 m of a body of water near sea level
  - Areas of Arkansas & Wisconsin: incidence of blastomycosis 10x higher in dogs vs. humans (dogs closer to ground?), man and dog natural hosts
- Recent rains/soil excavation seem to facilitate release of infective spores
- Kenneled animals kept on moist soil, in shady areas

Clinical forms: Disseminated/Systemic or Cutaneous

**Disseminated:**

- Typical route of infection: inhalation of aerosolized conidia
  - Dissemination via vascular & lymphatic routes (proposed mechanisms)
- Organs affected: Lungs, skin, eyes, bones, lymph nodes, brain, testes
- Dimorphic fungus so it has 2 different stages (yeast & mycelial) depending on temperature & gene regulation (DRK1)

Clinical signs

- Respiratory signs predominate (dyspnea, exercise intolerance, cough)
- Anorexia, weight loss, lameness, skin lesions, blindness
- Physical exam findings: Fever, lymphadenopathy, dry & harsh lung sounds, uveitis (organism persists in eyes even after treatment)
- Ocular lesions (corneal opacity, uveitis, conjunctivitis, or blindness) occurred in 30-40% of dogs with systemic disease.
- Possible clinicopathologic findings: non-regenerative anemia, inflammatory leukogram, hypercalcemia, hyperglobulinemia
- Radiographs: diffuse, nodular interstitial pattern/miliary pattern; bone involvement

**DOGS>>CATS; other species susceptible**
Large breed dogs, younger dogs.

![Image]

**Diagnosis:**

1. Direct visualization of organism:
   - Tissue and/or fluid aspirates of affected area(s)
   - Respiratory tract
     - Trans-tracheal wash/BAL
     - Aspiration of lung tissue
   - Aspiration of affected lymphoid organ (lymph node, spleen)
   - Impression smear of draining tract
   - Histologic identification of biopsy sample, tissues taken at necropsy

**Cytologic appearance:**

- Slightly larger (@2 x) than a neutrophil, consistent in size
- Deeply basophilic (deep blue), with a refractile, double contoured wall.
- Broad-based budding.
- Extracellularly
- Profound pyogranulomatous inflammation
  (neutrophils + epithelioid macrophages + multinucleated giant cells + lymphoid cells + plasma cells)

**Antibody vs. antigen detection**

**OLD:** presence of serum antibodies (using agar gel immunodiffusion or RIA)

**NEW:** Presence of ANTIGENS (using an enzyme immunoassay) in serum, urine, plasma, CSF, bronchial fluid or other body fluids sensitivity for the detection of antigen in urine was 93.5% and it was 87.0% in serum. The sensitivity of antibody detection by agar gel immunodiffusion (AGID) was 17.4% and it was 76.1% by EIA.
HISTOPLASMOSIS*

Caused by: *Histoplasma capsulatum*

Where to find it:
- Endemic in river valleys in Midwest (Mississippi & Missouri rivers), mid-Atlantic, & southeastern US
- Preferred ecologic niche:
  - nitrogen-rich soil due to accumulated bird or bat droppings
- Birds can act as fomites

How to get it:
- Stand downwind of accumulations of bird or bat droppings
  - Wind helps to disseminate the organism and infection
- Common in wild and domestic animals in endemic regions
- Previously cultured from soil, water, air
  - Inhalation is the #1 route of infection
    - Infection occurs through ingestion or inhalation of microconidia or mycelial fragments which then undergo transformation into the yeast form (dimorphism)
    - Is seen in both predominantly indoor or outdoor-house animals
- Disease severity is determined by # of conidia inhaled & host's immune response
  - Most individuals: asymptomatic infection or mild signs
    - Organisms walled off in nodules (organisms remain alive)
  - Individuals subjected to a large inoculum: severe pulmonary infection

Dogs most susceptible of the domestic species
Young, outdoor, sporting breeds most commonly affected.
3 forms of the disease - pulmonary, disseminated, and clinically inapparent

Canine infection
Most canine infections are inapparent but when clinical signs are evident reflect specific organ involvement.
Organs most commonly affected include GI, Skin, Lymphatics, CNS, BM, eyes, liver and spleen

Feline infection
Rare progressive debilitating disease. Weight loss, lethargy, fluctuating fever, splenomegaly, anemia, less often cutaneous or ocular lesions.
1. Visual identification of organism (via cytology or histopathology)
   - Bone marrow, lymph node aspiration, fluid analysis, tissue aspiration (liver, spleen)
   - Identify on blood smear/buffy coat examination of blood
   - Rectal scraping (dogs with diarrhea/GI signs)

   **Cytologic appearance:**
   - Intra- or extracellular
   - Ovoid and small (3-5 um length x 2-3 um width)
   - Displays 'half-empty/half-full' appearance with basophilic and eosinophilic center
   - Thin (0.5), clear or poorly-staining capsule (artifact, not true capsule)

   Variable degree of inflammation (minimal to pyogranulomatous)

2. Radiographic findings:
   - Diffuse pulmonary interstitial pattern
   - Infiltrates often coalescing & may appear miliary or grossly nodular

3. Immunodiagnosis
   - Intradermal skin tests (reactivity to histoplasmin)—unreliable
   - Serologic tests (complement fixation, agar-gel immunodiffusion)
     - Chronic low level exposure can lead to positive serologic titers but clinically inapparent disease.
     - Often falsely negative in animals with disease
     - Cross-reacts with Blasto!!
     - Antigen detection assay which identifies a polysaccharide antigen of *H. capsulatum* in serum, CSF, urine used in humans (MiraVista Diagnostics [www.miravistalabs.com](http://www.miravistalabs.com))
     - More likely to be positive with dissemination

4. PCR available in some commercial reference laboratories.
5. Fungal culture
- Not recommended in routine practice (highly infective microconidia) \(\rightarrow\) send to lab
- A *dimorphic fungus* that exists as a mold in the environment and a yeast in tissues (and blood agar culture) at 37°C

*Coccidiomycosis*

**Caused by:** *Coccidioides immitis* (CA, Valley only) & *C. posadasii* (CA & AZ)
-- These are morphologically identical but have slightly different niches

**Aliases:** 'Valley Fever' for the San Joaquin Valley in California

**Where to find it:**
- Southwestern U.S., Mexico, Central & South America
- Dinosaur National Monument (Northeastern Utah)
  - Excavation site

**How to get it:**
- Inhalation of arthroconidia (aka arthrospores) which are highly infectious
- Hang out in the desert after: recent soil excavation; intense/heavy rain following a prolonged period of drought, recent dust storm

**Disease**
- Most animals & people \(\rightarrow\) asymptomatic to mild respiratory signs = clear infection
- As with other fungal infections, CMI is necessary (not a humoral response—although antibodies are produced and can be used for diagnostic purposes, they are not protective).
  - Intact spherules:
    - Poorly chemotactic for neutrophils (neutrophils cannot penetrate spherule wall)
  - Endospores:

![Map showing areas where Coccidiomycosis is found](http://www.familyvet.com/Dogs/601.JPG)
- Very chemotactic and easily phagocytized
  - Macrophages remove the organism (endospores).
- With depressed cellularity immunity → dissemination

Affected organs: bones, eyes, heart, pericardium, testes, brain, spinal cord, viscera

**Clinical signs**

- Most common form of disease—*asymptomatic or mild respiratory tract disease (dogs)*
- Affected animals (can have disease limited to respiratory tract or disseminated): Surveys indicate 80% of dogs have primary pulmonary infection and 20% develop disseminated disease
  - Respiratory infection:
    - Dry, harsh cough similar to tracheobronchitis/kennel cough
    - Wet, moist productive cough (alveolar involvement)
    - Hilary lymphadenopathy or diffuse interstitial disease
  - Fever, anorexia, weight loss also
  - Disseminated disease (listed from most to least common):
    - Fever, anorexia, weight loss, depression and weakness, lameness, peripheral lymphadenopathy that is localized, draining skin lesions from systemic disease, seizures, bone/spinal pain, keratitis, uveitis, acute blindness

Extrapulmonary dissemination occurs most frequently to the bone and skin

**Feline:** Clinical signs in cats is similar (skin lesions more common though)

**Horses**—non-specific signs such as intermittent fever, abdominal pain, weight loss + pulmonary & musculoskeletal involvement (osteomyelitis in @ 1/3); recurrent superficial abscessation; causes abortion rarely.

**Llamas** highly susceptible to this organism - respiratory, dermatitis, osteomyelitis, meningitis, and polyarthritis.

**Diagnosis**

- In endemic areas, veterinarians may rely heavily on clinical suspicion of disease based on PE findings & coccidioidal serology. Travel history of animals is very relevant for veterinarians practicing in non-endemic areas. Radiography of the thorax and/or affected limb(s) (because of lameness) is also often utilized. More challenging cases may require aspiration (with cytology) or biopsy. More than one diagnostic procedure may be necessary.
  - DO NOT try and culture—extremely hazardous
1. **Lab findings:** often non-specific—mild non-regenerative anemia, leukocytosis due to neutrophilia and monocytosis, hyperglobulinemia, hypoalbuminemia, hypercalcemia

2. **Radiographic findings:**
   - Variable thoracic radiograph findings
     - Most common: diffuse interstitial pattern
     - Miliary to nodular densities may be found
     - Hilar lymphadenopathy
   - Osteomyelitis (lysis and bone production)

3. **Serologic testing**
   - AGID (agar gel immunodiffusion) for IgG & IgM antibodies run mostly by laboratories
     - Specific but insensitive
       - Infected animals may test negative
   - ELISA to detect IgM & IgG and latex particle agglutination (LA) for IgM
     - Both rapid screening (more sensitive) but false positives more likely
       - If positive, confirm with more specific AGID
   - IgM test reports as + OR -
   - IgG tests quantified by AGID to report a titer
     - Studies failed to find a consistent correlation between magnitude of IgG titer and severity of infection
       - e.g. dog with low titer of 1:2 can be clinically ill but subclinically infected dogs may have a titer as high as 1:6
       - Consider serial monitor of titers
       - Titers can remain high following recovery
   - Serology in cats useful for diagnosis (i.e. sick cat with positive titer likely has disease) but don’t use for monitoring
Visualization of organism:
- Can take samples from lytic bone lesions, transtracheal or bronchial washings, pleural fluid, lymph nodes, draining tracts, etc
- Via cytology or biopsy/histopathology

*SPHERULE CONTAINING ENDOスポRES defining feature cytology and histopathology
Several biopsies should be taken as organism can be missed.

Cryptococcosis *
Worldwide distribution
Unique amongst systemic mycotic agents as no geographical limitation

Monomorphic fungi—grows as a yeast in infected tissue and in the environment
Only encapsulated systemic mycotic agent

Originally divided into four serotypes (A-D) based on capsular agglutination reactions now divided using DNA molecular methods (PCR, AFLP, RFLP, sequencing).
1. C. neoformans var neoformans—VNIV, VNIII hybrid
2. C. neoformans var grubii—VNI, VNII, VNIII hybrid
3. C. gattii—VGI, VGII, VGIII, VGIV
** 1 and 2 are ubiquitous in the environment
3 was thought to be limited to tropical areas of Australia, South America, southeast Asia, Africa, and one area of California. Now it is recognized to include a concentrated area in the pacific northwest of the United States
Important to classify as 1 and 2 infect immunocompromised patients
*Whereas 3 is found in immunocompetent patients and is a primary pathogen
Clinical Signs

- **Cats:**
  - Nasal/upper respiratory tract disease
    - Sneezing with mucopurulent to serosanguinous nasal discharge
    - Swelling over bridge of nose (destruction of facial bones)
  - CNS signs (depression, seizures, bizarre behavior, ataxia, blindness);
  - Ocular abnormalities (blindness with dilated, unresponsive pupils, chorioretinitis);
  - Cutaneous lesions (nasal planum)
  - Lymphadenopathy
- **Dogs:** weight loss, lethargy + signs depending on organ system involvement
  - Nasal cavity—nasal planum swelling, nasal discharge
  - CNS—ataxia, seizures, neck pain, paresis, etc
  - Eyes—optic neuritis, retinal hemorrhage
  - Lungs—cough, dyspnea, etc
  - GI—diarrhea, weight loss, panhypoproteinemia
  - Lymphadenopathy
- **Cows**—mammary gland, adjacent lymph nodes
- **Horses**—nasal granulomas

Diagnosis:

1. **Visualization:**
   - Diagnosis via cytology of: CSF, tracheal wash/BAL fluid, lymph node/tissue aspirate, nasal discharge/swab, ocular fluid

   India ink highlights capsule and budding.

Cytologic appearance (Diff Quik)

- Round to ovoid
- Purple/basophilic internal round structure with thick, clear capsule
- Variably sized, often extracellular
- Clear (negatively-staining) capsule varies in thickness (arrow)
- Varying degrees of inflammation
Narrow-based budding

- **Histology**
  - H & E standard but highlighted with special stains (i.e. GMS, PAS)
- *Can vary in terms of numbers of inflammatory leukocytes:*
  - Gelatinous—more organisms than inflammation (common)
  - Granulomatous—more inflammation than organisms

**Serology**

**Latex agglutination test (latex cryptococcal agglutination test—LCAT)**

- Detects presence of polysaccharide capsular antigen in serum, urine or CSF within 3 weeks of infection
- LCAT titers used to monitor progress
- False negatives rare, more likely with very localized infection
- Detects all known serotypes
- High sensitivity and specificity (but use same test kit for repeated monitoring)
- Antigen titers can be extremely high in cats and dogs with disseminated disease (>1:65,536) but *even a titer of 1:2 considered positive*

3. **Culture**

- Both *C. neoforms & gattii* grow on almost all lab media

**Prognosis**—Variable: good to excellent if owners willing to medicate pets for many months; prognosis guarded or poor with CNS involvement

- Following treatment some patients worsen initially due to die off of organism

**Treatment**

- Amphotericin B considered most effective (can permanently eradicate CNS infections)
  - But...Nephrotoxic, parenteral
- Flucytosine
  - Use in combination (or else resistance develops); crosses BBB
- Itraconazole, fluconazole
Aspergillus *

Caused by: *Aspergillus* sp. (e.g. *A. fumigatus* + other invasive species; *A. flavus*—elaborates toxins when growing in foods, 'aflatoxin')

Where to find it: Wide distribution (it's a component of dust!)

Pathogenesis of disease:
- Inhalation
- Ingestion of spores (less common)
- Tissue trauma (uncommon)

Clinical signs
Horses:
Guttural pouch mycosis, mycotic keratitis, intestinal

**Dogs:**
1. Nasal aspergillosis - young to middle aged Young to middle aged dogs (German Shepherds, Rottweilers, but any breed)

   **Diagnosis:**
   - Clinical signs + radiographic findings
   - Sample of affected tissue for cytology/biopsy & fungal culture
     - Fungal hyphae are often under the large mats visualized
   - Treatment: Typically involves administration of anti-fungal via nasal tubes/cannula under anesthesia

2. Disseminated aspergillosis
   - Immunosuppression
   - German Shepherds reported
   - Fatal in published reports, but reports of treatment successes in humans
   - Clinical signs depend on organ(s) or system(s) affected, examples:
     - Ocular—uveitis/chorioretinitis
     - Respiratory—dyspnea, coughing, etc
     - Skeletal—osteomyelitis
     - CNS
**Cattle**
- Mycotic abortion (sporadic, association with poor quality contamination food harvested in wet seasons)
  - Hematogenous spread of fungus → placentitis → late gestation abortion
  - No signs of systemic illness
  - Diagnoses—histologic evidence of mycotic placentitis; aborted fetuses may have raised cutaneous plaques (looks like ringworm)
- Mycotic mastitis—introduced via intramammary tube
- Mycotic pneumonia (uncommon in housed calves)
- Intestinal aspergillosis (diarrhea in calves)

**Cats**
- Rare; immunosuppressed animals

**Birds**
- Brooder pneumonia (newly-hatch chickens in incubators)
- Pneumonia & airsacculitis (< 6 weeks of age)
- Generalized (from respiratory origin)

**Diagnosis**—depends on species/site affected
- Serology available...debatable usefulness Generally not utilized
- Antigen detection—inconsistent results in studies

**Pneumocystis**
*Caused by: Pneumocystis jiroveci an asomycetous fungus*

**Opportunistic pathogen**

**Where to find it:** Likely worldwide, but unclear as to whether there is a defined ecological reservoir or niche

**Transmission:** Not clear. person to person transmission most likely in humans, but does not occur between different mammalian species. Immunocompetent hosts may play a role in the life cycle.
- Increased susceptibility in: Miniature dachshund, Cavalier King Charles Spaniel
- Seen often in the horses with majority of cases in Arabian foals with CID or in foals treated with immunosuppressive drugs. Of note infection with Rhodococcus equi may be an immunosuppressive factor.
- Also reported sporadically in goats, pigs, goats, dogs, etc...
*Can be seen in any animals with acquired, inherited, or drug-induced immunodeficiency syndromes, but the exact host immunologic defect that allows for propagation of organism is not known.*
**Pathogenesis:**
Only part that is known involves the mammalian lung. Organisms proliferate extracellularly within the lung alveolus, diffuse alveolar injury ensues (thick foamy exudate develops).
Two stages noted trophozoites and cysts (can contain up to 8 intracystic bodies)

**Clinical signs:** RESPIRATORY (cough, dyspnea), fever, decreased appetite, exercise intolerance.

*Clinical case examples along with glass slides available for review.*