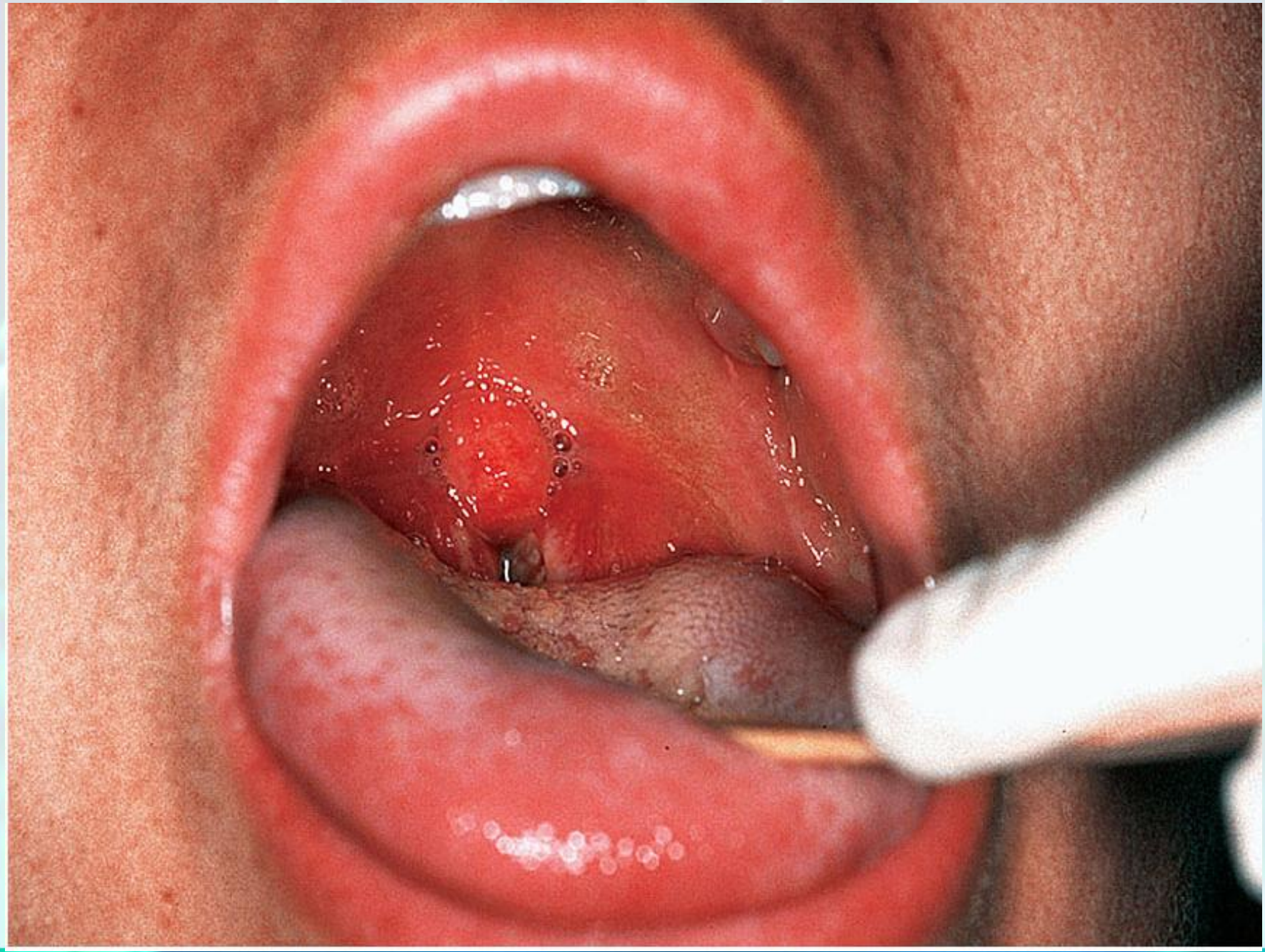

Dr. Gary Mumaugh
Respiratory System Infections



Respiratory System Infections

- Encompass enormous variety of illnesses
  - Trivial to fatal
- Divided into infections of
  - Upper respiratory
    - Head and neck
    - Uncomfortable but generally not life threatening
  - Lower respiratory
    - Chest
    - More serious
    - Can be life threatening
      - Particularly in the immunocompromised

Normal Microbiota

- Nasal cavity, nasopharynx and pharynx colonized by numerous bacteria
  - Other sites are sterile
  - Numerous classes of organisms are present from aerobes to anaerobes
- Conjunctiva commonly have no bacteria
  - Organisms that do invade are swept into the nasolacrimal duct (tear duct) and nasopharynx

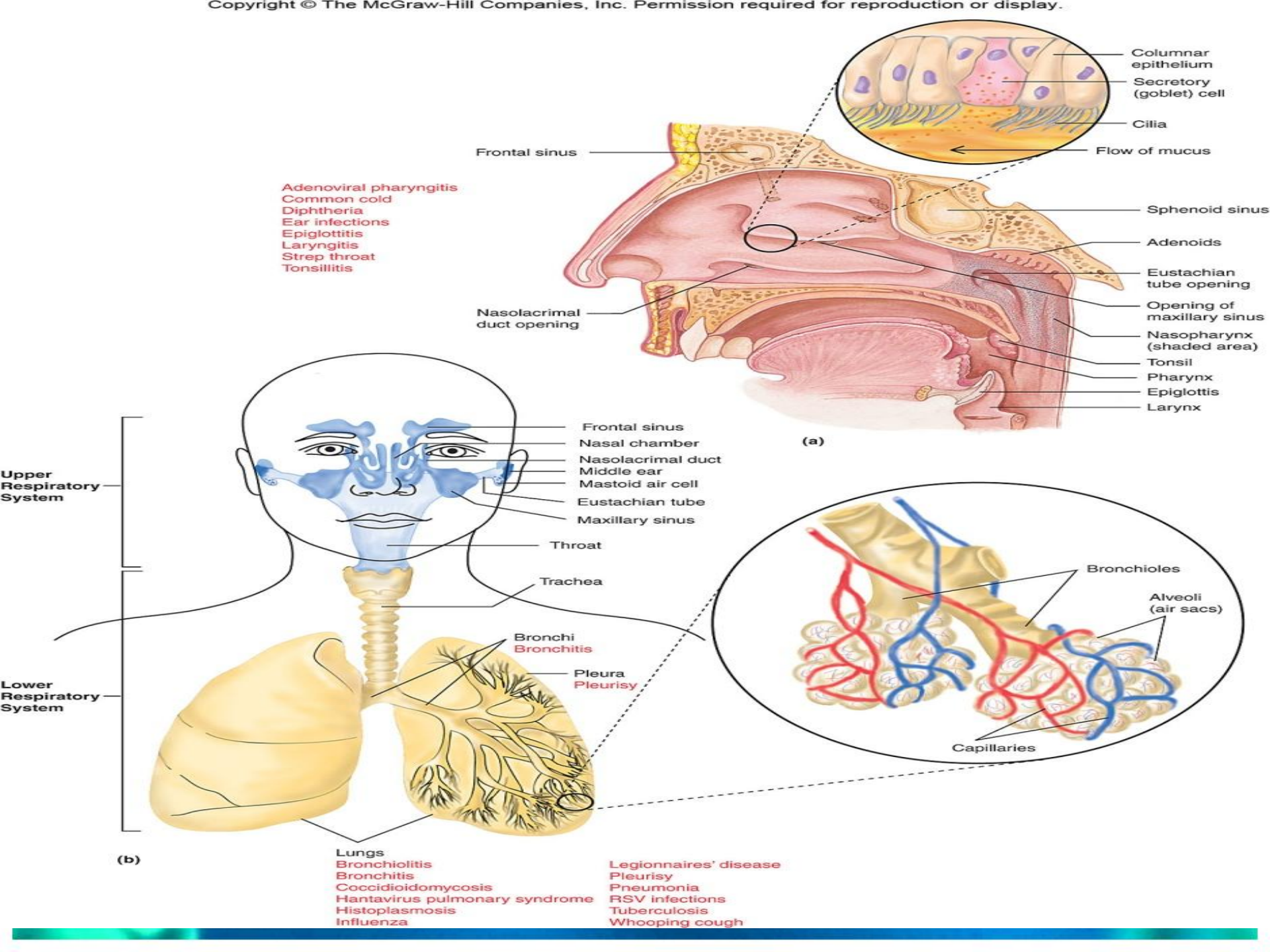


TABLE 22.1 Normal Microbiota of the Respiratory System

Genus	Characteristics	Comments
Staphylococcus	Gram-positive cocci in clusters	Commonly includes the potential pathogen *Staphylococcus aureus*, inhabiting the nostrils. Facultative anaerobes.
Corynebacterium	Pleomorphic, Gram-positive rods; non-motile; non-spore-forming	Aerobic or facultatively anaerobic. Diphtheroids include anaerobic and aerotolerant organisms.
Moraxella	Gram-negative diplococci and diplobacilli	Aerobic. Some microscopically resemble pathogenic *Neisseria* species such as *N. meningitidis.*
Haemophilus	Small, Gram-negative rods	Facultative anaerobes. Commonly include the potential pathogen *H. influenzae.*
Bacteroides	Small, pleomorphic, Gram-negative rods	Obligate anaerobes.
Streptococcus	Gram-positive cocci in chains	α (especially viridans, meaning green hemolysis), β (clear hemolysis), and γ (non-hemolytic) types; the potential pathogen, *S. pneumoniae* is often present. Aerotolerant (obligate fermenters).

Streptococcal Pharyngitis

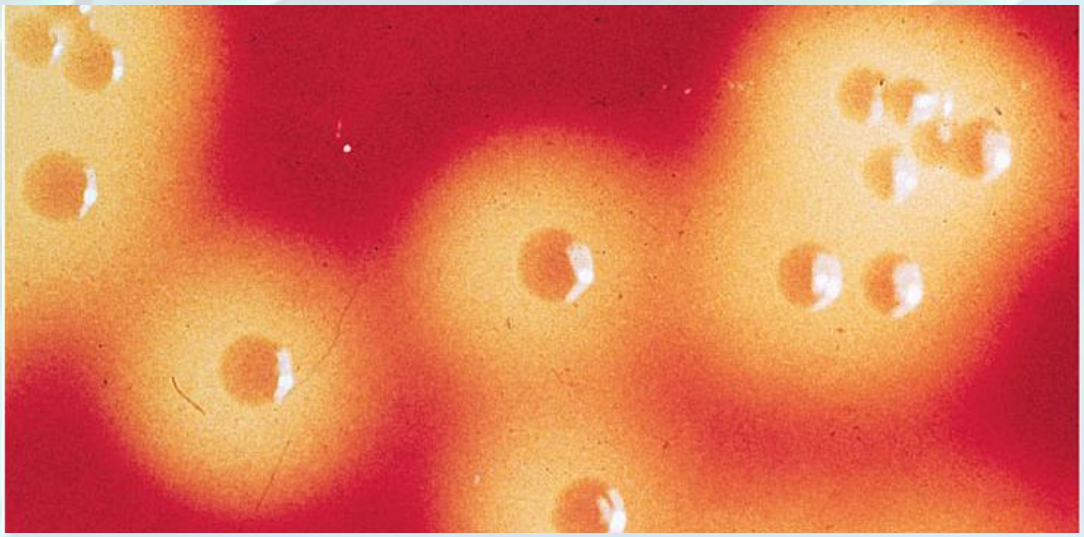
- Symptoms
  - Characterized by
    - Difficulty swallowing
    - Fever
    - Red throat with pus patches
    - Enlarged tender lymph nodes
      - Localized to neck
  - Most patients recover uneventfully in approximately a week

Streptococcal Pharyngitis

- Causative Agent
  - *Streptococcus pyogenes*
    - Gram-positive
    - Coccus in chains
    - β hemolytic
      - Complete hemolysis of red blood cells
    - Commonly referred to as group A streptococcus
      - Due to group A carbohydrate in cell wall
      - Basis for identification from other organisms

Streptococcal Pharyngitis

- Pathogenesis
  - Causes a wide variety of illnesses
    - Due to bacteria-producing enzymes and toxin that destroy cells
  - Complications of infection can occur during acute illness
  - Examples include scarlet fever and quinsy
  - Certain complications can develop late
    - Acute glomerulonephritis
    - Acute rheumatic fever



Streptococcal Pharyngitis

- Epidemiology
  - Spread readily by respiratory droplets
    - Especially in range of 2 to 5 feet
  - Infect only humans under natural conditions
  - Nasal organism spreads more effectively than pharyngeal carriers
  - Peak incidence occurs in winter or spring
    - Highest in grade school children

Streptococcal Pharyngitis

- Prevention
  - No vaccine available
  - Adequate ventilation
  - Avoid crowds
  - Sore throats in presence of fever should be cultured for prompt treatment
    - Prompt treatment is essential to prevent complications
- Treatment
  - Confirmed strep throat treated with 10 days of antibiotics
    - Penicillin or erythromycin are drugs of choice
      - Eliminates organisms in 90% of cases


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TABLE 22.3 Strep Throat (Streptococcal Pharyngitis)

① *Streptococcus pyogenes* enters by inhalation (nose), or by ingestion (mouth).

② Pharyngitis, fever, enlarged lymph nodes; sometimes tonsillitis, abcess; scarlet fever with strains that produce erythrogenic toxin.

Symptoms go away.

③ *S. pyogenes* exits by nose and mouth.

Late complications appear:

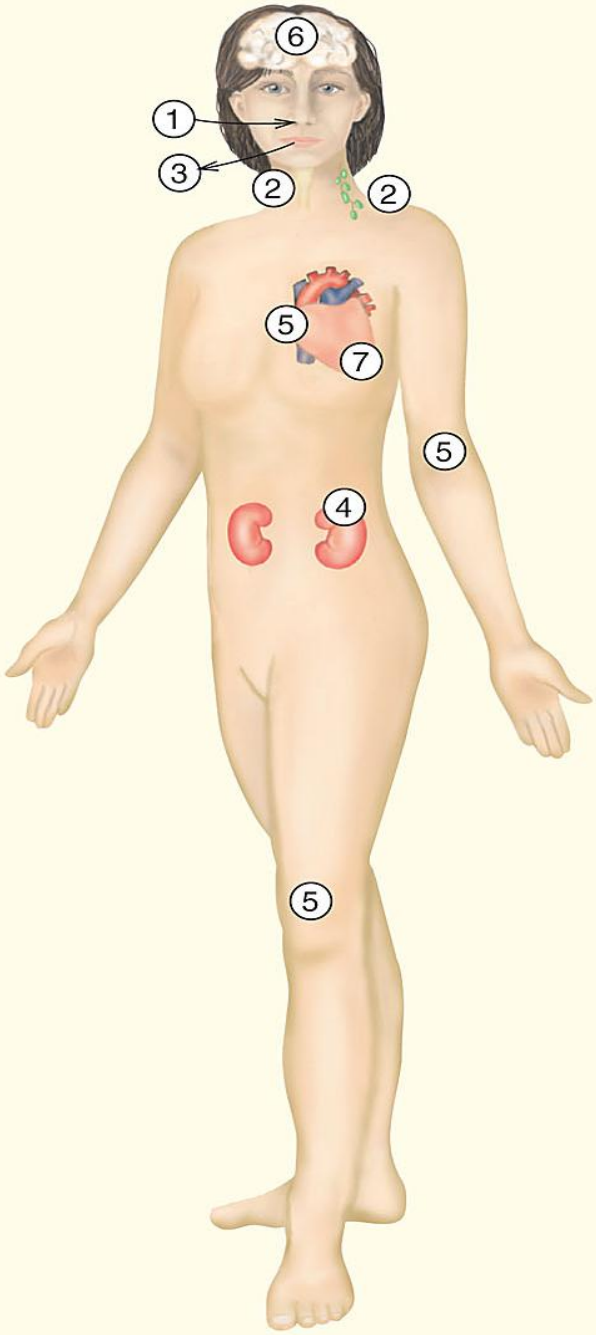
④ glomerulonephritis

⑤ rheumatic fever

⑥ neurological abnormalities

Complications subside.

⑦ Damaged heart valves leak, heart failure develops.



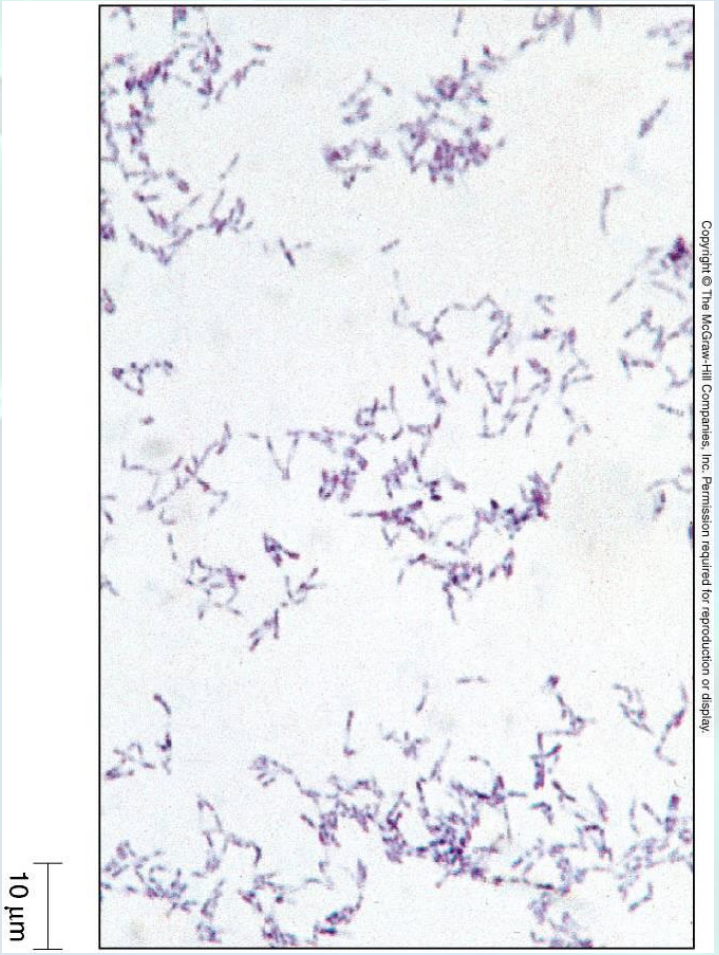
Symptoms	Sore, red throat, with pus and tiny hemorrhages, enlargement and tenderness of lymph nodes in the neck; less frequently, abscess formation involving tonsils; occasionally, rheumatic fever and glomerulonephritis as sequels
Incubation period	2 to 5 days
Causative agent	*Streptococcus pyogenes,* Lancefield group A β-hemolytic streptococci
Pathogenesis	Virulence associated with hyaluronic acid capsule and M protein, both of which inhibit phagocytosis; protein G binds Fc segment of IgG; protein F for mucosal attachment; multiple enzymes.
Epidemiology	Direct contact and droplet infection; ingestion of contaminated food.
Prevention and treatment	Avoidance of crowding; adequate ventilation; daily penicillin to prevent recurrent infection in those with a history of rheumatic heart disease. Treatment: 10 days of penicillin or erythromycin.

Diphtheria

- Symptoms
  - Usually begins with mild sore throat and slight fever, fatigue and malaise and dramatic neck swelling
  - Whitish membrane forms on tonsils, or in nasal cavity
  - Most strains release diphtheria toxin

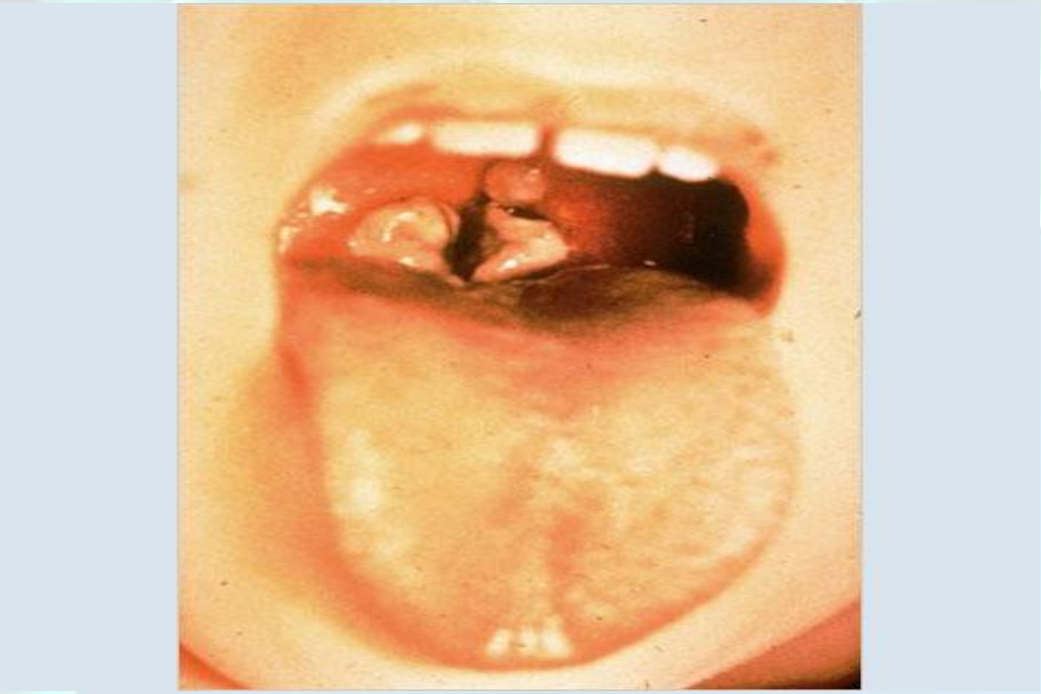
Diphtheria

- Causative Agent
  - *Corynebacterium diphtheria*
  - Variably shaped
  - Gram-positive
  - Non-spore forming
  - Certain strains produce diphtheria toxin



Diphtheria

- Pathogenesis
  - Exotoxin released into bloodstream
    - Results in damage to heart, nerves and kidneys



Diphtheria

- Epidemiology
  - Humans are primary reservoir
  - Spread by air
    - Acquired through inhalation
  - Sources of infection include
    - Carriers who recovered from infection
    - Asymptomatic cases
    - People with active disease
    - Contaminated objects
  - Bacterium can be carried in chronic skin ulcer
    - Cutaneous diphtheria

Diphtheria

- Prevention
  - Disease results primarily from toxin absorption
    - Not microbial invasion
  - Prevention directed at immunization
    - DPT - Neutralize toxin
  - Immunity wanes after childhood
    - Booster immunization should be given every 10 years

Diphtheria

- Treatment
  - Effectiveness depends on early antiserum treatment
    - Delay in treatment may be fatal
  - Antibiotics are given to eliminate bacteria
    - Penicillin and erythromycin
    - Stops transmission of disease
      - No effect on absorbed toxin
  - Even in presence of treatment 1 in 10 patients die

TABLE 22.4 Diphtheria

① *Corynebacterium diphtheriae* enters by inhalation.

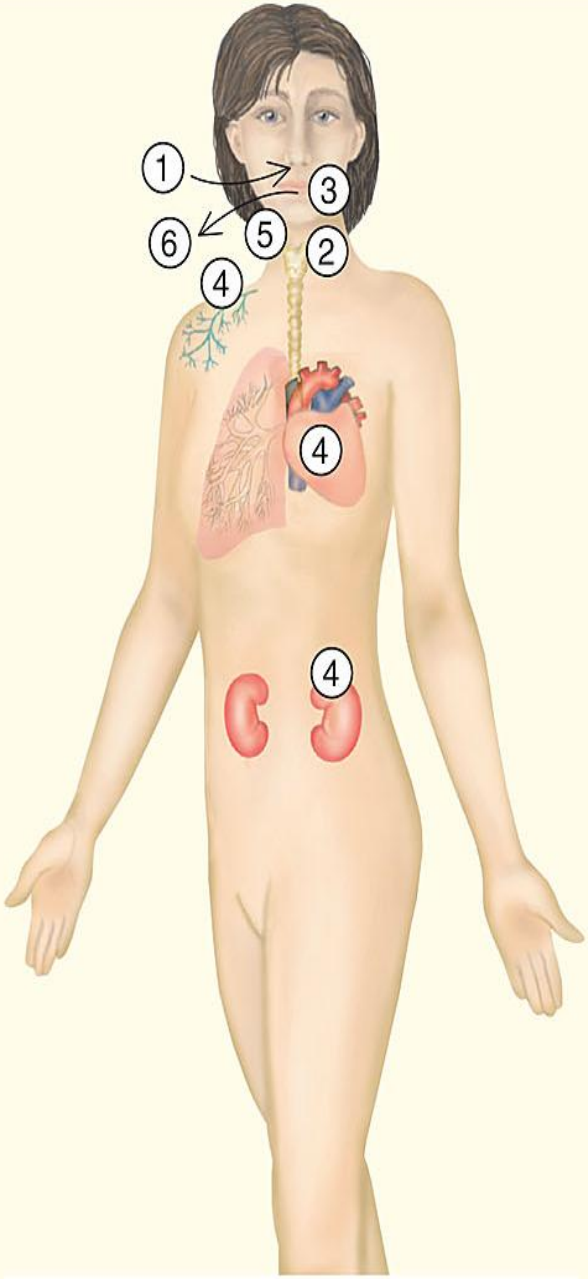
② Infection established in nasal cavity and/or throat.

③ Toxin released, pseudomembrane forms.

④ Toxin causes paralysis, damages heart muscle, kidneys, nerves.

⑤ Membrane may come loose and obstruct breathing.

⑥ Exit from body by respiratory secretions.



Symptoms	Sore throat, fever, fatigue, and malaise; membrane forms on tonsils and throat or in nose; paralysis, heart and kidney failure
Incubation period	2 to 6 days
Causative agent	*Corynebacterium diphtheriae,* a toxin-producing, non-spore-forming Gram-positive rod
Pathogenesis	Infection in upper respiratory tract; exotoxin released and absorbed by bloodstream; toxin kills cells by interfering with protein synthesis; effect is on cells that have receptors for the toxin—mainly heart, kidney, and nerve tissue.
Epidemiology	Inhalation of infectious droplets; direct contact with patient or carrier; indirect contact with contaminated articles.
Prevention and treatment	Immunization with diphtheria toxoid; given to children at 6 weeks, 4 months, 6 months, 18 months, and 4 to 6 years; boosters every 10 years. Treatment: antitoxin; erythromycin to prevent transmission.

Pinkeye, Earache and Sinus Infections

- Causative Agent
  - *Haemophilus influenza*
    - Gram-negative bacillus
  - *Streptococcus pneumoniae*
    - Gram-positive diplococci
    - A.k.a pneumococcus
  - Most common cause of all three conditions

Pinkeye, Earache and Sinus Infections

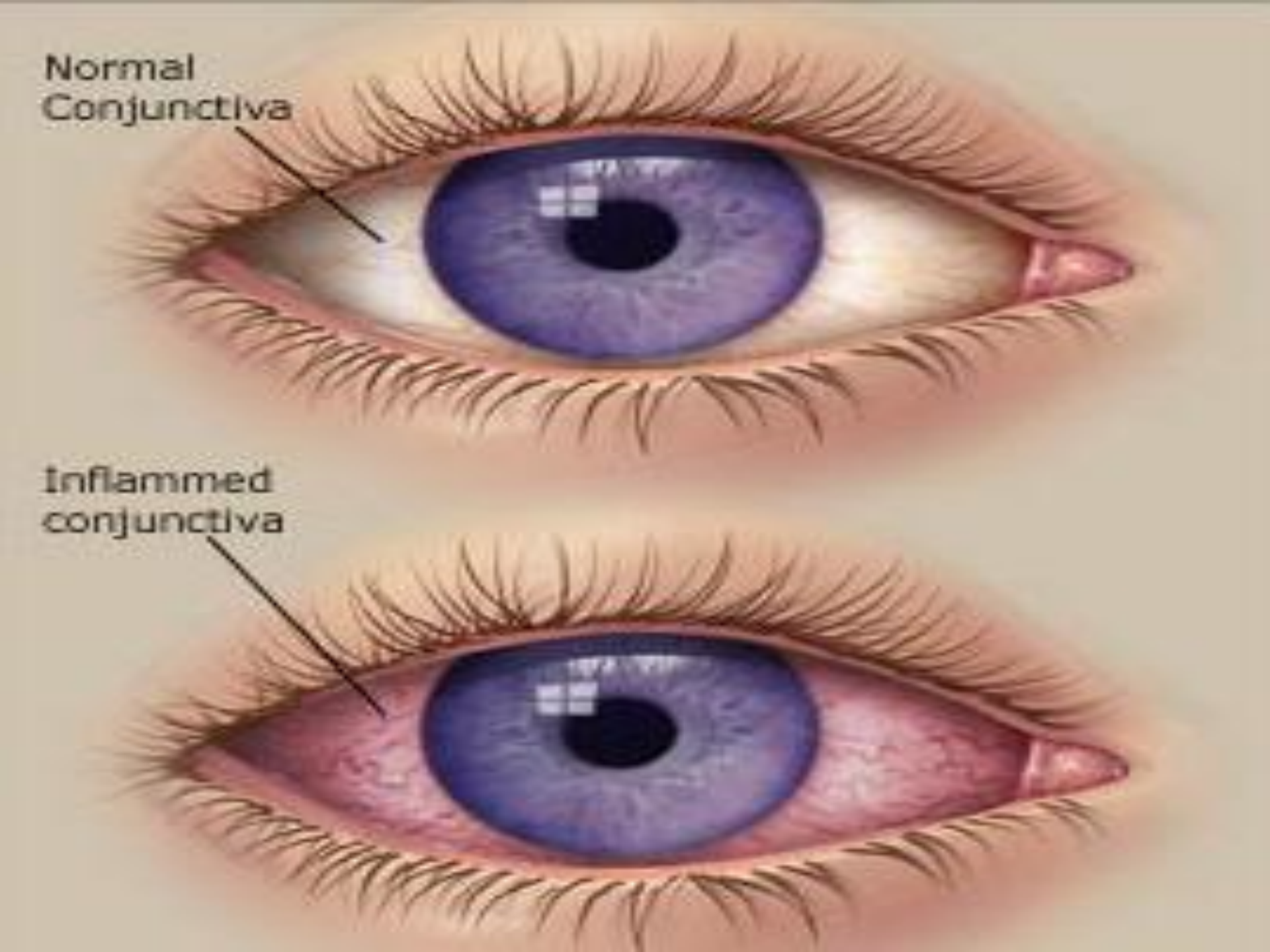
- Causative Agents
  - Otitis media and sinusitis
    - *Mycoplasma pneumoniae*
    - *Streptococcus pyogenes*
    - *Staphylococcus aureus*
  - One-third of cases of otitis media have viral etiology

Conjunctivitis – “Pink Eye”

- Rubbing causes transfer to other eyes
- Tears contain antibacterial agents
- Viral conjunctivitis
  - The most common and most contagious
- Bacterial conjunctivitis
  - Is common in developing countries with copious amounts of pus
- Allergic conjunctivitis
  - From sensitivity to environmental antigens

Pinkeye - Conjunctivitis

- Symptoms - Pinkeye
  - Increased tears and redness
  - Swelling eyelids
  - Sensitivity to bright light
  - Large amounts of pus

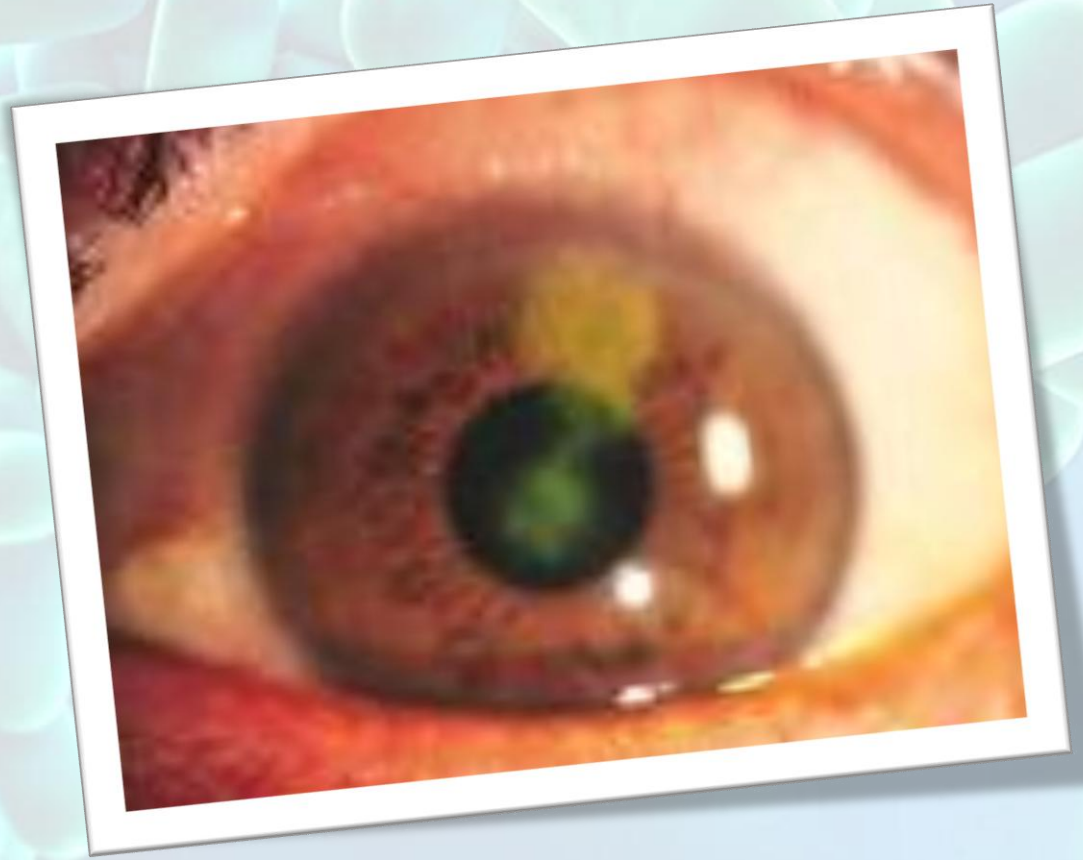

Normal
Conjunctiva
Inflammed
conjunctiva

- Pathogenesis
  - Few details known about pathogenesis of bacterial conjunctivitis
  - Most likely from airborne respiratory droplets
  - Resist destruction by lysozyme
- Prevention
  - Prevention is directed towards
    - Removal of infected individuals from school or day care
    - Hand washing
    - Avoid rubbing or touching eyes
    - Avoid sharing towels
  - Treatment is achieved through eyedrops or ointments containing antibacterial medications

Keratitis – corneal infection

- The most common form from *Staphylococci*
- Viral keratitis
  - Caused by herpes simplex resulting in corneal ulcer
  - Giving cortisone or eye drops with cortisone can worsen the condition to blindness
- Parasitic keratitis
  - Commonly seen in contact lens wearers who wash their lens with tap water
- Reactive keratitis
  - Not caused by an infection
  - Thought to be an autoimmune reaction and resolves in 2-3 years with considerable problems
  - Also caused by towel slapping in locker rooms

Herpes simplex keratitis



Otitis externa

Otitis externa – “swimmers ear”

- Is usually a mild annoyance
- Can be more severe in swimmers who swim daily
- Water trapped in the ear causes irritation, low grade infection and itching
- S & S
  - Otalgia and otorrhea with pruritis to severe pain, swelling can occlude canal with hearing loss
- DX
  - Elevated ESR, bone scan & CT scan to diagnose osteomyelitis
- TX
  - Mild cases – polymycin and cortisone drops
  - Severe cases – IV antibiotics and debridement

Otitis Media

Otitis media – middle ear infection

- Common in preschool and school age children
- Eustachian tube development
- Bacteria from mouth and pharynx travel up the tube to the middle ear
- DX
  - Requires the presence of fluid & redness or inflammation

Otitis Media Pathogenesis

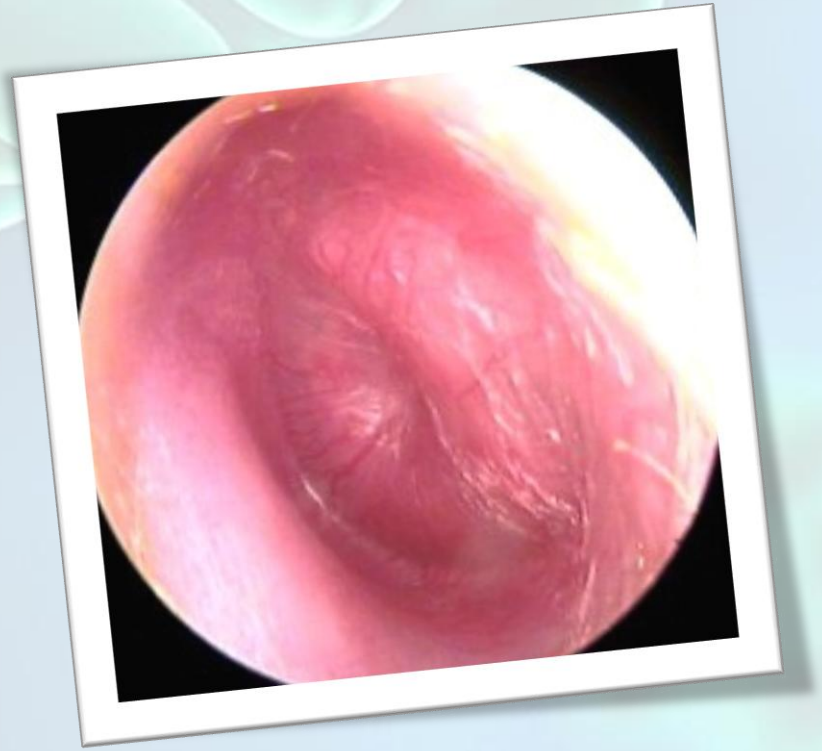
- Often developing at the time of conjunctivitis diagnosis
- Begins with infection of nasal chamber and nasopharynx
  - Infection moves to middle ear and damages ciliated cells in ear
- Ear drum often bursts
  - Gives immediate relief of pain

Otitis Media

- Epidemiology
  - Carrier rates of *H. influenza* and *S. pneumoniae* can reach 80%
  - Otitis media very common in early childhood
    - Older children develop immunity to *H. influenza*
      - Less common cause of earache after age five

Otitis media

Normal Tympanic Membrane



Two Types of Otitis Media

- Acute Otitis Media
  - Inflammatory symptoms of pain, fever, malaise
  - 80% of cases resolve in 24 hours
- Serous Otitis Media
  - Presents with effusion of fluid in the middle ear
  - Most frequent diagnosis in children under 15
  - Studies have shown no bacterial pathogen 65% of the time
  - Serous fluid may remain for up to 12 weeks after an acute episode

Ped Infect Dis J 1992: 11 (Supp): 7 Bluestone CD Ten year review of otitis media pathogens
Ped Otolaryngol 1998: 118 837-843 Rosenfield R An evidence based approach to otitis media

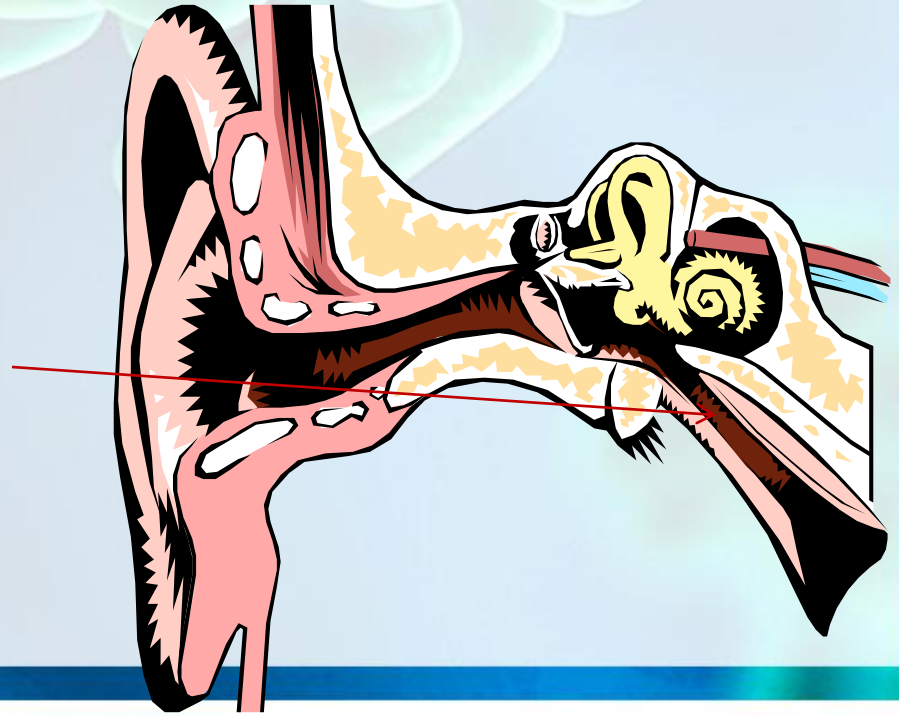
Clinical Manifestations

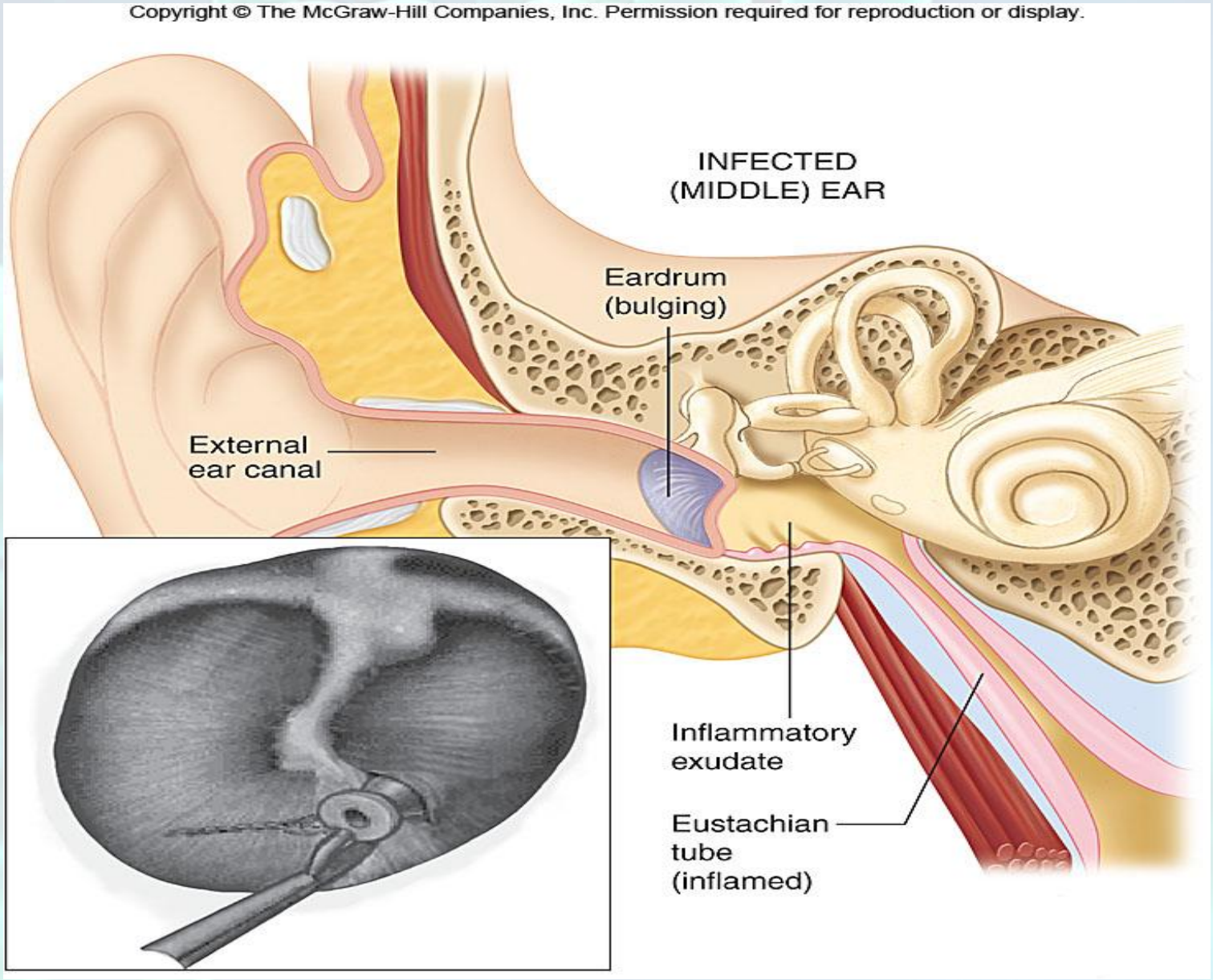
- Uncomplicated Otitis Media
  - Unilateral
  - Mild fever of no fever
  - No perforation of eardrum, little or no membrane bulging
  - Well appearance
  - Mild pain
- Complicated Otitis Media
  - Perforation of tympanic membrane
  - Suppuration
  - Mastoiditis
  - High Fever
  - Sick appearance
  - Severe pain

Anatomical Considerations

- Eustachian tube in infants and small children is very small and narrow. It connects the inner ear to back of nose
- In infants, the tube is horizontal and does not drain well
- As they grow, so grows the tube, allowing for better drainage
- With less retained fluid, pathogens have less opportunity to cause infection

Eustachian (auditory) tube



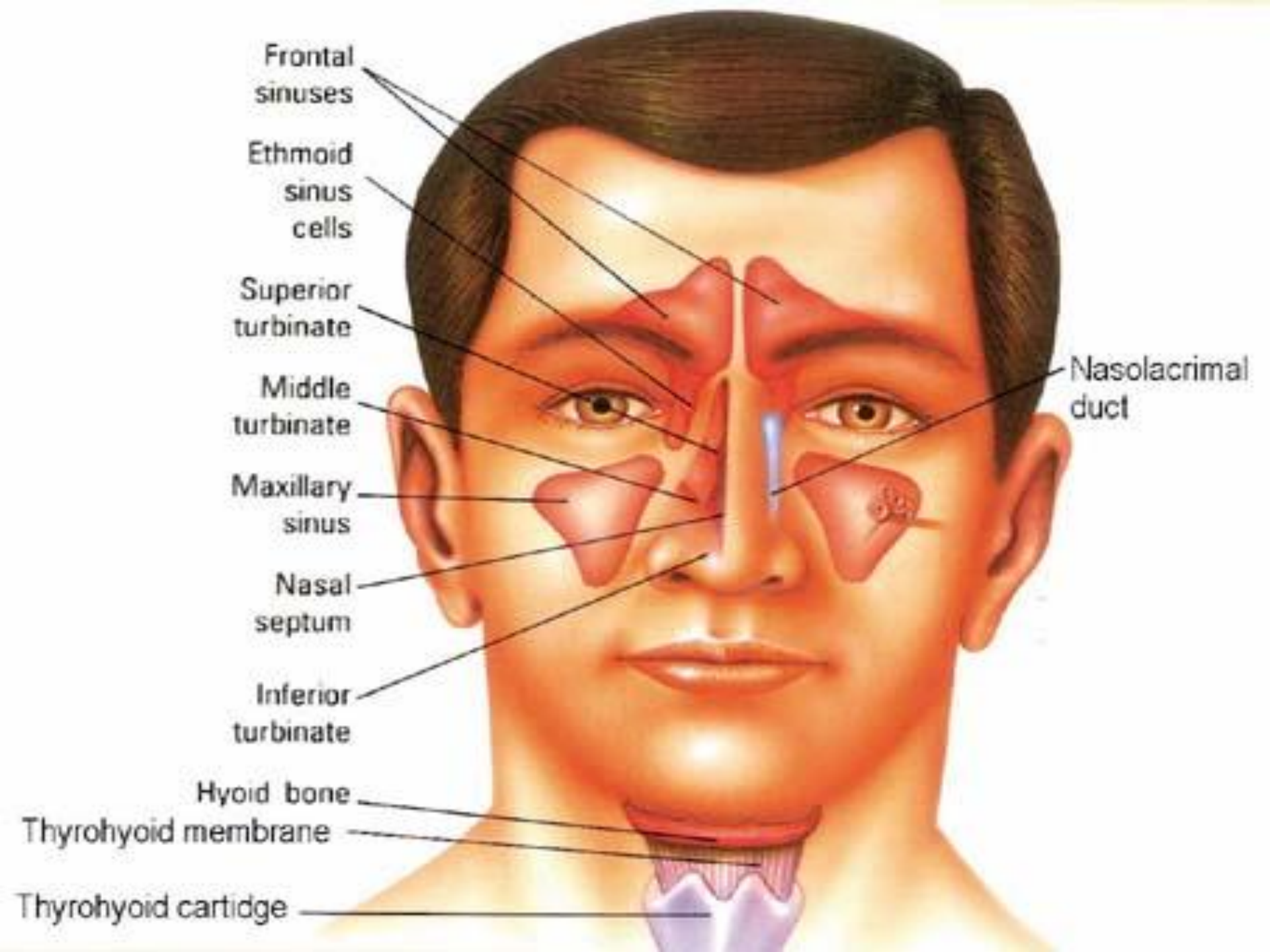


Otitis Media

- Symptoms - Otitis media
  - More common in young children
  - Extreme ear pain
  - Mild fever
    - Fever may even be absent
  - Vomiting
    - Often at the height of ear pain
  - In many cases ear drum ruptures
    - Trapped fluid drains to external ear canal
    - Pain ends abruptly

Otitis Media

- Prevention is directed towards
  - Administration of influenza vaccine to infants in day care facilities during “flu” season
    - Reduces incidences of earache
- Treatment includes
  - Amoxicillin 10 days
  - Augmentin in severe cases

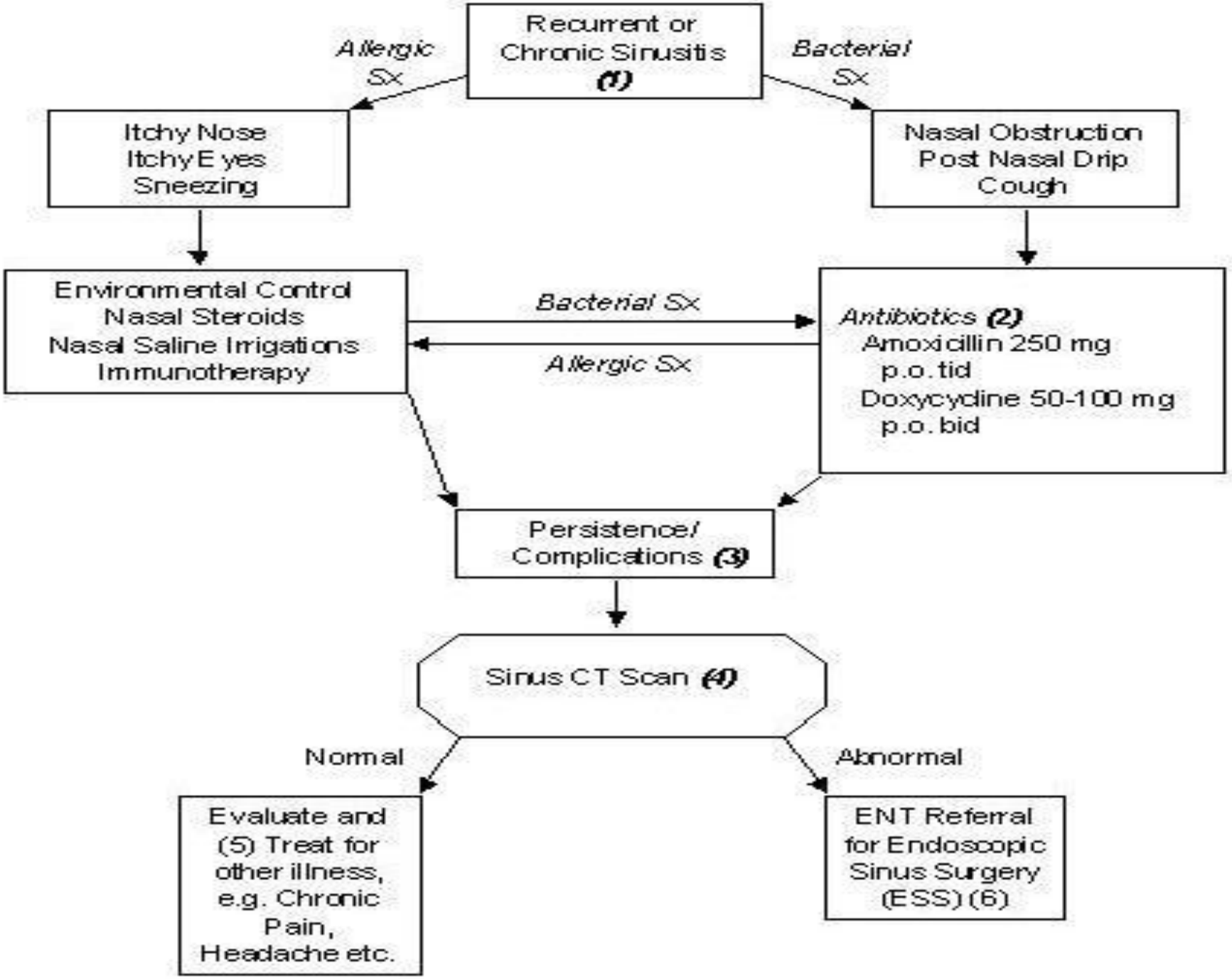

Frontal sinuses
Ethmoid sinus cells
Superior turbinate
Middle turbinate
Maxillary sinus
Nasal septum
Inferior turbinate
Hyoid bone
Thyrohyoid membrane
Thyrohyoid cartidge
Nasolacrimal duct

Sinusitis

- Symptoms - Sinusitis
  - Pain and pressure
    - Generally localized to involved sinus
  - Tenderness over sinus
  - Headache
  - Severe malaise
- Pathogenesis
  - Begins with infection of nasopharynx
  - Spreads upwards to sinuses
  - Pathogenesis mechanism much like that of otitis media

Sinusitis

- Prevention
  - There are no proven preventative measures for sinusitis
- Treatment is directed at support care
  - Decongestants and antihistamines are generally discouraged
    - Ineffective and can be harmful


Recurrent or Chronic Sinusitis (1)
Allergic Sx
Bacterial Sx
Itchy Nose
Itchy Eyes
Sneezing
Nasal Obstruction
Post Nasal Drip
Cough
Environmental Control
Nasal Steroids
Nasal Saline Irrigations
Immunotherapy
Bacterial Sx
Allergic Sx
Antibiotics (2)
Amoxicillin 250 mg p.o. tid
Doxycycline 50-100 mg p.o. bid
Persistence/ Complications (3)
Sinus CT Scan (4)
Normal
Abnormal
Evaluate and (5) Treat for other illness, e.g. Chronic Pain, Headache etc.
ENT Referral for Endoscopic Sinus Surgery (ESS) (6)

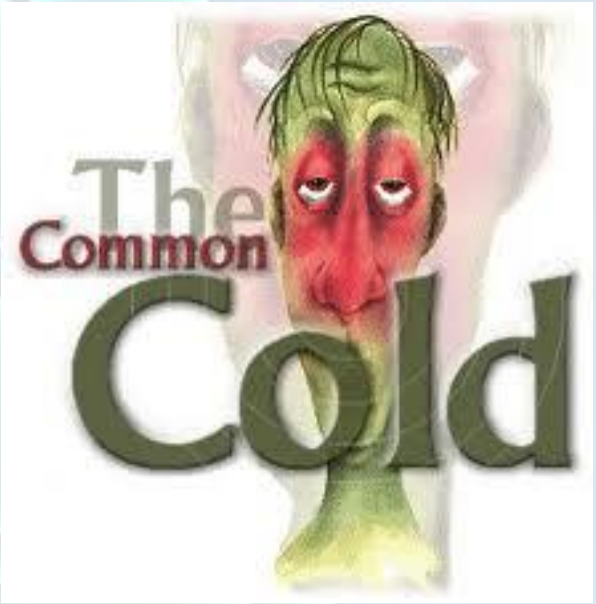
Mastoiditis

- Infection of the air cells of the mastoid process
- Severe cases can lead to brain abcess
- S & S
  - Severe pain most noticeable with othorrhea
  - Mimics severe supurative otitis media
- DX
  - Dx by x-rays
  - DD from otitis media by duration and intensity
- TX
  - Augmentin and possible admission with IV

Mastoiditis

Common Cold

- Symptoms
  - Malaise
  - Scratchy mild sore throat
  - Runny nose
  - Cough and hoarseness
  - Nasal secretion
    - Initially profuse and watery
    - Later, thick and purulent
    - No fever
      - Unless complicated with secondary infection
  - Symptoms disappear in about a week

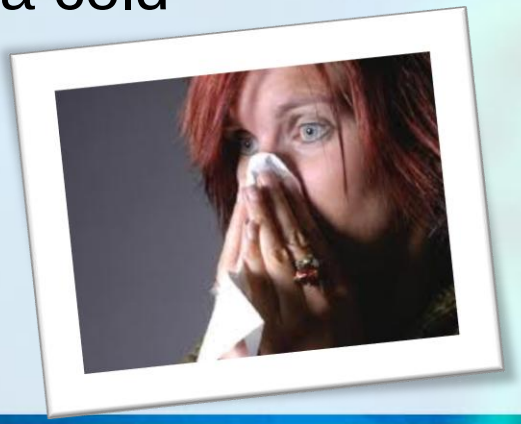


Common Cold

- Pathogenesis
  - Virus attaches to specific receptors on respiratory epithelial cells and multiplies in cells
    - Large number of viruses released from infected cells
  - Injured cells cause inflammation which stimulates profuse nasal secretion, sneezing and tissue swelling
  - Infection is halted by inflammatory response, interferon release and immune response
    - Infection can extend to ears, sinuses and lower respiratory tract before stopping

Common Cold

- Epidemiology
  - Humans are only source for cold virus
  - Close contact with infected person or secretions usually necessary for transmission
    - High concentrations are found in nasal secretions during first 2 or 3 days of a cold
  - Young children transmit cold virus easily
    - Due to lack of good hygiene
  - No reliable relationship between exposure to cold temperature and development of a cold

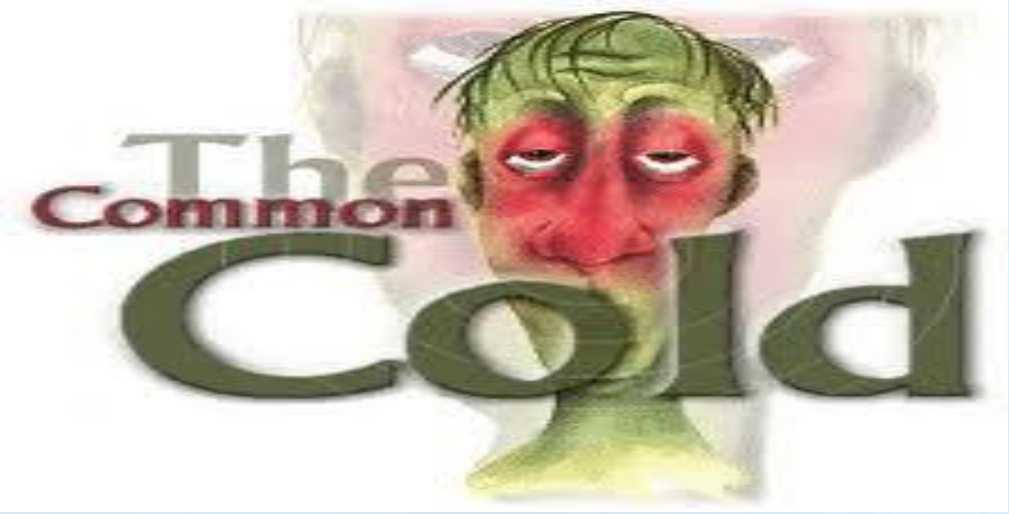


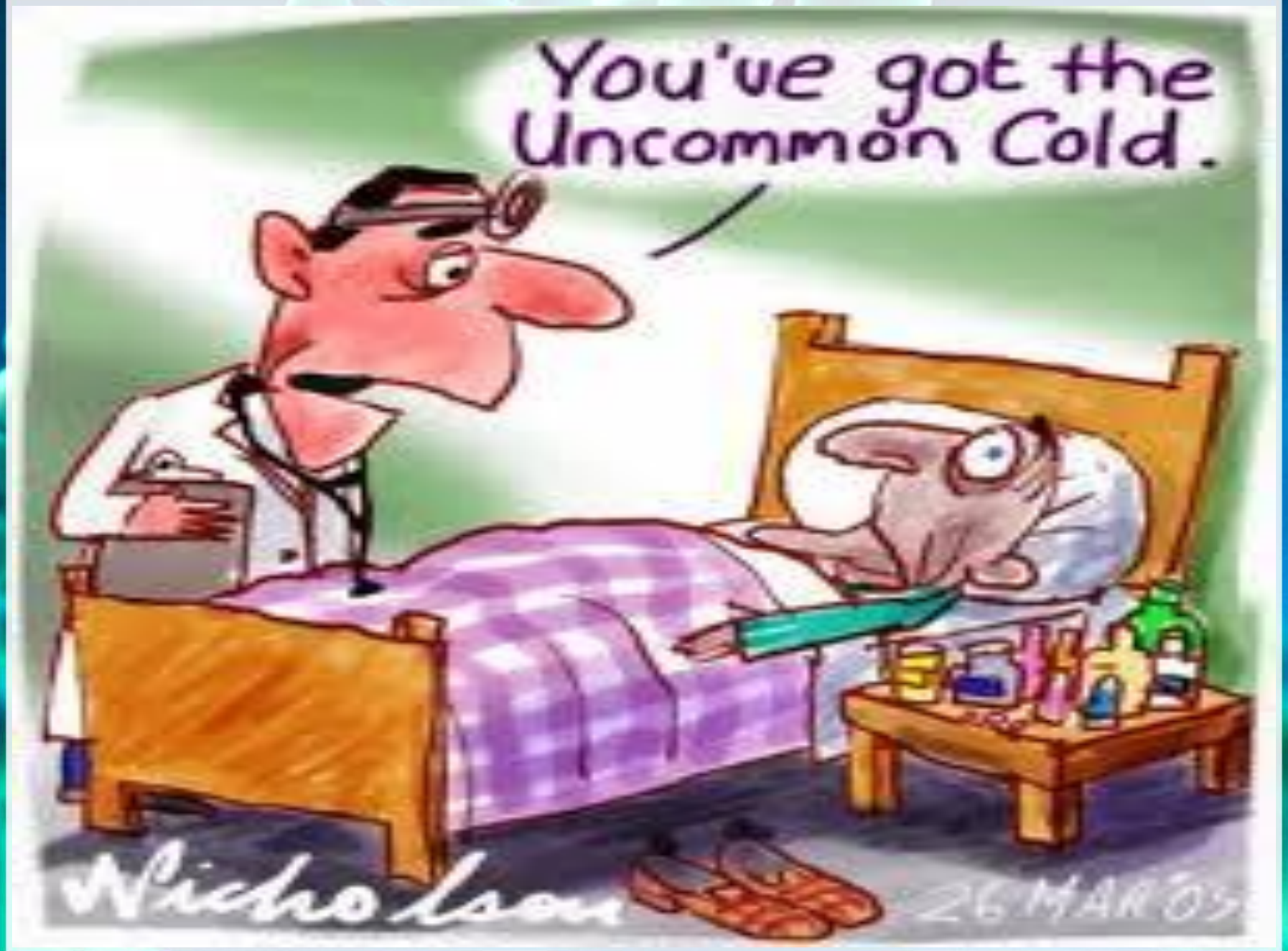
Common Cold

- Prevention
  - No vaccine
    - Too many different types of rhinovirus
      - Makes vaccination impractical
  - Prevention directed at
    - Hand washing
    - Keeping hands away from face
    - Avoiding crowds during times when colds are prevalent

Common Cold

- Treatment
  - Antibiotic therapy is ineffectual
  - Certain antiviral medications show promise
    - Must be taken at first onset of symptoms
  - Treatment with over-the-counter medications may prolong duration due to inhibition of inflammation




You've got the Uncommon Cold.
Nicholson
26 MAR 05


ACCORDING TO MEDICAL SCIENCE, BRANDY CAN'T CURE THE COMMON COLD!
NEITHER CAN MEDICAL SCIENCE!
PHARMACY
searchID: mfln284
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TABLE 22.5 The Common Cold

Symptoms	Scratchy throat, nasal discharge, malaise, headache, cough
Incubation period	1 to 2 days
Causative agent	Mainly rhinoviruses—more than 100 types; many other viruses, some bacteria
Pathogenesis	Viruses attach to respiratory epithelium, starting infection that spreads to adjacent cells; ciliary action ceases and cells slough; mucus secretion increases, and inflammatory reaction occurs; infection stopped by interferon release, cellular and humoral immunity.
Epidemiology	Inhalation of infected droplets; transfer of infectious mucus to nose or eye by contaminated fingers; children initiate many outbreaks in families because of lack of care with nasal secretions.
Prevention and treatment	Handwashing; avoiding people with colds and touching face. No generally accepted treatment except for control of symptoms.

Pharyngitis – common sore throat

- S & S
  - Sore throat, discharge, dry cough, malaise, low grade fever, can have a fulminating infection
- Viral pharyngitis
  - 85% of time in adults
  - Children – 50% viral and 50% bacterial
  - Common causes – rhinovirus, coronavirus, adenovirus, herpes, Epstein-Barr
- Bacterial pharyngitis
  - DD with purulent exudates and tender adenopathy, headache and fever common
  - Usually caused by streptococcus – dx with throat culture
  - Penicillin in tx for bacterial, but not for viral
  - Pharyngitis laryngoscopy

Adenoviral Pharyngitis

- Symptoms
  - Runny nose
  - Fever
  - Sore throat
    - Often accompanied with pus on the pharynx and tonsils
  - Lymph nodes in neck enlarged and tender
  - Certain strains of virus cause hemorrhagic conjunctivitis
  - Mild cough is common with infection
    - Cough may worsen; indication of complicating disease
  - Infection usually resolves in 1 to 3 weeks
    - With or without treatment

Adenoviral Pharyngitis

- Causative Agent
  - Adenovirus
    - 45 types infect humans
    - Non-enveloped
    - Double-stranded DNA genome
    - Remains infectious in environment for extended periods
    - Transmitted easily on medical instruments
    - Inactivated easily with heat and various disinfectants

Adenoviral Pharyngitis

- Pathogenesis
  - Virus infects epithelial cells
    - Attaches to specific surface receptors
    - Multiplies in cell nucleus
    - Cells escape to epithelial surface
    - Cell destruction initiates inflammation
  - Different viruses affect different tissues
    - Adenovirus type 4 causes sore throat and lymph node enlargement
    - Adenovirus type 8 causes extensive eye infection

Adenoviral Pharyngitis

- Epidemiology
  - Human is only source of infection
  - Common among school children
    - Usually sporadic; however, outbreaks do occur
    - Most common in winter and spring
      - Summer outbreaks linked to inadequately chlorinated swimming pools
  - Virus spread by respiratory droplets
  - Epidemic spread promoted by high number of asymptomatic carriers

Adenoviral Pharyngitis

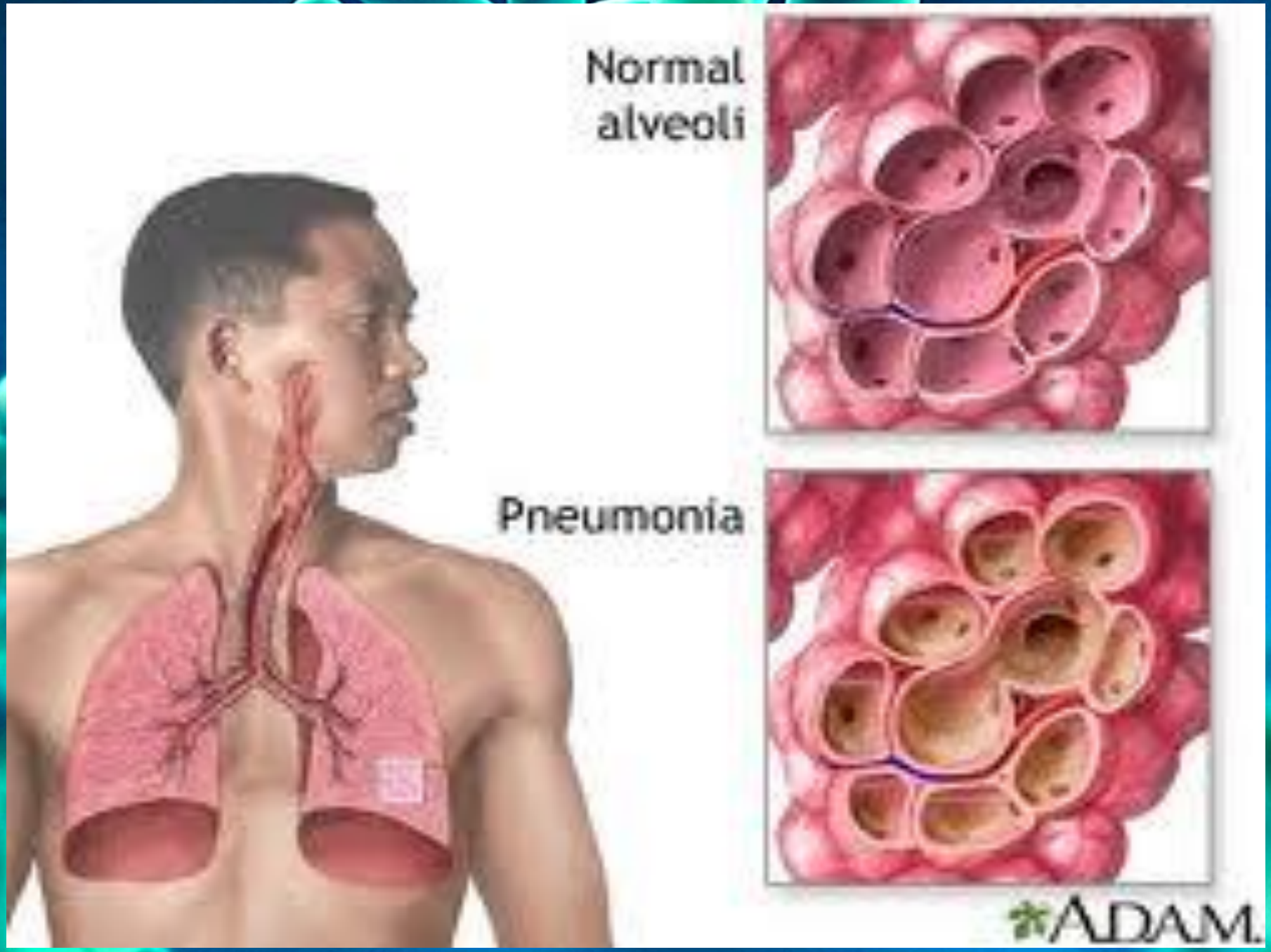
- Prevention and Treatment
  - Prevention is the same as the common cold
  - There is no treatment
    - Patients usually recover uneventfully
    - Bacterial secondary infections may occur requiring antibiotics for treatment

- Acute Pharyngitis

Pharyngitis Treatment

Table 2. Antibiotics and Dosing for Recurrent Episodes of Pharyngitis

Drug	Adult Dosage	Pediatric Dosage	Duration
Clindamycin	600 mg orally divided in 2-4 divided doses	20-30 mg/kg/ day in 3 divided doses (max:1.8 g/day)	10 days
Amoxicillin-clavulanate	500 mg twice daily	40 mg/kg/day in 3 divided doses	10 days
Penicillin benzathine	1.2 million units intra-muscularly for 1 dose	0.6 million units for under 27 kg (50,000 units/kg)	1 dose
Penicillin VK with rifampin	Rifampin: 300 mg PO BID	20 mg/kg/d divided in two equal doses	Last 4 days of treatment with 10 day therapy of penicillin VK


Normal alveoli
Pneumonia
ADAM.

Pneumonia

- 2-3 million cases in USA yearly causing 45,000 deaths
  - Mortality is 4 times higher over 65
- Predisposing factors
  - Preceded by viral URI causing cilia damage and the production of serous exudates
  - Smoking impairs mucociliary escalation
  - Elderly and compromised immune systems
  - HIV, AIDS, sickle cell disease, diabetes
  - Organ transplant patients
  - Close indoor quarters in the winter
  - Hypostatic pneumonia can occur from constant laying down

Acute vs chronic pneumonia

- Acute
  - Symptoms within 1-2 days after exposure
  - Shaking, fever, chills, prostration, dyspnea
  - Common cause of death before antibiotics
- Chronic
  - More slow progressive form
  - Are most viral and fungal pneumonias
  - May last several weeks to months

Dx based on symptoms

- Typical pneumonia
  - Rapid onset, productive cough, fever
  - X-ray changes
- Atypical pneumonia
  - Common with most viral pneumonias

Dx based on part of the lungs affected

- Lobar pneumonia
  - “Classic” pneumonia in which all the alveoli sacs in the lobe are pus filled or fluid filled
- Bronchopneumonia
  - Patchy infiltration throughout the bronchi and bronchioles
- Interstitial pneumonia
  - In the connective tissue between the alveoli with granular infiltration
- Lung abscess
  - Organisms destroy tissue and form pus abscess
- Empyema
  - Prurulent infection in the pleural space
- Nodular lung infections
  - TB, coccidiomycosis and histoplasmosis cause nodular infiltrations

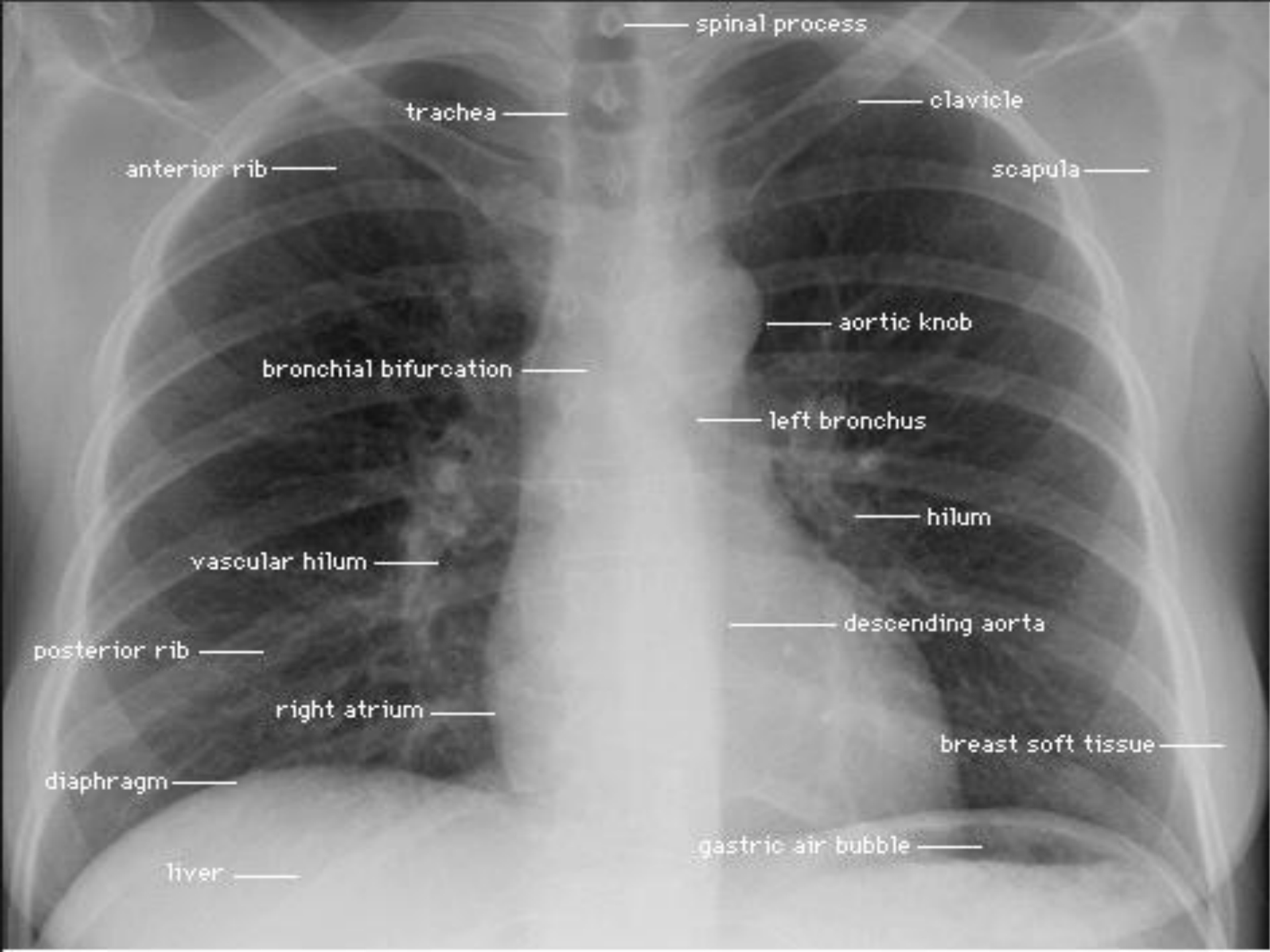
Dx according to where the pneumonia was acquired

- Community acquired
  - Acquired anywhere in the community, but not in a hospital
- Nosocomial
  - Acquired in a hospitalized setting

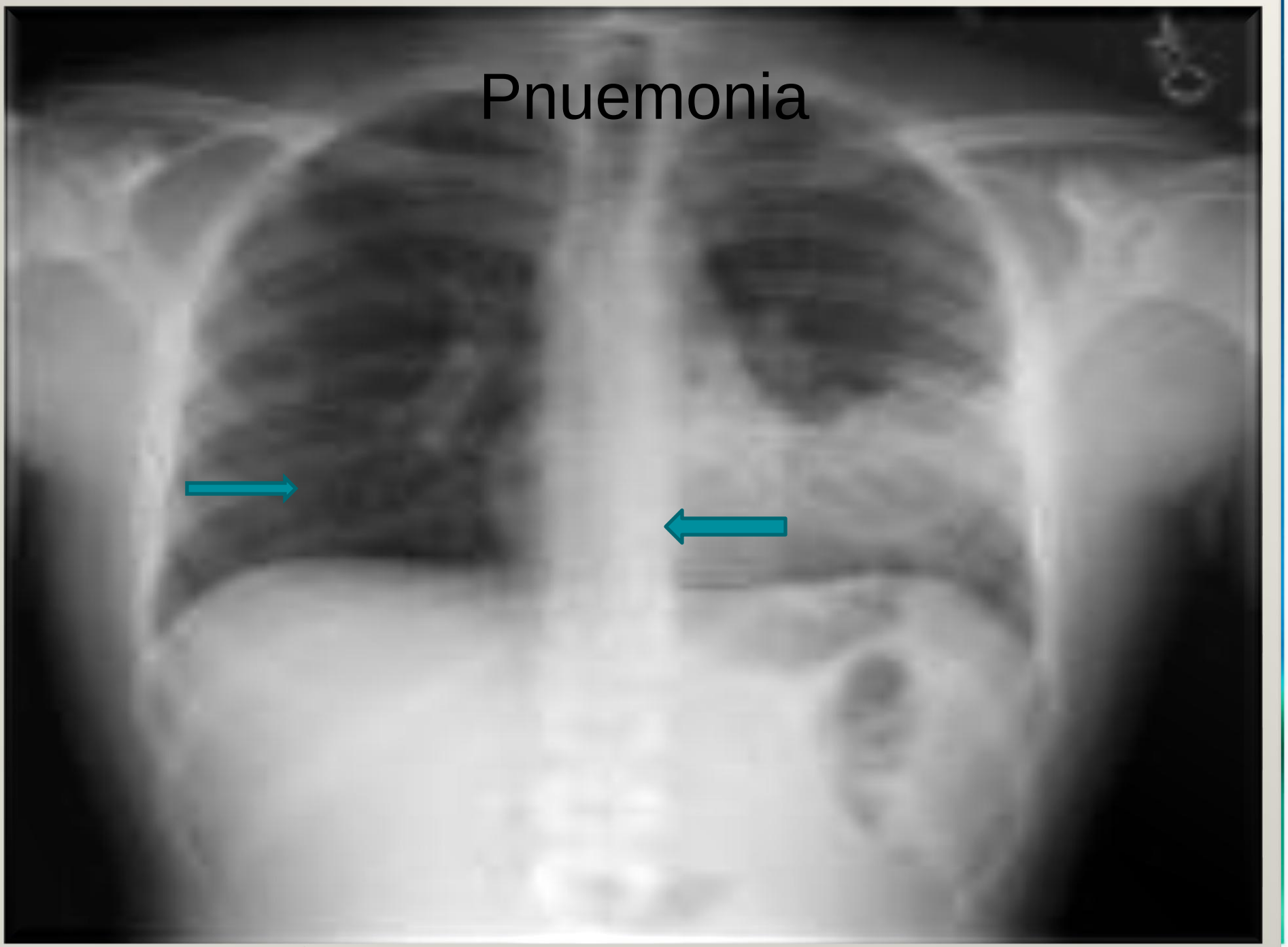
Dx according to etiologic agent

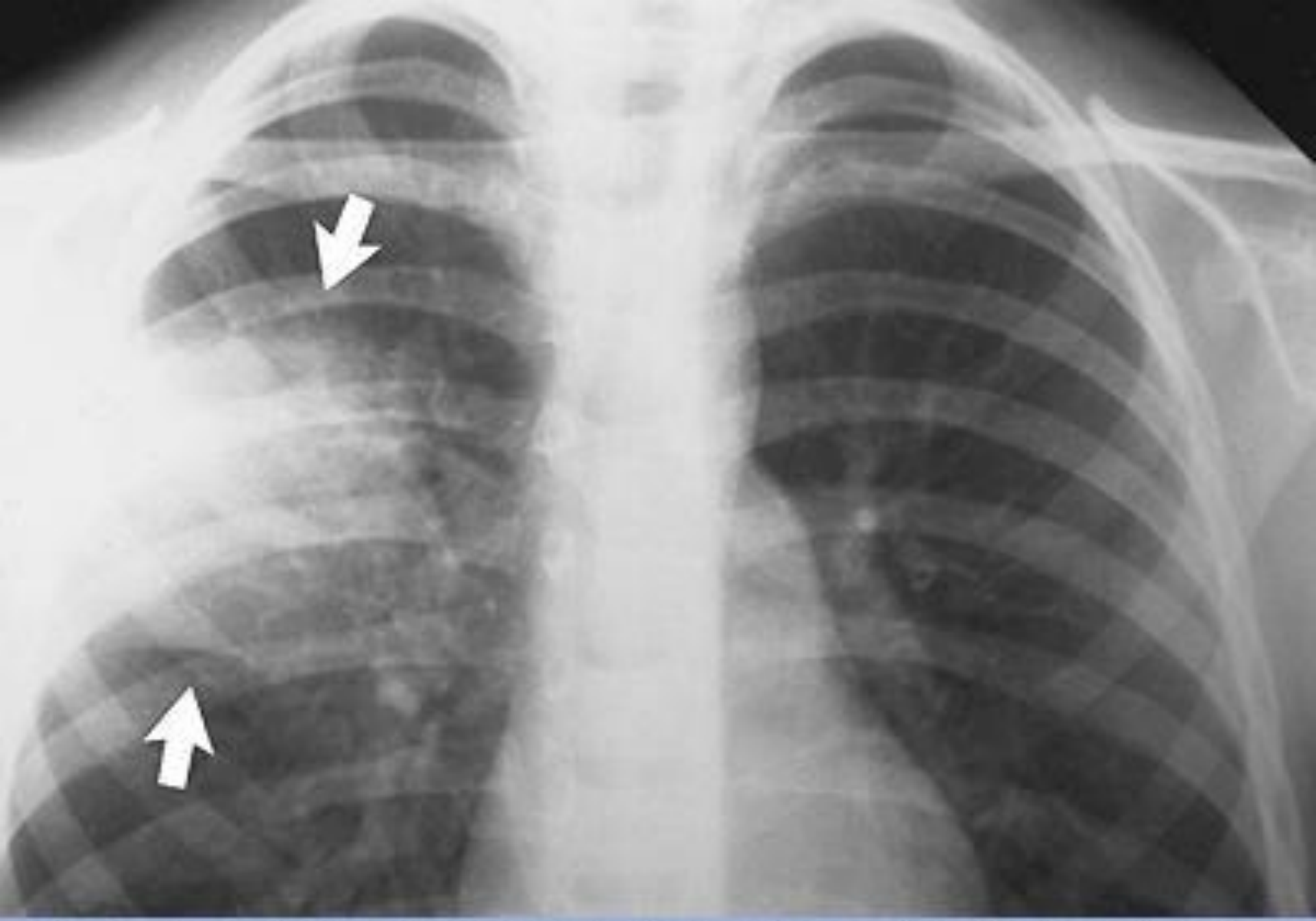
- Pneumococcal pneumonia
  - Classic bacterial pneumonia
  - AKA streptococcal pneumonia
- Aspiration pneumonia
  - Common in elderly from swallowing gastric or food contents in the trachea
  - Often vomiting with loss on consciousness
- Hemophilus pneumonia
  - Common on smokers with COPD
- Staphlococci pneumonia
  - Virulent infection often after influenza
- Viral pneumonia
  - Most common form

- S & S of pneumonia
  - Cough, sore throat, fever, chills, rapid breathing, wheezing, dyspnea, chest or abdominal pain, exhaustion, vomiting
- DX of pneumonia
  - Medical history, physical examination, x-ray
- TX of pneumonia
  - Antibiotics, respiratory therapy with oxygen
  - Amoxicillin is first-line therapy
  - Steroids for wheezing
  - Expectorates and lots of fluids
  - Codeine for severe pain


spinal process
trachea
clavicle
anterior rib
scapula
aortic knob
bronchial bifurcation
left bronchus
hilum
vascular hilum
descending aorta
posterior rib
right atrium
breast soft tissue
diaphragm
gastric air bubble
liver

Pnuemonia



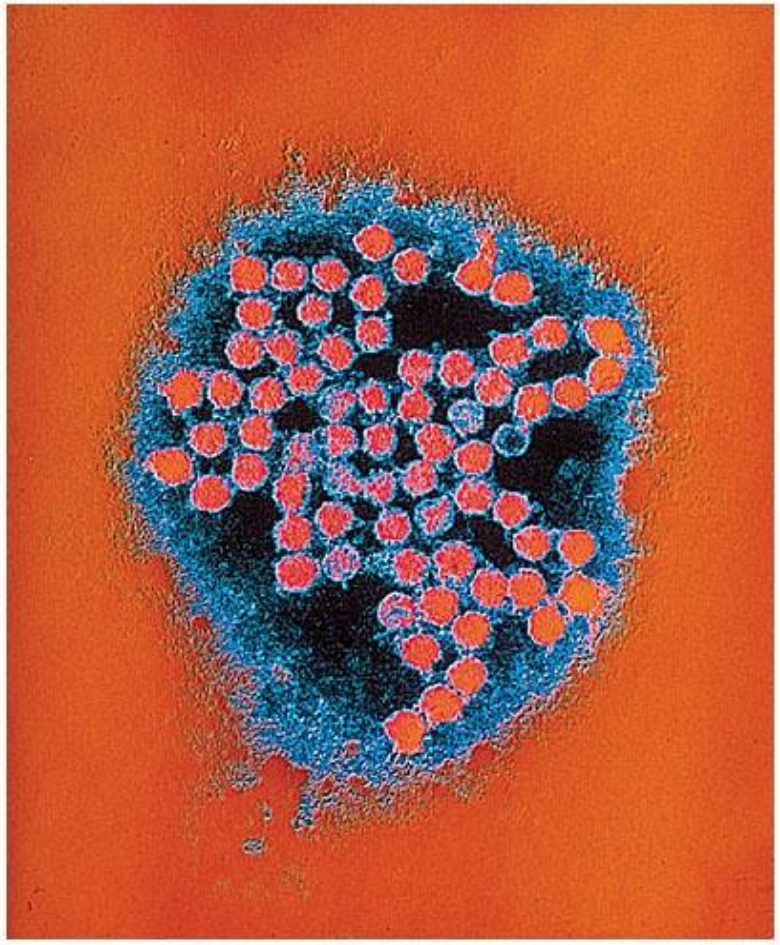


Pneumococcal Pneumonia

- Symptoms
  - Cough - Fever
  - Chest pain - Sputum production
  - Runny nose and upper respiratory congestion precede above symptoms
  - Chest pain is aggravated with each breath and by cough
    - Resulting pain causes breathing to become shallow and rapid
      - Causes skin to become dusky colored due to poor oxygenation
  - Symptoms abate in individuals who survive within 7 to 10 days without treatment

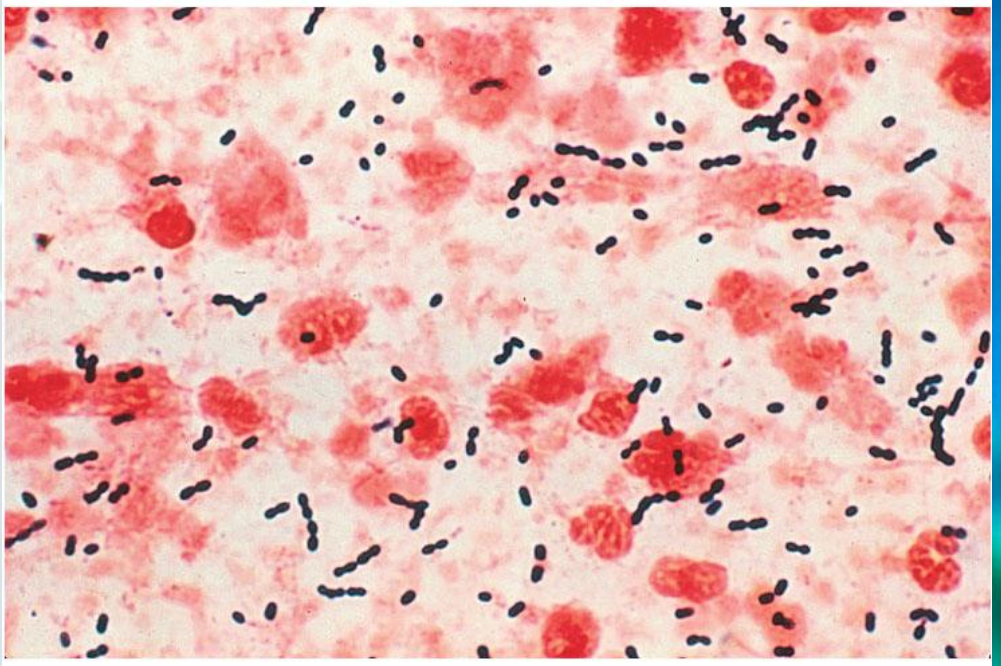
Pneumococcal Pneumonia

- Causative Agent
  - *Streptococcus pnuemoniae*
    - Gram-positive
    - Diplococci
    - Thick capsule
    - Capsule responsible for virulence
    - 80 different types of *S. pneumoniae* based on capsular antigen



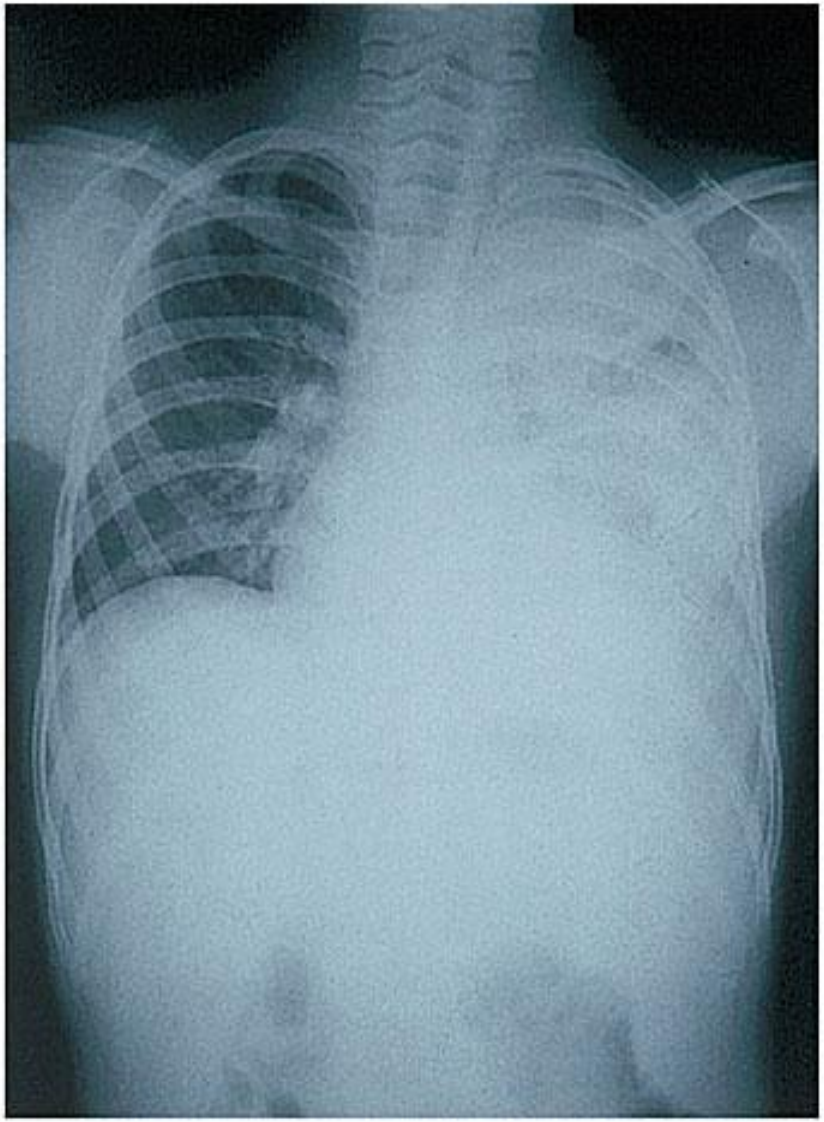
Pneumococcal Pneumonia

- Pathogenesis
  - Infection develops when bacteria are inhaled into alveoli
    - Bacterial capsule interferes with phagocytosis
  - Pneumococci that enter bloodstream are responsible fatal complications
    - Septicemia
    - Endocarditis
    - Meningitis
  - Recovery is usually complete



Pneumococcal Pneumonia

- Epidemiology
  - 30% of healthy individuals carry encapsulated strain in their throat
    - Bacterial rarely reach lung due to mucociliary escalator
    - Risk of pneumonia rises when escalator is destroyed
      - Underlying disease and age also increase risk of disease



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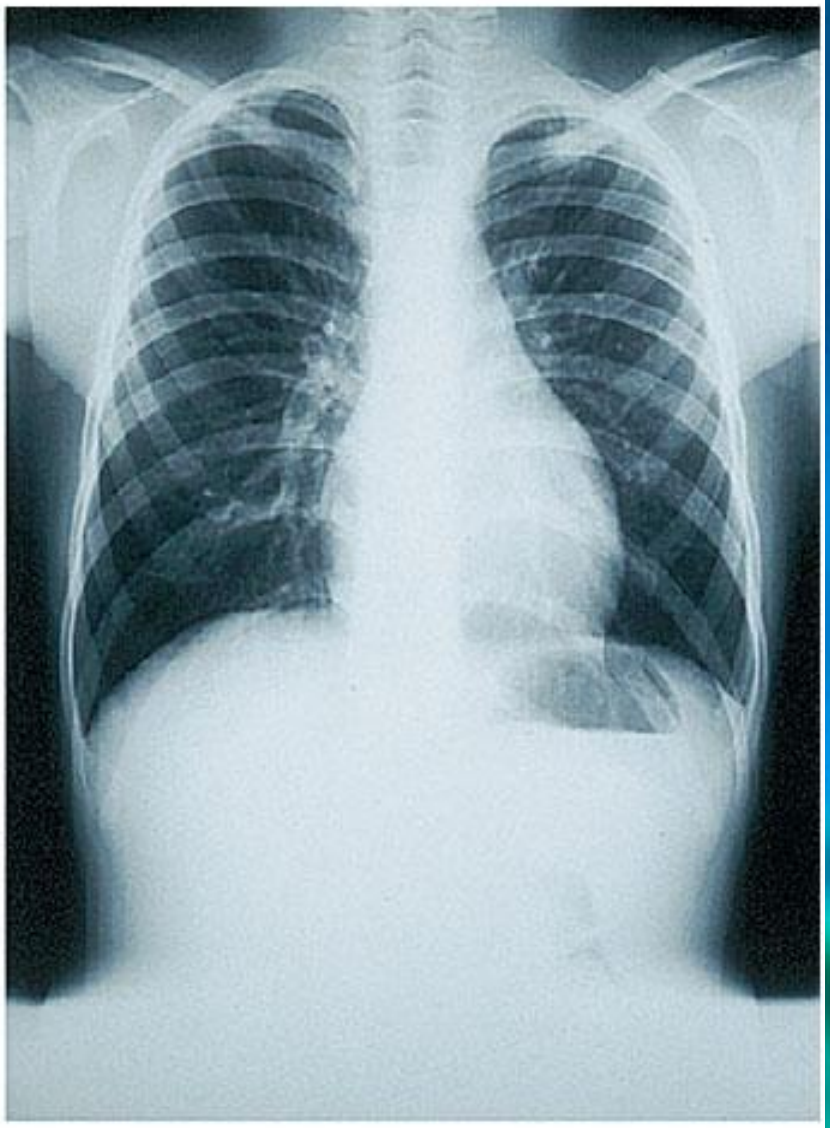


(b)

(both): © St. Francis Hospital/Joan K. Mann

Pneumococcal Pneumonia

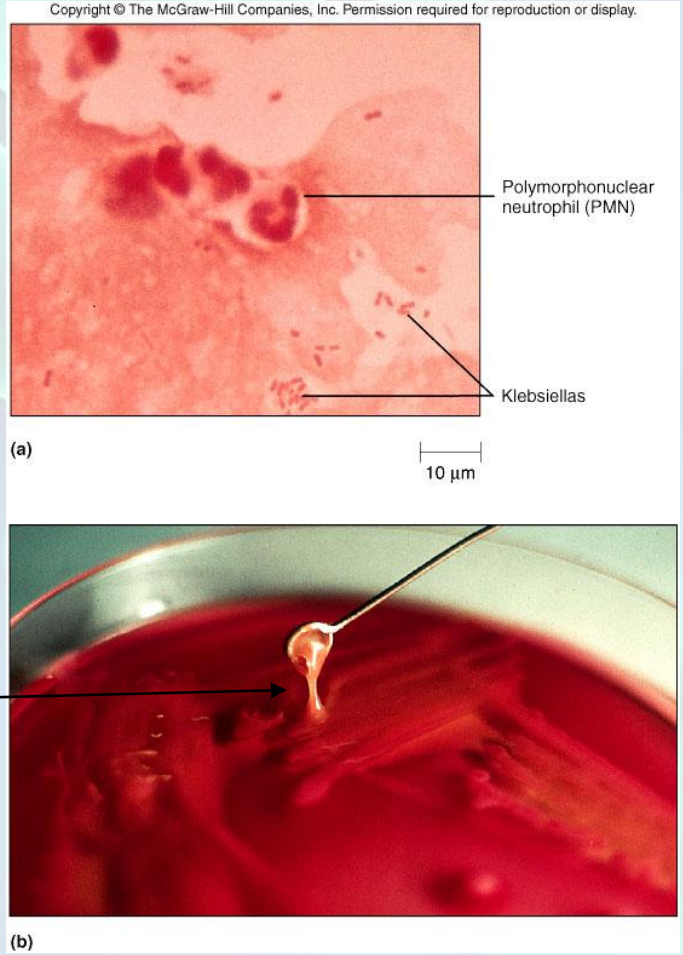
- Prevention and Treatment
  - Prevention is aided by vaccine
    - Gives immunity to 23 strains
    - Conjugate vaccine against 7 types is available for infants
  - Antibiotic treatment is generally successful if given early
    - Penicillin and erythromycin
    - More strains are becoming antibiotic resistant

Klebsiella Pneumonia

- Symptoms
  - Most symptoms are undistinguishable from pneumoncoccal pneumonia; they include
    - Cough
    - Fever
    - Chest pain
  - Other symptoms include
    - Repeated chills
    - Red gelatinous sputum
  - 50% to 80% mortality in untreated patients
    - These patients tend to die sooner than with other pneumonia

Klebsiella Pneumonia

- Causative Agent
  - Several species of *Klebsiella* cause pneumonia
  - Primary cause *Klebsiella pneumoniae*
    - Gram-negative
    - Bacillus
    - Encapsulated



Klebsiella Pneumonia

- Pathogenesis
  - Organism colonizes mouth and throat
  - Carried to the lung with inspired air or mucus
  - Survival in the lung is aided by capsule
    - Interferes with phagocytosis
  - Organism causes tissue death
    - Leads to formation of lung abscess
  - Infection in bloodstream leads to abscess in other tissues

Klebsiella Pneumonia

- Epidemiology
  - Part of the normal flora of the intestine in small population
  - Colonization of mouth and throat is more common in debilitated individuals
    - Especially in institutional settings
- Prevention and Treatment
  - No specific prevention measures
  - Disinfect environment
    - Make sure medical equipment is sterile
  - Use antimicrobials only when necessary
    - Help to control antimicrobial resistance

Mycoplasmal Pneumonia

- Symptoms
  - Onset is typically gradual
  - First symptoms include
    - Fever, headache, muscle pain, fatigue
  - Later symptoms are
    - Dry cough and mucoid sputum
- Causative Agent
  - *Mycoplasma pneumoniae*
    - Small
    - Deformed bacterial lacking cell wall
    - Slow growing
    - Aerobic
    - Colonies have a distinctive fried egg appearance

Mycoplasmal Pneumonia

- Pathogenesis
  - Small infecting dose
  - Organism attaches to receptors on epithelium
    - Attachment interferes with ciliated cell action
    - Ciliated cells slough off
  - Inflammation initiates thickening of bronchial and alveolar walls
    - Causes difficulty in breathing

Mycoplasmal Pneumonia

- Epidemiology
  - Bacterial are spread by aerosolized droplets from respiratory secretions
    - Survive for long periods in secretions
      - Aids in transmission
  - Accounts for approximately one-fifth of bacterial pneumonias
    - Peak incidence in young people
  - Immunity is not permanent

Mycoplasmal Pneumonia

- Prevention and Treatment
  - No practical prevention
    - Avoid crowding in schools and military facilities
      - Particularly dormitories and recruit barracks
  - Antibiotic treatment is successful
    - Penicillins and other cell wall synthesis inhibitors are ineffectual
    - Antibiotics of choice are tetracycline and erythromycin
      - Must be given early
      - Both are bacteriostatic
        - » Will only inhibit growth, not kill organism

TABLE 22.7 Pneumococcal, *Klebsiella,* and Mycoplasmal Pneumonias Compared

	Pneumococcal Pneumonia	*Klebsiella* Pneumonia	Mycoplasmal Pneumonia
Symptoms	Cough, fever, single shaking chill, rust-colored sputum from degraded blood, shortness of breath, chest pain	Chills, fever, cough, chest pain, and grossly bloody, mucoid sputum	Gradual onset of cough, fever, sputum production, headache, fatigue, and muscle aches
Incubation period	1 to 3 days	1 to 3 days	2 to 3 weeks
Causative agent	The pneumococcus, *Streptococcus pneumoniae,* encapsulated strains	*Klebsiella pneumoniae,* an enterobacterium	*Mycoplasma pneumoniae;* lacks cell wall
Pathogenesis	Inhalation of encapsulated pneumococci; colonization of the alveoli incites inflammatory response; plasma, blood, and inflammatory cells fill the alveoli; pain results from involvement of nerve endings.	Aspiration of colonized mucus droplets from the throat. Destruction of lung tissue and abscess formation common; infection spreads via blood to other body tissues.	Cells attach to specific receptors on the respiratory epithelium; inhibition of ciliary motion and destruction of cells follow.
Epidemiology	High carrier rates for *S. pneumoniae.* Risk of pneumonia increased with conditions such as alcoholism, narcotic use, chronic lung disease, and viral infections that impair the mucociliary escalator. Other predisposing factors are chronic heart disease, diabetes, and cancer.	Often resistant to antibiotics, and colonize individuals who are taking them. *Klebsiella* sp. and other Gram-negative rods are common causes of fatal nosocomial pneumonias.	Inhalation of infected droplets; mild infections common and foster spread of the disease.
Prevention and treatment	Capsular vaccine available contains 23 capsular antigens; conjugate vaccine for infants. Treatment: penicillin, erythromycin, and others.	No vaccine available. A cephalosporin with an aminoglycoside.	No vaccine available; avoidance of crowding in schools and military facilities advisable; tetracycline or erythromycin for treatment.

Whooping Cough

- Symptoms
  - Runny nose followed by bouts of uncontrollable coughing
    - Termed paroxymal coughing
      - Severe cough can cause rupture of small blood vessels in the eyes
  - Coughing spasm followed by characteristic “whoop”
    - Sound made by the forceful inspiration of air
  - Vomiting and seizure may occur

Whooping Cough

- Causative Agent
  - *Bordetella pertussis*
    - Small
    - Encapsulated
    - Strictly aerobic
    - Gram-negative
    - Bacillus
    - Does not survive long periods outside the host

Whooping Cough

- Pathogenesis
  - Enters respiratory tract with inspired air and attaches to ciliated cells
  - Organism colonizes structures of the upper and lower respiratory tract
  - Mucous secretion increases which causes ciliary action to decrease
    - Cough reflex is only mechanism for clearing secretions

TABLE 22.8 Pertussis

Symptoms	Runny nose followed after a number of days by spasms of violent coughing; vomiting and possible convulsions
Incubation period	7 to 21 days
Causative agent	*Bordetella pertussis,* a tiny Gram-negative rod
Pathogenesis	Colonization of the surfaces of the upper respiratory tract and tracheobronchial system; ciliary action slowed; toxins released by *B. pertussis* cause death of epithelial cells and increased cAMP; fever, excessive mucus output, and a rise in the number of lymphocytes in the bloodstream result.
Epidemiology	Inhalation of infected droplets; older children and adults have mild symptoms.
Prevention and treatment	Acellular vaccines, for immunization of infants and children; erythromycin, somewhat effective if given before coughing spasms start, eliminates *B. pertussis.*

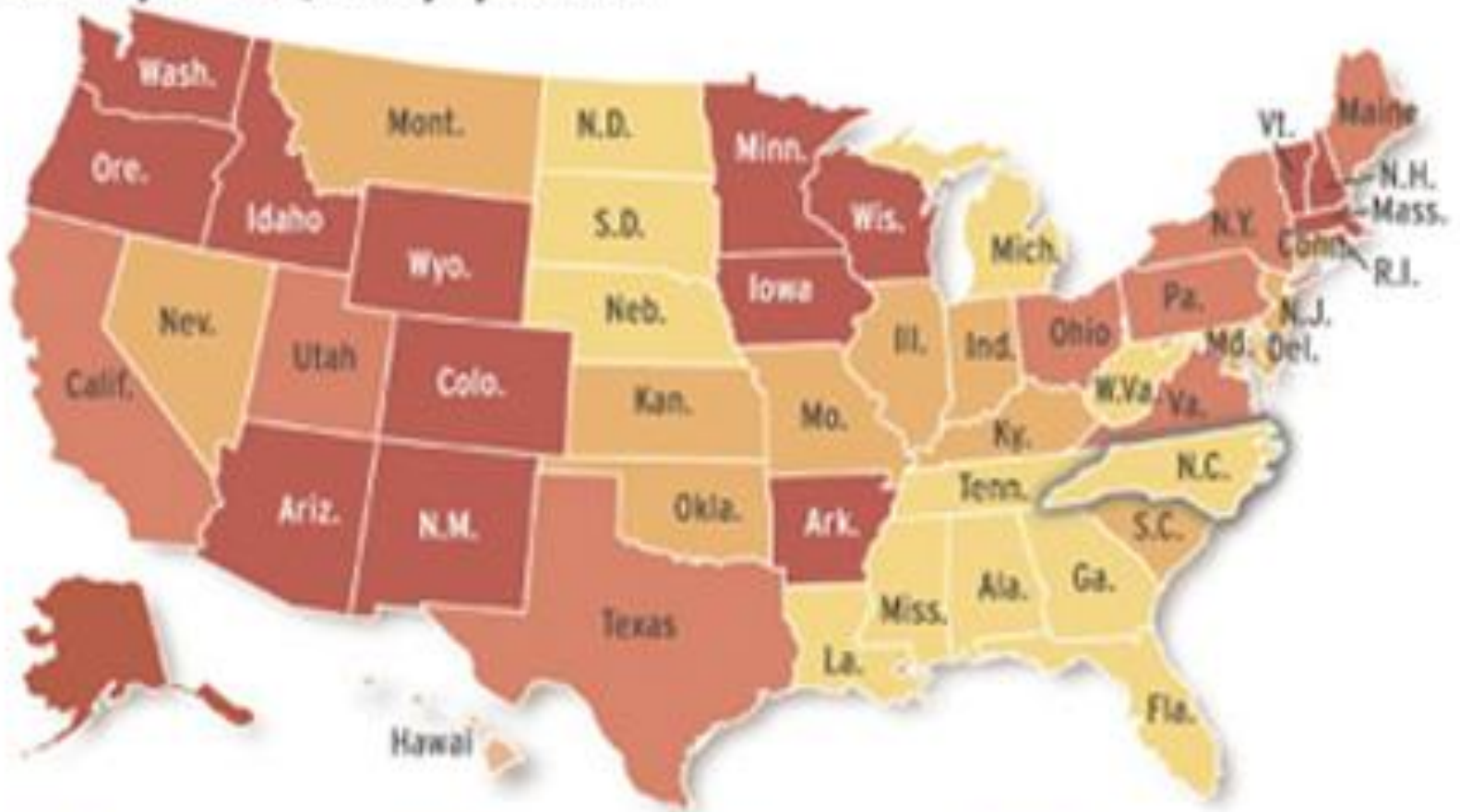
Whooping Cough

- Epidemiology
  - Spreads via infected respiratory droplets
  - Most infectious during runny nose period
    - Number of organisms decrease with onset of cough
  - Classically disease of infants
    - Milder forms are seen in older children and adults
  - Often overlooked as a persistent cold
    - Fosters transmission

Whooping Cough

- Prevention
  - Directed at vaccination of infants
    - Prevents disease in 70% of individuals
    - Pertussis vaccine combined with diphtheria and tetanus toxoids (DPT)
      - Injections given at 6 weeks, 4, 6 and 18 months
- Treatment
  - Erythromycin is effective at reducing symptoms if given early
  - Antibiotic usually eliminates bacteria from respiratory secretions

Average annual reported whooping cough cases per 100,000 population



Source: Centers for Disease Control and Prevention

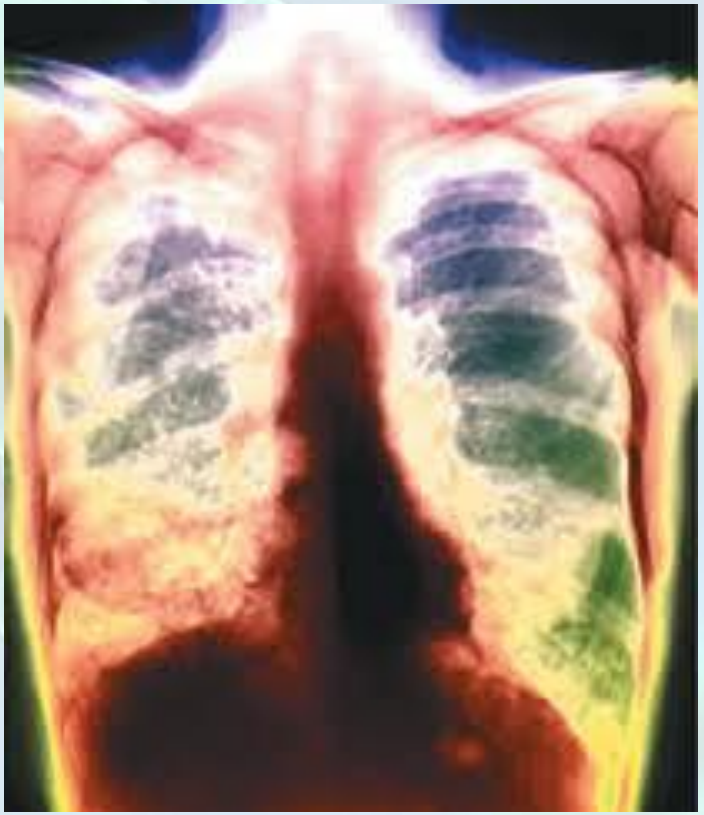

TUBERCULOSIS

Tuberculosis

- Symptoms
  - Chronic illness
  - Symptoms include
    - Slight fever with night sweats
    - Progressive weight loss
    - Chronic productive cough
      - Sputum often blood streaked
- Causative Agent
  - *Mycobacterium tuberculosis*
    - Gram-positive cell wall type
    - Slender bacillus
    - Slow growing
      - Generation time 12 hours or more
    - Resists most prevention methods of control

Tuberculosis

- Pathogenesis
  - Usually contracted by inhalation of airborne organisms
  - Bacteria are taken up by pulmonary macrophages in the lungs
  - Resists destruction within phagocyte



Tuberculosis

- Pathogenesis
  - Organisms are carried to lymph nodes
  - About 2 weeks post infection intense immune reaction occurs
    - Macrophages fuse together to make large multinucleated cell
    - Macrophages and lymphocytes surround large cell
      - This is an effort to wall off infected tissue
  - Activated macrophages release into infected tissue
    - Causes death of tissue resulting in formation of “cheesy” material

Tuberculosis

- Epidemiology
  - Estimated 10 million Americans infected
    - Rate highest among non-white, elderly poor people
  - Small infecting dose
    - As little as ten inhaled organisms
  - Factors important in transmission
    - Frequency of coughing, adequacy of ventilation, degree of crowding

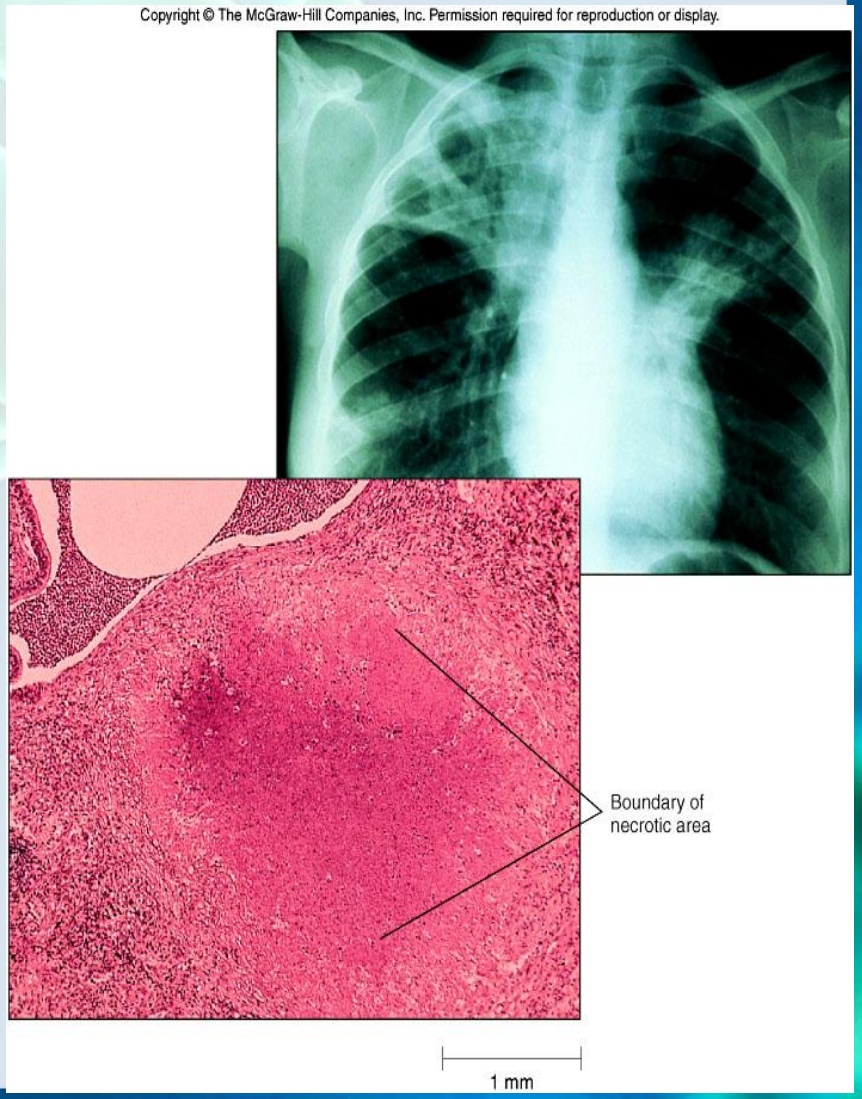


TABLE 22.9 Tuberculosis

① Airborne *Mycobacterium tuberculosis* bacteria are inhaled and lodge in the lungs.

② The bacteria are phagocytized by lung macrophages and multiply within them, protected by lipid-containing cell walls and other mechanisms.

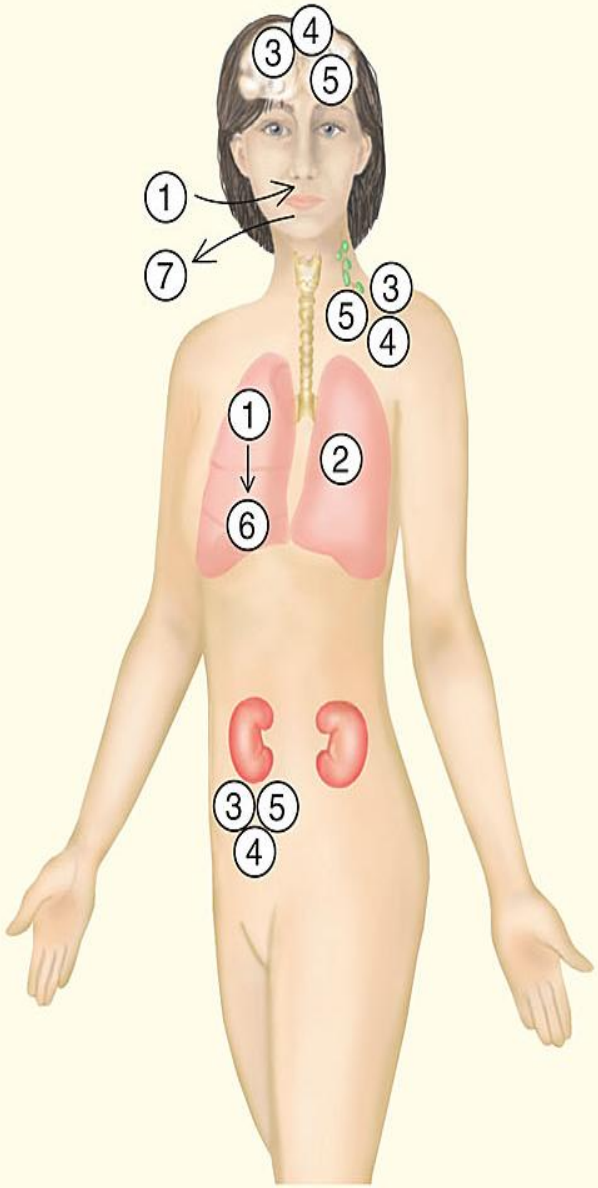
③ Infected macrophages are carried to various parts of the body such as the kidneys, brain, lungs, and lymph nodes; release of *M. tuberculosis* occurs.

④ Delayed hypersensitivity develops; wherever infected *M. tuberculosis* has lodged, an intense inflammatory reaction develops.

⑤ The bacteria are surrounded by macrophages and lymphocytes; growth of the bacteria ceases.

⑥ Intense inflammatory reaction and release of enzymes can cause caseation necrosis and cavity formation.

⑦ With uncontrolled or reactive infection, *M. tuberculosis* exits the body through the mouth with coughing or singing.



Symptoms	Chronic fever, weight loss, cough, sputum production
Incubation period	2 to 10 weeks
Causative agent	*Mycobacterium tuberculosis;* unusual cell wall with high lipid content
Pathogenesis	Colonization of the alveoli incites inflammatory response; ingestion by macrophages follows; organisms survive ingestion and are carried to lymph nodes, lungs, and other body tissues; tubercle bacilli multiply; granulomas form.
Epidemiology	Inhalation of airborne organisms; latent infections can reactivate.
Prevention and treatment	BCG vaccination, not used in the United States; tuberculin (Mantoux) test for detection of infection, allows early therapy of cases; treatment of all high-risk cases including young people with positive tests and individuals whose skin test converts from negative to positive. Treatment: two or more antitubercular medications given simultaneously long term, such as isoniazid (INH) and rifampin; DOTS.

Tuberculosis

- Epidemiology
  - Tuberculin test used to detect those infected
    - Small amount of tuberculosis antigen is injected under the skin
    - Injection site becomes red and firm if infected
    - Positive test does not indicate active disease

- Prevention
  - Vaccination for tuberculosis widely used in many parts of the world
    - Vaccine not given in United States because it eliminates use of tuberculin test as diagnostic tool
- Treatment
  - Antibiotic treatment is given in cases of active TB
    - Two or more medications are given together to reduce potential antimicrobial resistance
    - Antimicrobials include
      - Rifampin and Isoniazid (INH)
        - » Both target actively growing organisms and metabolically inactive intracellular organisms
    - Therapy is pronged
      - Lasting at least 6 months


L


Mystery of the Killer Fever
"KILLER BUG" THAT PUZZLED SCIENTISTS
DISEASE DETECTIVES
TRACING THE PHILLY KILLER

Legionnaires' Disease

- Symptoms
  - Early symptoms
    - Headache
    - Muscle ache
    - Rapid rise in temperature
    - Confusion
    - Shaking chills
  - Later symptoms
    - Dry cough
    - Sputum production
    - Pleurisy
  - One quarter of cases develop alimentary tract symptoms
    - Diarrhea, abdominal pain, vomiting

Legionnaires' Disease

- Pathogenesis
  - Acquired by breathing aerosolized contaminated water
  - Healthy people are quite resistant
  - Organisms lodge in or near alveoli and inhibit phagocytosis
  - Fatal respiratory arrest occurs in 15% of hospitalized cases
- Epidemiology
  - Organism widespread in natural warm waters
  - Relatively resistant to chlorine
  - Survives well in water system of buildings
  - Person-to-person transmission does not occur

Legionnaires' Disease

- Causative Agent
  - *Legionella pneumophila*
- Prevention and Treatment
  - Prevention focused on equipment to minimize risk of infectious aerosols
  - Adequate disinfection
  - Antibiotic treatment is successful
    - Treated with high doses of erythromycin
    - Bacteria produces β lactamase enzyme
      - Makes it resistant to penicillins and cephalosporins

TABLE 22.10 Legionnaires' Disease

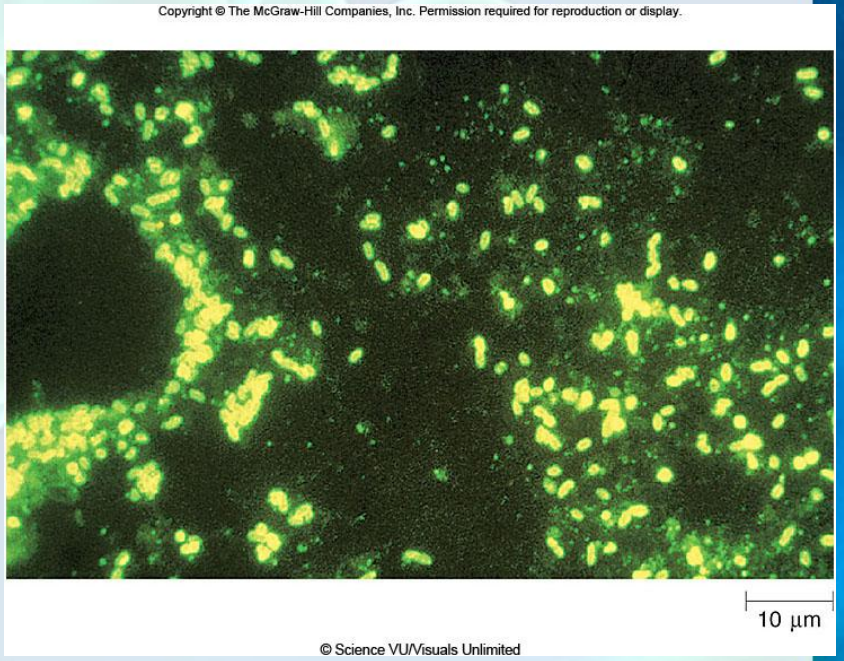
Symptoms	Muscle aches, headache, fever, cough, shortness of breath, chest and abdominal pain, diarrhea
Incubation period	2 to 10 days
Causative agent	*Legionella pneumophila,* a Gram-negative bacterium that stains poorly in clinical specimens.
Pathogenesis	Organism multiplies within phagocytes; released with death of the cell; necrosis of cells lining the alveoli; inflammation, and formation of microabscesses.
Epidemiology	Originates mainly from warm water contaminated with other microorganisms, such as found in air conditioning systems.
Prevention and treatment	Avoidance of contaminated water aerosols; regular cleaning and disinfection of humidifying devices. Treatment: erythromycin and rifampin.

Influenza

- A major cause of death worldwide
  - Bird flu pandemic at the end of WWI caused 50 million worldwide deaths
  - Current bird flu beginning to see a resurgence
  - Resultant new strains are what causes pandemics
- S & S
  - Dramatic and abrupt with malaise, chills, cough, fever (3 days), rhinorrhea, cervical adenopathy
  - Virus kills the respiratory epithelium causing pulmonary function decline
  - Major complication is viral pneumonia

Influenza

- Symptoms
  - Influenza Type A
    - Short incubation period
      - Averaging 2 days
    - Headache
    - Fever
    - Muscle pain
    - Dry cough
  - Acute symptoms abate within a week
    - Cough, fatigue and generalized weakness may linger



Influenza

- Epidemiology
  - Outbreaks occur in United States every year
    - Associated with 10,000 to 40,000 deaths
  - Pandemics occur periodically
    - Most “famous” pandemic of 1918
      - Spanned the globe in 9 months
    - Pandemics have higher than normal morbidity

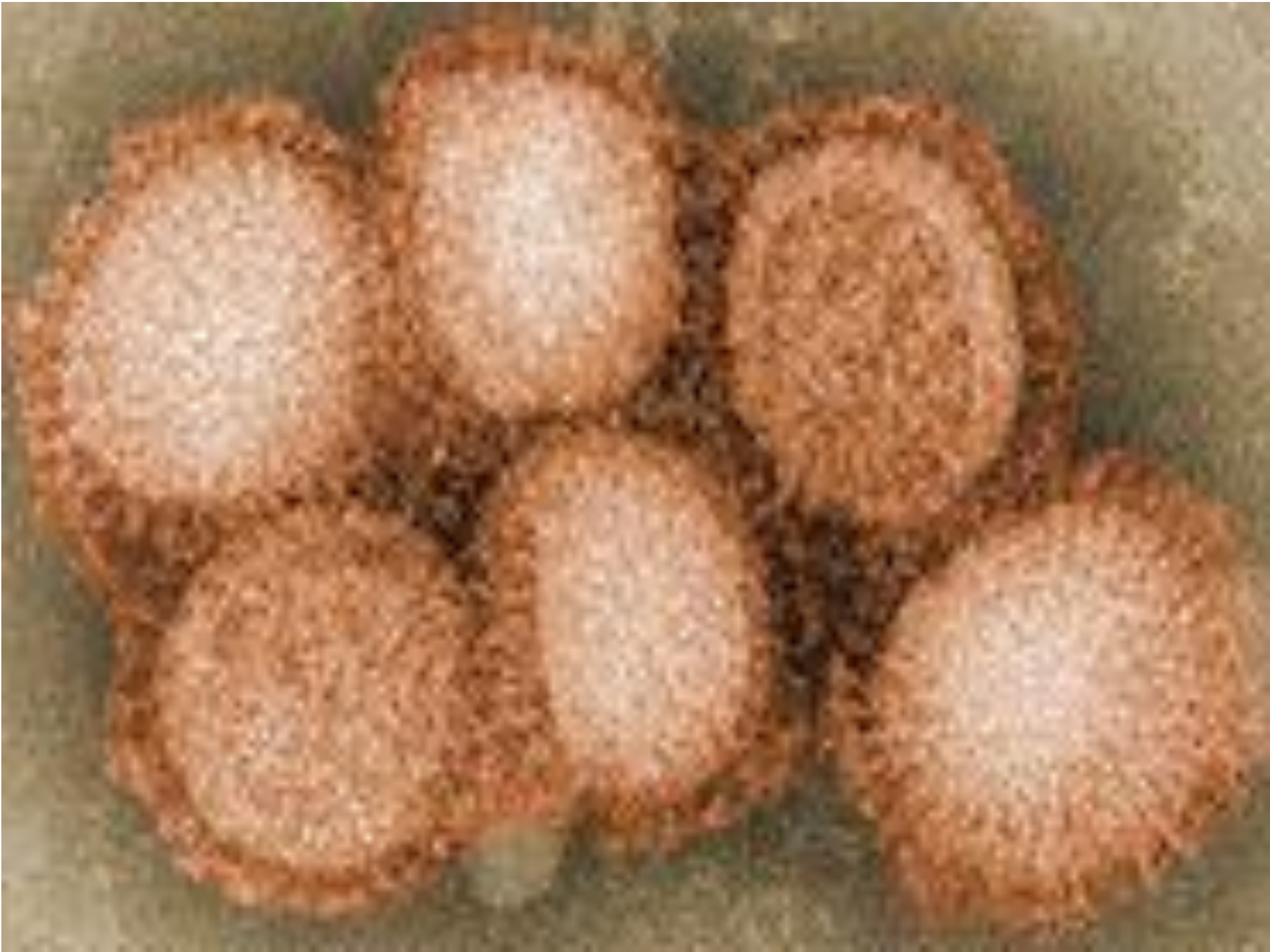
Bird flu (H5N1 virus)

- First noted in China in1996 among birds
  - Has caused deaths of 140 million birds
  - Spread to humans via saliva, blood and contact with bird droppings – less then 150 human cases
  - 50% human fatality
  - Epidemiologists expect a genetic mutation with possible transmission from human to human
- S & S
  - Similar flu symptoms
- Diagnosis
  - Lab conformation
- TX
  - Tamiflu and Relenza
  - Best defense is vaccine

Swine Flu (H1N1) Virus

- Is a subtype of influenza A virus and the most common cause of influenza (flu) in humans.
- Some strains of H1N1 are endemic in humans and cause a small fraction of all influenza-like illness and a small fraction of all seasonal influenza.
- Swine flu (swine influenza) is a respiratory disease caused by viruses that infect the respiratory tract of pigs and result in nasal secretions, a barking-like cough, decreased appetite, and listless behavior

- H1N1 flu is contagious
- H1N1 flu is NOT caused by eating pork or pork products
- Illness with the new H1N1 flu virus has ranged from mild to severe
- About 70 percent of people who have been hospitalized with H1N1 flu have had one or more medical conditions that placed them in the “high risk” category
  - These include pregnancy, diabetes, heart disease, asthma and kidney disease.
- Seniors (adults 65 years and older) are prioritized for antiviral treatment to limit risk of complication if they get flu



Symptoms of Seasonal and H1N1 Flu

Seasonal Flu

- Fever
- Coughing and/or sore throat
- Runny or stuffy nose
- Headaches and/or body aches
- Chills
- Fatigue

H1N1 Flu

- Similar to seasonal flu, but symptoms may be more severe.
- There may be additional symptoms. A significant number of H1N1 flu cases:
- Vomiting
- Diarrhea

Emergency Warning Signs

In Children

- Fast breathing or trouble breathing
- Bluish or gray skin color
- Not drinking enough fluids
- Severe or persistent vomiting
- Not waking up or not interacting
- Being so irritable that the child does not want to be held
- Flu-like symptoms improve but then return with fever and worse cough

In Adults

- Difficulty breathing or shortness of breath
- Pain or pressure in the chest or abdomen
- Sudden dizziness
- Confusion
- Severe or persistent vomiting
- Flu-like symptoms improve but then return with fever and worse cough

Diagnosis of H1N1

- If the symptoms indicate the presence of the H1N1 flu, the physician usually performs a nasopharyngeal swab test to determine if the H1N1 virus is present. If it is present, the flu is diagnosed
- The test is performed by inserting a thin cotton swab two inches into the nostril, aimed towards the throat.

Treatment of H1H1

- Antiviral Therapy
  - Efficacy — Therapy should be started as soon as possible, since evidence of benefit is strongest for seasonal influenza when treatment is started within 48 hours of illness onset
  - At this time, treatment with oseltamivir (trade name Tamiflu®) or zanamivir (trade name Relenza®) is recommended for all people with suspected or confirmed influenza who require hospitalization
  - The recommended duration of treatment is five days

Influenza

- Prevention and Treatment
  - Vaccine can be 80% to 90% effective
  - New vaccine required every year
    - Due to antigenic drift
- Antiviral medications are 70% to 90% effective
  - Include amantidine and rimantidine
    - Must be taken early
    - Not a substitute for vaccine

TABLE 22.11 Influenza

① Influenza virus is inhaled and carried to the lungs.

② Viral hemagglutinin attaches to specific receptors on ciliated epithelial cells, the viral envelope fuses with the epithelial cell, and the virus enters the cell by endocytosis.

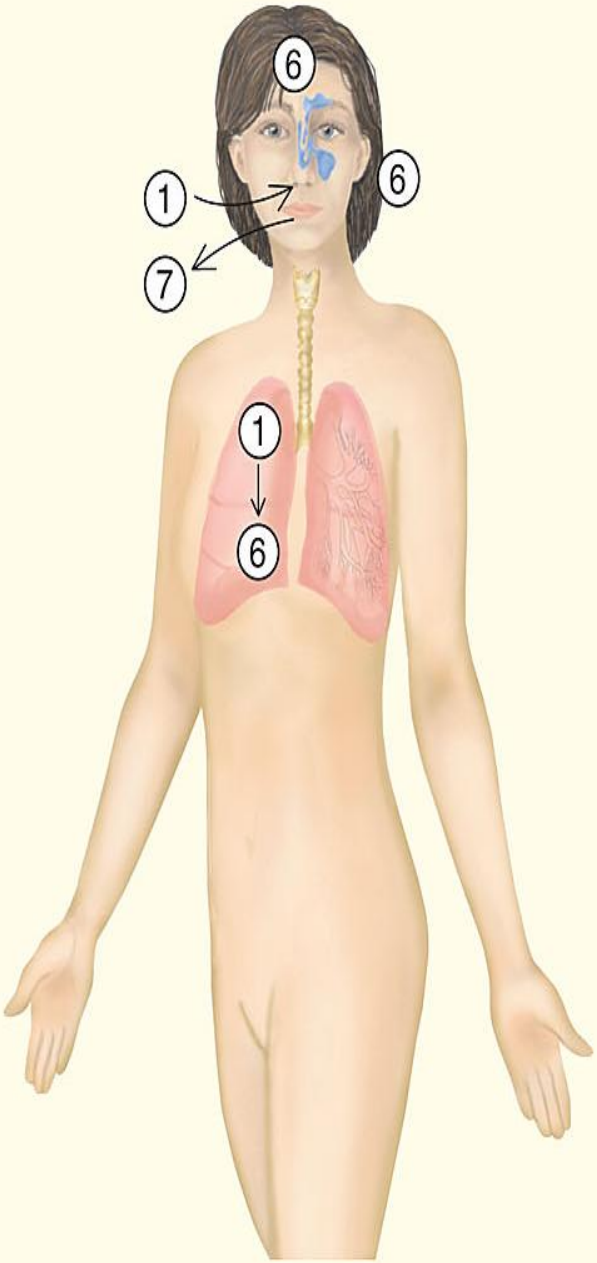
③ Host cell synthesis is diverted to synthesizing new virus.

④ Newly formed virions bud from infected cells, they are released by viral neuraminidase and infect ciliated epithelium, mucus-secreting, and alveolar cells.

⑤ Infected cells ultimately die and slough off; recovery of the mucociliary escalator may take weeks.

⑥ Secondary bacterial infection of the lungs, ears, and sinuses is common.

⑦ The virus exits with coughing.



Symptoms	Fever, muscle aches, lack of energy, headache, sore throat, nasal congestion, cough
Incubation period	1 to 2 days
Causative agent	Influenza virus, an orthomyxovirus
Pathogenesis	Infection of respiratory epithelium; cells destroyed and virus released to infect other cells. Secondary bacterial infection results from damaged mucociliary escalator.
Epidemiology	Antigenic drift and antigenic shift thwart immunity.
Prevention and treatment	Vaccines usually 80% to 90% effective. Amantadine and rimantadine are sometimes effective for preventing type A but not type B virus disease; neuraminidase inhibitors effective against both A and B viruses. These medications somewhat effective for treatment when given early in the disease.

Respiratory Syncytial Virus Infection

- Symptoms
  - Incubation period 1 – 4 days
  - Runny nose
  - Cough and wheezing
  - Difficulty breathing
  - Fever
    - May or may not be present
  - Some develop dusky colored skin
    - Due to poor oxygenation
  - One of the causes of croup in older infants
- Causative Agent
  - Respiratory syncytial virus (RSV)

Respiratory Syncytial Virus Infection

- Pathogenesis
  - Enters body through inhalation
  - Infects respiratory epithelium
  - Causes death and sloughing of infected cells
  - Bronchiolitis is common feature
    - Bronchioles become obstructed by sloughing cells
      - Responsible for wheezing
  - Inflammation of the alveoli may lead to secondary pneumonia

TABLE 22.12 Respiratory Syncytial Virus (RSV) Infections

Symptoms	Runny nose, cough, fever, wheezing, difficulty breathing, dusky color
Incubation period	1 to 4 days
Causative agent	RSV, a paramyxovirus that produces syncytia
Pathogenesis	Sloughing of respiratory epithelium and inflammatory response plug bronchioles, cause bronchiolitis; pneumonia results from bronchiolar and alveolar inflammation, or secondary infection.
Epidemiology	Yearly epidemics during the cool months; readily spread by healthy older children and adults who often have mild symptoms; no lasting immunity.
Prevention and treatment	No vaccine. Preventable by injections of immune serum globulin or a monoclonal antibody; no satisfactory antiviral treatment.

Respiratory Syncytial Virus Infection

- Epidemiology
  - Outbreaks are common
    - Generally from late fall to late spring, peaking mid-winter
  - Recovery produces short-lived immunity
  - Healthy adults and children usually suffer mild disease but readily spread virus
- Prevention and Treatment
  - No vaccine
  - Isolation of sick individual best prevention
  - No effective antiviral medications