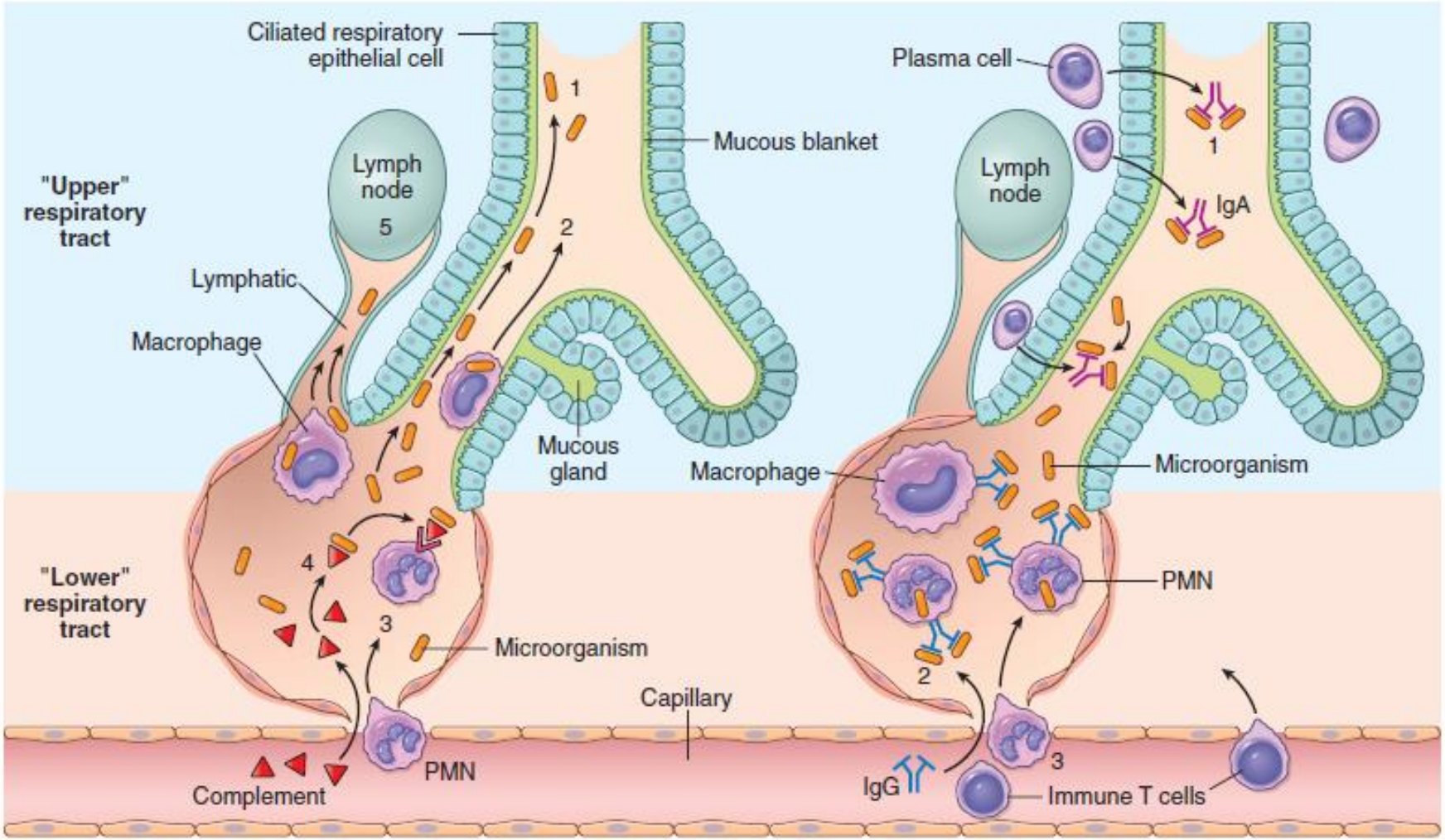
Pneumonia

Pneumonia

- **Infection** and inflammation of the **lung parenchyma**

Local Defense Compromise

- Loss or suppression of the cough reflex
- Injury to the muco-ciliary apparatus
- Accumulation of secretions
- Interference with phagocytosis or bactericidal actions of alveolar macrophages
- Pulmonary congestion and edema



A. INNATE IMMUNE DEFENSES

B. ADAPTIVE IMMUNE DEFENSES

Pyogenic Bacterial Infections

- Incidence increases when defects in innate or humoral immunity are present
- May also be due to MyD88 germline mutation

Intracellular Microbe Infection

- Defects in cell mediated immunity can lead to this type of infection
- Includes mycobacteria, herpes, pneumocystis jiroveci

Pneumonia Classification

A) **Anatomical**

- Bronchopneumonia
- Lobar pneumonia.

B) **Aetiological or according to clinical setting**

- Community-Acquired Acute Pneumonia
- Community-Acquired Atypical Pneumonia
- Nosocomial Pneumonia/ hospital acquired pneumonia
- Health care associated pneumonia
- Aspiration Pneumonia
- Chronic Pneumonia
- Necrotizing Pneumonia and Lung Abscess
- Pneumonia in the Immunocompromised host

Community Acquired Acute Pneumonia

- Lung infection in otherwise healthy individuals that is acquired from normal environment
- May be bacterial or viral
- Bacterial infection follows URTI

Bacterial invasion of lung parenchyma → alveoli filled with inflammatory exudates → consolidation (solidification) of pulmonary tissue

Community Acquired Acute Pneumonia

- Clinical features
  - Abrupt onset
  - High fever
  - Chills
  - Pleuritic chest pain
  - Productive mucopurulent cough
  - Occasional haemoptysis
  - High cell count in blood cells (WBC)

Community Acquired Acute Pneumonia

- Strep pneumonia
- Haemophilus influenzae
- Moraxella catarrhalis
- S. aureus
- Legoinella pneumophila
- Enterobacteriaceae (klebsiella, pseudomonas)

Community-Acquired Atypical Pneumonia

- Also known as "**Walking pneumonia**"
- "**Atypical**" denotes;
  - The moderate amounts of sputum
  - Absence of physical findings of consolidation
  - Only moderate elevation of white cell count
  - Lack of alveolar exudates

Community-Acquired Atypical Pneumonia

- Agents:
  - Mycoplasma pneumonia
  - Chlamydia spp. (C. pneumoniae, C. psittaci, C. trachomatis)
  - Coxiella burnetti (Q fever)
  - Viruses:
    - Respiratory syncytial virus
    - Para influenza virus
    - Human metapneumo virus (children)
    - Influenza A and B (adults)
    - Adenovirus
    - SARS virus
    - CORONA VIRUS

Hospital acquired (Nosocomial) Pneumonia

- Pulmonary infections acquired in the course of a hospital stay
- Gram negative rods, Enterobacteriaceae (Klebsiella spp., Serratia marcescens, Escherichia coli), Pseudomonas spp.)
- Staphylococcus aureus (usually methicillin resistant)

Health care associated pneumonia

- Hospitalization of at least 2 days within the recent past
- Presentation from a nursing home or long term care facility
- Attending a hospital or hemodialysis clinic and recent intravenous antibiotic therapy, chemotherapy or wound care
- Agents:
  - S. Aureus (methicillin sensitive or resistant)
  - Pseudomonas aeruginosa
  - Streptococcus pneumonia

Aspiration Pneumonia

- Anaerobic oral flora
  Bacteroides, *Fusobacterium*, *Peptostreptococcus*
- Admixed with aerobic bacteria
  Strep pneumoniae
  S. aureus
  Haemophilus influenzae
  Pseudomonas aeruginosa

Aspiration Pneumonia

- In markedly **debilitated or unconscious patients**
- Due to inhaled food, gastric contents (partly chemical) and infected oral materials (partly bacterial)
- Pneumonia is often necrotizing leading to fulminant clinical course
- In those who survive, abscess formation is a common complication
- More common in right lung

Chronic Pneumonia

-Nocardia

-Actinomyces

- Granulomatous
  - Mycobacterium tuberculosis
  - Histoplasma capsulatum
  - Coccioides immitis
  - Blastomyces dermatitidis

Pneumonia in the Immunocompromised Host

-CMV

-Pneumocystis jiroveci

- Mycobacterium avium-intracellulare

- Invasive aspergillosis

- Invasive candidiasis

- Usual bacterial, viral and fungal organisms

Community Acquired Acute Pneumonia

- Lung infection in otherwise healthy individuals acquired from the normal environment

- Bacterial or viral

CA-Bacterial Pneumonia: Clinically

- Abrupt onset of high fever, rigors, productive cough and occasional hemoptysis
- Pleural involvement: pleuritic chest pain + friction rub
- Tx: antibiotics change course of dz within 48-72 hrs
  - Determine organism and antibiotic sensitivity

Bacterial Infection

-↑ CRP and procalcitonin

- Often follows an upper respiratory viral infection

- Causes alveoli to be filled with inflammatory exudate causing consolidation of pulmonary tissue

- Predisposition: age, chronic disease, congenital or acquired immunodeficiency, compromised splenic function

Streptococcus pneumoniae

- Most common cause of community acquired pneumonia

Increased frequency in 3 subsets of patients:

(1) Chronic diseases (CHF, COPD or diabetes)

(2) Congenital or acquired immunoglobulin defects (e.g. AIDS);

(3) Decreased or absent splenic function (e.g. sickle cell disease or after splenectomy)

Streptococcus pneumoniae

- Vaccines for those at high risk contain capsular polysaccharides from common serotypes

Haemophilus influenzae

- Most common bacterial cause of acute exacerbation of COPD

Unencapsulated Haemophilus influenzae

-less virulent

-spread along upper resp tract

- otitis media
- sinusitis
- bronchopneumonia

Haemophilus influenzae

- Can cause life threatening lower resp infxn and suppurative meningitis in children

- Vaccine has ↓ incidence
- dysregulates ciliary beating, degrades IgA

Haemophilus influenzae Pneumonia

- Can follow a viral URI-pediatric emergency
- High mortality rate
- Descending laryngotracheobronchitis → airway obstruction
    Small bronchi are plugged with dense, fibrin rich exudates with neutrophils
- Lobular, patchy consolidation

Moraxella catarrhalis

- Bacterial pneumonia commonly in the elderly
- 2nd most common bacterial cause of COPD exacerbation
- Otitis media in children

Otitis Media in Children

- S. Pneumoniae
- H. influenzae
- M. catarrhalis

Staphylococcus aureus

- 2° bacterial pneumonia in children and healthy adults post viral resp illness
- Several complications
  lung abscess, empyema
- IV drug users are at ↑ risk in association with endocarditis
- Often hospital acquired

Klebsiella pneumoniae

- Affects debilitated pts, chronic alcoholics and malnourished individuals

*thick, mucoid (blood tinged) sputum

'currant jelly sputum'

organism produces viscid capsular polysaccharide, difficult to expectorate

Pseudomonas aeruginosa

- Common cause of nosocomial in function

- Invades blood vessels to spread systemically

- Common in CF and neutropenic pts

Legionella pneumophila

- Causative agent of Legionnaire's dz and Pontiac fever
- Flourishes in artificial aquatic envirnoments
- Spreads via aerosolization
- Severe pneumnia in immunocompromised pts, especially pts who have had organ transplant
- Diagnose: *culture*, antigens in urine or antibodies in sputum

Mycoplasma pneumoniae

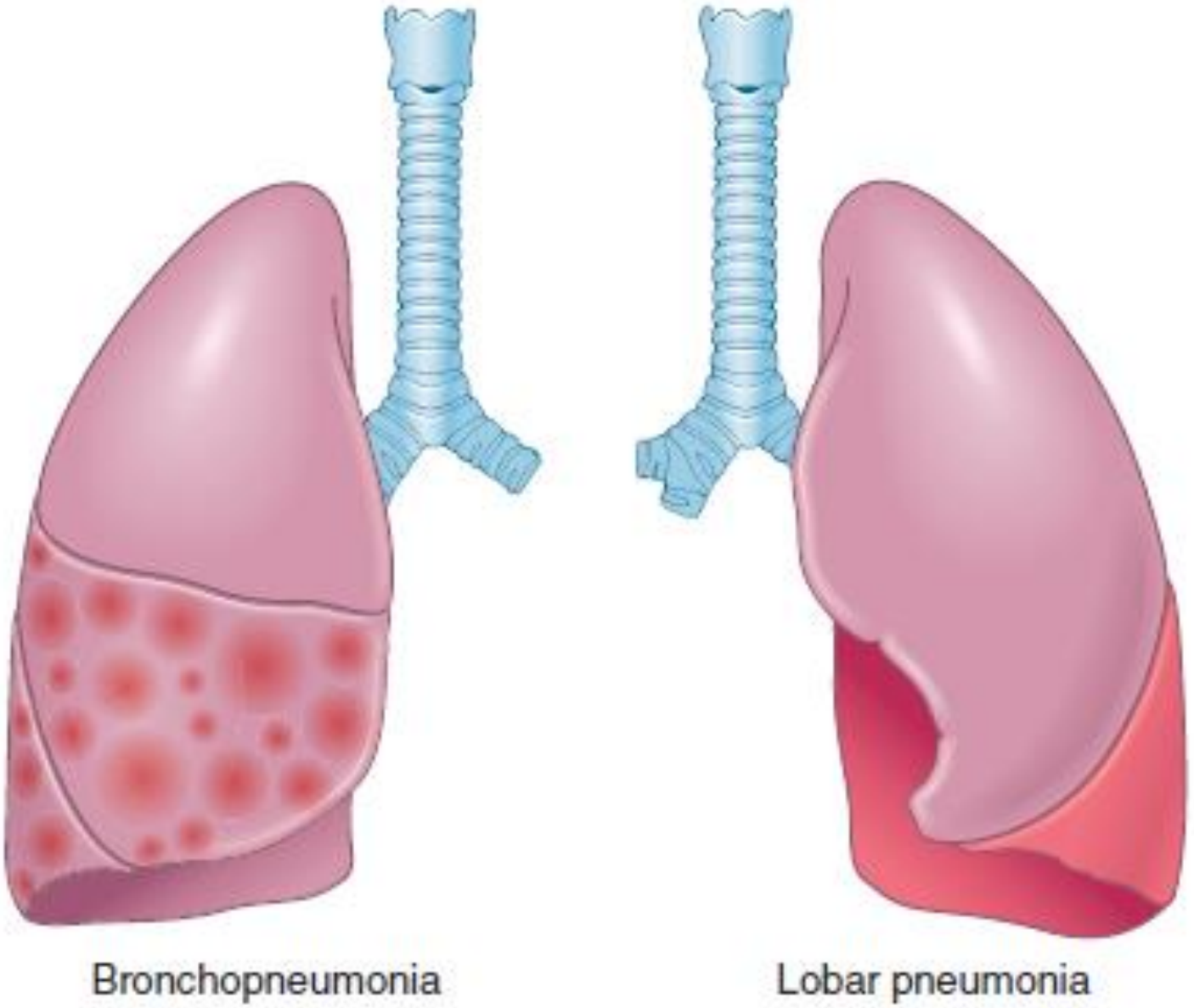
- Sporadic in fxn or as local epidemics in closed communities such as schools, military camps or prisons

- Common in children and young adults

Anatomical pneumonia

- Bronchopneumonia

- Lobar pneumonia



Bronchopneumonia

- Patchy exudative consolidation of the lung parenchyma-focal areas of palpable consolidation
- Acute neutrophilic suppurative exudation filling bronchi, bronchioles and alveoli that eventually resolves
- Usually bilateral
- Involves more than one lobe
- Area white in X-ray

Bronchopneumonia

- Gross:
  - Foci consolidation in patches throughout one or several lobes
  - Frequently bilateral or basal
  - 3 or 4 cm in diameter, slightly elevated, gray-red to yellow
  - Pleural involvement is less common
- Microscopy:
  - Focal neutrophilic suppurative exudate that fills bronchi, bronchioles, and adjacent alveolar spaces
  - Ciliated epithelium is destroyed
  - Vascular congestion

Lobar Pneumonia

- Consolidation of a large portion of a lobe or an entire lobe
- Visualized on radiograph as a lobar or segmental consolidation
- Usually unilateral

Difference

Bronchopneumonia	Lobar pneumonia
Staph., Strep., H. influenzae	95% pneumococcus (Klebsiella spp)
Patchy consolidation	Entire lobe consolidation
Around small bronchi	Diffuse
Not limited by anatomic boundaries	Limited anatomic boundaries
Bilateral	Unilateral usually
Pleural involvement less common	Pleural involvement

Bacterial Pneumonia

Bronchopneumonia

Lobar Pneumonia

Lobar Pneumonia

- 4 pathological stages of Inflammation
  1. **Stage I: Congestion**
  2. **Stage II: Red hepatization**
  3. **Stage III: Gray hepatization**
  4. **Stage IV: Resolution**

Lobar Pneumonia

- **Congestion**:
  - Gross:
    - Heavy, boggy, dark red lung
    - Abundant frothy red fluid can be from it.
  - Microscopy
    - Alveolar spaces filled with inflammatory exudates and organisms
    - Neutrophils are abundant
    - Fibrin will present

Lobar Pneumonia

Red hepatization

- **Gross:**
  - Lungs: **red, firm, and airless**
  - **Liver like consistency**
  - Affected lung tissue sink in water
- **Microscopy:**
  - Capillary engorgement
  - Alveolar spaces are packed **with neutrophils, red cells and fibrin**
  - Organisms (if present) only few

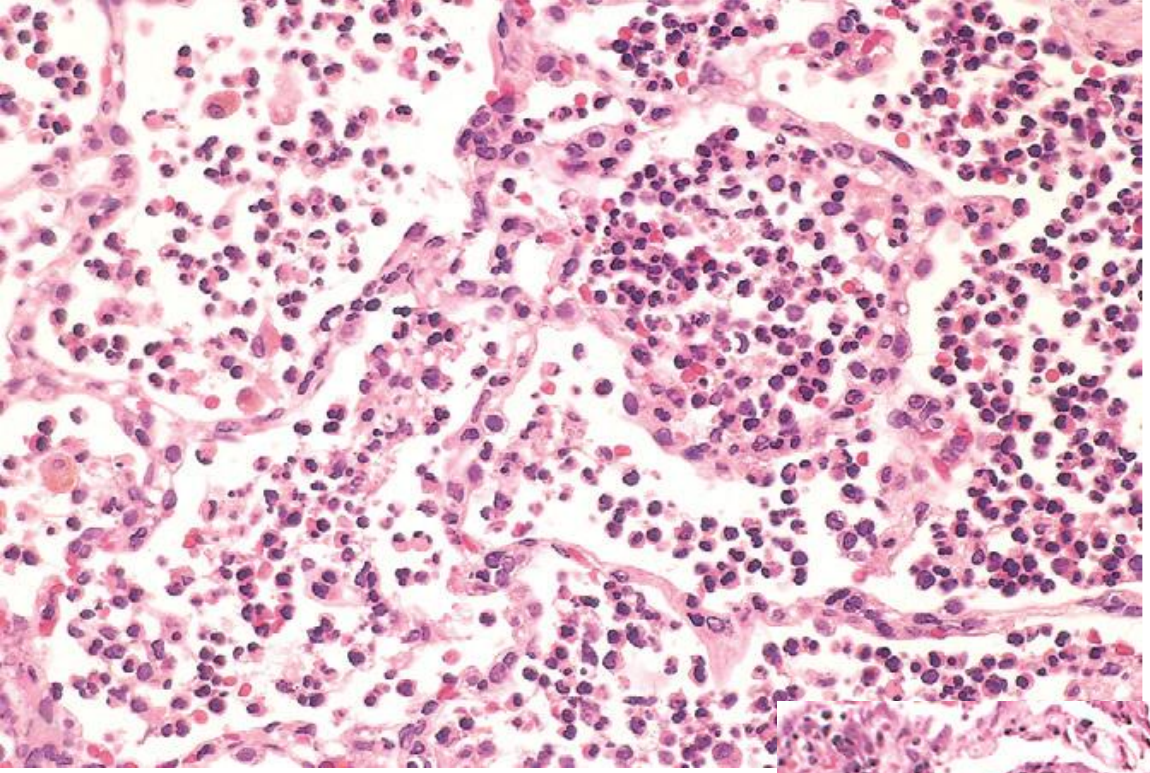
Lobar Pneumonia

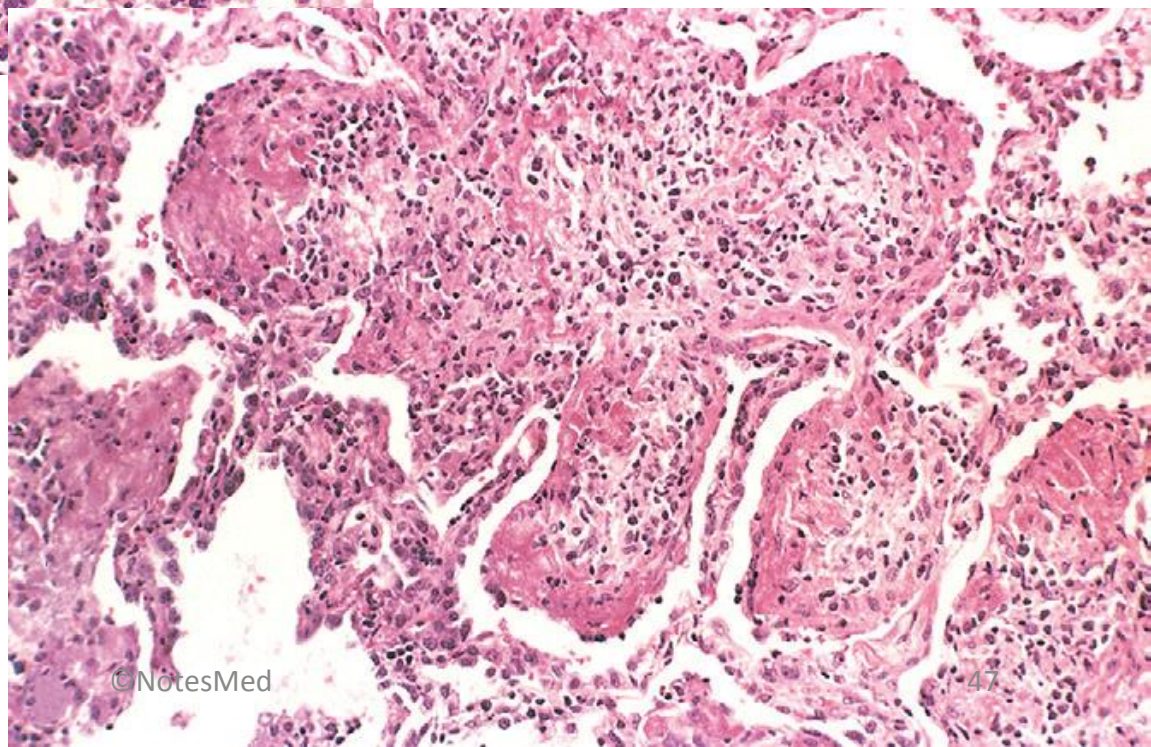
Gray hepatization

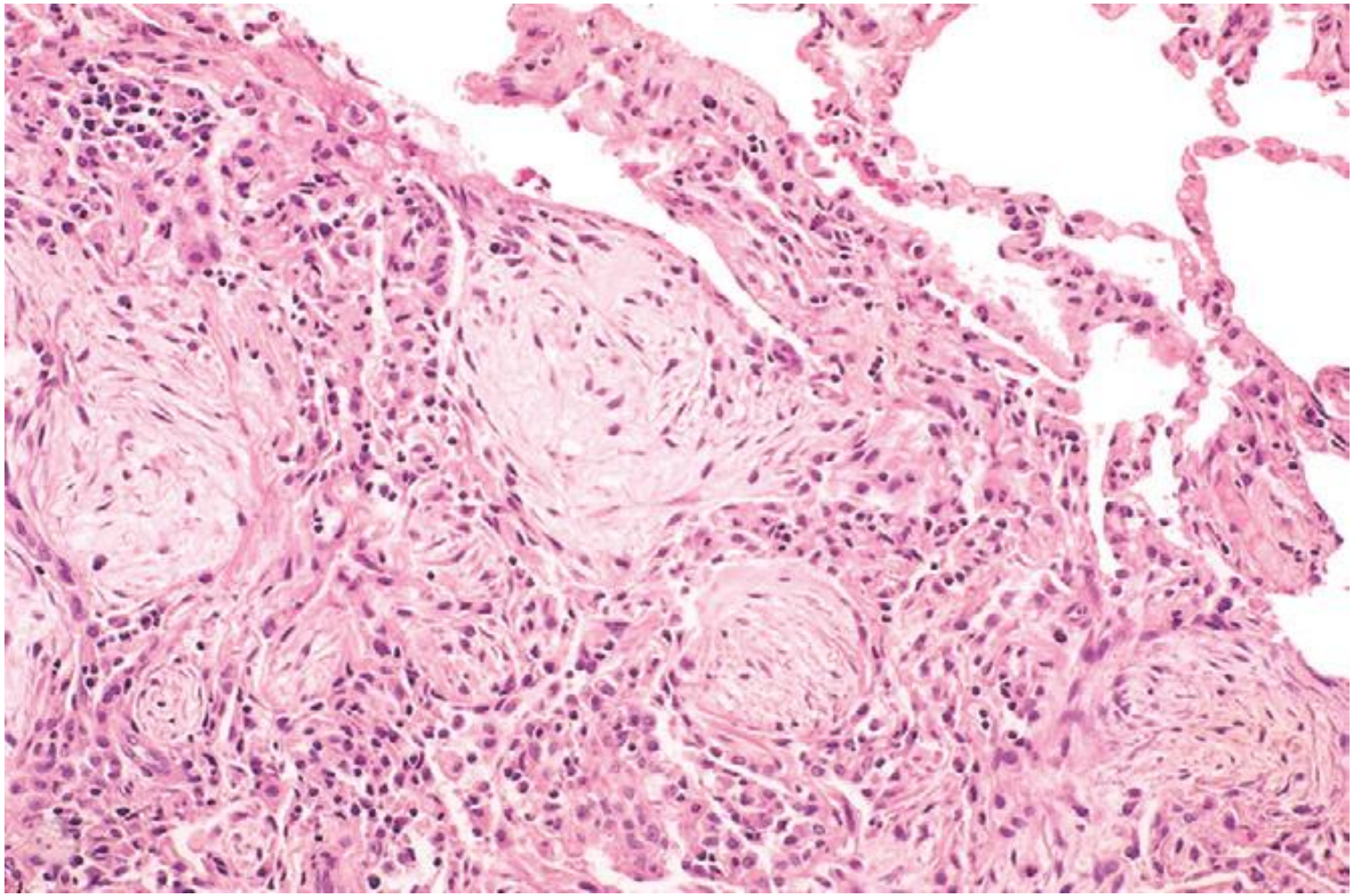
- **Gross:**
  - **Fibrinous pleurisy** will be present
  - Cut surface: **dry, granules, and gray**
- **Microscopy:**
  - Capillary engorgement resolved
  - Alveolar spaces are distended filled with dense fibrin and with dead ad dying polymorphs
  - Progressive degeneration of red cells are seen → hence **gray color**

Lobar Pneumonia

- **Resolution**
- **Gross:**
  - **Fibrinous or fibrinopurulent** pleural exudates resolve or undergo organization, leaving fibrous thickening or permanent adhesions
- **Microscopy:**
  - Capillary will be normal
  - Exudates within alveoli are
    - Enzymatically digested to produce granular, semifluid debris that is resorbed, ingested by macrophages or coughed up
    - Or organized by fibroblasts growing into it.







CA-Bacterial Pneumonia

- Most important factors to determine are the causative agent and extent of disease

CA-Bacterial Pneumonia Complications

- Abscess formation
  - d/t tissue destruction and necrosis
- Empyema
  - In fxn spreads into pleural cavity causing fibrinosuppurative rxn
- Bacteremic dissemination
  - to heart valves, pericardium, brain, kidneys, spleen, etc. causing endocarditis, meningitis, suppurative arthritis, etc.

CA Viral Pneumonia

- Attachment of organisms to epithelial cells followed by cellular necrosis and inflammation
  - alveoli- fluid transudation
  - upper airways- loss of normal mucociliary clearance can predispose to 2° infxn

CA Viral Pneumonia

- Patchy or lobar areas of congestion without consolidation (atypical)
- Interstitial pneumonitis occurs with widened, edematous alveolar walls and mononuclear inflammation
- Hyaline membranes
- Chytopathic changes may occur

- Influenza virus
- H5N1 (Avian virus)
- Human Metapneumovirus
- Severe Acute Respiratory Syndrome(SARS)

Viral Infection: Clinical Course

- Variable progression with HA, fever, muscle aches/pains in legs-few localizing s/s, and may masquerade as URI or chest colds
- Edema and exudation cause V/Q mismatch causing s/s out of proportion to scant physical findings
- Usually mild and resolve spontaneously

Viral Infection: Morphology

- URI with mucosal hyperemia + swelling + lymphocomonocytic and plasmacytic infiltration of submucosa + mucus overproductionwhich may plug sinuses or Eustachian tubes leading to suppurative 2° bacterial infection
- Lung involvement: red-blue areas with congestion
  - interstitial inflammatory reaction involving walls of the alveoli causing wide alveolar septa
  - if complicated by ARDS, pink hyaline membranes line alveolar walls

Health Care Associated Pneumonia

- Risk factors
  - recent hospitalization of 2+ days
  - presentation from a nursing home/long term facility
  - attending hospital/hemodialysis clinic
  - recent IV antibiotic therapy, chemotherapy or wound care
- *methicillin resistant *S. aureus* and *P. aeruginosa*
- ↑ mortality vs. CA pneumonia

Hospital Acquired Pneumonia

- Pulmonary infxn acquired in the course of a hospital stay-↑ risk with underlying dz, immunosuppression, prolonged antibiotic therapy, invasive access devices
  - ↑↑ risk if pt is on mechanical ventilation

- -gram (+) cocci *S. aureus* and *S. pneumonia*
- -gram (-) rods Enterobacteriaceae and *Pseudomonas* sp

Aspiration Pneumonia

- Occurs in markedly debilitated pts with abnormal gag and swallowing reflexes- pneumonia is chemical + bacterial
  - aerobes > anaerobes
- Fulminant necrotizing pneumonia
- Frequent cause of death
- Complication in survivors: lung abscess

Chronic Pneumonia

- Localized inflammation in *immunocompetent* pts +/- regional LN involvement
  - asymptomatic
  - limited granulomatous dz
- In *immunocompromised* pts the infection can become disseminated
  - fulminant, widespread dz

Lung (pulmonary) Abscess

- Local suppurative necrosis of lung tissue
- Streptococci, *S. aureus*, many gram (-) organisms
- Commonly mixed infxn due to aspiration which means many anaerobic organisms (*Bacteroides*, *Fusobacterium*, *Peptococcus* *60%)
- Other causes
  - antecendent primary lung infxn
  - septic embolism
  - neoplasia
  - miscellaneous

Lung (pulmonary) Abscess

- Single or multiple-microscopic to large cavities
- Pus + air depending on available drainage
- Chronically ay be surrounded by a reactive fibrous wall
- Complicated by extension into pleural cavity, hemorrhage, septic embolization, 2° amyloidosis
- Confirm with CXR
- Tx: antimicrobials resolve most cases with a scar

Pneumonia in the Immunocompromised Host

- Opportunistic infxns rarely affect normal hosts, but in this setting can cause life-threatening pneumonia-often multiple organisms are involved
  - bacteria: *Pseudomonas*, *Legionella*, *Listeria*, mycobacteria
  - viruses: CMV, herpes
  - fungi: *Pneymocystis*, *Candida*, *Aspergillus*

Cryptogenic organizing pneumonia

- Rare lung condition affecting the small airways (bronchioles) and alveoli (tiny air sacs)

- Previous called idiopathic bronchiolitis obliterans with organizing pneumonia (BOOP)