Chapter 24

Microbial Diseases of the Respiratory System

The Respiratory System

24-1 Describe how microorganisms are prevented from entering the respiratory system.
24-2 Characterize the normal microbiota of the upper and lower respiratory systems.

Normal Microbiota of the Respiratory System

Suppress pathogens by competitive inhibition in upper respiratory system
Lower respiratory system is sterile

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

Differentiate pharyngitis, laryngitis, tonsillitis, sinusitis, and epiglottitis.
List the causative agent, symptoms, prevention, preferred treatment, and laboratory identification tests for streptococcal pharyngitis, scarlet fever, diphtheria, cutaneous diphtheria, and otitis media.
List the causative agents and treatments for the common cold.

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
  • Erythrogenic toxin produced by lysogenized S. pyogenes

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14 **Diphtheria**
• Corynebacterium diphtheriae: gram-positive rod
• Diphtheria toxin produced by lysogenized C. diphtheriae
• Prevented by DTaP vaccine
  • Diphtheria toxoid
• Cutaneous diphtheria
  • Infected skin wound leads to slow-healing ulcer

15 **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

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17 **The Common Cold**
• Rhinoviruses (30–50%)
• Coronaviruses (10–15%)

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• 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

19 **Diseases in Focus: Diseases of the Upper Respiratory System**
• A patient presents with fever and a red, sore throat. Later, a grayish membrane appears in the throat. Gram-positive rods are cultured from the membrane.
• Can you identify infections that could cause these symptoms?
21 Lower Respiratory System Diseases

• 24-6 List the causative agent, symptoms, prevention, preferred treatment, and laboratory identification tests for pertussis and tuberculosis.

• 24-7 Compare and contrast the seven bacterial pneumonias discussed in this chapter.

• 24-8 List the etiology, method of transmission, and symptoms of melioidosis.

22 Lower Respiratory System Diseases

• Bacteria, viruses, and fungi cause
  • Bronchitis
  • Bronchiolitis
  • Pneumonia

23 Pertussis (Whooping Cough)

• Bordetella pertussis
  • Gram-negative coccobacillus

• Capsule
  • Tracheal cytotoxin of cell wall damages ciliated cells
  • Pertussis toxin
  • Prevented by DTaP vaccine (acellular Pertussis cell fragments)

24 Pertussis (Whooping Cough)

• Stage 1: catarrhal stage, like common cold
• Stage 2: paroxysmal stage—violent coughing sieges
• Stage 3: convalescence stage

25 Tuberculosis

• Mycobacterium tuberculosis
  • Acid-fast rod; transmitted human-to-human

• M. bovis: <1% of U.S. cases; not transmitted from human to human

• M. avium-intracellulare complex infects people with late-stage HIV infection
36 **Treatment of Tuberculosis**
- Treatment: prolonged treatment with multiple antibiotics
- Vaccines: BCG vaccine, live culture of avirulent *M. bovis*; not widely used in United States

37 **Diagnosis of Tuberculosis**
- 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

39 **Pneumococcal Pneumonia**
- *Streptococcus pneumoniae*: 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: macrolides, fluoroquinolones
- Prevention: pneumococcal vaccine

41 **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

42 **Mycoplasmal Pneumonia**
- Primary atypical pneumonia; walking pneumonia
- *Mycoplasma pneumoniae*
  - Pleomorphic, wall-less bacteria
  - Common in children and young adults

45 **Mycoplasmal Pneumonia**
• Symptoms: mild but persistent respiratory symptoms; low fever, cough, headache
• Diagnosis: PCR and serological testing
• Treatment: tetracyclines

46 **Legionellosis**
- Legionella pneumophila
  - Gram-negative rod
- Found in water
- Transmitted by inhaling aerosols; not transmitted from human to human

47 **Legionellosis**
- Symptoms: potentially fatal pneumonia that tends to affect older men who drink or smoke heavily
- Diagnosis: culture on selective media, DNA probe
- Treatment: erythromycin

48 **Psittacosis (Ornithosis)**
- Chlamydomphila psittaci
  - Gram-negative intracellular bacterium
- Transmitted to humans by elementary bodies from bird droppings
- Reorganizes into reticulate body after being phagocytized

49 **Psittacosis (Ornithosis)**

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51 **Chlamydial Pneumonia**
- Chlamydomphila pneunomiae
- Transmitted from human to human
- Symptoms: mild respiratory illness common in young people; resembles mycoplasmal pneumonia
- Diagnosis: serological tests
- Treatment: tetracyclines

52 **Q Fever**
- Causative agent: Coxiella burnetii
- Reservoir: large mammals
- Tick vector
- Can be transmitted via unpasteurized milk

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54 **Q Fever**
- Symptoms: mild respiratory disease lasting 1–2 weeks; occasional complications such as endocarditis occur
• Diagnosis: growth in cell culture
• Treatment: doxycycline and chloroquine

55 **Meliodosis**
• Causative agent: Burkholderia pseudomallei
• Reservoir: soil
• Mainly in southeast Asia and northern Australia
• Symptoms: pneumonia, or tissue abscesses and severe sepsis
• Diagnosis: bacterial culture
• Treatment: ceftazidime

56 **Diseases in Focus:**
**Common Bacterial Pneumonias**
• A 27-year-old man with a history of asthma is hospitalized with a 4-day history of progressive cough and 2 days of spiking fevers. Gram-positive cocci in pairs are cultured from a blood sample.
• Can you identify infections that could cause these symptoms?

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• 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

59 **Lower Respiratory System Diseases**
• 24-9 List the causative agent, symptoms, prevention, and preferred treatment for viral pneumonia, RSV, and influenza.

60 **Viral Pneumonia**
• Viral pneumonia occurs as a complication of influenza, measles, or chickenpox
• Viral etiology suspected if no other cause is determined

61 **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

62 **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

The Influenza Virus
- Hemagglutinin (HA) spikes used for attachment to host cells
- Neuraminidase (NA) spikes used to release virus from cell
- 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 one amino acid
  - Allows virus to avoid mucosal IgA antibodies

Influenza Serotypes

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

Lower Respiratory System Diseases
- 24-10 List the causative agent, mode of transmission, preferred treatment, and laboratory identification tests for four fungal diseases of the respiratory system.

Coccidioidomycosis
- Causative agent: Coccidioides immitis
- Reservoir: desert soils of American Southwest
- 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

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**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

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- 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

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**Diseases in Focus: Diseases of the Lower Respiratory System**
- A worker is hospitalized for acute respiratory illness. He had been near a colony of bats. The mass is surgically removed. Microscopic examination of the mass reveals ovoid yeast cells.
- Can you identify infections that could cause these symptoms?