

# **PATHOLOGY OF THE REPIRATORY SYSTEM**

## **LEC 4**

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# Lung Pathology Outline

- Congenital anomalies
- Atelectasis
- Acute respiratory distress syndrome
- Diffuse lung diseases
- Pulmonary disease of vascular origin
- **Infections**
- Lung tumors

# Pneumonia

- Pneumonia can be broadly defined as **any infection in the lung**.
- Pneumonias are **common cause of death**.
- Could be **bacterial** (90% due to streptococcal pneumoniae), **Viral and fungal**.

## Predisposing factors:

### 1. Defect in immunity:

- Defect in humoral immunity & neutrophils  $\longrightarrow$  pyogenic infection.
- Defect in cellular immunity  $\longrightarrow$  Intracellular infections (tuberculosis, viruses, pneumocystic carinii).

### 2. Cigarette smoking

- decrease in mucociliary clearance
- Affect pulmonary macrophages activity.

### 3. Alcohols

- Decrease cough & epiglottis activity.
- increase aspiration
- Decrease neutrophils activity.

### 4. Head injury & surgery $\longrightarrow$ increase aspiration

### 5. Lung cancers & cystic fibrosis $\longrightarrow$ Pulmonary Obstruction $\longrightarrow$ increases risk of pneumonia.

# Classification of pneumonia:

1. According to **anatomical (and radiographic) patterns**
2. According to **setting** in which the pneumonia is occurred
3. **Microbiological classification**

It Could be: bacterial, Viral, fungal...

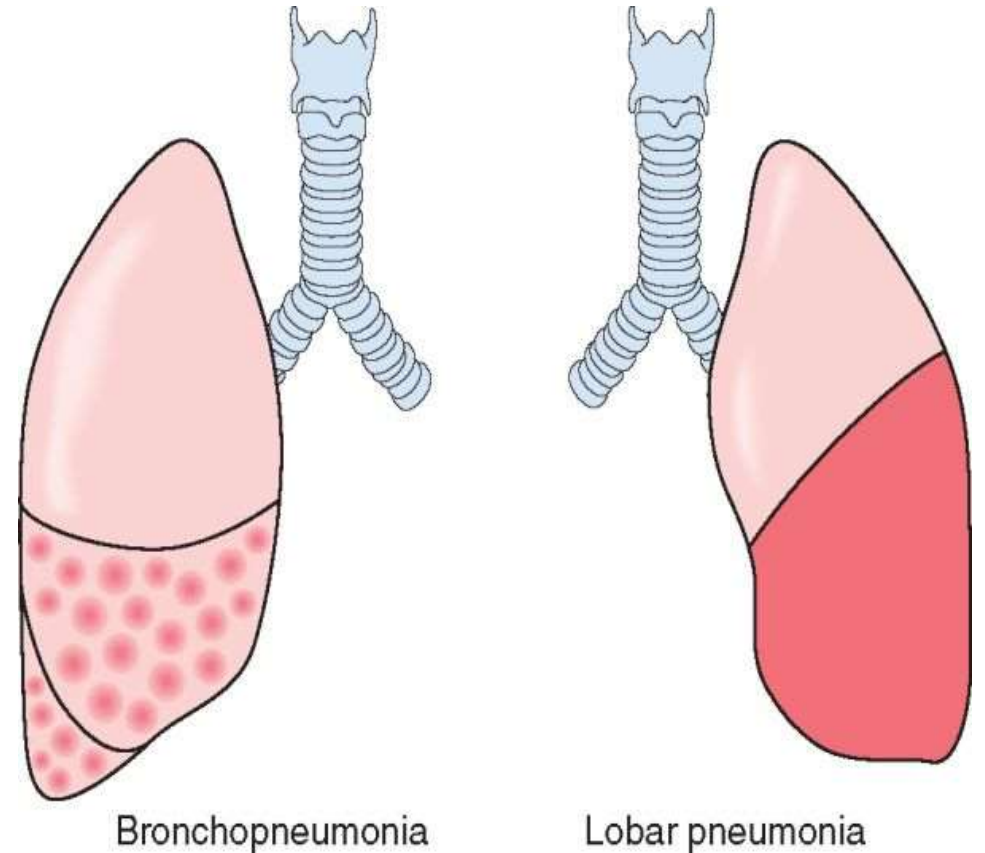
# I. According to anatomical (and radiographic) patterns

## 1) Bronchopneumonia:

- Showing a **patchy distribution** of inflammation that generally involves more than one lobe. The initial infection is of the bronchi and bronchioles with extension into the adjacent alveoli.

## 2) Lobar pneumonia:

- Which affect the airspaces of **part or all of a lobe**; these are **homogeneously** filled with an exudate that can be visualized on radiographs as a lobar or segmental consolidation.



## **2- According to setting in which the pneumonia is occurred:**

- 1- Community acquired bacterial pneumonia**
- 2- Community acquired atypical pneumonias**
- 3- Nosocomial Pneumonia (hospital-acquired)**
- 4- Aspiration Pneumonia**
- 5- Necrotizing pneumonia & Lung Abscess**
- 6- Chronic Pneumonia**
- 7- Pneumonia in the Immunocompromised Host**

# 1- Community acquired bacterial pneumonia:

- This is the **commonest type**.
- Often follow viral upper respiratory tract infection.
- **Streptococcus pneumoniae, or pneumococcus**, is the **most common** cause of community-acquired pneumonia.
- **Haemophilus influenzae** can cause life-threatening lower respiratory tract infections and **meningitis** in **children** and is a common cause of pneumonia in adults, especially those with **COPD**
- **Moraxella catarrhalis**: especially in the **elderly**; it **exacerbates COPD** and is a common cause of **pediatric otitis media**.
- **Staphylococcus aureus pneumonia** often complicates viral illnesses and has a high risk of **abscess formation and empyema**. Intravenous (IV) drug abusers are at high risk of staphylococcal pneumonia in association with endocarditis.



- **Klebsiella pneumoniae** is the most common cause of Gram negative pneumonia; it affects debilitated individuals, especially **chronic alcoholics**.
- **Pseudomonas aeruginosa** is a common cause of **nosocomial infections** with a propensity to invade blood vessels and spread systemically; it is also common in **cystic fibrosis and neutropenic patients**.
- **Legionella pneumophila**: cause **severe pneumonia in the immunocompromised patient (particularly in organ transplant recipients)**.
- **Mycoplasma pneumoniae**: common among **children and young adults**. They occur **sporadically** or as **local epidemics** in closed communities (schools, military camps, prisons).

## ❖ Morphology of bacterial pneumonia

Depending on bacterial **virulence** and **host resistance**, the **same organism** can cause **bronchopneumonia, lobar pneumonia**.

# Bronchopneumonia

➤ The consolidation is **patchy** centered around inflamed bronchi that involve more than one **lobe (Multifocal & may be bilateral)**

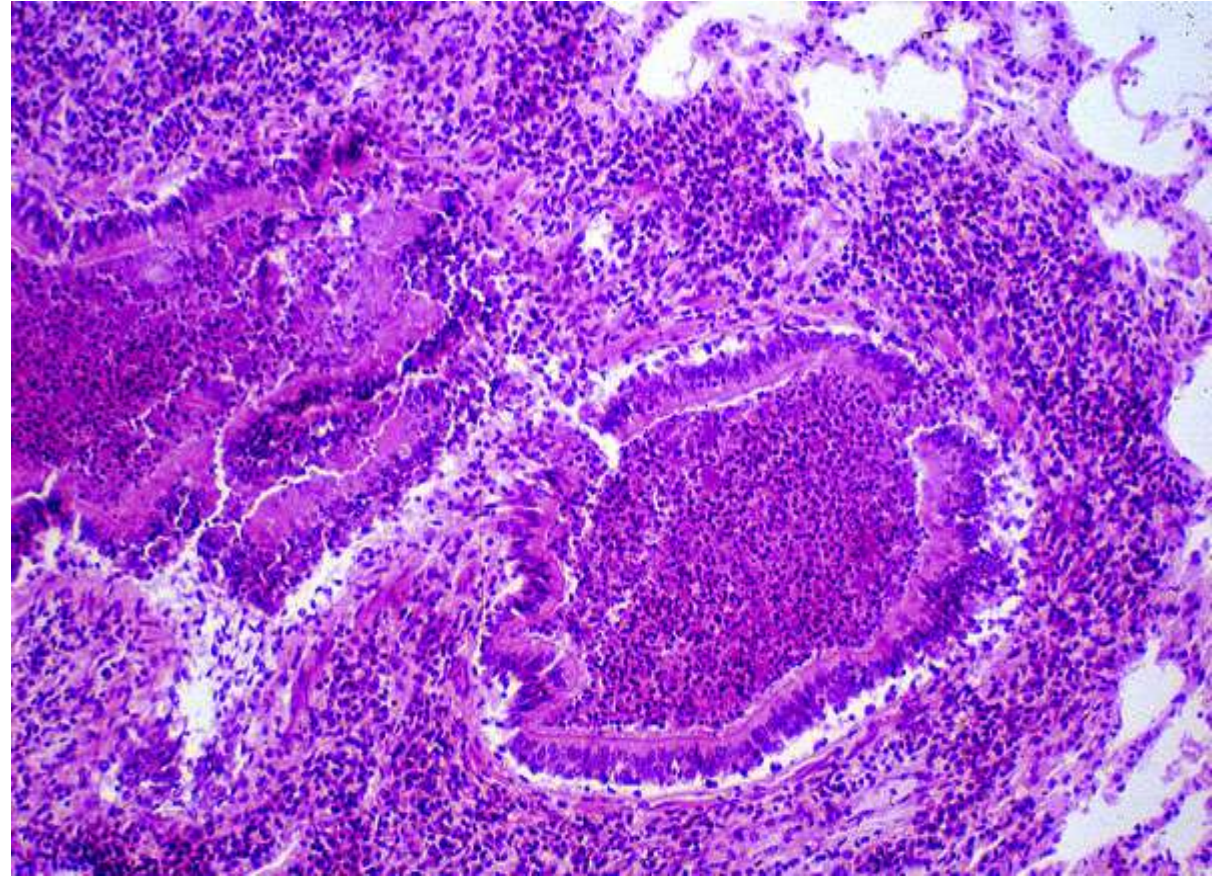
➤ **Grossly:**

- The lungs exhibit **focal areas (patches)** of palpable **consolidation**.
- Lesions are **multiple** & may be **bilateral**.



## Microscopically:

- There is a neutrophil-rich exudate fills the bronchi, bronchioles, and adjacent alveolar spaces





# Lobar pneumonia

- Consolidation of a large portion of a lobe or of an entire lobe defines



**Lobar pneumonia:** gray hepatization, the lower lobe is uniformly consolidated.

- There are **four stages** of evolvement of lobar pneumonia, they are:

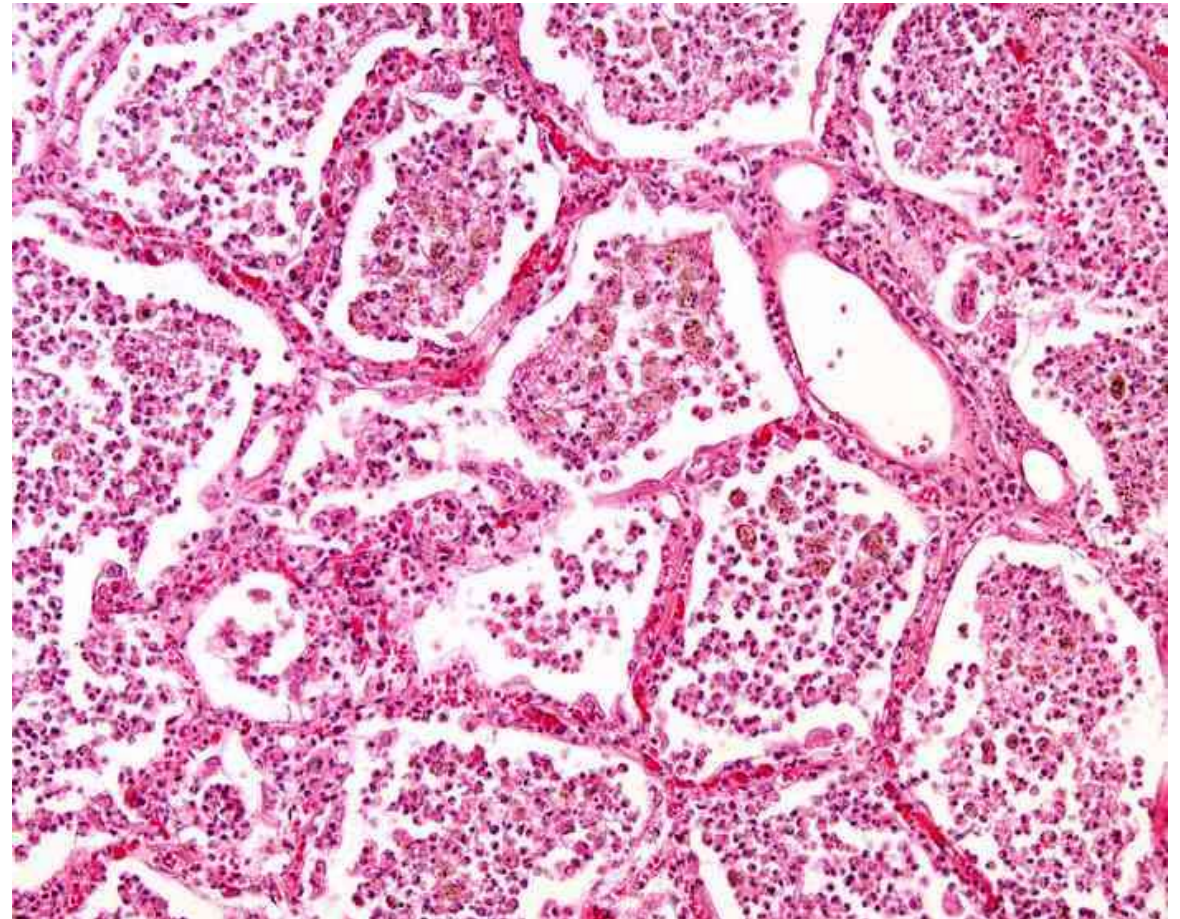
## **1- Congestion stage:**

### **Grossly:**

The lung is heavy, boggy, and red.

### **Microscopically:**

Characterized by **vascular engorgement**, **intraalveolar fluid** with few **neutrophils**, and often the presence of **numerous bacteria**.





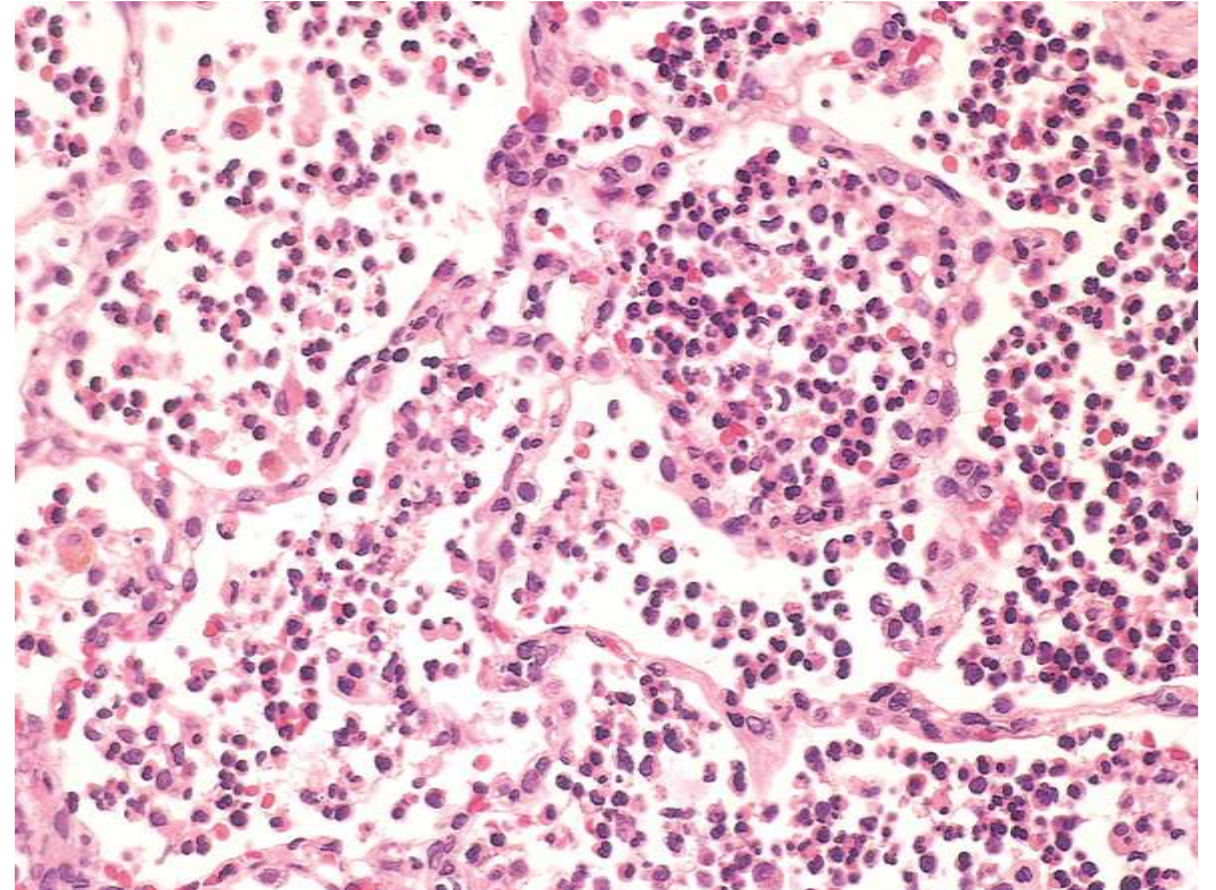
## 2- Red hepatization:

### Grossly:

- Lobe is red, firm, airless, look like a liver.

### Microscopically:

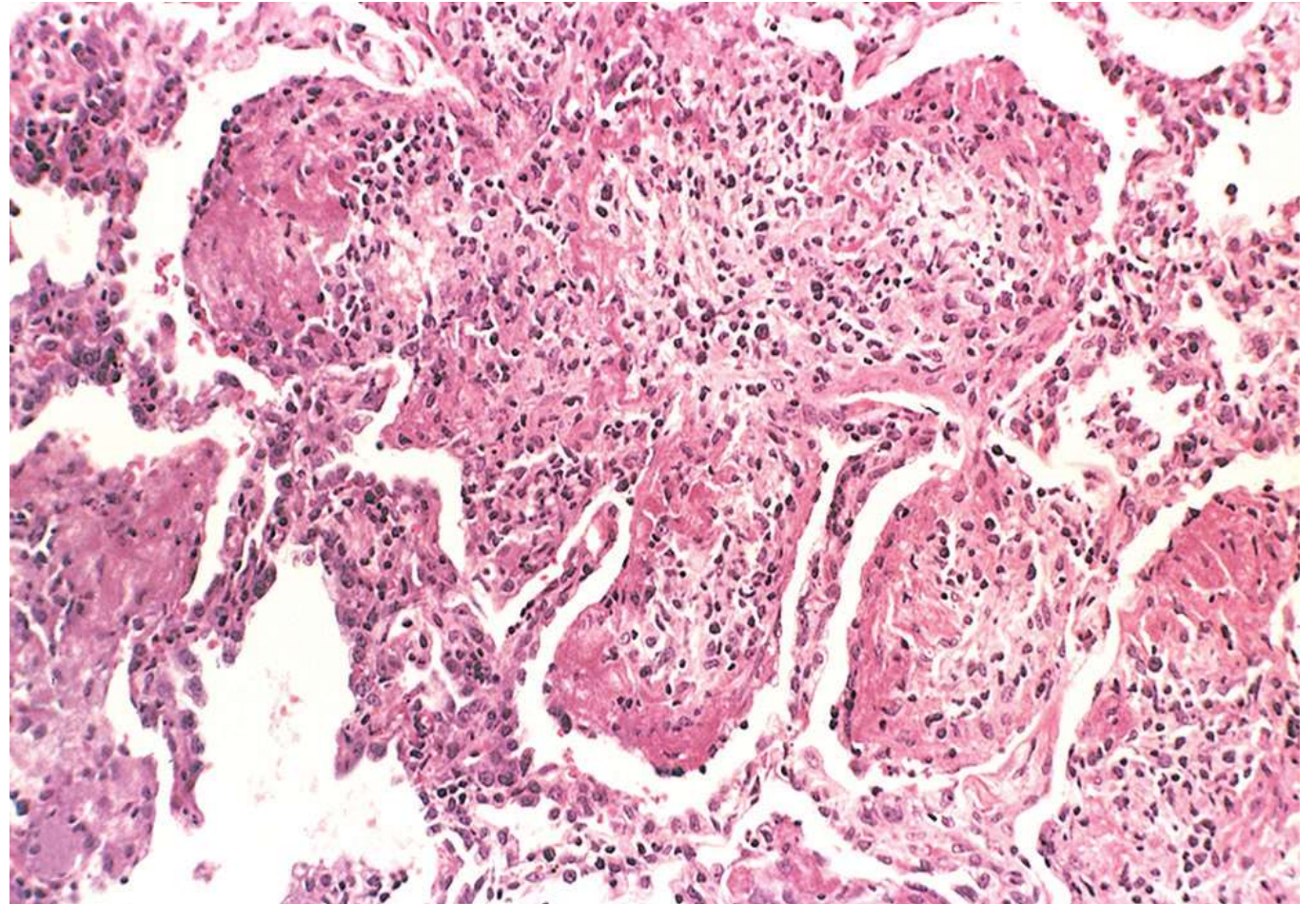
- The inflammatory exudate composed of RBC, neutrophils and fibrin fill the alveolar spaces





### 3- Gray hepatization:

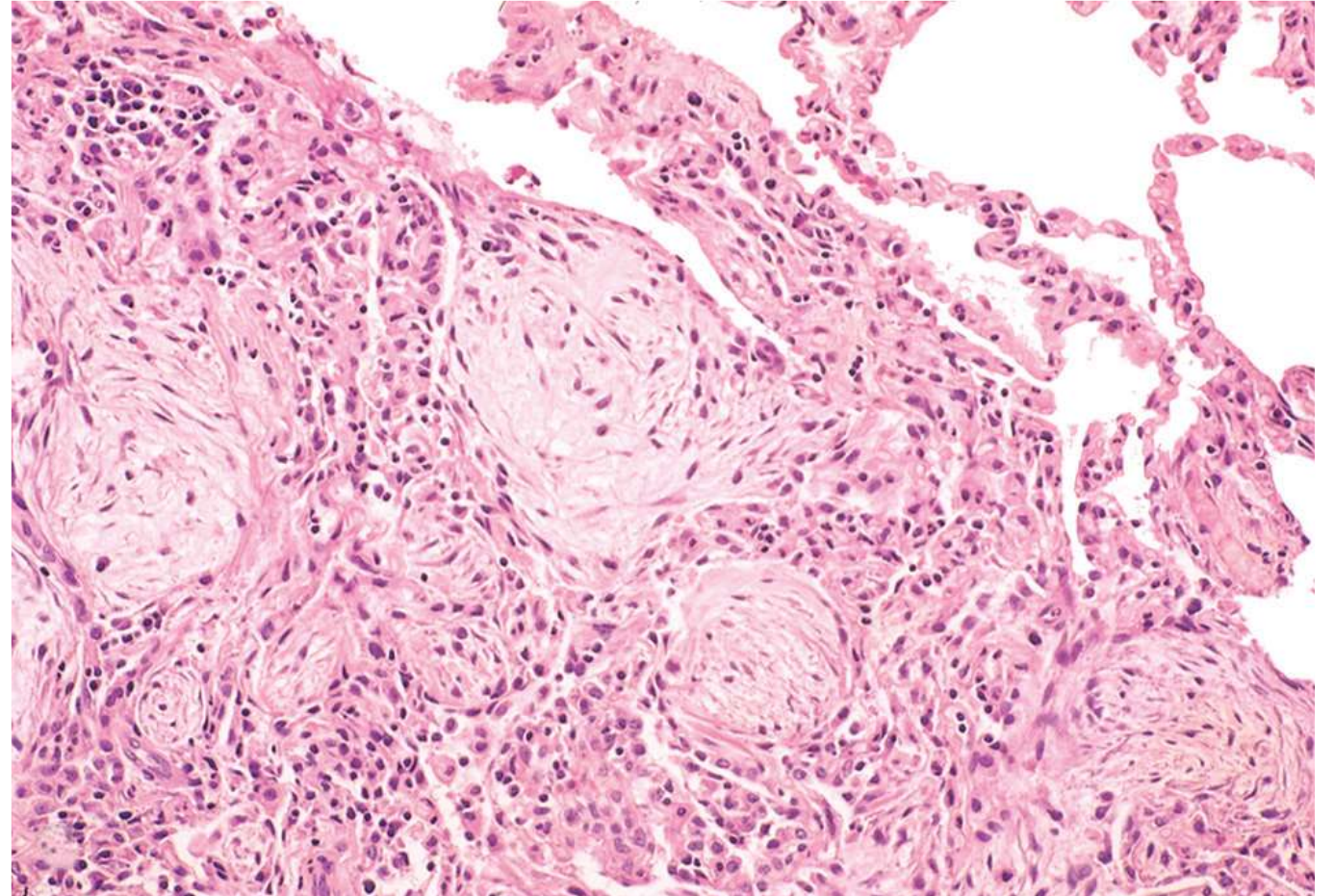
- Characterized by **red cell disintegration** but persistence of fibrinopurulent exudates.
- **Grossly:**
- **Gray –brownish, dry surface & firm.**
- **Microscopically:**
- The exudate within alveoli is fibrino-suppurative (**WBC, fibrin and lysed RBC**).





## 4- Resolution:

- Characterized by progressive **enzymatic digestion** of the exudates and **macrophage resorption** of the debris, or organized by fibroblasts growing into it.
- **Exudate resolution** usually restores normal lung structure and function, but **organization** with fibrous scarring can occur.



❖ **The anatomic distinction between lobar pneumonia and bronchopneumonia is often become blurred because:**

1. Many organisms can produce either of the two patterns of distribution
2. Confluent bronchopneumonia can be hard to distinguish radiologically from lobar pneumonia.

- **Most important from the clinical standpoint are identification of the **causative agent** and determination of the **extent of disease**.**

## ➤ Symptoms of pneumonia (in general):

- Abrupt onset of **high fever** with **shaking chills**, **pleuritic chest pain**, **cough with mucopurulent (rusty) sputum**. Occasionally **hemoptysis**.

## ➤ Diagnostic tests:

- **Sputum examination**: for Gram stain (numerous neutrophils contain diplococci).  
(nonspecific because due to presence of normal flora)
- **Blood culture**: More specific, 20-30% is positive in early cases.
- **CXR**: The whole lobe is radiopaque in lobar pneumonia, whereas there are focal opacities in bronchopneumonia.

## Complications :

- **90%** of cases will end up with **resolution**, otherwise complication includes:
  1. **Abscess formation** because of tissue destruction and necrosis
  2. Spread of infection to the pleural cavity → **empyema** (pus inside the pleural cavity).
  3. **Bacteremic dissemination** cause meningitis, infective endocarditis, arthritis
  4. **Organization (fibrosis)** of the exudate → part of the lobe will turn solid.

## 2- Community acquired Atypical pneumonias:

- The most common causes are influenza types A and B, the respiratory syncytial viruses, adenovirus, rhinoviruses, rubeola virus, and varicella virus. Nearly all of these agents also cause upper-respiratory tract infections (“common cold”).

### ❖ Morphology:

#### ➤ Grossly:

- Patchy or lobar areas of congestion (red- blue areas) appear **without the consolidation** of bacterial pneumonias (hence the term atypical pneumonia).

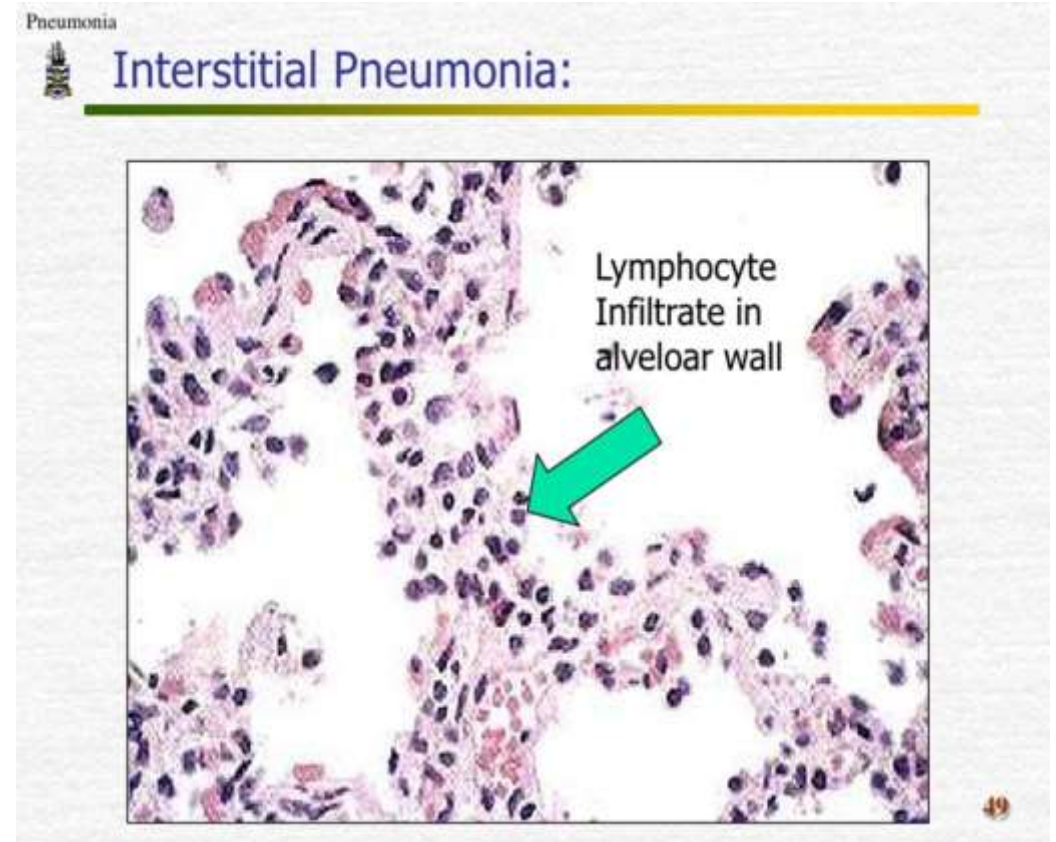
#### ➤ Microscopically:

- Interstitial Pneumonia



## Interstitial Pneumonia (atypical):

- The **inflammatory reaction** is largely confined **within the alveolar walls** and connective tissue of lung (interstitial tissue).
- **Alveolar walls** widened by edema & inflammatory infiltrate of lymphocytes, histiocytes, and, occasionally, plasma cells.
- **In contrast to bacterial pneumonias**, **alveolar spaces are free of cellular exudates**.
- **Superimposed bacterial infection**, as expected, results in a mixed histologic picture.



### 3- Nosocomial Pneumonia (hospital-acquired):

- Defined as "pulmonary infections acquired in the course of a hospital stay".
- They are common in hospitalized persons with severe illness, immune suppression, or prolonged antibiotic therapy and those on mechanical ventilation are also susceptible.
- Gram negative rods (*Klebsiella* spp., *Escherichia coli* and *Pseudomonas* spp.) and **Staphylococcus aureus** are the most common cause.

## 4- 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.
- The resultant pneumonia is **partly chemical**, resulting from the extremely irritating effects of the gastric acid, and **partly bacterial ( mixed oral flora)**
- This type of pneumonia is often **necrotizing** with a **fulminant** (sever and sudden) clinical course.
- In those who survive, **abscess formation** is a common complication.

## 5- Necrotizing pneumonia & Lung Abscess

- Necrotizing pneumonia often coexists or evolves into lung abscess, making the distinction between the two somewhat subjective.



# Lung abscess

- Define as **necrosis of pulmonary parenchyma** and **formation of cavity** containing necrotic debris and fluids or pus.
- The formation of multiple small abscesses in lung parenchyma is referred as necrotizing pneumonia.

## Clinically:

- Cough, copious amount of foul smell sputum and fever.

## Complications:

- Extension into the pleural cavity ( Empyema), hemorrhage, septic embolization, and secondary amyloidosis.

## Pathogenesis:

These microorganisms reach lungs via the followings mechanisms:

- 1) **Aspiration of infected material** from carious teeth, infective sinuses or tonsils, this is occurring during oral surgery & anesthesia, acute alcoholism, coma, in which the cough reflexes are depressed.
- 2) **Aspiration of gastric contents**
- 3) **Complications** of necrotizing bacterial pneumonia (staph. aureus, strepto. Pyogenes, & pseudomonas).
- 4) **Bronchial obstruction:** particularly with bronchogenic cancers; Obstruct the bronchi, impaired drainage of secretion & increase risk of abscess formation.
- 5) **Septic embolism** from infective endocarditis of right side of heart or from septic thrombophlebitis.
- 6) **Hematogenous spread of bacteria** (Staphylococcal Bacteremia).
- 7) **Direct traumatic penetrations of the lungs;** spread of infections from a neighboring organ, such as pleural cavity.

## Gross:

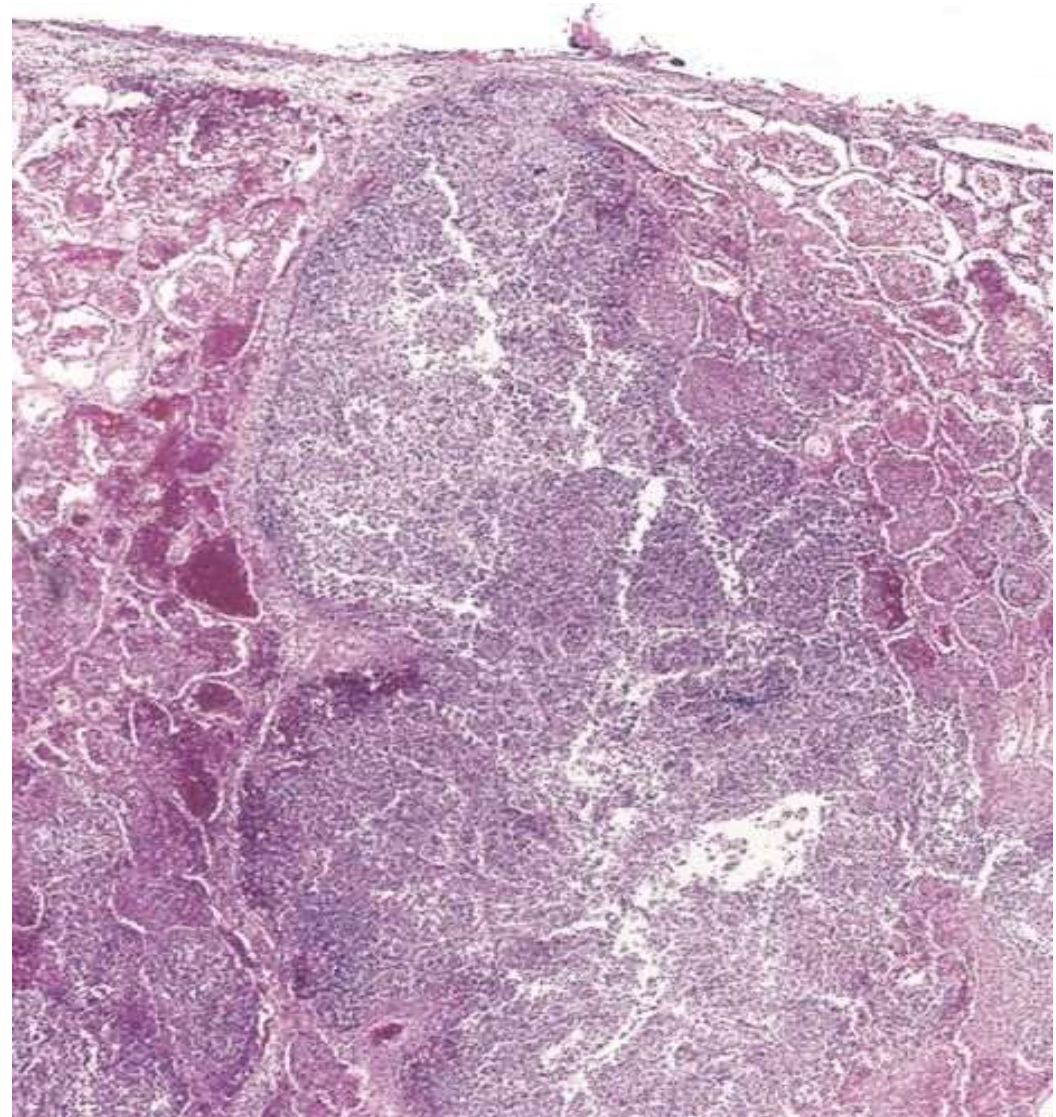
- Various size cavities, filled with pus.
- Those occur on right side are mostly due to aspiration (more vertical airway).
- Those follow pneumonia & Bronchiectasis are multiple, basal in locations



**lung abscess** (center) with complete destruction of underlying parenchyma within the focus of involvement

## **Microscopically:**

Suppurative inflammation,  
necrosis & destruction of the  
lung parenchyma



## 6. Chronic Pneumonia:

- 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; discussed in infection**) or **fungi**.
- In the **immunocompromised**, there is usually **systemic dissemination** of the causative organism, accompanied by widespread disease.



# Fungal pneumonia

- **Histoplasmosis , Coccidioidomycosis and Blastomycosis**
- Mainly caused by **Histoplasma capsulatum , Coccidioides immitis** and **Blastomyces dermatidis**.
- Most are **asymptomatic** and result in only limited **granulomatous disease**; however, **immunocompromised** can cause **fulminant**, widespread dissemination.
- Initiated by **delayed-type hypersensitivity response to the organism**.
- The lesions develop in to small **granulomas** with **giant cells**, may develop **central necrosis** and later **fibrosis** and **calcification**
- Should be differentiated from **tuberculosis**; by identification of the yeast forms which are best seen with **periodic acid- Schiff** or **silver stains**.

## 7. Pneumonia in the Immunocompromised Host

A wide variety of **opportunistic microorganisms**, many of which rarely cause infection in normal hosts, but can cause life-threatening pneumonias in the immunocompromised host.

*Examples of pulmonary opportunistic pathogens include;*

1. **Bacteria** (*Pseudomonas aeruginosa*, *Mycobacterium* spp., etc)
2. **Viruses** (cytomegalovirus and herpesvirus )
3. **Fungi** (*Pneumocystis jiroveci*, *Candida* spp., *Aspergillus* spp., and *Cryptococcus neoformans*).

**THANK YOU**