

Diseases of the Respiratory System

Pulmonary Infections and Pneumonias



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Respiratory block
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Pathology
Lecture 6

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
- Know the classification of pneumonia.
- Is able to appreciate the aetiology and pathogenesis of lung abscess.

Pulmonary infections

- Pneumonia /pulmonary infection can be very broadly defined as any infection in the lung
- Respiratory tract infections are more frequent than infections of any other organ. Why?

- The epithelium of the lung is exposed to liters of contaminated air
- Nasopharyngeal flora are aspirated during sleep
- Underlying lung diseases render the lung parenchyma vulnerable to virulent organism

Pulmonary infections: Predisposing factors

Other causes:

- **Loss or suppression of the cough reflex:** coma, anesthesia, neuromuscular disorders, drugs, or chest pain.
- **Injury to the mucociliary apparatus:** by either impairment of ciliary function or destruction of ciliated epithelium e.g. cigarette smoke, inhalation of hot or corrosive gases, viral diseases, chronic diseases or genetic disturbances
- **Decreased function of alveolar macrophages:** by alcohol, tobacco smoke, anoxia, or oxygen intoxication
- **Pulmonary congestion and edema**
- **Retention and accumulation of secretions:** e.g. cystic fibrosis and bronchial obstruction
- **Immunologic deficiencies,** treatment with immunosuppressive agents, leukopenia
- **chronic diseases**

Pathogenesis of pneumonia

- **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.
- **Pneumonia can be acute or chronic**

Anatomic classification of pneumonia

Classification of pneumonia can be made according to causative agent or gross anatomic distribution of the disease.

▶ **1. Alveolar**

- **Bronchopneumonia:** (*Streptococcus pneumoniae*, *Haemophilus influenzae*, *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

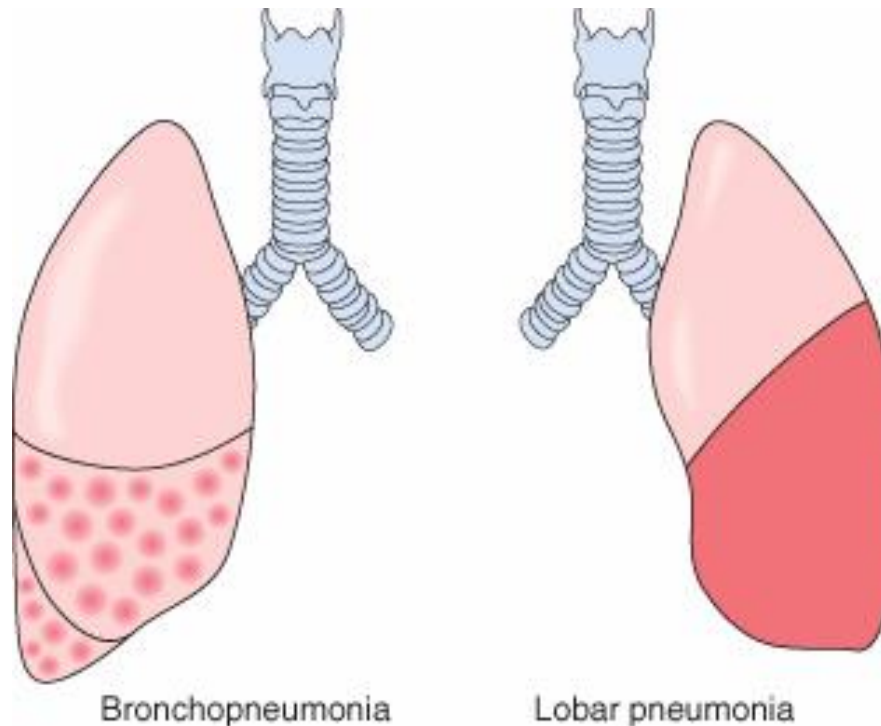
- ## ▶ **2. Interstitial:** Influenza virus (children), *Mycoplasma pneumoniae*

The clinical types of pneumonia

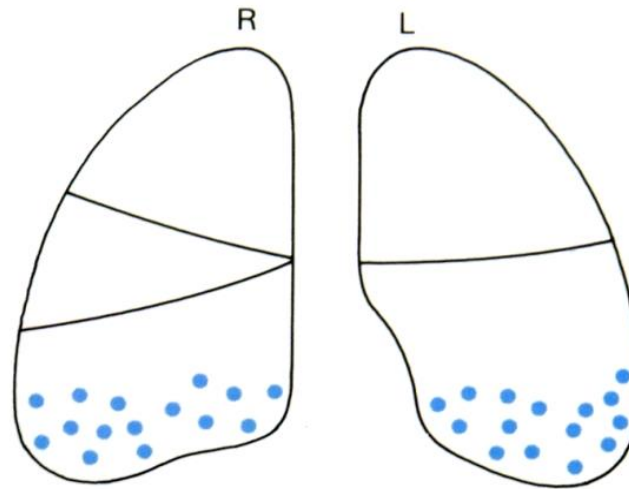
- 1. Community-Acquired Acute Pneumonia**
- 2. Community-Acquired Atypical Pneumonia**
- 3. Nosocomial Pneumonia**
- 4. Aspiration Pneumonia**
- 5. Chronic Pneumonia**
- 6. Opportunistic pneumonias/Pneumonia in the Immunocompromised Host**

1. Community-Acquired Acute Pneumonia

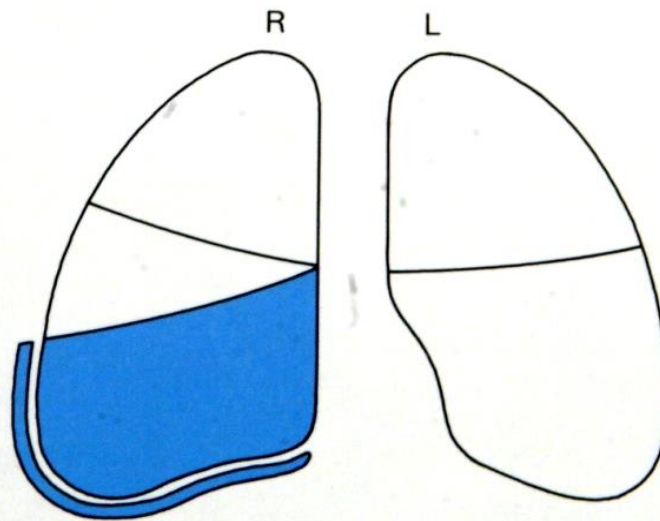
- Usually Bacterial
- Can follow URT infection
- It can be lobar or bronchopneumonia



Diseases of Lung



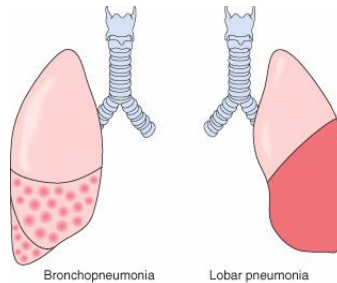
A. Bronchopneumonia



B. Lobar pneumonia

The distribution of lesions in lobar - and bronchopneumonia

1. Community-Acquired Acute Pneumonia



Bronchopneumonia

– most common agents are:
Staphylococci after URTI
Streptococcus pneumoniae,
Haemophilus Influenza, in COPD
Pseudomonas Aeroginosa in cystic
fibrosis
coliform bacteria

Lobar pneumonia

- 90-95% are caused by pneumococci
(*Streptococcus pneumoniae* type
1,3,7 & 2)
-Rare agents:
K. pneumoniae (in elderly)
H. influenzae - *Pseudomonas* and *Proteus*
Legionella pneumophila

Cause of pneumonia:

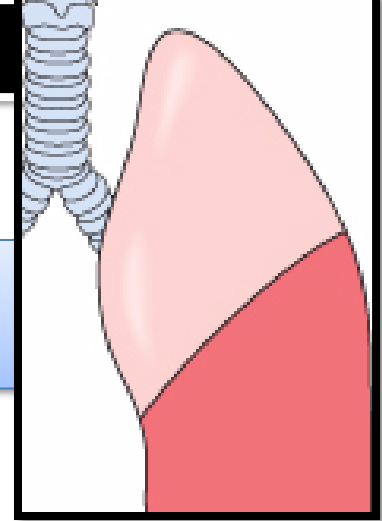
- **The most common cause** of Community-Acquired Acute Pneumonia is ***Streptococcus pneumoniae***
- **Other common causes:** *Haemophilus influenzae*, *Moraxella catarrhalis*, *Staphylococcus aureus* after URTI, *Legionella pneumophila*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* spp.
- **In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

It is more common in:

1. Underlying chronic disease e.g. DM, COPD, and congestive heart failure
2. Congenital or acquired immune deficiency
3. Decreased or absent splenic function

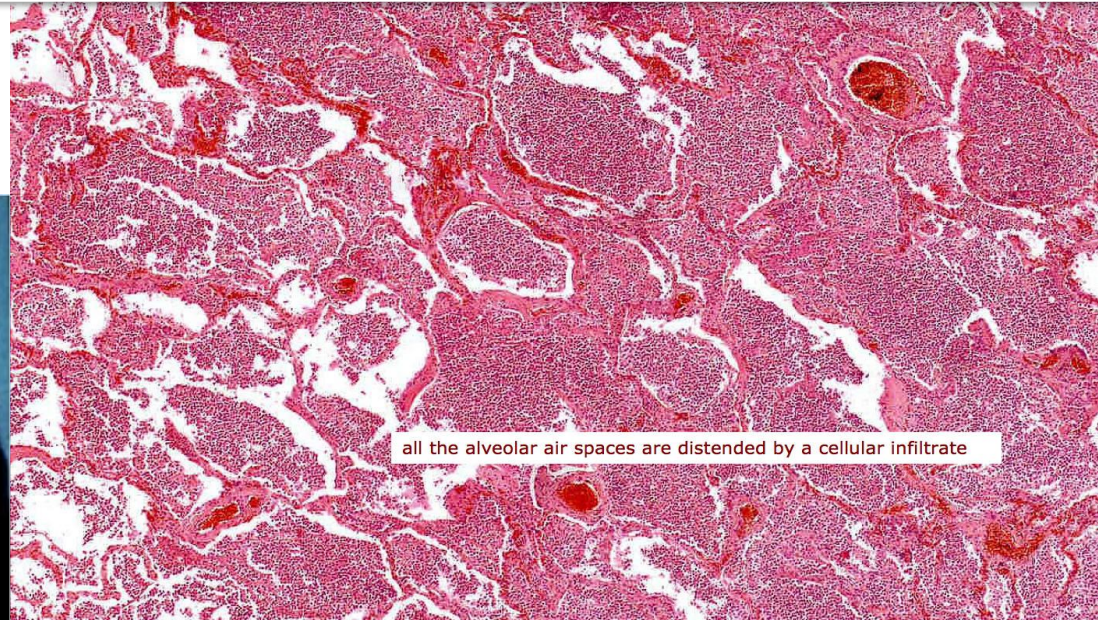
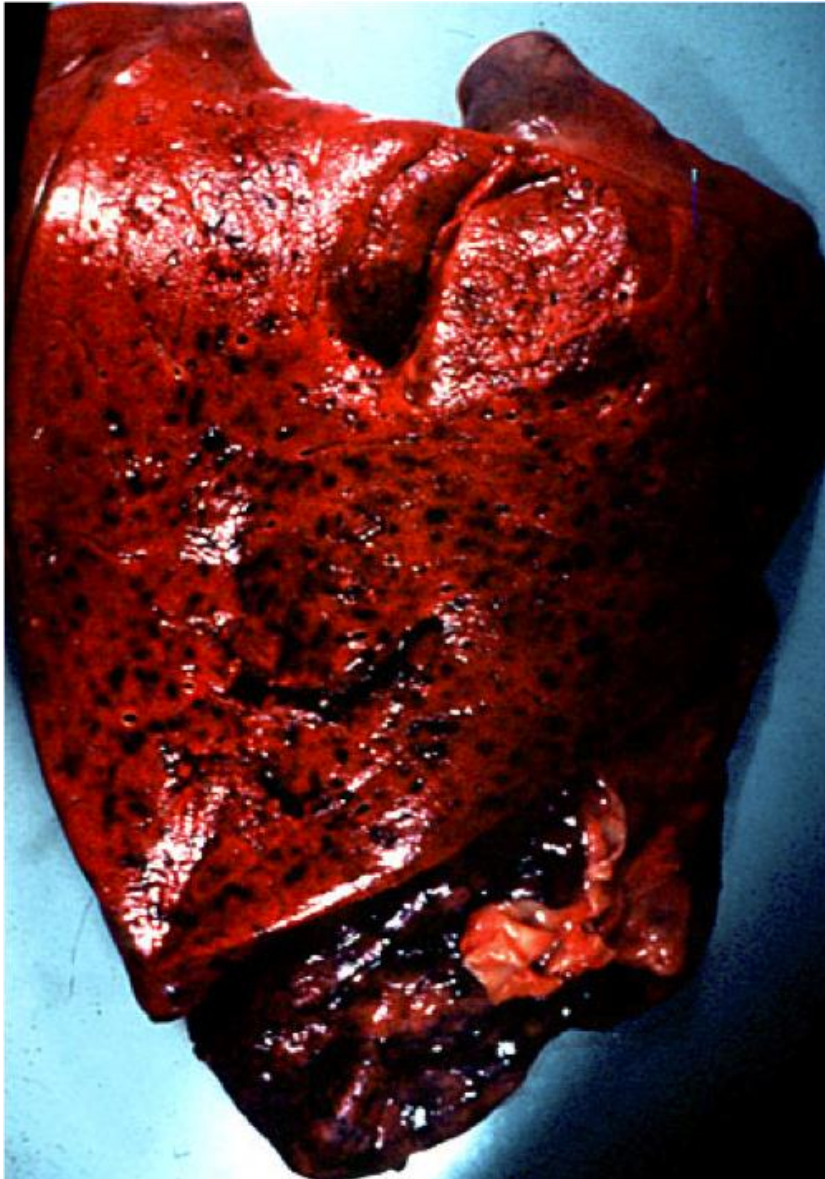
Lobar pneumonia

It is widespread involvement of the entire lobe (widespread fibrinosuppurative consolidation).

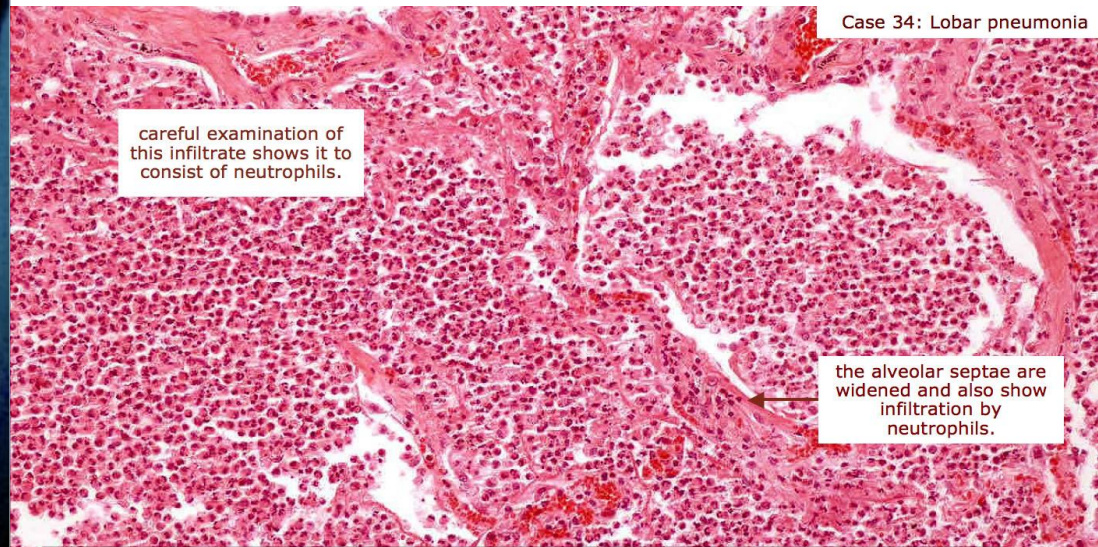


- There are 4 stages:
 - i. **Stage I: Congestion:** lung is heavy, boggy and red. The intra-alveolar space is filled with fluid, few scattered neutrophils and numerous bacteria.
 - ii. **Stage II: Red hepatization (solidification):** alveolar spaces are filled with neutrophils, red cells (congestion) 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 gray to brown cut surface.
 - iv. **Stage IV: Resolution:** exudates within the alveoli are being enzymatically digested, resorbed, ingested by macrophages or coughed up.

Red hepatization



all the alveolar air spaces are distended by a cellular infiltrate

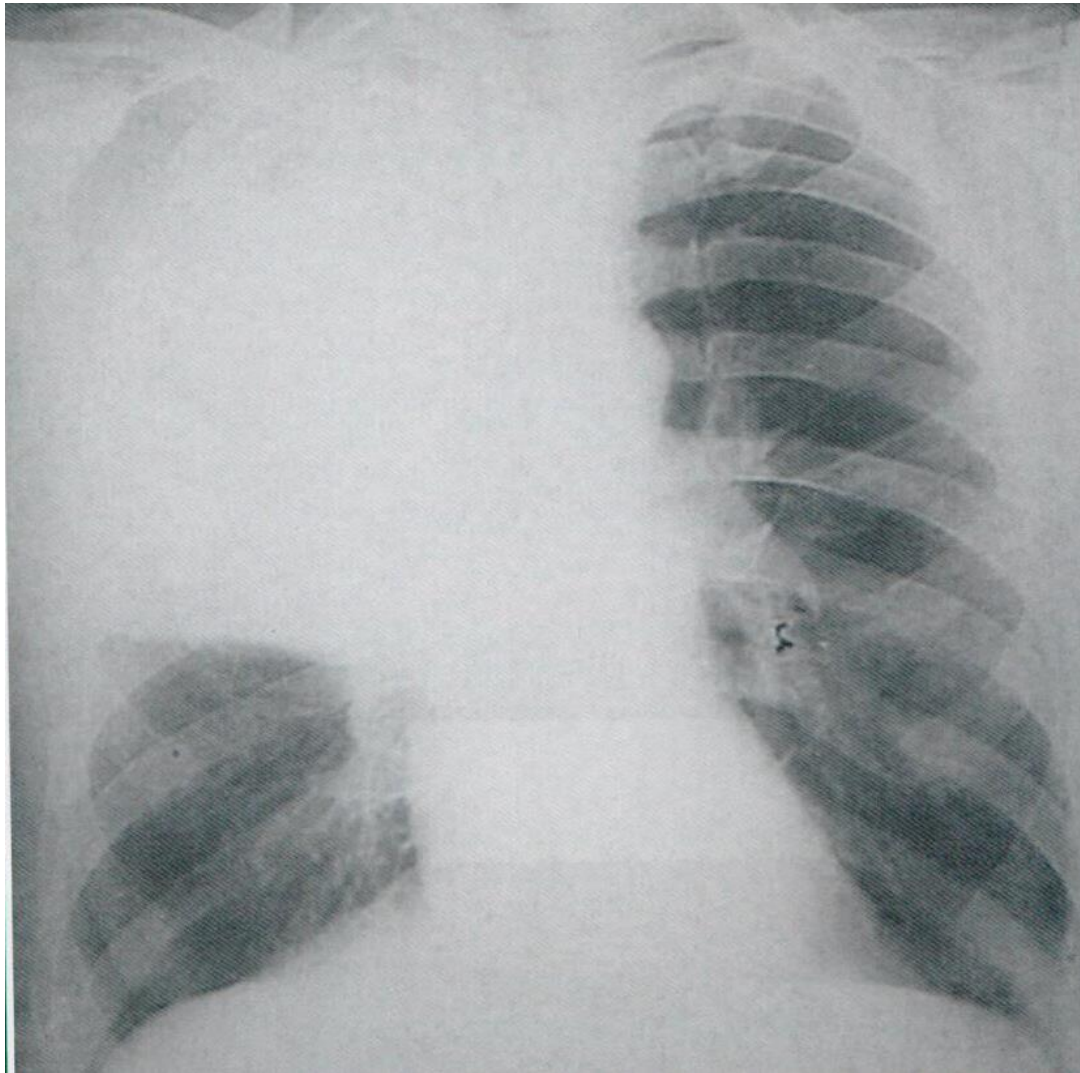


Case 34: Lobar pneumonia

Careful examination of this infiltrate shows it to consist of neutrophils.

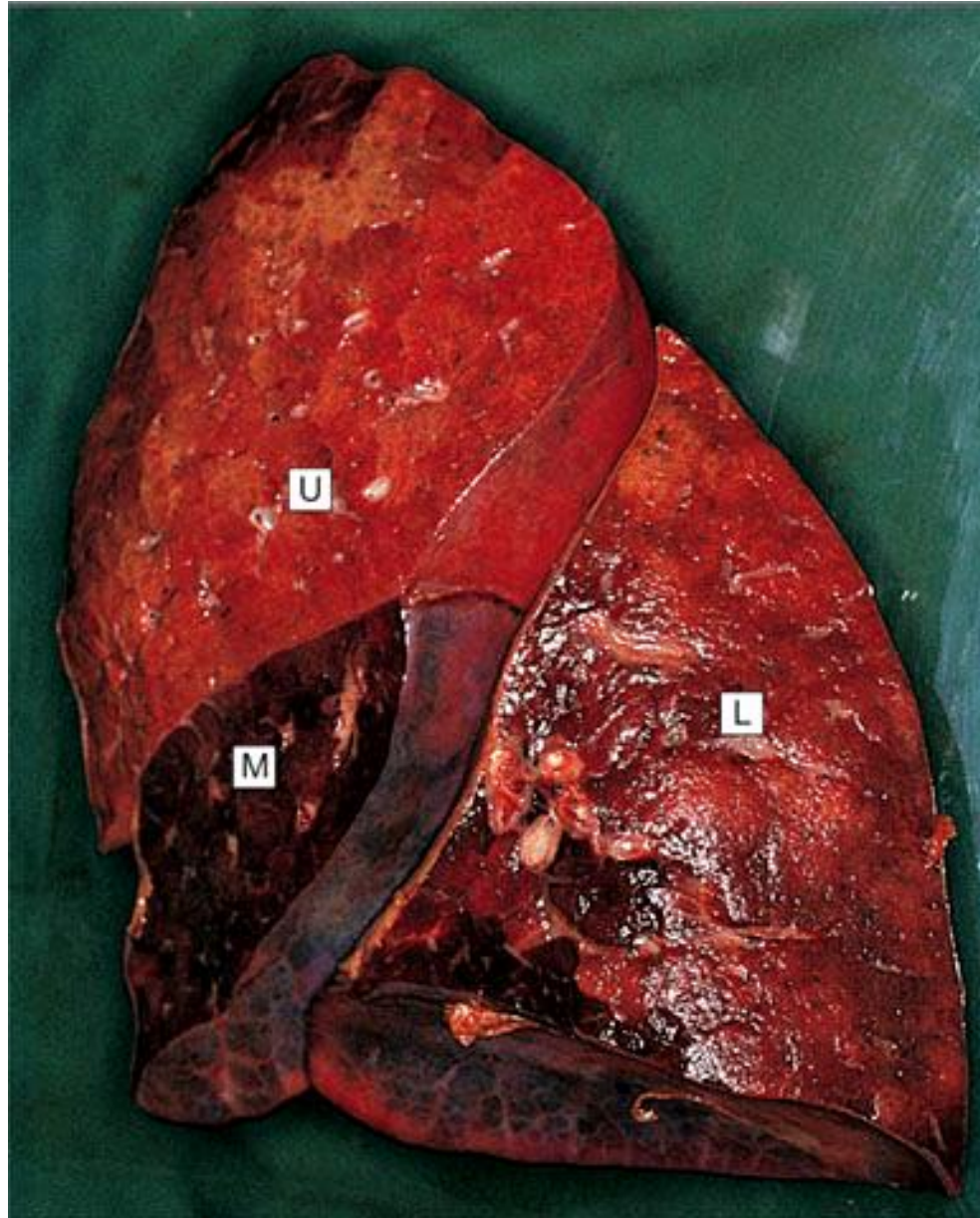
the alveolar septae are widened and also show infiltration by neutrophils.

Alveoli are filled with fibrin, RBC's and neutrophils



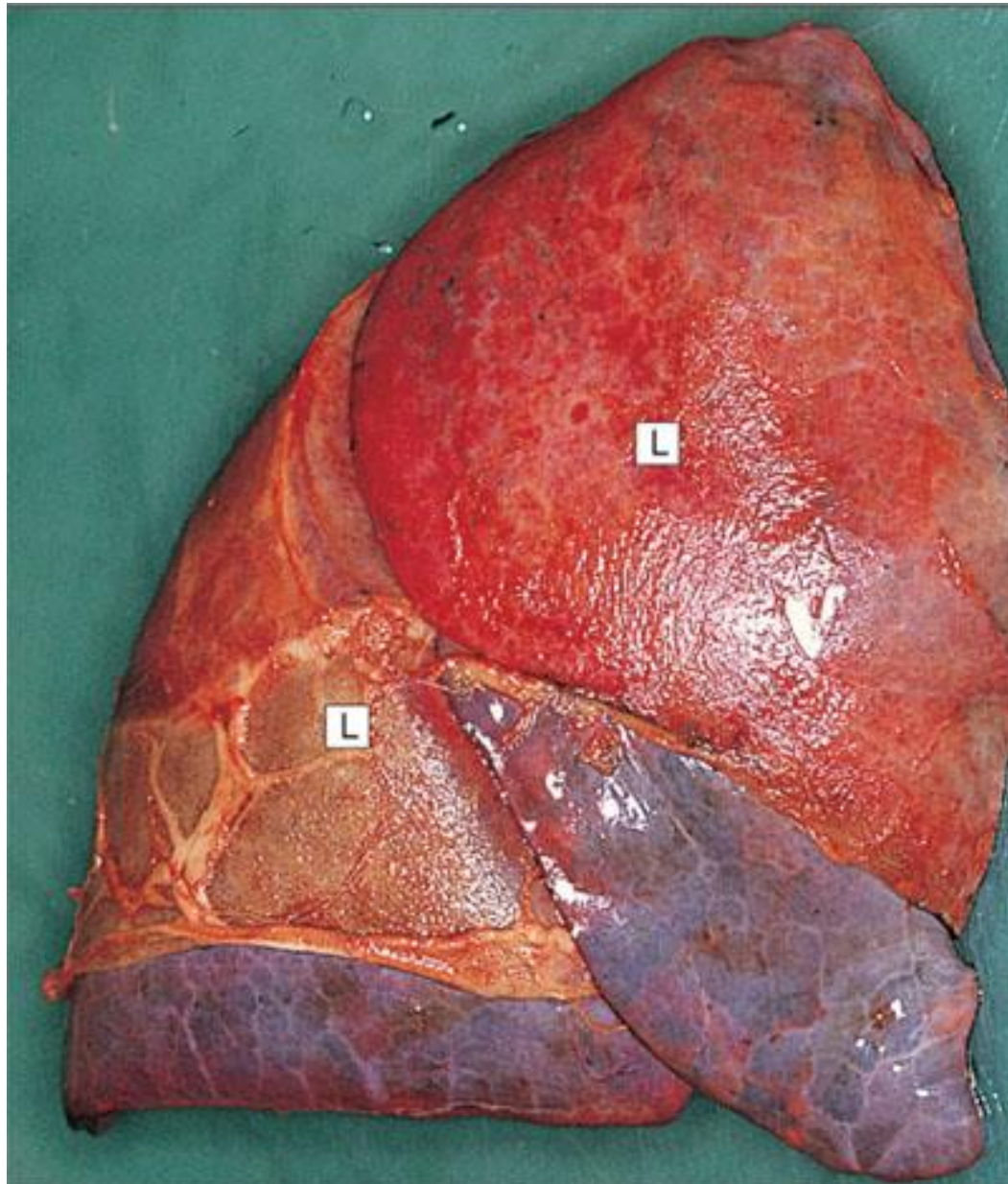
Bacterial pneumonia, radiograph
Chest x-ray showed consolidation of the upper lobe in Rt. lung

Diseases of Lung

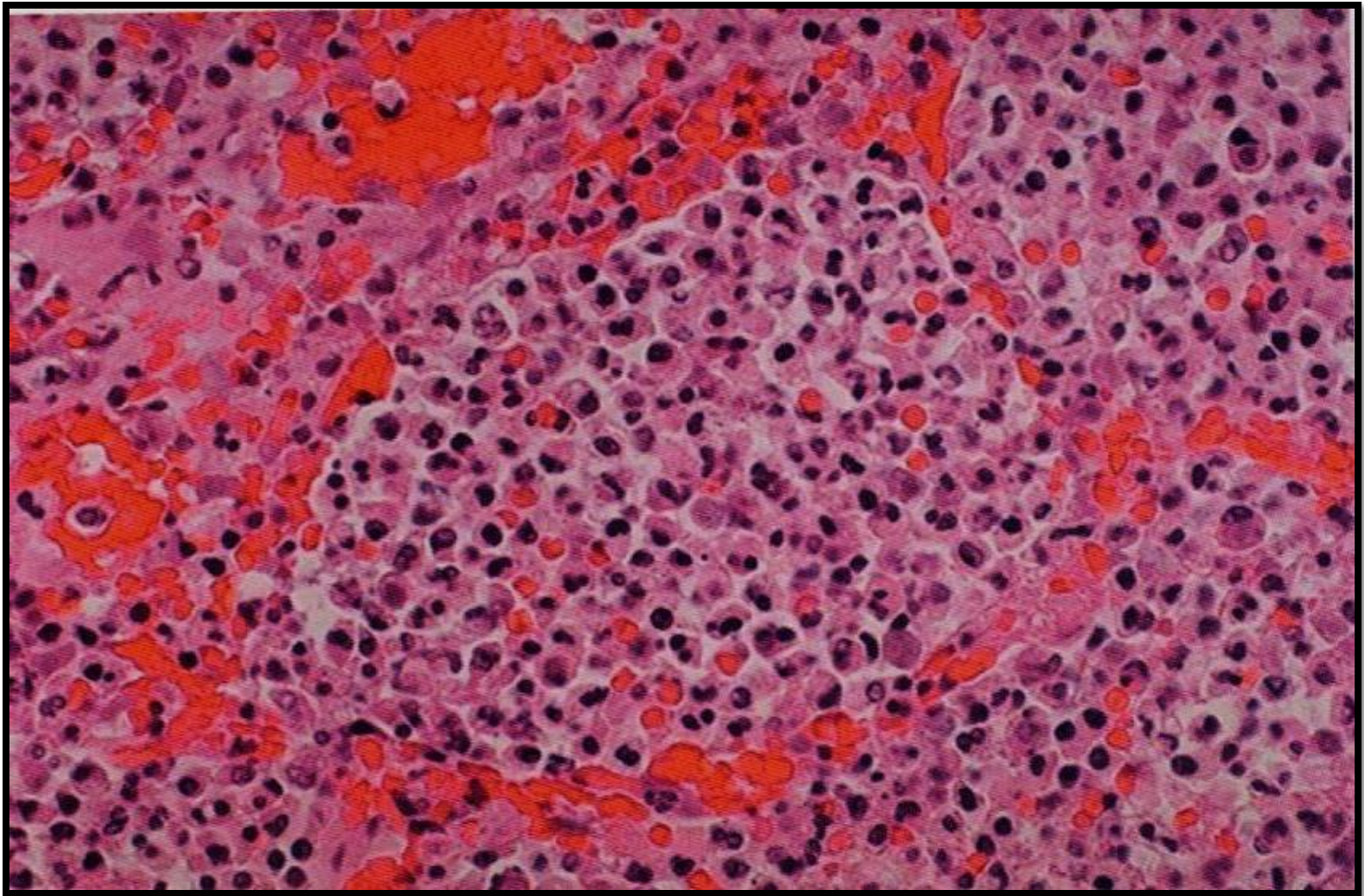


Lobar pneumonia. The upper (U) and lower (L) lobes are consolidated compared to the congested but uninvolved middle lobe (M).

Diseases of Lung



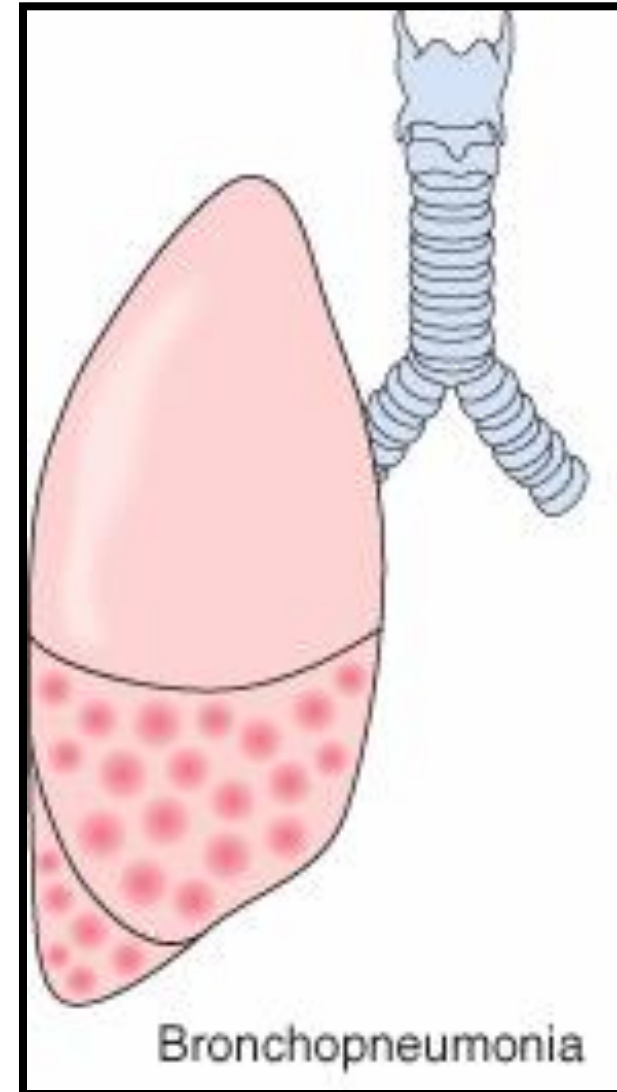
Acute pleurisy in lobar pneumonia. The pleural surfaces over consolidated lobes (L) are covered by a patchy, white, fibrinous exudate, causing acute pleurisy.



Bacterial pneumonia, microscopic

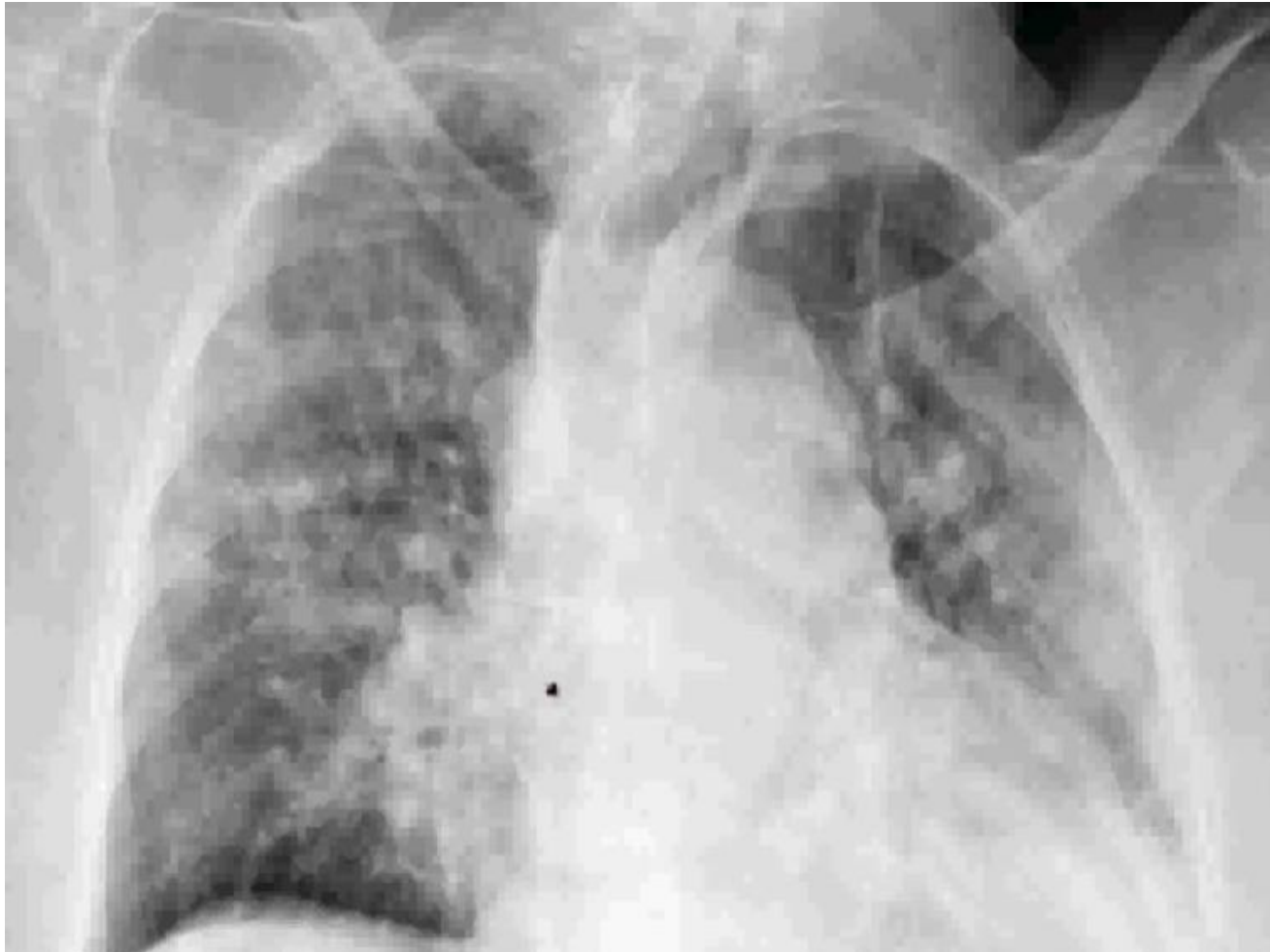
Bronchopneumonia

- It begins as an acute bronchitis and spreads locally into the lungs.
- The lower lobes or right middle lobe are usually involved.
- Are focal/patchy areas of consolidated acute suppurative inflammation in one or more lobes.
- *Staphylococcus aureus* is an important cause of secondary bacterial pneumonia after viral respiratory illnesses (e.g., measles in children and influenza in both children and adults)
- Usually it involves lower lobes (basal) 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.
- Microscopy: neutrophil rich exudate filling the bronchi, bronchioles and adjacent alveolar spaces.



1. Community-Acquired Acute Pneumonia

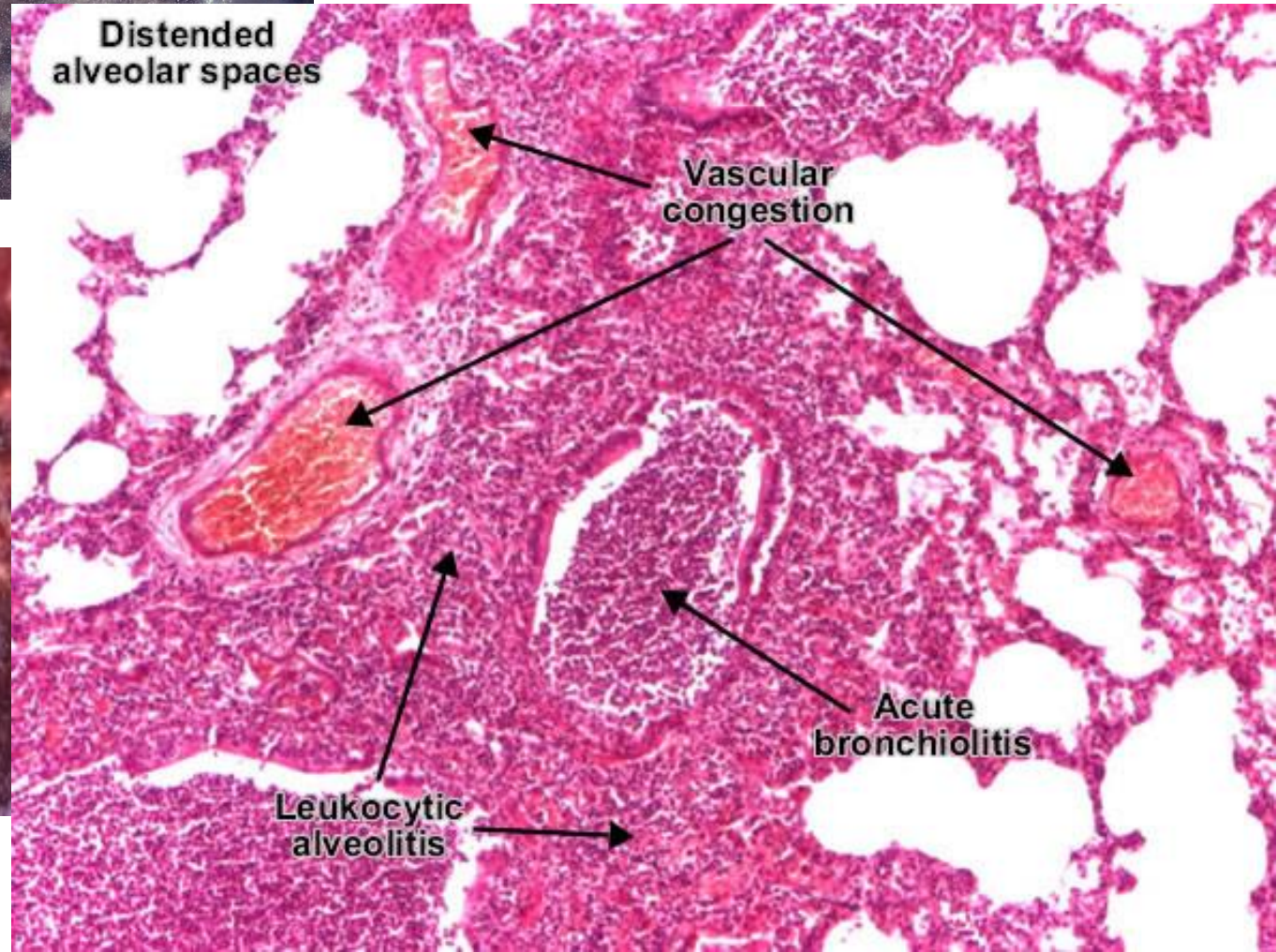
Bronchopneumonia



multiple small opacities (consolidation)

1. Community-Acquired Acute Pneumonia

Bronchopneumonia



Clinical features:

Sudden onset of high fever, chills, pleuritic chest pain and productive cough (mucopurulent sputum “rusty”), may be with hemoptysis

Reduced air entry and dullness by percussion

- When fibrinosuppurative pleuritis is present, it is accompanied by pleuritic pain and pleural friction rub
- Blood test: Leukocytosis with a predominance of neutrophils
- Radiology:
 - in lobar pneumonia there is a radio opaque (consolidation) well circumscribed lobe
 - in bronchopneumonia there are multiple small opacities usually basal and bilateral

Complications

- Tissue destruction and necrosis (abscess).
- Spread of infection to the pleura leading to empyema.
- Organization of the exudate which converts the lung into solid tissue.
- Bacteremic dissemination to heart valves (infective endocarditis), pericardium, brain (meningitis), kidneys, spleen or joints (arthritis)

Primary atypical pneumonia/interstitial pneumonitis

- Characterized by patchy inflammation in the lungs confined to the alveolar septae and pulmonary interstitium and therefore it is called interstitial pneumonitis.
- It is also called **atypical pneumonia** because it is not the typical pneumonia in which the inflammation is primarily in the alveolar spaces.

Primary atypical pneumonia/interstitial pneumonitis

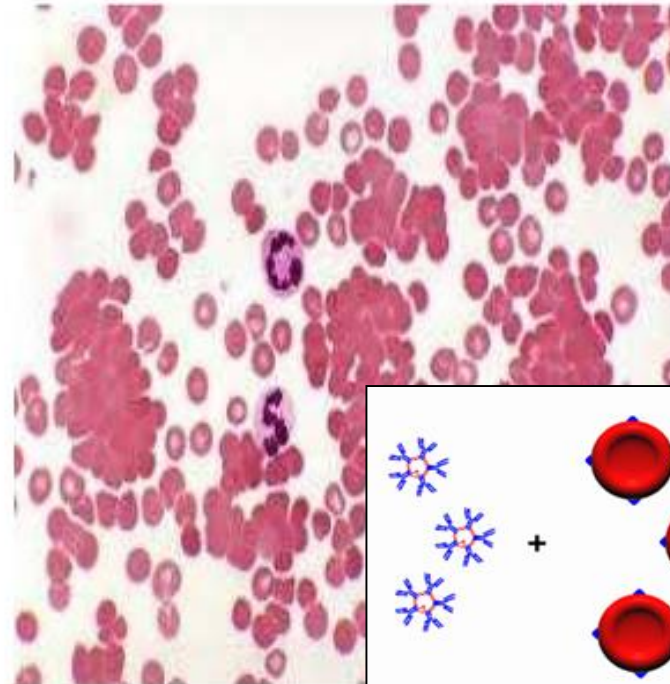
- caused by many organisms
 - the most common is *Mycoplasma pneumonia*
 - *Others include:*
 - **Viruses** e.g. respiratory syncytial virus, influenza virus (children), influenza A and B (adults); adenovirus and SARS virus
 - ***Chlamydia* spp.** (*C. pneumonia etc.*) and *Coxiella burnetti* (Q fever).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

Predisposing factors: malnutrition, alcoholism and any underlying debilitating disease

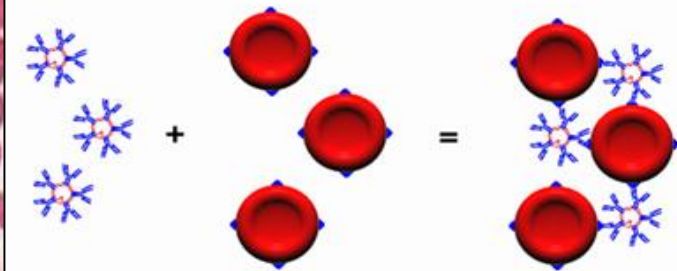
Test for *Mycoplasma pneumoniae*:

Cold Agglutination test

- Positive in Mycoplasma (Primary Atypical) Pneumonia
- The patients sera agglutinated human O group erythrocytes at 4 o c the agglutination being reversible at 37 0 c



Dr.T.V.Rao MD



Beispiel:

Anti-A Antikörper

Erythrozyten mit Antigen A

Agglutination

Serological assays, and polymerase chain reaction (PCR) are used for diagnosis

Primary atypical pneumonia/interstitial pneumonitis

Clinical course:

- Extremely variable course. Patient usually present with flulike symptoms which may progress to life-threatening situations.
- Identification of the organism is difficult.
- Prognosis in uncomplicated pt. is good

Gross:

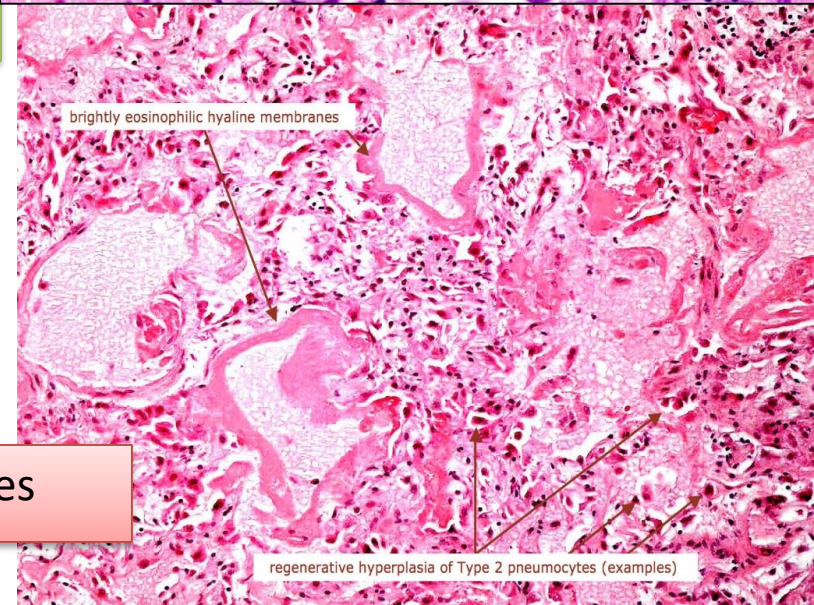
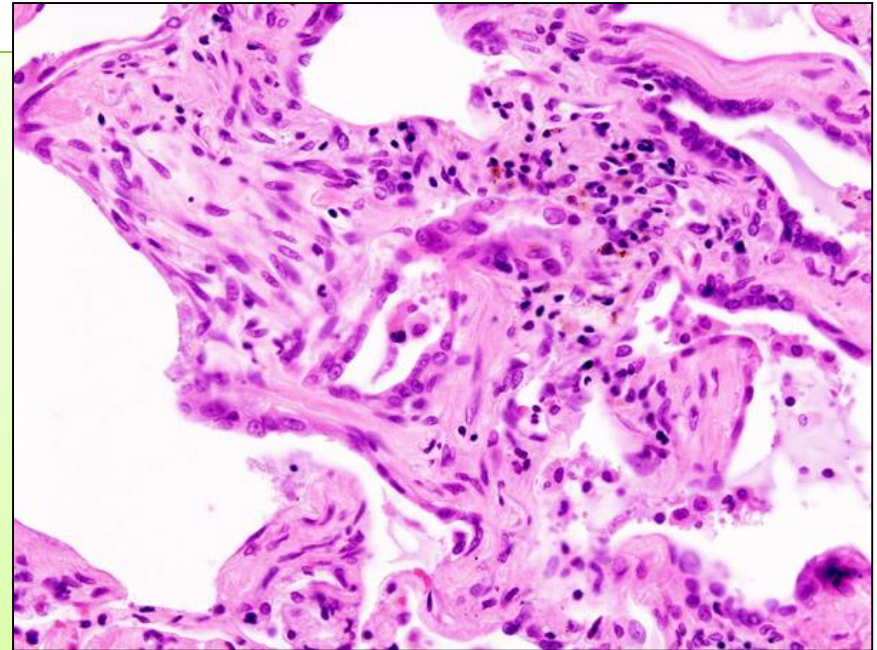
- Pneumonic involvement may be patchy, or involve whole lobes bilaterally or unilaterally.
- Affected areas are red-blue congested.

2) Community Acquired Atypical Pneumonia

Primary atypical pneumonia/interstitial pneumonitis

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)
- Severe cases: Intra-alveolar proteinaceous material with pink hyaline membrane lining the alveolar walls (diffuse alveolar damage)



Sever cases

3) Nosocomial Pneumonia:

- 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

4) Aspiration pneumonia

- Occur in debilitated patients, comatose, alcoholic, or those who aspirated gastric contents
- Chemical injury due gastric acid and bacterial infection (anaerobic bacteria admixed with aerobic bacteria, e.g. *Bacteroides, Fusobacterium and Peptococcus*)
- A necrotizing pneumonia with fulminant clinical course, common complication (abscess) and frequent cause of death.

5) Chronic pneumonia

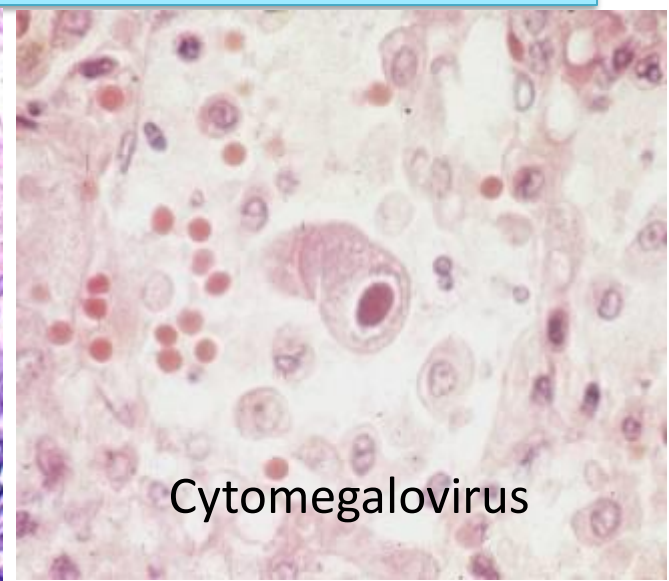
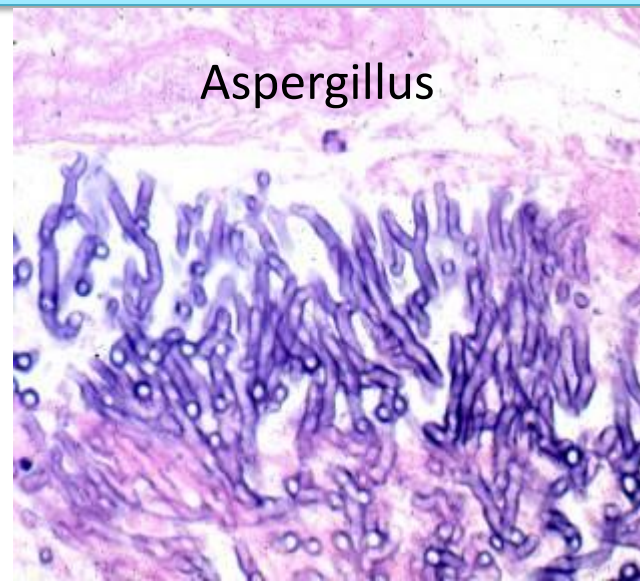
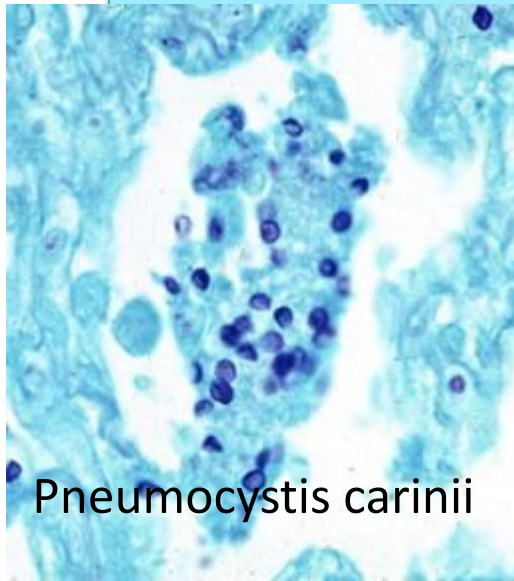
- ❖ is most often a localized lesion in an immunocompetent person, with or without regional lymph node involvement.
- ❖ There is typically granulomatous inflammation, Which may be due to bacteria (e.g., *M. tuberculosis*) or fungi (*Histoplasma capsulatum*, *Coccidioides immitis*, *Blastomyces*)
- ❖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

6) Opportunistic pneumonias

- Infections that affect immunosuppressed patients (AIDS, cancer patients and transplant recipients)

Causative organisms:

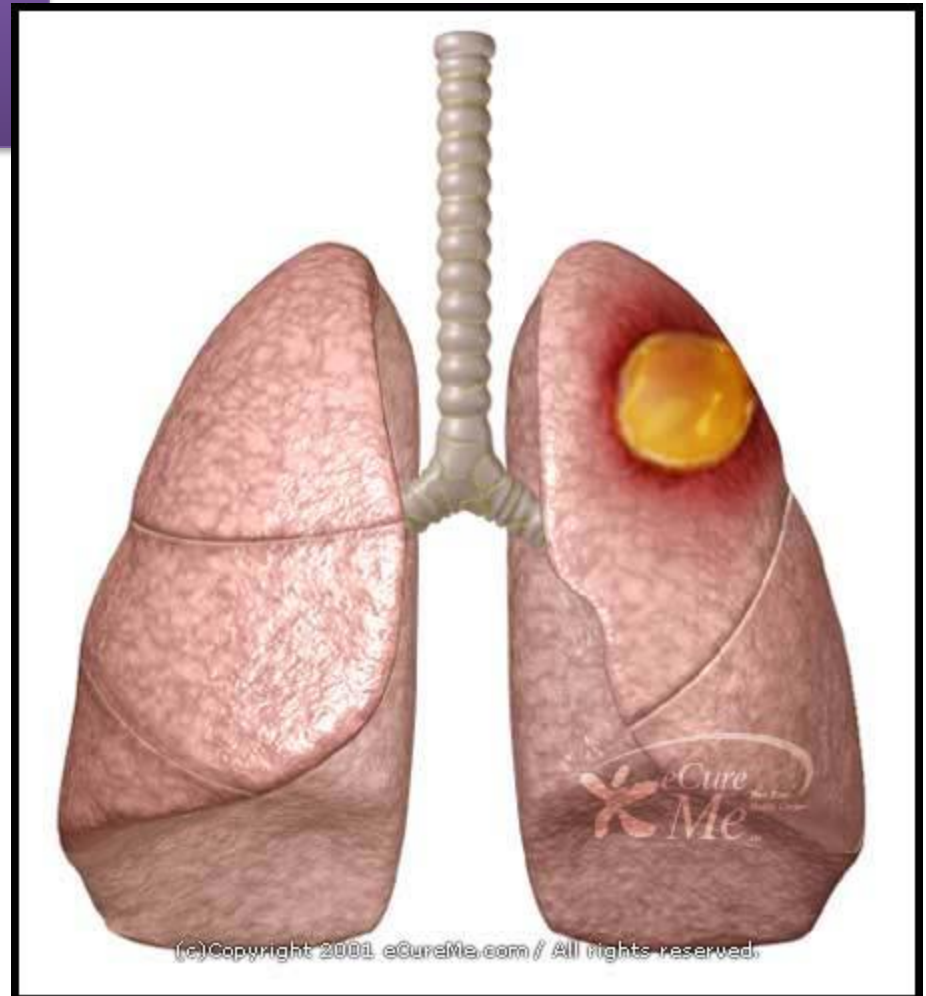
- Cytomegalovirus
- *Pneumocystis jiroveci (carinii)*
- *Mycobacterium avium-intracellulare*
- Invasive aspergillosis
- Invasive candidiasis
- "Usual" bacterial, viral, and fungal organisms



Pneumocystis Pneumonia

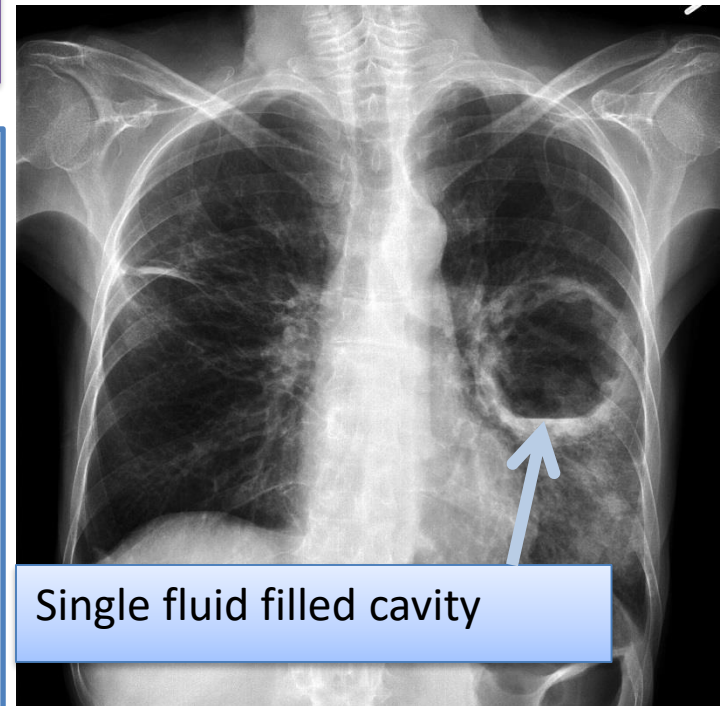
- *P. jiroveci* (formerly *P. carinii*) is an opportunistic infectious agent (a fungus)
- Seen in immunocompromised individuals especially AIDS.
- *Pneumocystis* infection is confined to the lung, produces an interstitial pneumonitis.
- Effective methods of diagnosis are:
 - identify the organism in bronchoalveolar lavage fluids or in a transbronchial biopsy specimen.
 - immunofluorescence antibody kits and PCR-based assays

Lung abscess



Lung abscess

- Is localized suppurative necrotic process within the pulmonary parenchyma
- **Features:** tissue necrosis and marked acute inflammation.
 - ▣ **Organisms:**
 - Staphylococci
 - Streptococci
 - Gram-negative organisms
 - Anaerobes
 - ▣ **Pathogenesis:**
 - Can follow aspiration
 - As a complication of bronchopneumonia
 - Septic emboli
 - Tumors
 - Direct infection



Single fluid filled cavity



Abscess is filled with necrotic suppurative debris

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

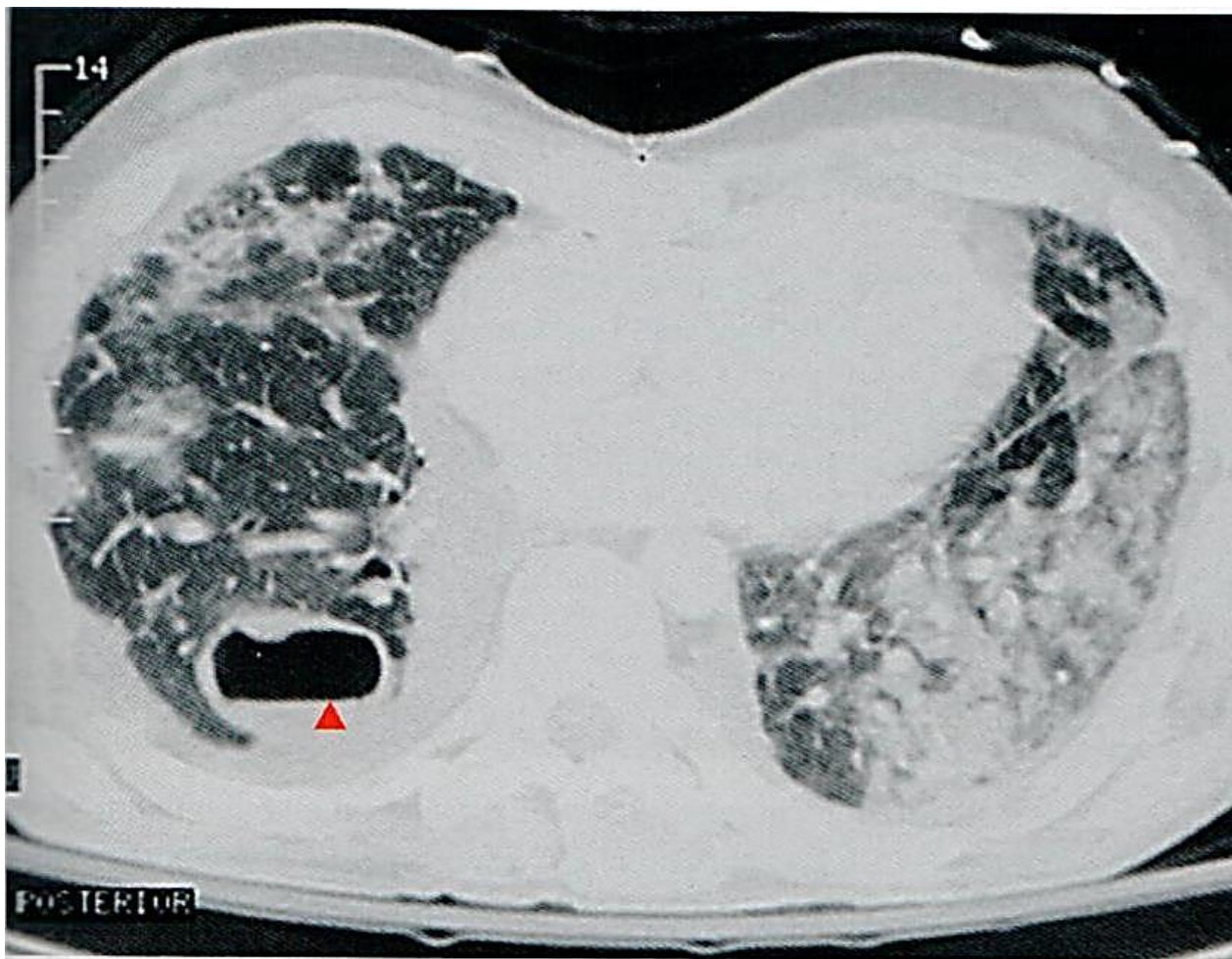
Prognosis:

with antibiotic therapy, 75% of abscess resolve

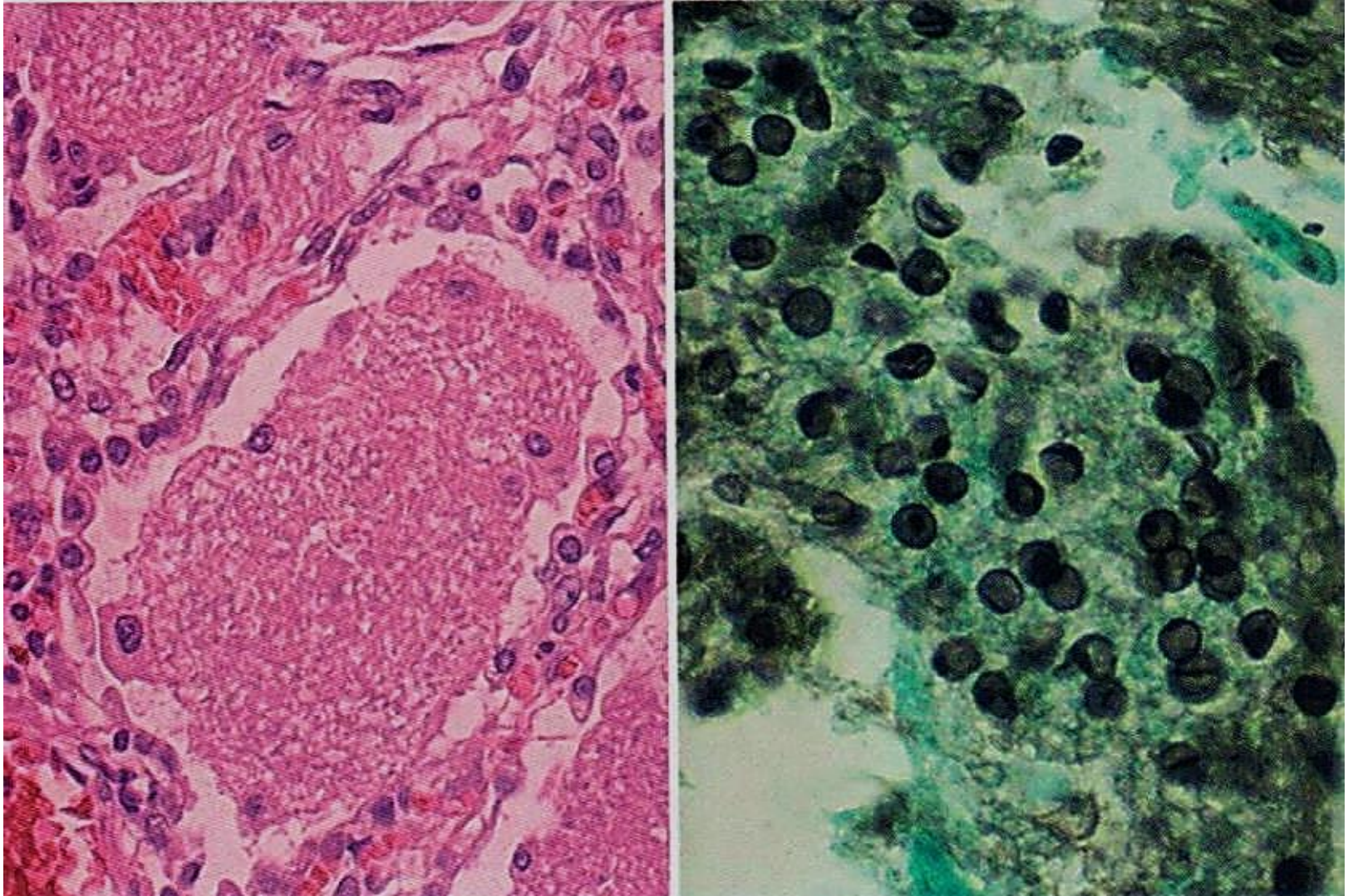




Lung abscesses, gross

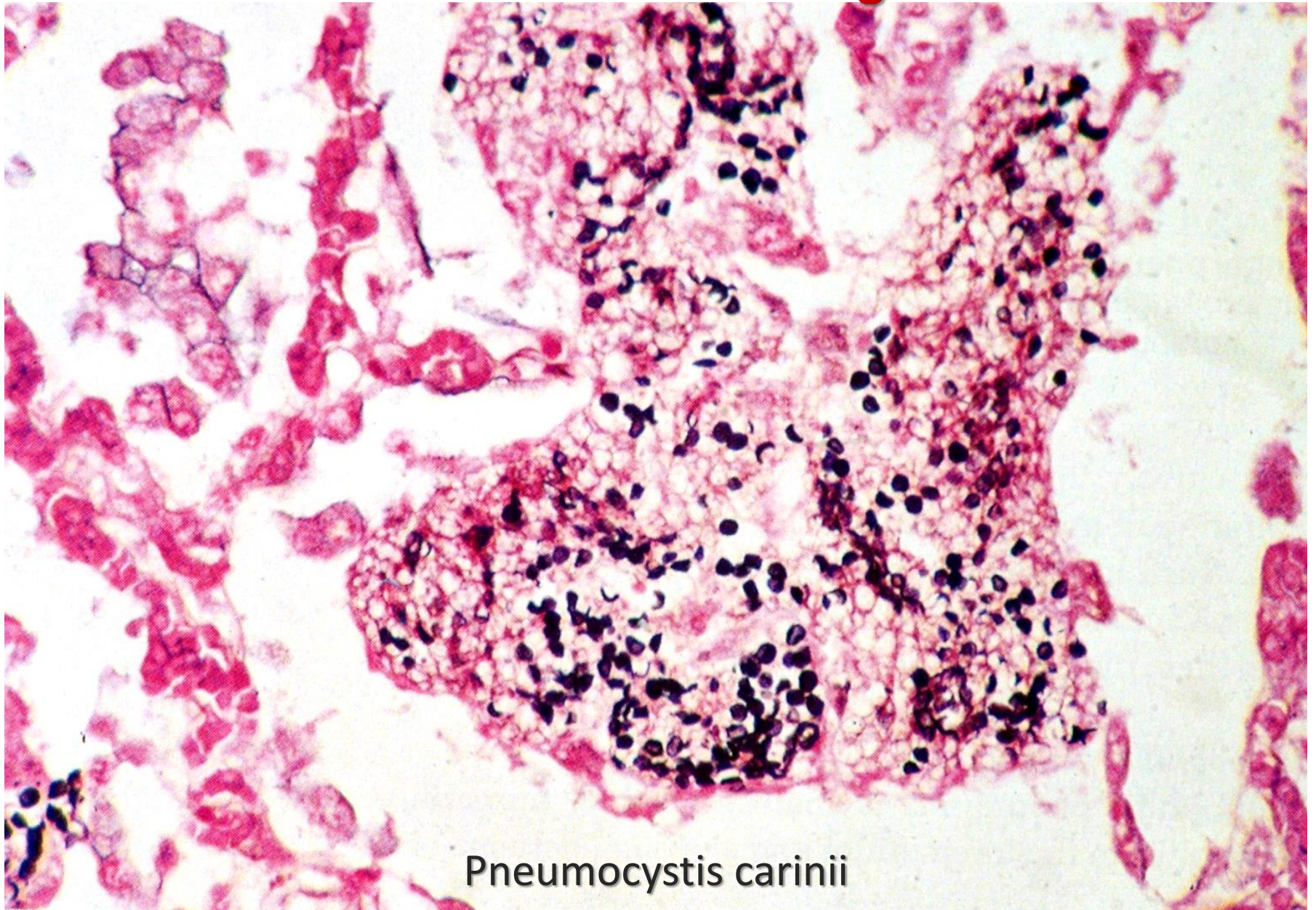


Lung abscess, CT image

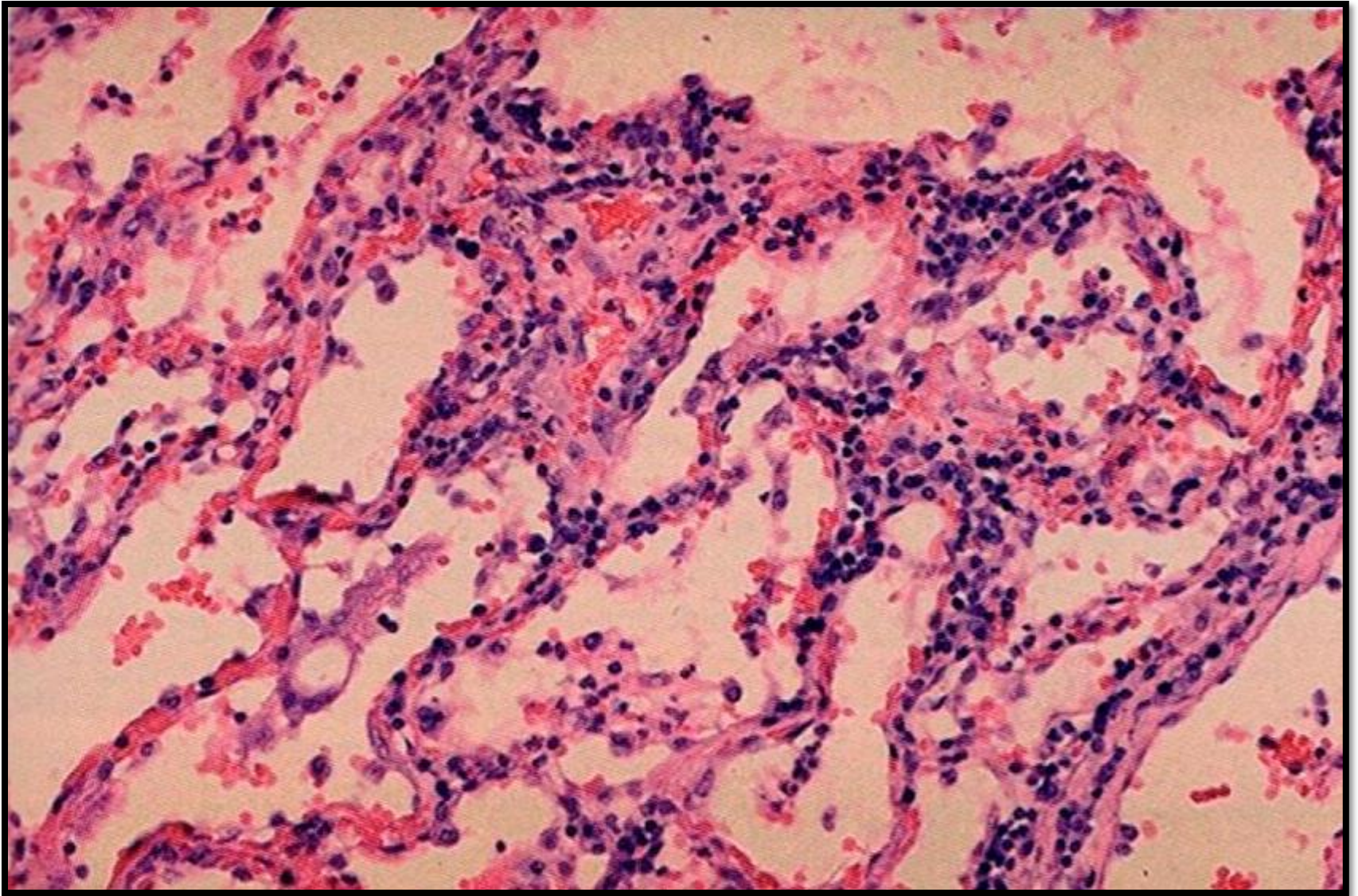


Pneumocystic pneumonia, microscopic

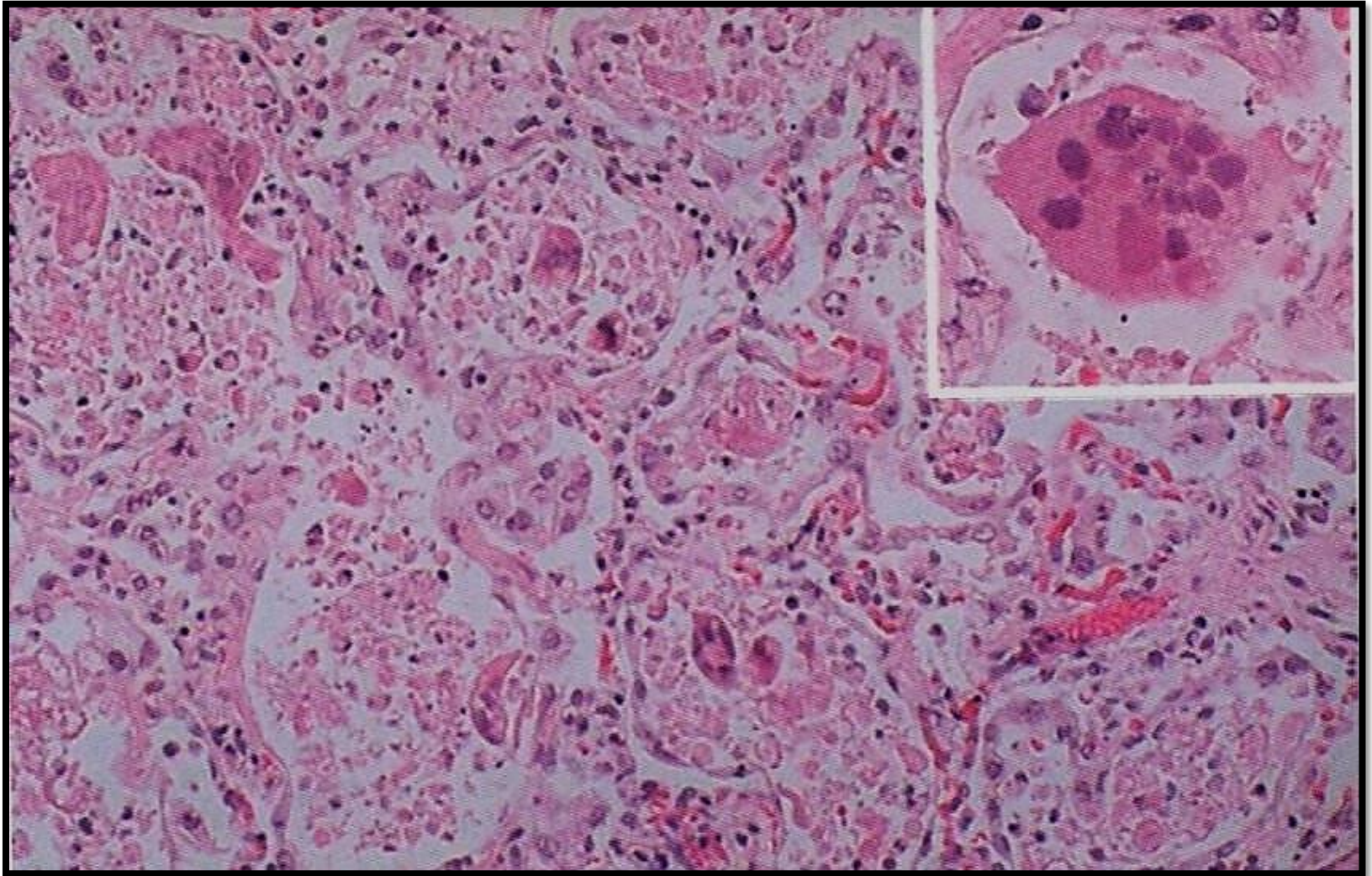
Diseases of Lung



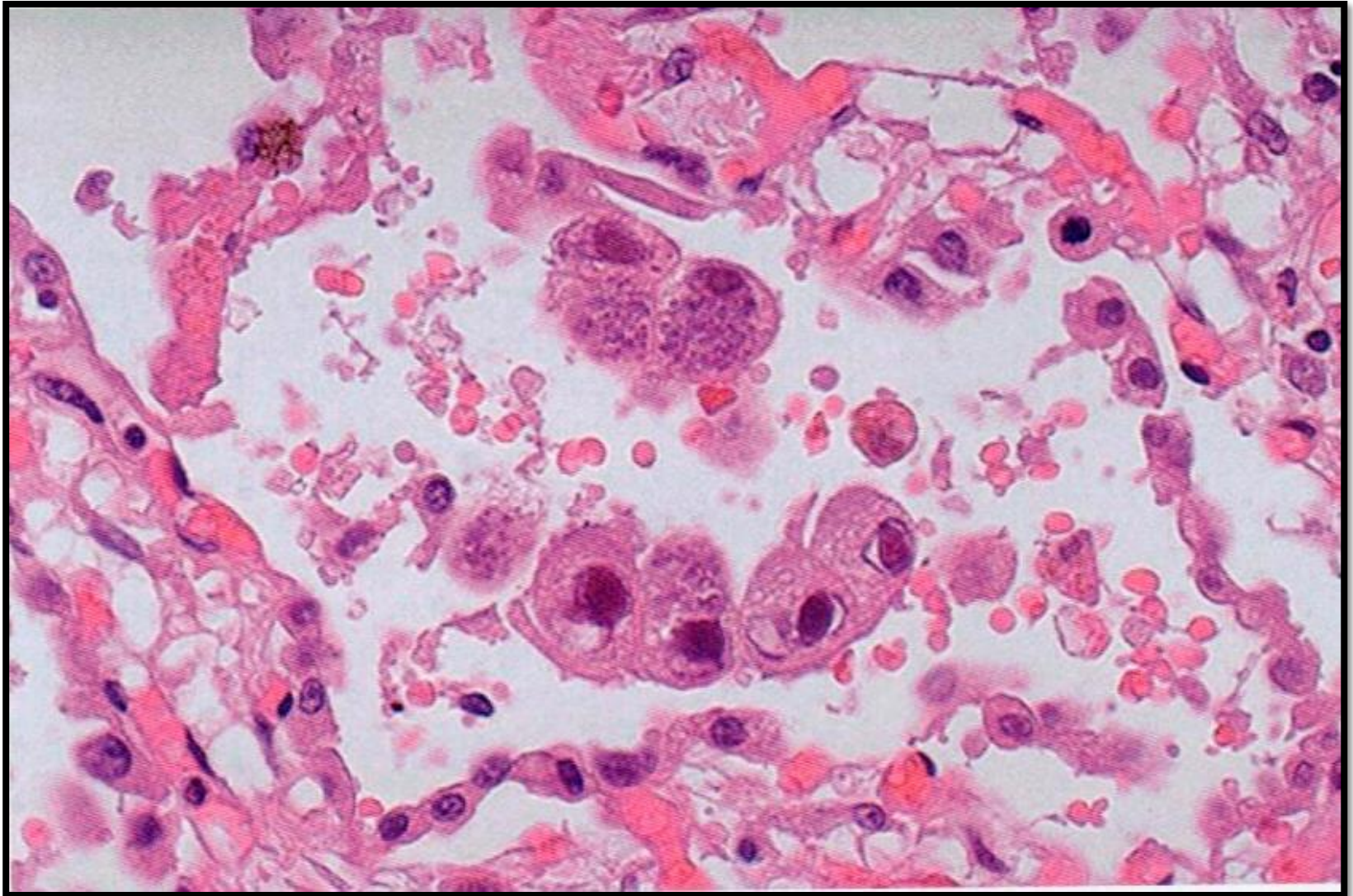
Pneumocystis carinii



Viral pneumonia, microscopic

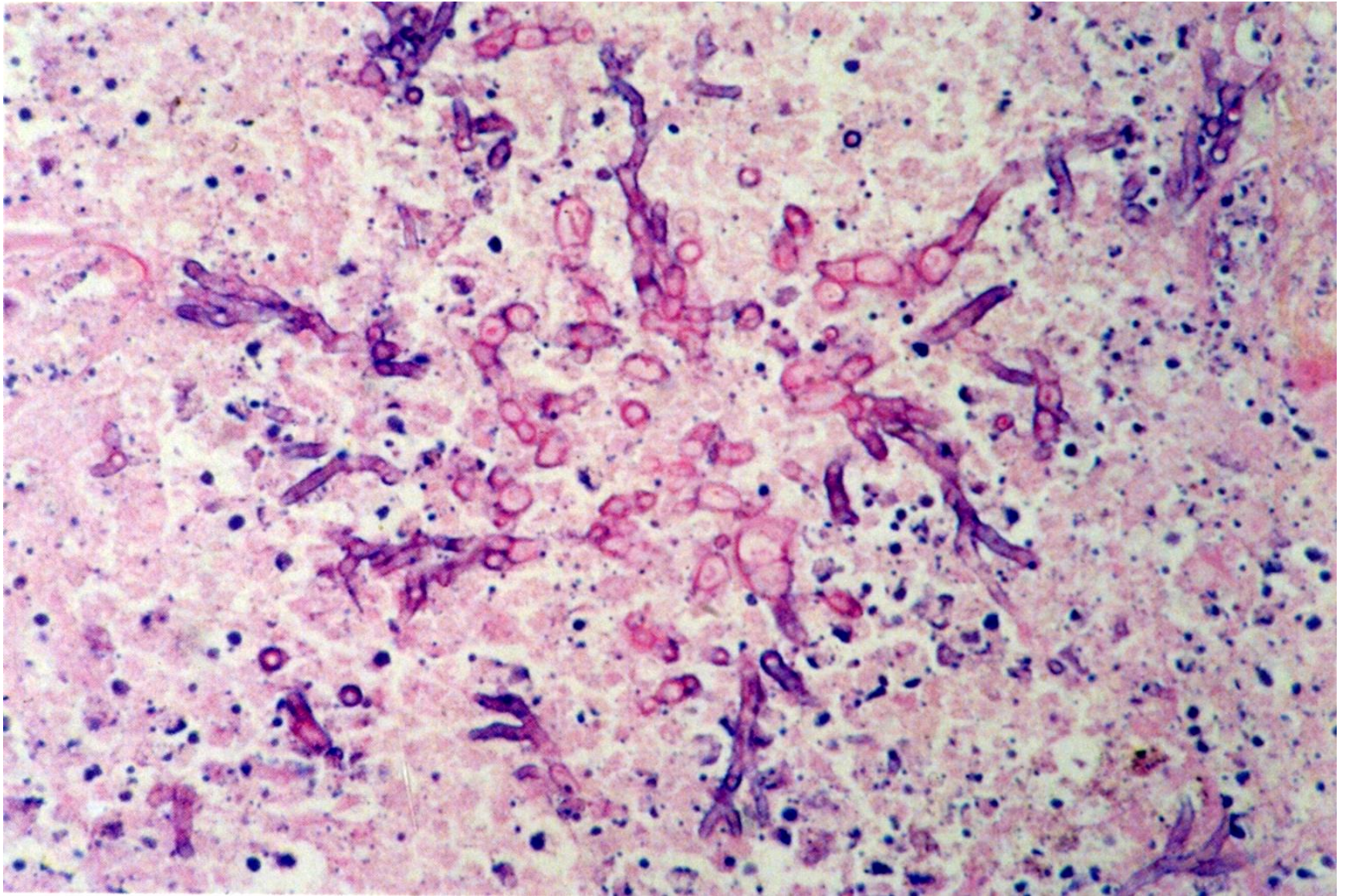


Respiratory syncytial virus pneumonia, microscopic



Cytomegalovirus pneumonia, microscopic

Diseases of Lung

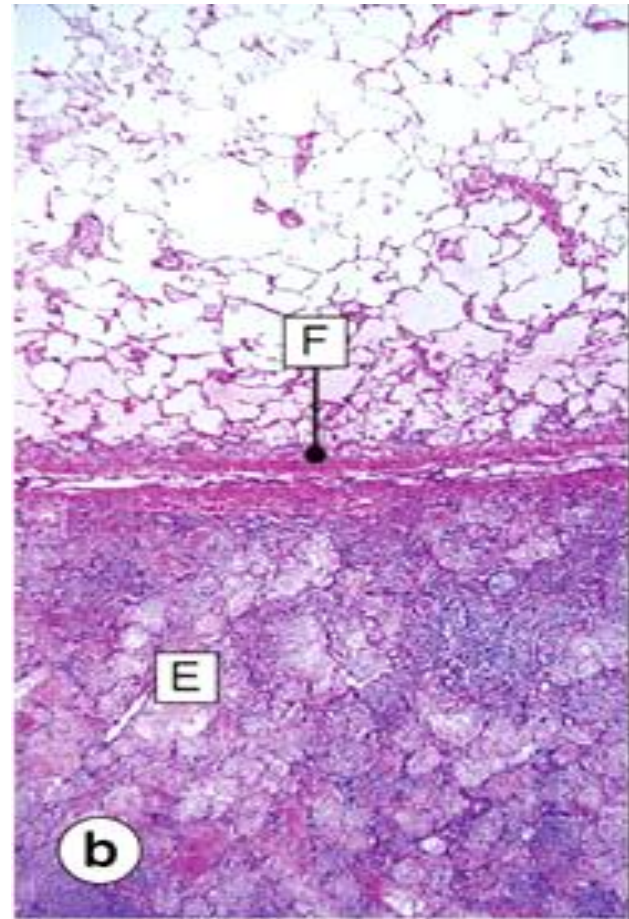
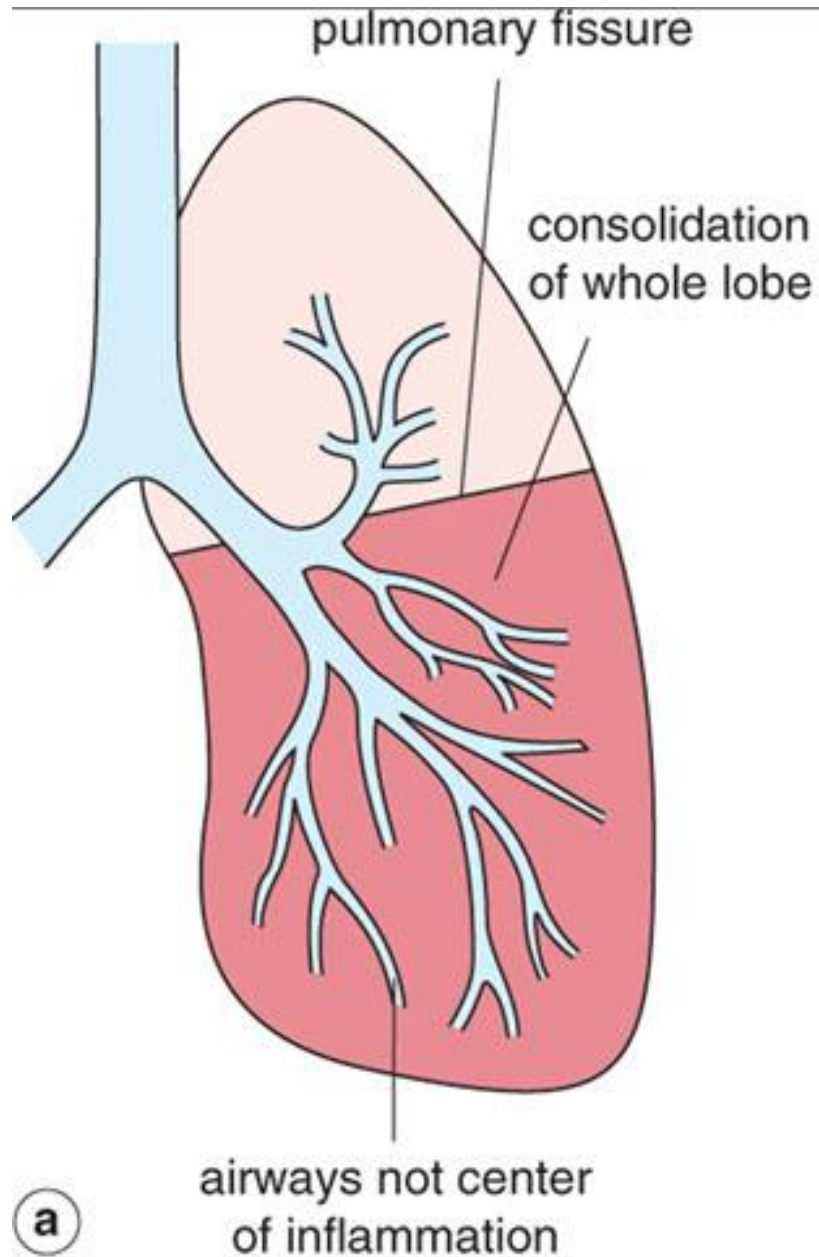


Fungal pneumonia



Empyema, gross

Diseases of Lung



Lobar pneumonia.