Chapter 24
Microbial Diseases of the Respiratory System

The Upper Respiratory System
- Nose
- Pharynx (throat)
- Middle ear
- Eustachian tubes

The Lower Respiratory System
- Larynx
- Trachea
- Bronchial tubes
- Alveoli
- Pleura

Normal Microbiota of Respiratory System
- Suppress pathogens by competitive inhibition in upper respiratory system
- Lower respiratory system is sterile

Check Understanding
- What is the function of hairs in the nasal passages? 24-1
- Normally, the lower respiratory tract is nearly sterile. What is the primary mechanism responsible? 24-2

Upper Respiratory System Diseases
- Pharyngitis
- Laryngitis
- Tonsillitis
- Sinusitis
- Epiglottitis: H. influenzae type b

Streptococcal Pharyngitis
- Also called strep throat
- Streptococcus pyogenes
- Resistant to phagocytosis
- Streptokinases lyse clots
- Streptolysins are cytotoxic
- Diagnosis by enzyme immunoassay (EIA) tests

Scarlet Fever
- Streptococcus pyogenes
- Pharyngitis
- Erythrogenic toxin produced by lysogenized S. pyogenes

Diphtheria
- Corynebacterium diphtheriae: Gram-positive rod
- Diphtheria toxin produced by lysogenized C. diphtheriae
- Diphtheria membrane: Fibrin, tissue, bacterial cells
- Prevented by DTaP vaccine
  - Diphtheria toxoid
- Cutaneous diphtheria
  - Infected skin wound leads to slow-healing ulcer

Otitis Media
- S. pneumoniae (35%)
- H. influenzae (20–30%)
- M. catarrhalis (10–15%)
- S. pyogenes (8–10%)
- S. aureus (1–2%)
- Incidence of S. pneumoniae reduced by vaccine

The Common Cold
- Rhinoviruses (50%)
- Coronavirus (15–20%)

Picornaviridae
- Single-stranded RNA, + strand, nonenveloped
- Enterovirus
- Poliovirus and coxsackievirus
- Rhinovirus
- Hepatitis A virus

Coronaviridae
- Single-stranded RNA, + strand, enveloped
- Upper respiratory infections
- Coronavirus
- SARS

Check Understanding
- Which one of the following is most likely to be associated with a headache: pharyngitis, laryngitis, sinusitis, or epiglottitis? 24-3
- Among streptococcal pharyngitis, scarlet fever, or diphtheria, which two diseases are usually caused by the same genus of bacteria? 24-4
- Which viruses, rhinoviruses or coronaviruses, cause about half of cases of the common cold? 24-5

Lower Respiratory System Diseases
- Bacteria, viruses, and fungi cause
- Bronchitis
- Bronchiolitis
- Pneumonia

Pertussis (Whooping Cough)
- Bordetella pertussis
  - Gram-negative coccobacillus
- Capsule
- Tracheal cytotoxin of cell wall damaged ciliated cells
- Pertussis toxin
- Prevented by DTaP vaccine (acellular Pertussis cell fragments)
- Stage 1: Catarrhal stage, like common cold
- Stage 2: Paroxysmal stage—violent coughing sieges
- Stage 3: Convalescence stage
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Tuberculosis
- Mycobacterium tuberculosis
  - Acid-fast rod; transmitted from human to human
- M. bovis: <1% U.S. cases; not transmitted from human to human
- M. avium-intracellulare complex infects people with late-stage HIV infection
- Treatment: Prolonged treatment with multiple antibiotics
- Vaccines: BCG, live, avirulent M. bovis; not widely used in United States
- Tuberculin skin test screening
  - Positive reaction means current or previous infection
  - Followed by X-ray or CT exam, acid-fast staining of sputum, culturing of bacteria

Pneumococcal Pneumonia
- Streptococcus pneumoniae
  - Gram-positive encapsulated diplococci
  - Symptoms: Infected alveoli of lung fill with fluids; interferes with oxygen uptake
  - Diagnosis: Optochin-inhibition test or bile solubility test; serological typing of bacteria
  - Treatment: Penicillin, fluoroquinolones
  - Prevention: Pneumococcal vaccine

Haemophilus influenzae Pneumonia
- Gram-negative coccobacillus
  - Predisposing factors: Alcoholism, poor nutrition, cancer, or diabetes
  - Symptoms: Resemble those of pneumococcal pneumonia
  - Diagnosis: Isolation; special media for nutritional requirements
  - Treatment: Cephalosporins

Mycoplasmal Pneumonia
- Primary atypical pneumonia; walking pneumonia
- Mycoplasma pneumoniae
  - Pleomorphic, wall-less bacteria
  - Common in children and young adults
  - Symptoms: Mild but persistent respiratory symptoms; low fever, cough, headache
  - Diagnosis: PCR and serological testing
  - Treatment: Tetracyclines

Legionellosis
- Legionella pneumophila
  - Gram-negative rod
  - Found in water
  - Transmitted by inhaling aerosols; not transmitted from human to human
  - Symptoms: Potentially fatal pneumonia that tends to affect older men who drink or smoke heavily
- Diagnosis: Culture on selective media, DNA probe
- Treatment: Erythromycin

Psittacosis (Ornithosis)
- Chlamydia psittaci
  - Gram-negative intracellular bacterium
  - Transmitted to humans by elementary bodies from bird droppings
  - Reorganizes into reticulate body after being phagocytized
  - Symptoms: Symptoms, if any, are fever, headache, chills
  - Diagnosis: Growth of bacteria in eggs or cell culture
  - Treatment: Tetracyclines

Chlamydial Pneumonia
- Chlamydia pneumoniae
  - Transmitted from human to human
  - Symptoms: Mild respiratory illness common in young people; resembles mycoplasmal pneumonia
  - Diagnosis: Serological tests
  - Treatment: Tetracyclines

Q Fever
- Causative agent: Coxiella burnetii
- Reservoir: Large mammals
- Tick vector
- Can be transmitted via unpasteurized milk
- Symptoms: Mild respiratory disease lasting 1–2 weeks; occasional complications such as endocarditis occur
- Diagnosis: Growth in cell culture
- Treatment: Doxycycline and chloroquine

Melioidosis
- Causative agent: by Burkholderia pseudomallei
- Reservoir: Soil
- Mainly in southeast Asia and northern Australia
- Symptoms: Pneumonia, or tissue abscesses and severe sepsis
- Diagnosis: Bacterial culture
- Treatment: Ceftazidime

Check Understanding
- Another name for pertussis is whooping cough. This symptom is caused by the pathogens’ attack on which cells? 24-6
- What group of bacterial pathogens causes what is informally called “walking pneumonia”? 24-7
- The bacterium causing melioidosis in humans also causes a disease of horses known as what? 24-8
Viral Pneumonia
- Viral pneumonia occurs as a complication of influenza, measles, or chickenpox
- Viral etiology suspected if no other cause is determined

Respiratory Syncytial Virus (RSV)
- Common in infants; 4500 deaths annually
- Causes cell fusion (syncytium) in cell culture
- Symptoms: Pneumonia in infants
- Diagnosis: Serological test for viruses and antibodies
- Treatment: Ribavirin, palivizumab

Paramyxoviridae
- Single-stranded RNA, – strand, one RNA strand
- Paramyxovirus
- Morbillivirus
- Parainfluenza
- Mumps
- Newcastle disease (chickens)

Influenza (Flu)
- Symptoms: Chills, fever, headache, and muscle aches
- No intestinal symptoms
- 1% mortality, very young and very old
- Treatment: Zanamivir and oseltamivir inhibit neuraminidase
- Prophylaxis: Multivalent vaccine
- Hemagglutinin (HA) spikes used for attachment to host cells
- Neuraminidase (NA) spikes used to release virus from cell

Orthomyxoviridae
- Single-stranded RNA, – strand, multiple RNA strands
- Envelope spikes can agglutinate RBCs
- Influenzavirus (influenza viruses A and B)
- Influenza C virus

The Influenza Virus
- Antigenic shift
- Changes in HA and NA spikes
- Probably due to genetic recombination between different strains infecting the same cell
- Antigenic drift
- Point mutations in genes encoding HA or NA spikes
- May involve only 1 amino acid
- Allows virus to avoid mucosal IgA antibodies

Check Understanding
- Is reassortment of the RNA segments of the influenza virus the cause of antigenic shift or antigenic drift? 24-9

Histoplasmosis
- Histoplasma capsulatum, dimorphic fungus

Coccidioidomycosis
- Causative agent: Coccidioides immitis
- Reservoir: Desert soils of Southwest U.S.
- Symptoms: Fever, coughing, weight loss
- Diagnosis: Serological tests
- Treatment: Amphotericin B

Pneumocystis Pneumonia
- Causative agent: Pneumocystis jirovecii
- Reservoir: Unknown; possibly humans or soil
- Symptoms: Pneumonia
- Diagnosis: Microscopy
- Treatment: Trimethoprim

Blastomycosis
- Causative agent: Blastomyces dermatitidis
- Reservoir: Soil in Mississippi valley area
- Symptoms: Abscesses; extensive tissue damage
- Diagnosis: Isolation of pathogen
- Treatment: Amphotericin B

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Other Fungi Involved in Respiratory Disease
- Systemic
- Predisposing factors:
  - Immunocompromised state
  - Cancer
  - Diabetes
  - Aspergillus fumigatus
  - Mucor
  - Rhizopus

Check Understanding
- The droppings of both blackbirds and bats support the growth of Histoplasma capsulatum; which of these two animal reservoirs is normally actually infected by the fungus? 24-10