Microbial Diseases of the Respiratory System
Structures of the Respiratory System

• Respiratory system exchanges gases between the atmosphere and the blood

• Divided into two main parts
  • Upper respiratory system
  • Lower respiratory system
Structures of the Respiratory System

• Structures of the Upper Respiratory System, Sinuses, and Ears
  • Components of the upper respiratory system
    • Nose
    • Nasal cavity
    • Pharynx
    • Uvula
  • Various antimicrobial chemicals
Structures of the Respiratory System

- **Structures of the Lower Respiratory System**
  - Components of the lower respiratory system
    - Larynx
    - Trachea
    - Bronchi
    - Alveoli
    - Diaphragm
  - Various protective components
    - Ciliated mucous membrane, alveolar macrophages, and secretory antibodies
Figure 22.1 Structures of the respiratory system.
Structure of the Respiratory System

• Microbiome of the Respiratory System

  • Lower respiratory system
    • Typically microorganisms are not present
  • Upper respiratory system
    • Colonized by many microorganisms
    • Normal microbiome limits growth of pathogens
    • Normal microbiome may be opportunistic pathogens
Structure of the Respiratory System

• Tell Me Why
  • Why do patients with methicillin-resistant *Staphylococcus aureus* (MRSA) as part of their normal microbiota pose a risk to other patients in a hospital?
Bacterial Diseases of the Upper Respiratory System, Sinuses, and Ears

• **Streptococcal Respiratory Diseases**
  - Signs and symptoms
    - Pharyngitis
      - Sore throat and difficulty swallowing
    - Often accompanied by fever, malaise, and headache
    - Laryngitis and bronchitis can occur if infection spreads to lower respiratory tract
    - Complications including scarlet fever, rheumatic fever, and acute glomerulonephritis occur in some cases
Bacterial Diseases of the Upper Respiratory System, Sinuses, and Ears

• **Streptococcal Respiratory Diseases**
  • Pathogen and virulence factors
    • Caused by group A streptococci (*S. pyogenes*)
    • Variety of virulence factors
      • M proteins
      • Hyaluronic acid capsule
      • Streptokinases
      • C5a peptidase
      • Pyrogenic toxins
      • Streptolysins
Bacterial Diseases of the Upper Respiratory System, Sinuses, and Ears

• **Streptococcal Respiratory Diseases**
  • Pathogenesis
    • Occurs when normal microbiota are depleted, large inoculum is introduced, or adaptive immunity is impaired
  • Epidemiology
    • Spread via respiratory droplets
    • Occurs most often in winter and spring
  • Diagnosis, treatment, and prevention
    • Often confused with viral pharyngitis
    • Oral penicillin is an effective treatment
Table 22.1 Manifestations of Some Respiratory Diseases

<table>
<thead>
<tr>
<th>Ailment</th>
<th>Manifestations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Cold (Viral)</td>
<td>Sneezing, rhinorrhea, congestion, sore throat, headache, malaise, cough</td>
</tr>
<tr>
<td>Influenza (Viral)</td>
<td>Fever, rhinorrhea, headache, body aches, fatigue, dry cough, pharyngitis, congestion</td>
</tr>
<tr>
<td>“Strep” Throat (Bacterial)</td>
<td>Fever, red and sore throat, swollen lymph nodes in neck</td>
</tr>
<tr>
<td>Viral Pneumonia</td>
<td>Fever, chills, mucus-producing cough, headache, body aches, fatigue</td>
</tr>
<tr>
<td>Bacterial Pneumonia</td>
<td>Fever, chills, congestion, cough, chest pain, rapid breathing, and possible nausea and vomiting</td>
</tr>
<tr>
<td>Bronchitis (Viral or Bacterial)</td>
<td>Mucus-producing cough, wheezing</td>
</tr>
<tr>
<td>Inhalational Anthrax (Bacterial)</td>
<td>Fever, malaise, cough, chest discomfort, vomiting</td>
</tr>
<tr>
<td>Coronavirus Respiratory Syndromes (SARS, MERS)</td>
<td>High fever (&gt;38°C), cough, shortness of breath</td>
</tr>
</tbody>
</table>
Bacterial Diseases of the Upper Respiratory System, Sinuses, and Ears

• **Diphtheria**

  • Signs and symptoms
    • Sore throat, localized pain, and fever
    • Presence of a *pseudomembrane* that can obstruct airways

  • Pathogen and virulence factors
    • Caused by *Corynebacterium diphtheriae*
      • Ubiquitous in animals and humans
    • Virulence factors
      • *C. diphtheriae* produces diphtheria toxin
        • Prevents polypeptide synthesis and causes cell death
Figure 22.2 A pseudomembrane, characteristic of diphtheria.
Figure 22.3 Characteristic arrangements of Gram-stained cells of Corynebacterium diphtheriae.
Bacterial Diseases of the Upper Respiratory System, Sinuses, and Ears

• **Diphtheria**
  
  • Pathogenesis and epidemiology
    • Spread via respiratory droplets or skin contact
    • Symptomatic in immunocompromised or nonimmune individuals
    • Leading cause of death among unimmunized children
  
  • Diagnosis, treatment, and prevention
    • Diagnosis is based on presence of a pseudomembrane
    • Treated with antitoxin and antibiotics
    • Immunization is an effective prevention
Bacterial Diseases of the Upper Respiratory System, Sinuses, and Ears

• **Rhinosinusitis and Otitis Media**
  • Signs and symptoms
    • Malaise accompanied by headache and inflamed nasal passages
    • Otitis media results in severe pain in the ears
  • Pathogen and virulence factors
    • Caused by various respiratory microbiota
      • May be due to damage to upper respiratory system and auditory tube
Bacterial Diseases of the Upper Respiratory System, Sinuses, and Ears

• Sinusitis and Otitis Media
  • Pathogenesis and epidemiology
    • Bacteria in the pharynx spread to the sinuses via the throat
    • Rhinosinusitis is more common in adults
    • Otitis media is more common in children
  • Diagnosis, treatment, and prevention
    • Symptoms are often diagnostic
    • No known way to prevent rhinosinusitis
    • Flushing nasal and sinus cavities with saline solution can reduce duration of symptoms
Figure 22.4 Neti pot.
Bacterial Diseases of the Upper Respiratory System, Sinuses, and Ears

• **Tell Me Why**
  
  • Why must diphtheria immunization be boosted every 10 years?
Viral Diseases of the Upper Respiratory System

• **Common Cold**
  • Signs and symptoms
    • Sneezing, runny nose, congestion, sore throat, malaise, and cough
  • Pathogens and virulence factors
    • Enteroviruses (rhinoviruses) are the most common cause
    • Numerous other viruses cause colds
    • Cold viruses replicate at the lower temperature of the nasal cavity
  • Pathogenesis
    • Cold viruses replicate in and kill infected cells
Figure 22.5 Artist’s rendition of a rhinovirus
Viral Diseases of the Upper Respiratory System

• **Common Cold**
  • Epidemiology
    • Rhinoviruses are highly infective
    • Spread by coughing/sneezing, fomites, or person-to-person contact
    • Develop some immunity to serotypes over time
  • Diagnosis, treatment, and prevention
    • Signs and symptoms are usually diagnostic
    • Pleconaril can reduce duration of symptoms
    • Hand antisepsis is important preventive measure
• **Tell Me Why**
  
  • Why is it inappropriate to treat a cold with penicillin, erythromycin, or ciprofloxacin?
Bacterial Diseases of the Lower Respiratory System

- Lower respiratory organs are usually axenic.
- Bacterial infection of the lower respiratory system can cause life-threatening illness.
Bacterial Diseases of the Lower Respiratory System

• **Bacterial Pneumonias**
  • Lung inflammation accompanied by fluid-filled alveoli and bronchioles
  • Described by affected region or organism causing the disease
    • Lobar pneumonia
    • Mycoplasmal pneumonia
    • Healthcare-associated pneumonia
  • Bacterial pneumonias are the most serious and the most frequent in adults
Bacterial Diseases of the Lower Respiratory System

• **Bacterial Pneumonias**
  - Pneumococcocal pneumonia
    - Signs and symptoms
      - Fever, chills, congestion, cough, and chest pain
      - Results in short, rapid breathing
      - Blood enters the lungs, causing rust-colored sputum
    - Pathogen and virulence factors
      - Caused by *Streptococcus pneumoniae*
  - Virulence factors
    - Adhesins
    - Capsule
    - Pneumolysin
Figure 22.6 *Streptococcus pneumoniae*, the most common cause of bacterial pneumonia.
Bacterial Diseases of the Lower Respiratory System

- **Bacterial Pneumonias**
  - Pneumococcal pneumonia
    - Pathogenesis and epidemiology
      - Infection occurs by inhalation of bacteria
      - Bacterial replication causes damage to the lungs
      - Pneumococcal IgA protease destroys host secretory IgA
    - Accounts for most cases of bacterial pneumonia
  - Diagnosis, treatment, and prevention
    - Diagnosed by identifying diplococci in sputum smears
    - Penicillin is drug of choice for treatment
      - Some strains are now penicillin resistant
    - Vaccination is method of prevention
Bacterial Diseases of the Lower Respiratory System

• **Bacterial Pneumonias**
  • Primary atypical (mycoplasmal) pneumonia
    • Signs and symptoms
      • Fever, malaise, sore throat, and excessive sweating
      • Symptoms may last for weeks
    • Pathogen and virulence factors
      • Caused by *Mycoplasma pneumoniae*
      • Virulence factors include an adhesion protein
  • Pathogenesis
    • Bacteria colonize and kill epithelial cells
    • Mucus buildup and colonization by other bacteria
Figure 22.7 Pleomorphic forms of *Mycoplasma*.
Bacterial Diseases of the Lower Respiratory System

• **Bacterial Pneumonias**
  - Primary atypical (mycoplasmal) pneumonia
    - Epidemiology
      - Bacteria spread by nasal secretions
      - Most common pneumonia in teenagers and young adults
  - Diagnosis, treatment, and prevention
    - Difficult to diagnose
    - Treated with erythromycin or doxycycline
    - Prevention difficult since infected individuals may be asymptomatic
• **Bacterial Pneumonias**
  
  • *Klebsiella* pneumonia
    
    • Signs and symptoms
      
      • Pneumonia symptoms with bloody sputum and chills
    
    • Pathogen and virulence factors
      
      • Caused by *Klebsiella pneumoniae*
      
      • Virulence factors include a capsule
    
    • Pathogenesis and epidemiology
      
      • Immunocompromised patients at greater risk for infection
    
    • Diagnosis, treatment, and prevention
      
      • Diagnosed by identifying *Klebsiella* in sputum samples
      
      • Treated with antimicrobials
      
      • Prevention involves good aseptic technique by health care workers
Figure 22.8 The prominent capsule of *Klebsiella pneumoniae*. 
Bacterial Diseases of the Lower Respiratory System

- **Bacterial Pneumonias**
  - Other bacterial pneumonias
    - *Haemophilus influenzae* and *Staphylococcus aureus*
      - Disease similar to pneumococcal pneumonia
    - *Yersinia pestis*
      - Causes pneumonia, called pneumonic plague
    - *Chlamydophila psittaci*
      - Causative agent of psittacosis
    - *Chlamydophila pneumoniae*
      - Causes pneumonia, bronchitis, and rhinosinusitis
Bacterial Diseases of the Lower Respiratory System

• **Legionnaires’ Disease**
  • Signs and symptoms
    • Typical pneumonia symptoms
      • Pulmonary function can rapidly decrease
  • Pathogen and virulence factors
    • Most cases caused by *Legionella pneumophila*
  • Pathogenesis
    • *L. pneumophila* lives in and kills human cells
      • Causes tissue damage and inflammation
Figure 22.9 *Legionella pneumophila* growing on buffered charcoal yeast extract agar.
• **Legionnaires’ Disease**

  • Epidemiology
    • *Legionella* survives in domestic water sources
    • The elderly, smokers, and immunocompromised individuals are at increased risk for infection
  
  • Diagnosis, treatment, and prevention
    • Diagnosed with fluorescent antibody staining or serology
    • Quinolones or macrolides are the preferred treatment
    • Controlled by reducing bacterial presence in water
Bacterial Diseases of the Lower Respiratory System

• **Tuberculosis**
  • The leading disease killer in the world
  • Incidence has declined in the industrialized world
  • Signs and symptoms
    • Initially limited to minor cough and mild fever
    • Symptoms are not always apparent
  • Pathogen and virulence factors
    • Caused by *Mycobacterium tuberculosis*
    • Presence of mycolic acid gives bacteria unique features
      • Slow growth
      • Protection from phagocytic lysis
      • Intracellular growth
      • Resistance to many antimicrobial drugs
• **Tuberculosis**
  
  • Pathogenesis
    
    • Spread via inhalation of respiratory drops
    • Three types of tuberculosis
      
      • Primary tuberculosis
      • Secondary tuberculosis
      • Disseminated tuberculosis
Disease in Depth: Tuberculosis: Pathogenesis

1. Mycobacterium typically infects the respiratory tract via inhalation of respiratory droplets from infected individuals.

2. Macrophages in alveoli phagocytize mycobacteria but are unable to digest them, in part because the bacterium inhibits fusion of lysosomes to endocytic vesicles.

3. Instead, bacteria replicate freely within macrophages, gradually killing the phagocytes. Bacteria released from dead macrophages are phagocytized by other macrophages, beginning the cycle anew.

4. Infected macrophages present antigen to T lymphocytes, which produce lymphokines that attract and activate more macrophages and trigger inflammation. Tightly packed macrophages surround the site of infection, forming a tubercle over a two- to three-month period.

5. Other cells deposit collagen fibers, enclosing infected macrophages and lung cells within the tubercle. Infected cells in the center die, releasing M. tuberculosis and producing caseous necrosis—the death of tissue that takes on a cheese-like consistency due to protein and fat released from dying cells. A stalemate between the bacterium and the body’s defenses develops.

6. Secondary/reactivated tuberculosis results when M. tuberculosis breaks the stalemate, ruptures the tubercle, and reactivates an active infection. Reactivation occurs in about 10% of patients; patients whose immune systems are weakened by disease, poor nutrition, drug or alcohol abuse, or by other factors.

Disseminated tuberculosis results when macrophages carry the pathogen via blood and lymph nodes to other sites, including bone marrow, spleen, kidneys, spinal cord, and brain.

Tuberculosis lesions in spleen.

Tubercle in lung tissue.

Cavern necrosis

Lung lesions caused by TB.

Ruptured tubercle

Mycobacteria

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• **Tuberculosis**
  
  • Epidemiology
    • One-third of the world’s population is infected
    • Most deaths occur in Asia and Africa
  
  • Diagnosis, treatment, and prevention
    • Tuberculin skin test identifies exposure to tuberculosis
    • Chest X-ray images can identify tubercles in the lungs
    • Treatment requires combination of drugs
    • Drug-resistant strains of *M. tuberculosis* have emerged
    • BCG vaccine is available where tuberculosis is common
Disease at a Glance: Diagnosis of tuberculosis—overview.
• Dr. Bauman’s Microbiology Video Tutor
  • For more information, listen to the Disease in Depth video tutor on tuberculosis.
Bacterial Diseases of the Lower Respiratory System

• **Pertussis (Whooping Cough)**
  • Signs and symptoms
    • Initially coldlike, then characteristic cough develops
  • Pathogen and virulence factors
    • *Bordetella pertussis* is the causative agent
    • Produces numerous virulence factors
      • Includes adhesins and several toxins
  • Pathogenesis
    • Pertussis progresses through four phases
      • Incubation, catarrhal, paroxysmal, and convalescent
• Pertussis (Whooping Cough)
  • Epidemiology
    • Highly contagious
    • Bacteria spread through airborne droplets
    • Bacteria do not survive long outside the body
  • Diagnosis, treatment, and prevention
    • Symptoms are usually diagnostic
    • Treatment is primarily supportive
    • Prevention is with the DTaP vaccine
Bacterial Diseases of the Lower Respiratory System

• **Inhalational Anthrax**
  • Signs and symptoms
    • Initially resembles a cold or flu
    • Progresses to severe coughing, lethargy, shock, and death
  • Pathogen and virulence factors
    • *Bacillus anthracis* is the causative agent
    • Virulence factors include a capsule and anthrax toxin
  • Pathogenesis and epidemiology
    • Anthrax not spread from person to person
    • Acquired by contact or inhalation of endospores
Bacterial Diseases of the Lower Respiratory System

• **Inhalation Anthrax**
  • Diagnosis, treatment, and prevention
    • Diagnosis based on identification of bacteria in sputum
    • Early and aggressive antimicrobial treatment is necessary
    • Anthrax vaccine is available to select individuals
• **Tell Me Why**

  - *Mycoplasma pneumoniae* is resistant to penicillin, though *Mycoplasma* does not synthesize an enzyme to break down penicillin. Explain why *Mycoplasma* is resistant to penicillin.
Viral Diseases of the Lower Respiratory System

• **Influenza**
  • Signs and symptoms
    • Pharyngitis, congestion, cough, and myalgia
    • Sudden fever distinguishes flu from a common cold
  • Pathogens and virulence factors
    • Influenza virus types A and B are the causative agents
    • Mutations in hemagglutinin and neuraminidase produce new strains
      • Occurs via antigenic drift and antigenic shift
    • Concern about the fatality associated with strains similar to those of past pandemics
Disease in Depth: Virulence Factors

- ssRNA molecules (8 total) in helical capsid
- Hemagglutinin
- Neuraminidase
- Envelope
Disease in Depth: Pathogenesis

ANTIGENIC DRIFT
Mutations and recombination in the genes coding for HA and NA spikes are responsible for the production of new strains of influenza A and B viruses via a process known as antigenic drift.

1. Influenzavirus A or B enters host cell.
2. Mutation occurs during replication within host cell’s nucleus.
3. New strain of influenza virus, differing slightly from original virus, exits cell.

ssRNA from virus

ANTIGENIC SHIFT
Antigenic shift by influenza A virus occurs about once a decade. Influenza B virus does not undergo antigenic shift.

1. Two different strains of influenza A viruses enter the same host cell.
2. Genes and antigens from both viral types are combined in new virions.
3. A new influenza virus A, which can be very different from the original two viruses, exits cell.
Viral Diseases of the Lower Respiratory System

- **Influenza**
  - **Pathogenesis**
    - Virus causes damage to the lung epithelium
    - Flu patients are susceptible to secondary bacterial infections
  - **Epidemiology**
    - Infection provides some immunological protection from similar strains
    - Concern that changes in type A influenza viruses may cause another major pandemic
Viral Diseases of the Lower Respiratory System

• Influenza
  • Diagnosis, treatment, and prevention
    • Signs and symptoms during a community-wide outbreak are often diagnostic
    • Treatment involves supportive care to relieve symptoms
    • Oseltamivir and zanamivir can be administered early in infection
    • Prevented by immunization with a multivalent vaccine
Figure 22.10  Prevention of coronavirus respiratory syndromes.
Viral Diseases of the Lower Respiratory System

• **Coronavirus Respiratory Syndromes**
  • Two recently emerging diseases
    • Severe acute respiratory syndrome (SARS)
    • Middle East respiratory syndrome (MERS)
  • Signs and symptoms
    • High fever, shortness of breath, difficulty breathing
    • Later, patients develop dry cough and pneumonia
  • Pathogen and virulence factors
    • Coronaviruses are the causative agent
    • Most diseases are usually mild
    • SARS and MERS have higher fatalities
Viral Diseases of the Lower Respiratory System

• Coronavirus Respiratory Syndromes
  • Pathogenesis and epidemiology
    • Coronaviruses spread via respiratory droplets
    • Virus spreads from the lungs to the heart and kidneys
  • Diagnosis, treatment, and prevention
    • Diagnosis is based on signs and symptoms
    • Confirmed by isolating the virus or antibodies against the virus
    • Treatment is supportive
Viral Diseases of the Lower Respiratory System

- **Respiratory Syncytial Virus (RSV) Infection**
  - Most common childhood respiratory disease
  - Signs and symptoms
    - Fever, runny nose, and coughing in babies or immunocompromised individuals
    - Mild coldlike symptoms in older children and adults
  - Pathogen
    - Respiratory syncytial virus
  - Pathogenesis
    - Virus causes syncytia to form in the lungs
    - Immune response to RSV further damages the lungs
Figure 22.11 A syncytium forms when RSV triggers infected cells to fuse with uninfected cells.
Viral Diseases of the Lower Respiratory System

• **Respiratory Syncytial Virus (RSV) Infection**
  • Epidemiology
    • Transmission via close contact with infected persons
    • Prevalent in the United States
  • Diagnosis, treatment, and prevention
    • Diagnosis is made by immunoassay
    • Supportive treatment for young children
    • Prevention includes aseptic technique of health care and day care employees
Viral Diseases of the Lower Respiratory System

- **Hantavirus Pulmonary Syndrome (HPS)**
  - Signs and symptoms
    - Symptoms progress to cough, shock, and labored breathing
  - Pathogen
    - Caused by *Hantavirus*
    - Transmitted from mice via inhalation
  - Pathogenesis
    - *Hantavirus* travels throughout body via the blood
    - Infection causes widespread inflammation leading to shock
**Figure 22.12** *Hantavirus* is an enveloped, segmented, $-\text{ssRNA}$ bunyavirus.
Viral Diseases of the Lower Respiratory System

- *Hantavirus Pulmonary Syndrome (HPS)*
  - Epidemiology
    - Human disease more likely as mouse population increases
    - Person-to-person contact does not occur
  - Diagnosis, treatment, and prevention
    - Diagnosis is based on characteristic symptoms
    - No pharmacological treatment is available
    - Prevention requires control of rodents
Viral Diseases of the Lower Respiratory System

• **Other Viral Respiratory Diseases**
  
  • Other viruses cause respiratory disease in children, the elderly, or immunocompromised individuals
    
    • Cytomegalovirus
    
    • Metapneumovirus
      
      • Estimated to be the second most common cause of viral respiratory disease
    
    • Parainfluenzaviruses
      
      • Three strains cause croup and viral pneumonia
      
      • Occur primarily in young children
Viral Diseases of the Lower Respiratory System

• Tell Me Why
  • Why do epidemiologists think that there will be a major flu pandemic in people caused by bird influenza viruses?
Mycoses of the Lower Respiratory System

• Cases of mycoses have increased over the last two decades
  • AIDS patients are susceptible to fungal infections
• Fungal infections seen in North America include
  • Coccidioidomycosis
  • Blastomycosis
  • Histoplasmosis
  • *Pneumocystis* pneumonia
Figure 22.13 The geographic distributions of three systemic fungal diseases endemic to North America.

(a) Coccidioidomycosis  (b) Blastomycosis  (c) Histoplasmosis
Mycoses of the Lower Respiratory System

• **Coccidioidomycosis**
  • Signs and symptoms
    • Resembles pneumonia or tuberculosis
    • Can become systemic in immunocompromised persons
  • Pathogen and virulence factors
    • Caused by *Coccidioides immitis*
    • Pathogen assumes yeast form at human body temperature
  • Pathogenesis
    • Arthroconidia from the soil enter the body through inhalation
Figure 22.14 Coccidioidomycosis lesions in subcutaneous tissue.
Figure 22.15  Spherules of *Coccidioides immitis*.
Mycoses of the Lower Respiratory System

- **Coccidioidomycosis**
  - Epidemiology
    - Almost exclusively in southwestern United States and northern Mexico
  - Diagnosis, treatment, and prevention
    - Diagnosed by presence of spherules in clinical specimens
    - Treated with amphotericin B
    - Protective masks can prevent exposure to arthroconidia
Mycoses of the Lower Respiratory System

- **Blastomycosis**
  - Signs and symptoms
    - Flulike symptoms
    - Systemic infections can produce lesions on the face and upper body or purulent lesions on various organs
  - Pathogen
    - Caused by *Blastomyces dermatitidis*
    - Pathogenic yeast form at human body temperature
Figure 22.16  Cutaneous blastomycosis in an American woman.
Mycoses of the Lower Respiratory System

• **Blastomycosis**
  • Pathogenesis and epidemiology
    • Enters body through inhalation of dust carrying fungal spores
    • Endemic across southeastern United States north to Canada
  • Diagnosis, treatment, and prevention
    • Diagnosis is based on identifying fungus in clinical samples
    • Treated with amphotericin B
    • Relapse common in AIDS patients
Mycoses of the Lower Respiratory System

- **Histoplasmosis**
  - Signs and symptoms
    - Asymptomatic in most cases
    - Symptomatic infection causes coughing with bloody sputum or skin lesions
  - Pathogen
    - Caused by *Histoplasma capsulatum*
    - Pathogenic yeast form at human body temperature
    - *Histoplasma* produces several proteins that inhibit macrophage activation and other host defenses
Mycoses of the Lower Respiratory System

• **Histoplasmosis**
  
  • Pathogenesis and epidemiology
    • Humans inhale airborne spores from the soil
    • Prevalent in the eastern United States
  
  • Diagnosis, treatment, and prevention
    • Diagnosis is based on identifying fungus in clinical samples
    • Infections in immunocompetent individuals typically resolve without treatment
Mycoses of the Lower Respiratory System

• **Pneumocystis Pneumonia**
  • Signs and symptoms
    • Difficulty breathing, anemia, hypoxia, and fever
  • Pathogen
    • Caused by *Pneumocystis jirovecii*
  • Pathogenesis and epidemiology
    • Transmit by inhalation of droplets containing the fungus
    • Common disease in AIDS patients
  • Diagnosis, treatment, and prevention
    • Diagnosis is based on clinical and microscopic findings
    • Treated with trimethoprim and sulfamethoxazole
    • Impossible to prevent infection with *P. jirovecii*
Figure 22.17 Cysts of *Pneumocystis jirovecii* in lung tissue.
Mycoses of the Lower Respiratory System

• **Tell Me Why**
  
  • Outbreaks of blastomycosis have occurred in Latin America even though the organism itself is not normally found there. Why might a few cases of blastomycosis appear outside endemic areas?