Respiratory Block

PNEUMONIA

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Objectives

- Understand that pneumonia is an inflammatory condition of the lung characterized by consolidation (solidification) of the pulmonary tissue
- Is aware of the pathogenesis of pneumonia and its classification which principally include bronchopneumonia, lobar pneumonia and atypical pneumonia
- Can appreciate the etiology and pathogenesis of lung abscess

PULMONARY INFECTIONS

- Pulmonary infections in the form of pneumonia are responsible for one sixth of all deaths in the United States
- Pneumonia defined as any infection in the lung
- Normally, the lung parenchyma remains sterile because of a number of highly effective immune and non- immune defense mechanisms that extend throughout the respiratory system from the nasopharynx to the alveolar air spaces
- The vulnerability of the lung to infection despite these defenses is not surprising because
  1. many microbes are airborne and readily inhaled into the lungs
  2. nasopharyngeal flora are regularly aspirated during sleep, even by healthy individuals
  3. lung diseases often lower local immune defenses
- The vast majority are upper respiratory tract infections caused by viruses, but bacterial and fungal infections can also occur
- Pneumonias are classified by the specific etiologic agent, which determines the treatment, or, if no pathogen can be isolated, by the clinical setting in which the infection occurs

Who’s at risk ?

- Loss or suppression of the cough reflex, as a result of coma, anesthesia, neuromuscular disorders, drugs, or chest pain (may lead to aspiration of gastric contents)
- Injury to the mucociliary apparatus, by either impairment of ciliary function or destruction of ciliated epithelium, due to cigarette smoke, inhalation of hot or corrosive gases, viral diseases, or genetic defects of ciliary function (e.g., the immotile cilia syndrome)
- Accumulation of secretions in conditions such as cystic fibrosis and bronchial obstruction
- Interference with the phagocytic or bactericidal action of alveolar macrophages by alcohol, tobacco smoke, anoxia, or oxygen intoxication
- Pulmonary congestion and edema

Pathogenesis & classification

- **Portal of entry for most pneumonias** is
  - Inhalation of air droplets
  - Aspiration of infected secretions or objects
  - Hematogenous spread from one organ to other organs can occur

- **Classification of pneumonia can be made according to causative agent**

TABLE 15–8 The Pneumonia Syndromes

COMMUNITY-ACQUIRED ACUTE PNEUMONIA

Streptococcus pneumoniae
Haemophilus influenzae
Moraxella catarrhalis
Staphylococcus aureus
Legionella pneumophila
Enterobacteriaceae (*Klebsiella pneumoniae*) and *Pseudomonas* spp.

COMMUNITY-ACQUIRED ATYPICAL PNEUMONIA

Mycoplasma pneumoniae
Chlamydia spp. (*C. pneumoniae, C. psittaci, C. trachomatis*)
Coxiella burnetii (Q fever)
Viruses: respiratory syncytial virus, parainfluenza virus (children); influenza A and B (adults); adenovirus (military recruits); SARS virus

HOSPITAL-ACQUIRED PNEUMONIA

Gram-negative rods, Enterobacteriaceae (*Klebsiella* spp., *Serratia marcescens, Escherichia coli*) and *Pseudomonas* spp.
Staphylococcus aureus (usually penicillin resistant)

ASPIRATION PNEUMONIA

Anaerobic oral flora (*Bacteroides, Prevotella, Fusobacterium, Peptostreptococcus*), admixed with aerobic bacteria (*Streptococcus pneumoniae, Staphylococcus aureus, Haemophilus influenzae*, and *Pseudomonas aeruginosa*)

CHRONIC PNEUMONIA

Nocardia
Actinomyces
Granulomatous: *Mycobacterium tuberculosis* and atypical mycobacteria, *Histoplasma capsulatum, Coccidioides immitis, Blastomyces dermatitidis*

NECROTIZING PNEUMONIA AND LUNG ABSCESS

Anaerobic bacteria (extremely common), with or without mixed aerobic infection
Staphylococcus aureus, Klebsiella pneumoniae, Streptococcus pyogenes, and type 3 pneumococcus (uncommon)

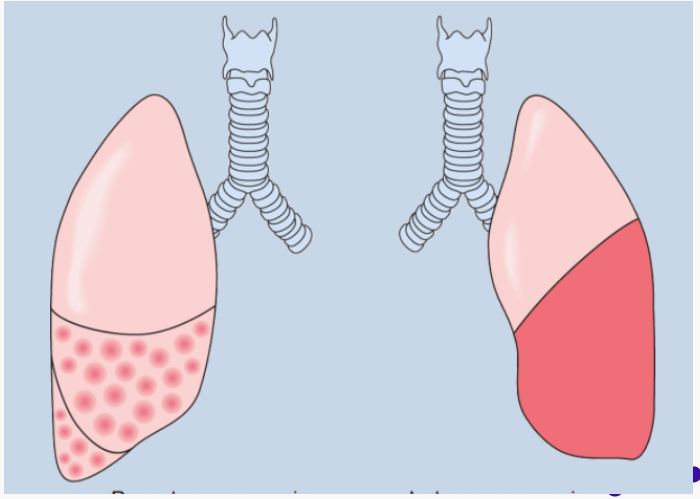
PNEUMONIA IN THE IMMUNOCOMPROMISED HOST

Cytomegalovirus
Pneumocystis jiroveci
Mycobacterium avium-intracellulare
Invasive aspergillosis
Invasive candidiasis
"Usual" bacterial, viral, and fungal organisms (listed above)

SARS, severe acute respiratory syndrome.

Anatomic classification of pneumonia

Classification of pneumonia also can be made according gross anatomic distribution of the disease:



1. Alveolar

- **Bronchopneumonia:** (*Streptococcus pneumoniae, Haemophilus influenza, Staphylococcus aureus*) Represent an extension from preexisting bronchitis or bronchiolitis. Extremely common tends to occur in two extremes of life
- **Lobar pneumonia:** (*Streptococcus pneumoniae*) Acute bacterial infection of a large portion of a lobe or entire lobe. Classic lobar pneumonia is now infrequent
- Note: Overlap of the two patterns often occur

2. Interstitial:

- Influenza virus (children), *Mycoplasma pneumoniae*

Community-Acquired Acute Pneumonia

- Usually, Bacterial
- Can follow URT infection
- It can be lobar or bronchopneumonia
- **Clinical features:** Sudden onset of high fever, chills, pleuritic chest pain and productive cough, may be with hemoptysis
- Reduced air entry and dullness by percussion

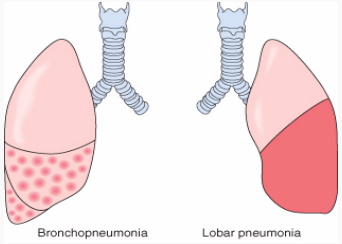
- **Cause:**
  - **The most common cause** of Community-Acquired Acute Pneumonia is ***Streptococcus pneumoniae***
  - **Other common causes:** *Haemophilus influenzae, Moraxella catarrhalis, Staphylococcus aureus, Legionella pneumophila, Klebsiella pneumoniae and Pseudomonas aeruginosa spp*.
  - **In intravenous drug abuser:** *Staphylococcus aureus*

- **It is more common in:**
  - Underlying chronic disease e.g., DM, COPD, and congestive heart failure
  - Congenital or acquired immune deficiency
  - Decreased or absent splenic function

Bronchopneumonia

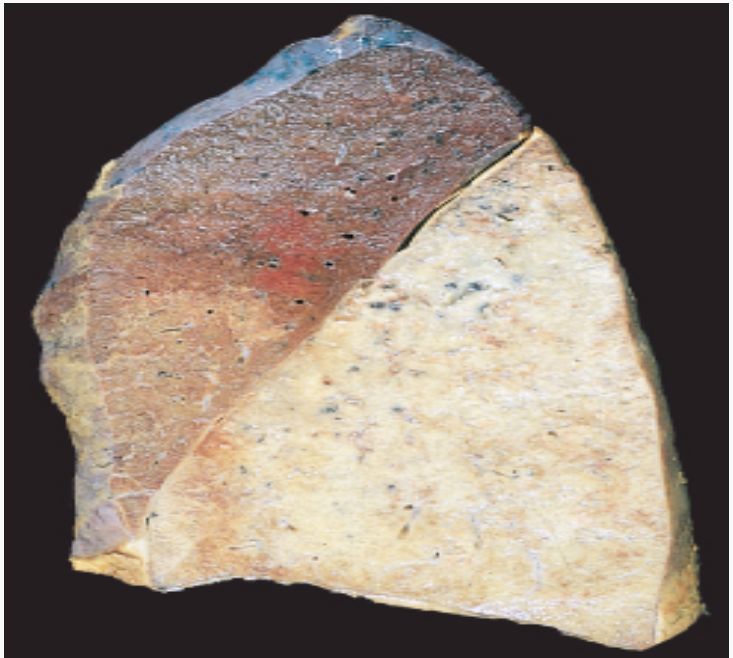
– most common agents are:

- *Streptococcus pneumoniae,*
- *Haemophilus Influenza, in* COPD
- *Pseudomonas Aeroginosa* in CF
- coliform bacteria.
- staphylococci



Lobar pneumonia

- 90-95% are caused by pneumococci(*Streptococcus pneumoniae)*
- Rare agents: *K. pneumoniae,* staphylococci, streptococci, *H. influenzae,* Pseudomonas and Proteus

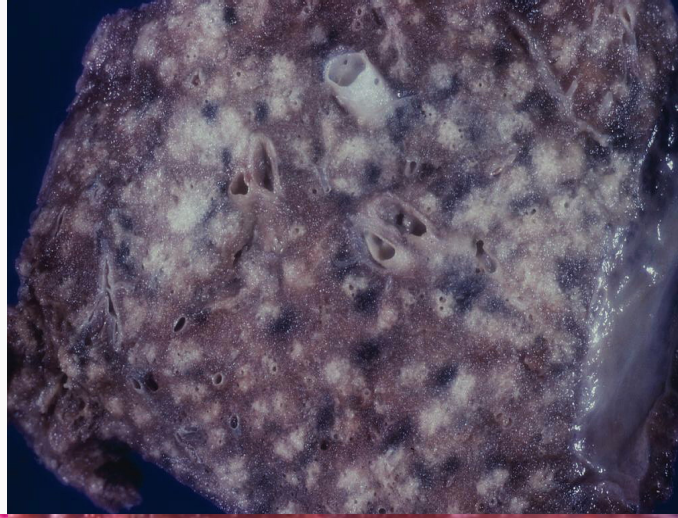


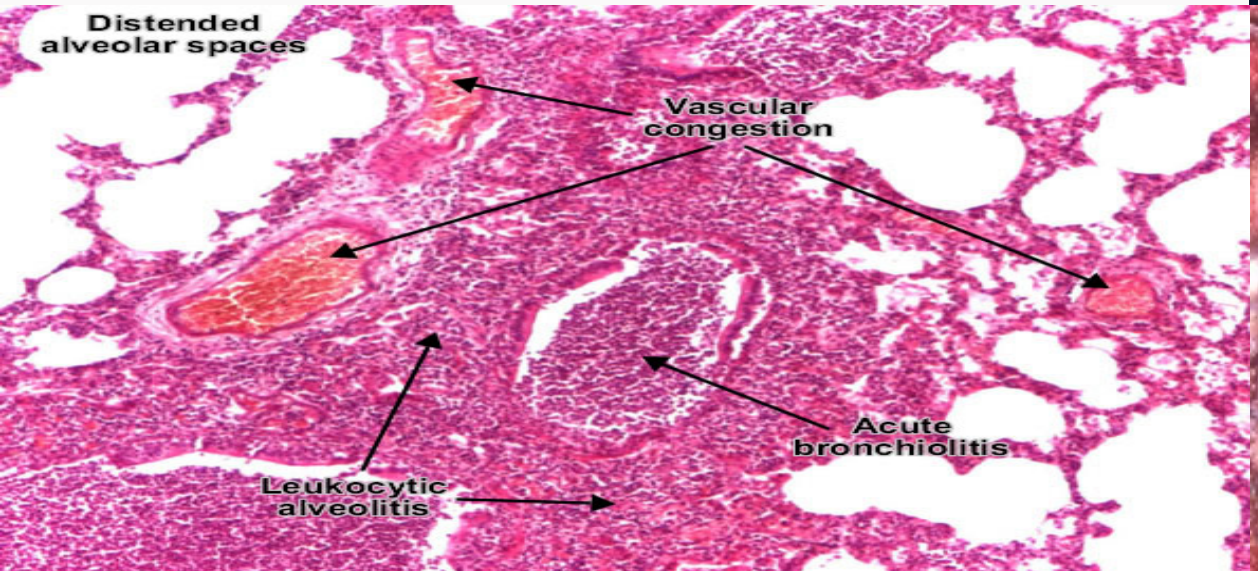
Bronchopneumonia

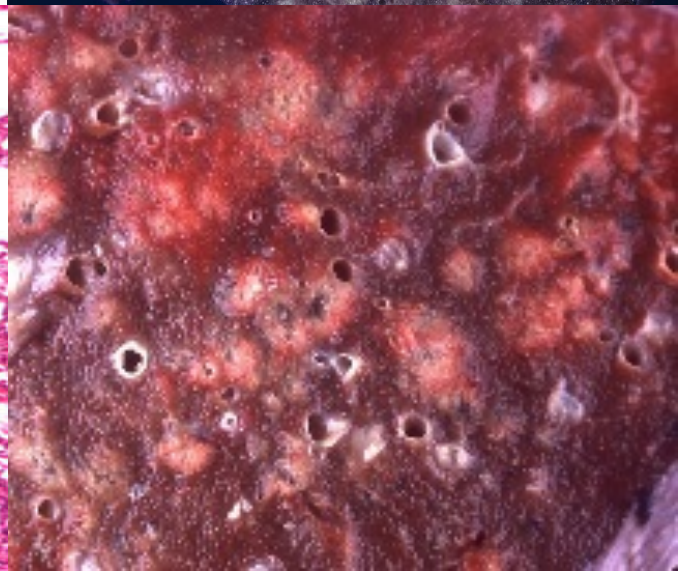
- Are focal/patchy areas of consolidated acute suppurative inflammation in one or more lobes
- Usually it involves lower lobes (basal) bilaterally because there is a tendency of the secretions to gravitate into the lower lobes
- Well developed lesions are 3 to 4 cm dry grey red ill defined nodules

Bronchopneumonia

- **Grossly:** patchy consolidation of the lung, slightly elevated, dry, granular, gray-red to yellow, and poorly delimited at their margins
- **Micro:** suppurative, neutrophil-rich exudate that fills the bronchi, bronchioles, and adjacent alveolar spaces







Lobar pneumonia

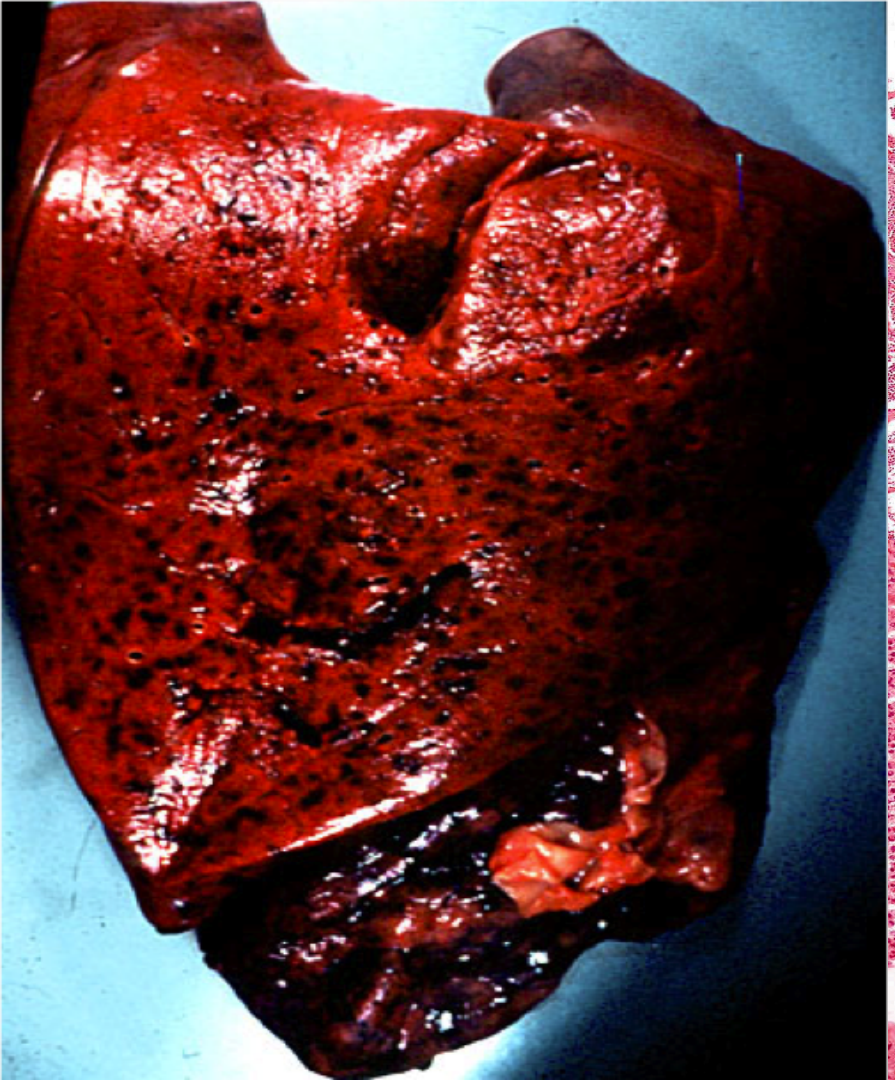
- It is widespread involvement of a large area and even an entire lobe of lung (widespread fibrinosuppurative consolidation)
- There are 4 stages:

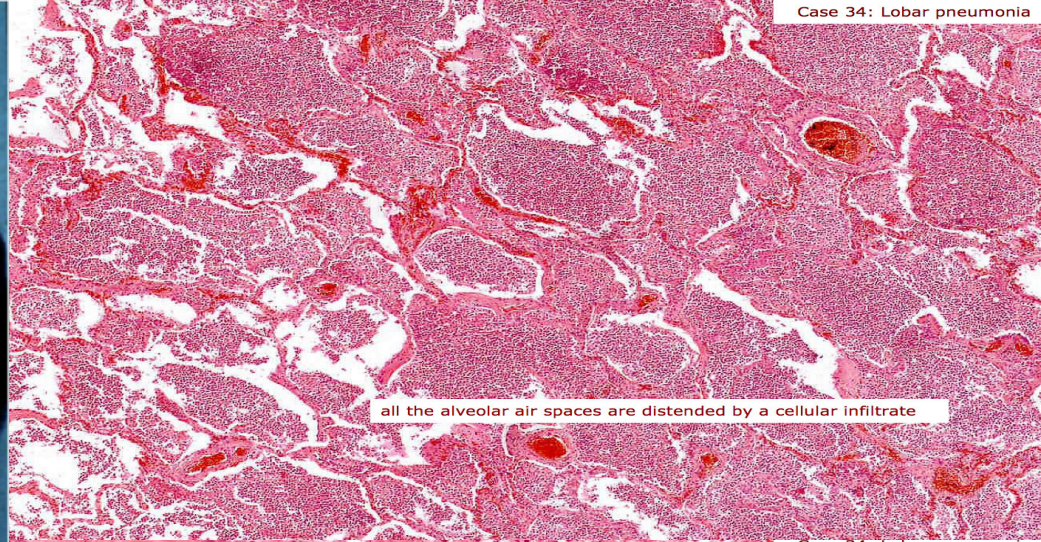
I. **Stage I: Congestion**: lung is heavy, boggy and red. The intra-alveolar space is filled with fluid, few scattered neutrophils and numerous bacterias

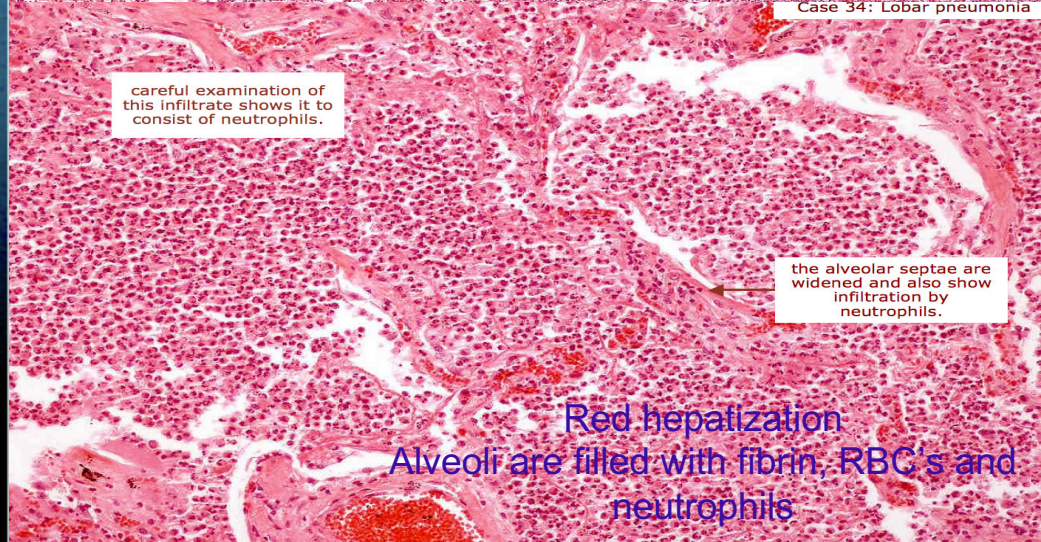
II. **Stage II: Red hepatization (solidification):** alveolar spaces are filled with neutrophils, red cells (congestion) and fibrin. Grossly the lung is firm/solid red and liver-like

III. **Stage III: Gray hepatization:** here the red cells are reduced but neutrophils and fibrin(fibrinopurulent/suppurative exudate) are still present. Grossly the lung is still firm/solid and liver-like but grey

IV. **Stage IV: Resolution:** exudates within the alveoli are being enzymatically digested, resorbed, ingested by macrophages or coughed up



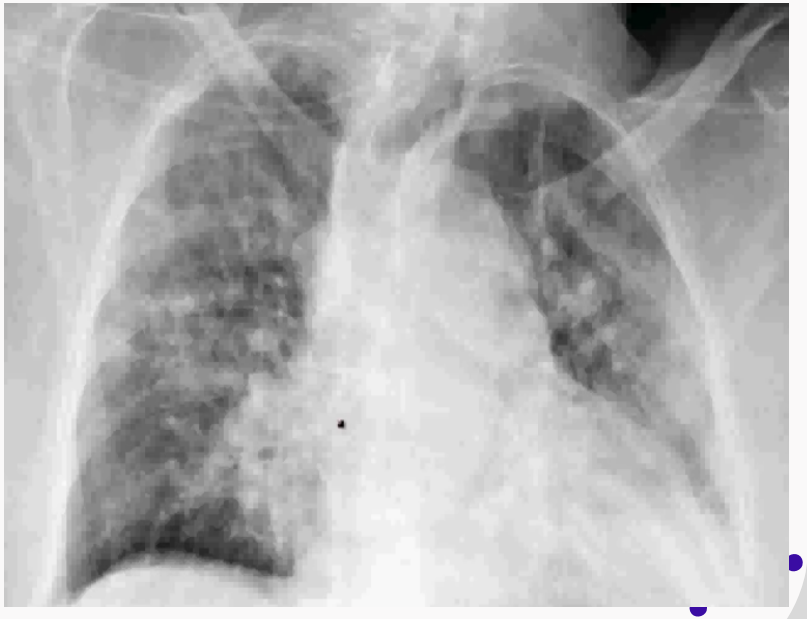




Red hepatization
Alveoli are filled with fibrin, RBC's and neutrophils

Clinical features

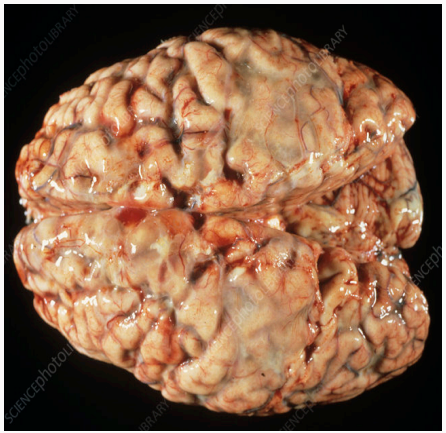
- Abrupt onset of high fever, shaking chills, cough productive mucopurulent sputum occasional patients may have hemoptysis
- When fibrinosuppurative pleuritis is present, it is accompanied by pleuritic pain and pleural friction rub
- Radiology:
  - in lobar pneumonia there is a radio opaque (consolidation) well circumscribed lobe
  - in bronchopneumonia there are multiple small opacities usually basal and bilateral



multiple small opacities (consolidation)

Complications

- Tissue destruction and necrosis, causing **abscess formation** (particularly common with type 3 pneumococci or *Klebsiella* infections)
- Spread of infection to the pleural cavity, causing the intrapleural fibrinosuppurative reaction known as **empyema**
- **Bacteremic dissemination** to the heart valves, pericardium, brain, kidneys, spleen, or joints, causing metastatic abscesses, endocarditis, meningitis, or suppurative arthritis



COMMUNITY-ACQUIRED ATYPICAL (VIRAL AND MYCOPLASMAL) PNEUMONIAS

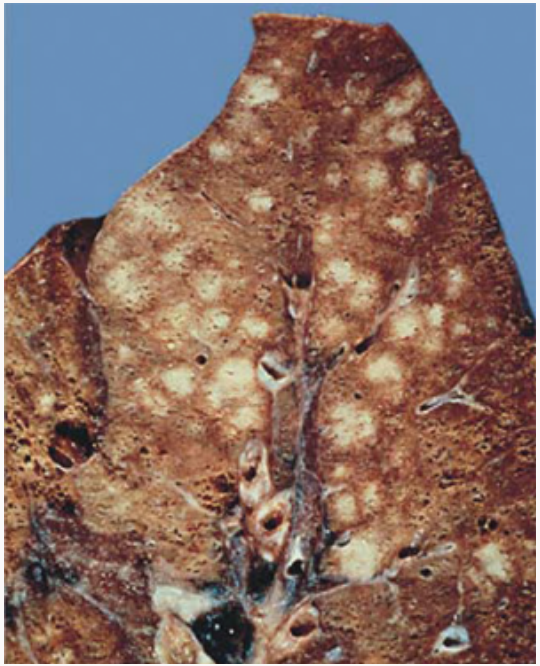
- Characterized by patchy inflammation in the lungs confined to the alveolar septae and pulmonary interstitium and therefore it is called interstitial pneumonitis
- The term *atypical* denotes the moderate amount of sputum, no physical findings of consolidation, only moderate elevation of white cell count, and lack of alveolar exudate

- It is caused by many organisms but the most common is ***Mycoplasma pneumonia (***common in children and young adults)
- *Others include:*
  - **Viruses** e.g. respiratory syncytial virus, influenza virus (children), influenza A and B (adults); adenovirus and SARS virus
  - ***Chlamydia*** spp. (*C. pneumonia etc.*) and *Coxiella burnetti* (Q fever). Chlamydia is transmitted by inhalation of dried excreta of infected birds and causes ornithosis/psittacosis.

Predisposing factors: malnutrition, alcoholism and any underlying debilitating disease

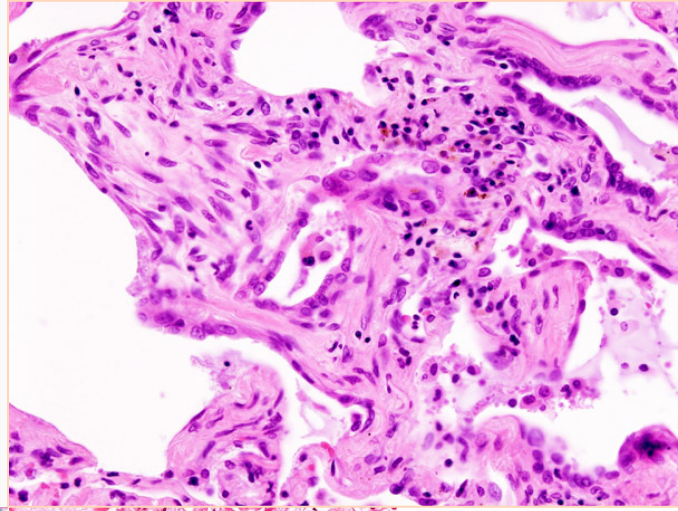
Gross:

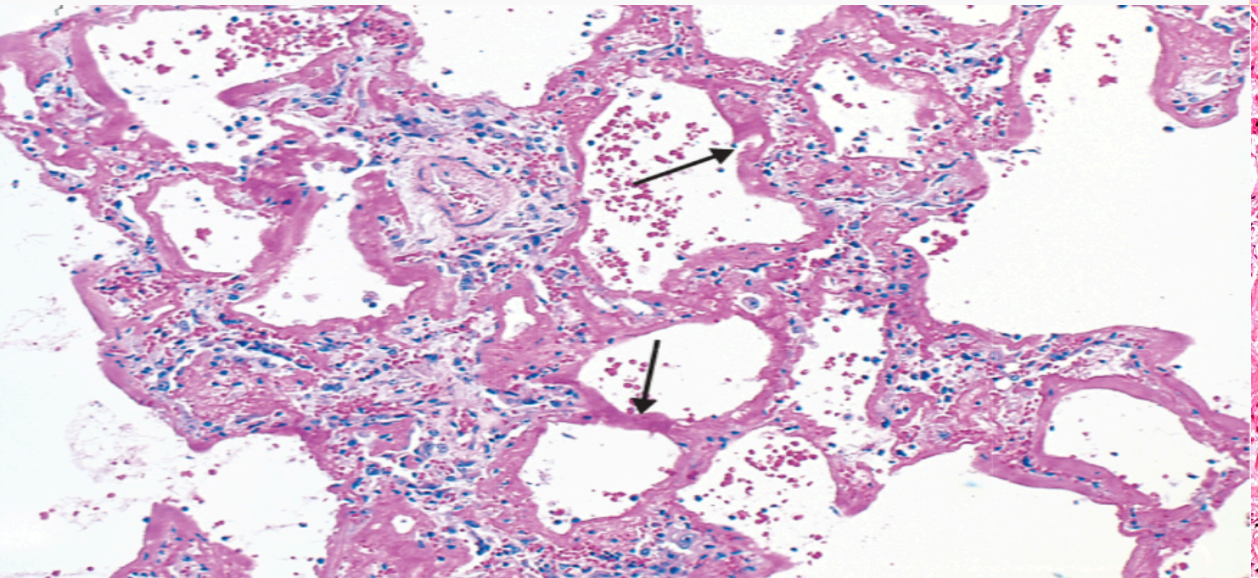
- All causal agents produce essentially similar morphologic patterns
- The lung involvement may be quite patchy or may involve whole lobes bilaterally or unilaterally
- The affected areas are red-blue and congested. The pleura is smooth, and pleuritis or pleural effusions are infrequent

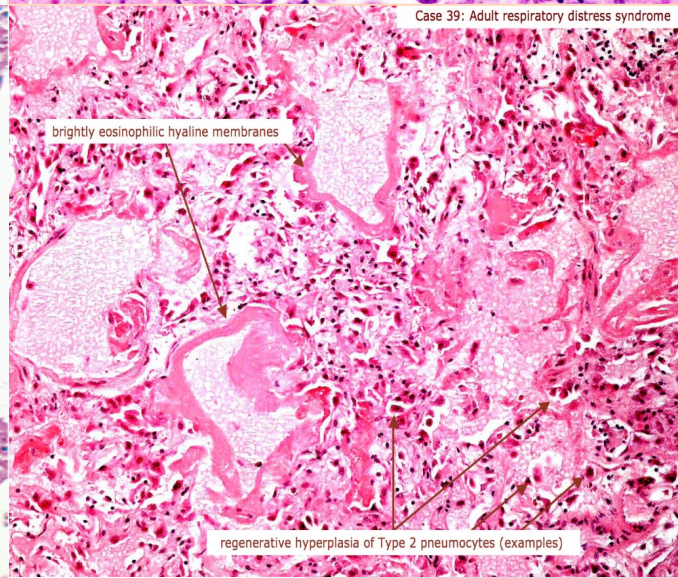


Micro:

- Predominantly there is inflammation in the interstitium/alveolar wall
- Alveolar septa are widened and edematous with mononuclear inflammatory infiltrate (and neutrophils in acute cases only)
- Sever cases: Intra-alveolar proteinaceous material with pink hyaline membrane lining the alveolar walls (diffuse alveolar damage)







Clinical course

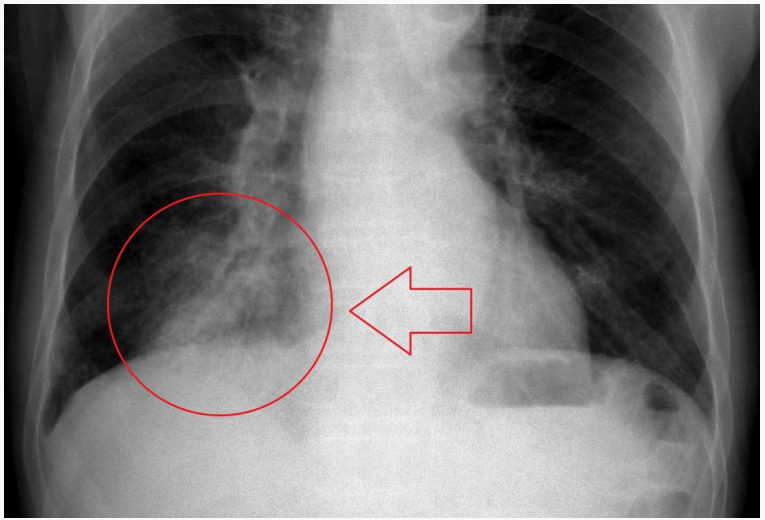
- The clinical course is extremely varied
- Many cases masquerade as severe upper respiratory tract infections or as chest colds
- Cough may be absent, and the major manifestations may consist only of fever, headache, muscle aches, and pains in the legs
- The ordinary sporadic form of the disease is usually mild with a low mortality rate, below 1%. Interstitial pneumonia (good prognosis)
- Secondary bacterial infection by staphylococci or streptococci is common in such circumstances

HOSPITAL-ACQUIRED PNEUMONIA

- acquire terminal pneumonias while hospitalized (nosocomial infection)
- **Predisposing factor:** sever underlying conditions e.g. immunosuppression, prolonged antibiotic therapy, intravascular catheter and pt. with mechanical ventilator
- **Cause:** Gram-negative organisms like Klebsiella, Pseudomonas aeruginosa and E. coli have been implicated

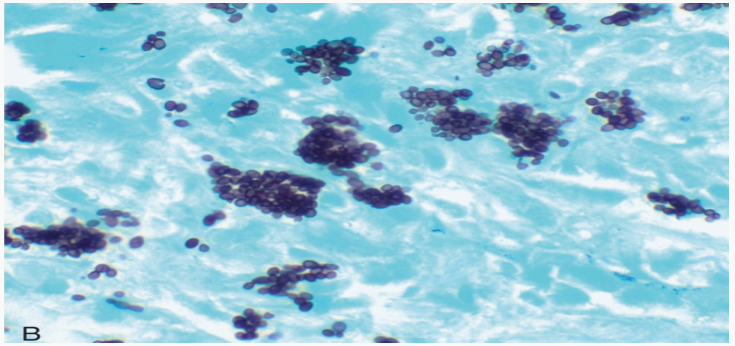
Aspiration pneumonia

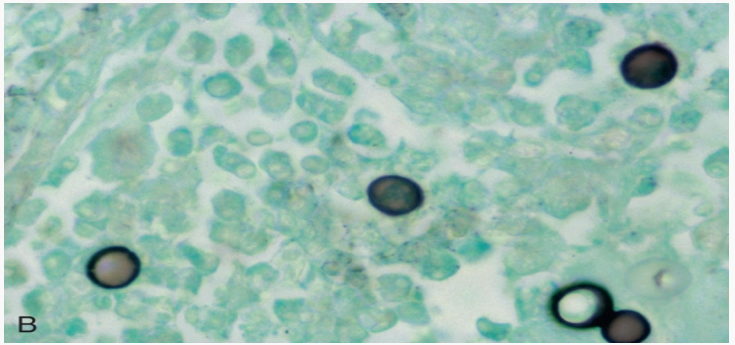
- Occurs in markedly debilitated patients or those who aspirate gastric contents either while unconscious (e.g., after a stroke) or during repeated vomiting
- These patients have abnormal gag and swallowing reflexes that predispose to aspiration
- The resultant pneumonia is partly chemical because of the extremely irritating effects of the gastric acid, and partly bacterial (from the oral flora)
- Typically, more than one organism is recovered on culture, aerobes being more common than anaerobes
- This type of pneumonia is often necrotizing, pursues a fulminant clinical course, and is a frequent cause of death. In those who survive, lung abscess is a common complication

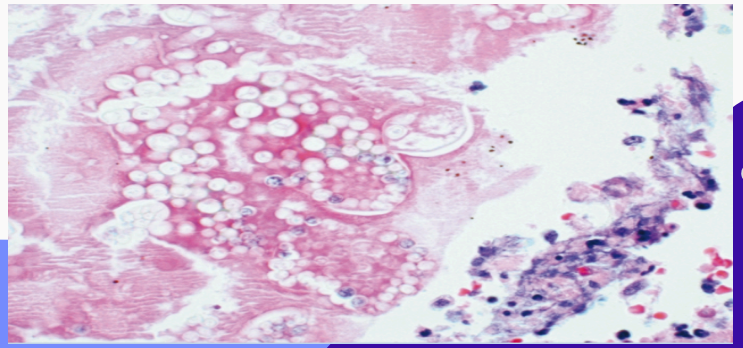


Chronic pneumonia

- Most often a localized lesion in an immunocompetent person, with or without regional lymph node involvement
- There is typically granulomatous inflammation
  - Bacteria (e.g., *M. tuberculosis*) or
  - Fungi (*Histoplasma capsulatum, Coccidioides immitis, Blastomyces)*
- In the immunocompromised, there is usually systemic dissemination of the causative organism, accompanied by widespread disease
- Tuberculosis is by far the most important entity within the spectrum of chronic pneumonias





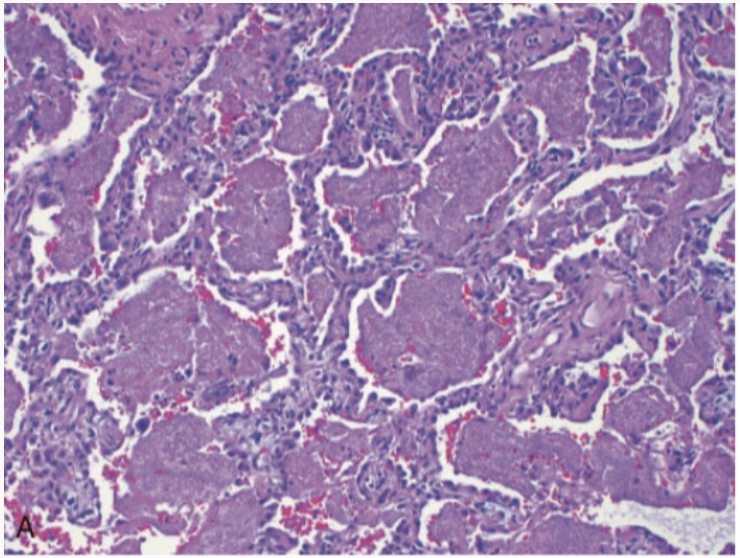


Opportunistic pneumonia

- Infections that affect immunosuppressed patients (AIDS, cancer patients and transplant recipients)
- The appearance of a pulmonary infiltrate, with or without signs of infection (e.g., fever)
- Is one of the most common and serious complications in patients whose immune defenses are suppressed by disease, immunosuppressive therapy for organ transplants, chemotherapy for tumors, or irradiation

TABLE 15–9 Causes of Pulmonary Infiltrates in Immunocompromised Hosts

Diffuse Infiltrate	Focal Infiltrate
COMMON	
Cytomegalovirus	Gram-negative rods
Pneumocystis jiroveci	*Staphylococcus aureus*
Drug reaction	*Aspergillus*
	Candida
	Malignancy
UNCOMMON	
Bacteria	*Cryptococcus*
Aspergillus	*Mucor*
Cryptococcus	*Pneumocystis jiroveci*
Malignancy	*Legionella pneumophila*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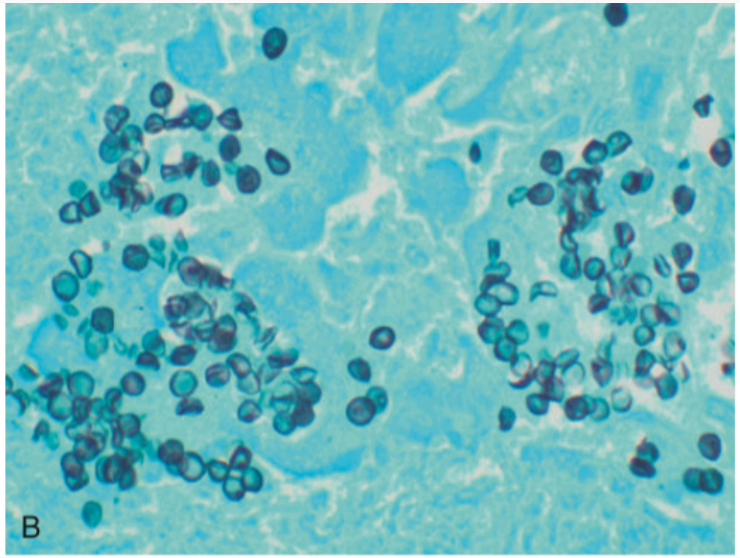
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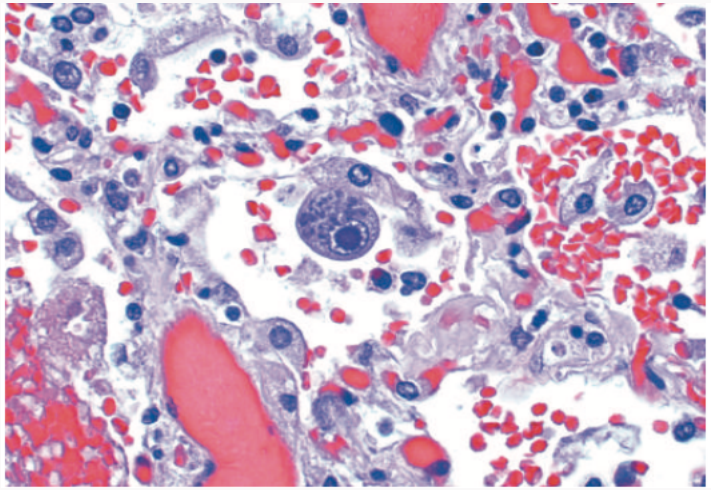


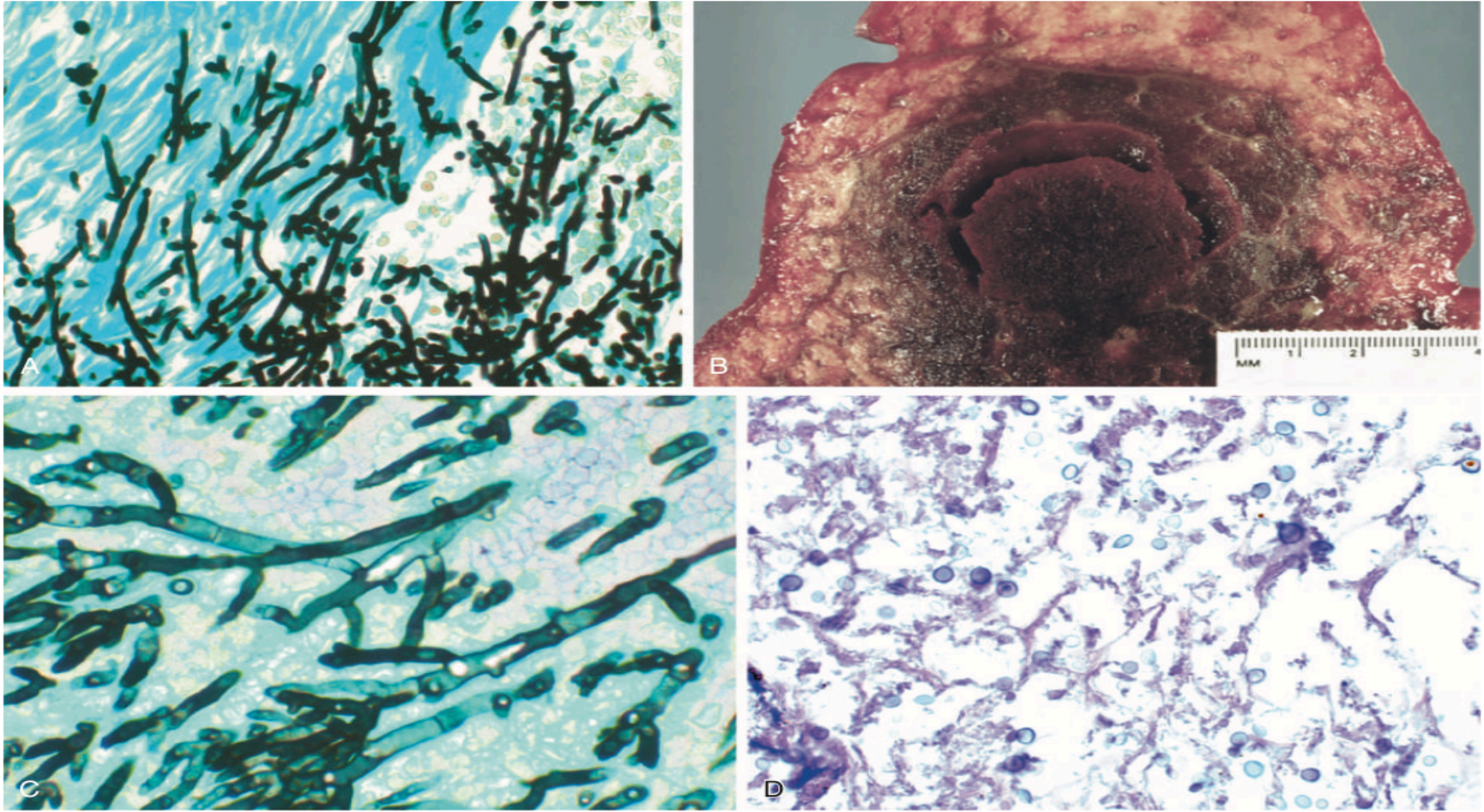
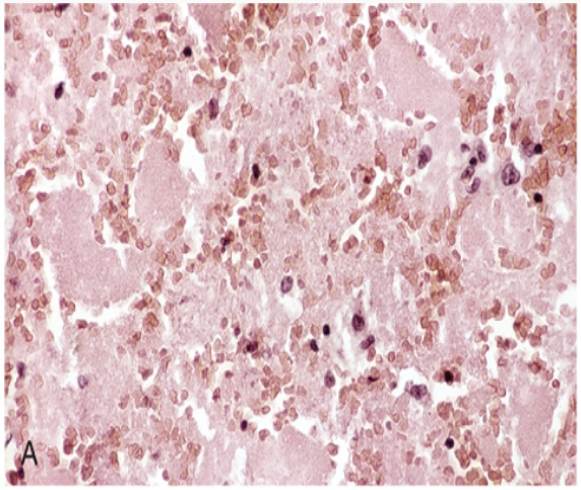
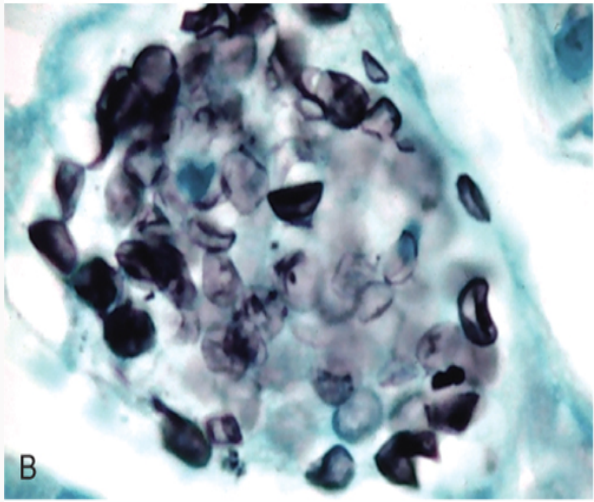


Fig. 13.42 The morphology of fungal infections. (A) Candida organism has pseudohyphae and budding yeasts (silver stain). (B) Invasive aspergillosis (gross appearance) of the lung in a hematopoietic stem cell transplant recipient. (C) Gomori methenamine-silver (GMS) stain shows septate hyphae with acute-angle branching, consistent with Aspergillus. (D) Cryptococcosis of the lung in a patient with AIDS. The organisms are somewhat variable in size. *(B, Courtesy of Dr. Dominick Cavuoti, Department of Pathology, University of Texas Southwestern Medical School, Dallas, Texas.)*

Pneumocystis Pneumonia

- *P. jiroveci* (formerly *P. carinii*) is an opportunistic infectious agent considered as a fungus
- Seen in immunocompromised individuals especially AIDS
- Effective methods of diagnosis are:
  - Identify the organism in bronchoalveolar lavage fluids or in a transbronchial biopsy specimen.
  - Immunofluorescence antibody kits and PCR-based assays
- Microscopically:
  - characteristic **intra-alveolar foamy, pink-staining exudate** on H&E stains (A)
  - organism is trapped in the foamy material and can be seen on silver stain as oval cup shaped structures (B)





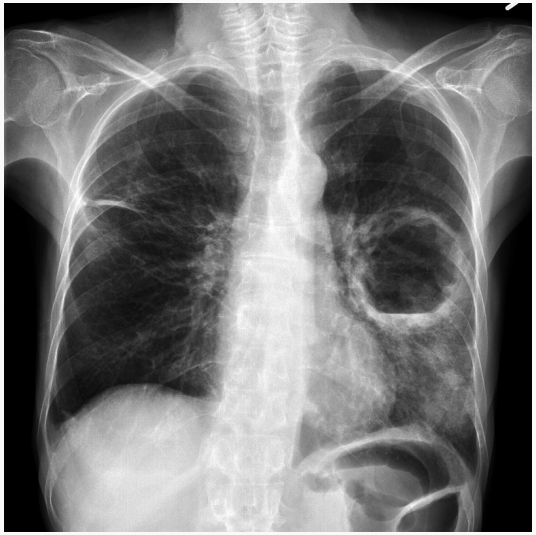
Lung abscess

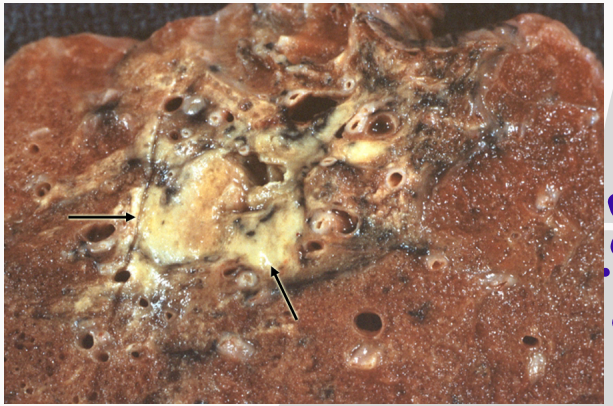
Lung abscess

- Is localized suppurative necrotic process within the pulmonary parenchyma
- **Features:** tissue necrosis and marked acute inflammation. Abscess is filled with necrotic suppurative debris

- **Organisms**:
  - Staphylococci
  - Streptococci
  - Gram-negative organisms
  - Anaerobes

- **Pathogenesis:**
  - Can follow aspiration
  - As a complication of pneumonia
  - Septic emboli
  - Tumors
  - Direct infection





Lung abscess

Clinical features

- Prominent cough producing copious amount of foul smelling and bad-tasting purulent sputum
- Change in position evoke paroxysm of cough
- Fever malaise and clubbing of fingers
- Radiology shows fluid filled cavity

Complications

- Bronchopleural fistula and pleural involvement resulting in empyema
- Massive hemoptysis, spontaneous rupture into uninvolved lung segments
- Non-resolution of abscess cavity
- Bacteremia could result in brain abscess and meningitis

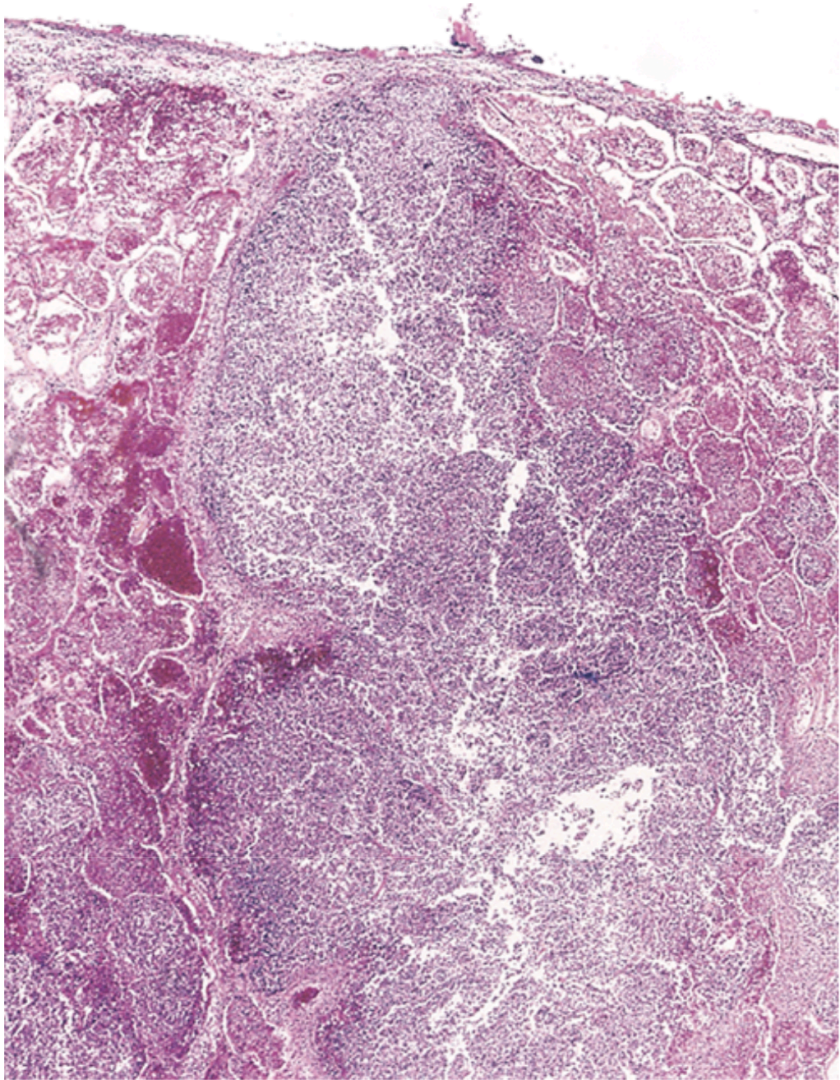
Prognosis:

- with antibiotic therapy 75% of abscess resolve

Morphology

- Variable in size
- Single or multiple
- Pulmonary abscesses due to aspiration are more common on the right (because of the more vertical right main bronchus) and are most often single
- Abscesses that develop in the course of pneumonia or bronchiectasis are usually multiple, basal, and diffusely scattered

- The **cardinal histologic change in all abscesses is suppurative destruction of the lung parenchyma within the central area of cavitation**



Summery (Acute pneumonia)

- S. pneumoniae (the pneumococcus) is the most common cause of community-acquired bacterial pneumonia and usually has a lobar pattern of involvement.
- Morphologically, lobar pneumonias evolve through four stages: congestion, red hepatization, gray hepatization, and resolution.

- Other common causes of bacterial pneumonias in the community include H. influenzae and M. catarrhalis (both associated with acute exacerbations of COPD), S. aureus (usually secondary to viral respiratory infections), K. pneumoniae (observed in chronic alcoholics), P. aeruginosa (seen in individuals with cystic fibrosis, in burn victims, and in patients with neutropenia), and L. pneumophila, seen particularly in organ transplant recipients.

- Viral pneumonias are characterized by respiratory distress out of proportion to the clinical and radiologic signs, and by inflammation that is predominantly confined to alveolar septa, with generally clear alveoli.

- Common causes of viral pneumonia include influenza A and B, respiratory syncytial virus, human metapneumovirus, parainfluenza virus, and adenovirus.

Protect yourself