

# Bacterial Respiratory Tract Infections (B)

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# Mycoplasma pneumoniae

## Introduction

- Mycoplasma pneumoniae is a bacterium responsible for atypical pneumonia (also known as "walking pneumonia").
- Common cause of respiratory infections, especially in young adults.
- Polymorphic: Spherical, short rod, pear shaped.
- **Lacks Cell Wall:** No peptidoglycan, making it resistant to antibiotics like penicillin.
- Genome: Small genome with minimal biosynthetic capability.



# Mycoplasma pneumoniae

## Pathogenesis

- **Transmission:**

- Spread via respiratory droplets.
- Common in close contact environments (e.g., schools, military recruits).

- **Attachment to Host Cells:**

- Adheres to respiratory epithelial cells via specific protein (adhesin) localized at the tips of organism to attach it to the respiratory epithelium and erythrocytes. This adherence leads to:
  - Ceases of cilia Movement
  - Clearance mechanism stops → coughing

- **Immune Response:**

- Activation of macrophages & stimulation of cytokine production
- Can evade immune detection due to its pleomorphism and intracellular survival.



# Mycoplasma pneumoniae

## Clinical Features

- **Incubation Period:**

- 1-3 weeks after exposure.

- **Symptoms:**

- Gradual onset of fever, headache, malaise, and dry cough.
- May have pharyngitis, tracheobronchitis.
- Mild pneumonia; often not requiring hospitalization.

- **Complications:**

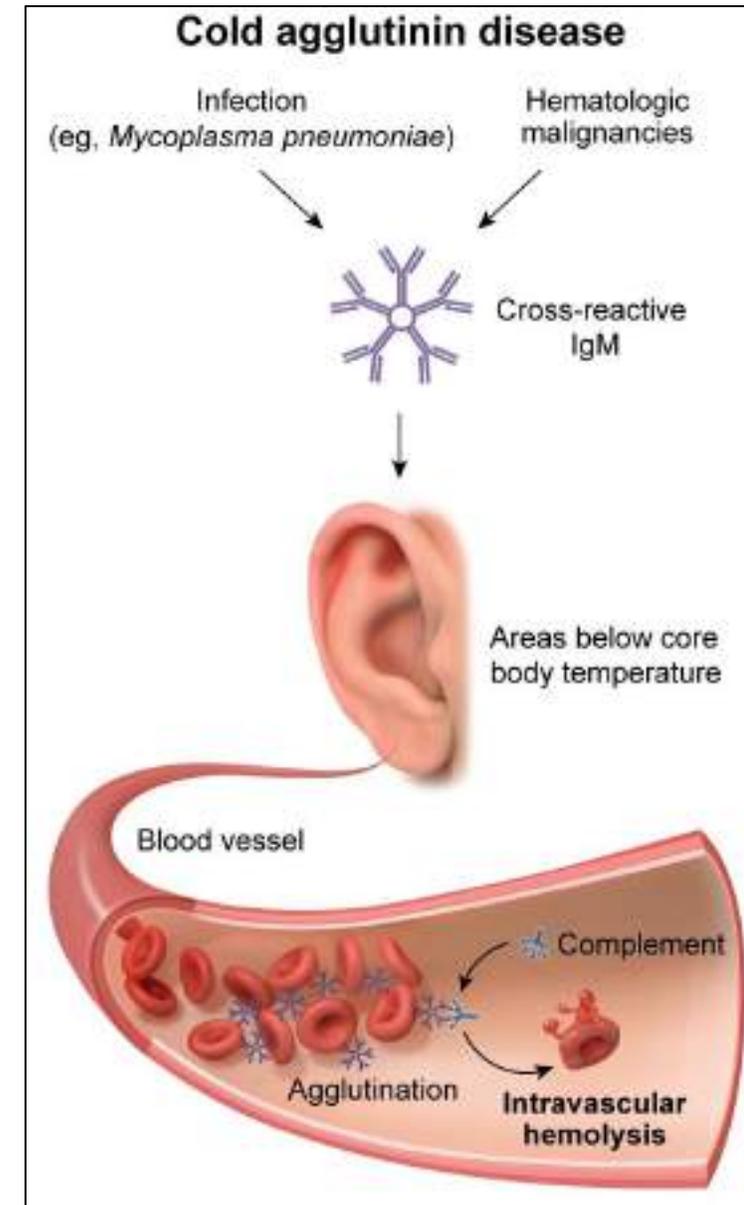
- Rare but can include skin rashes, joint pain, **hemolytic anemia**, and neurological complications (e.g., encephalitis).



# Mycoplasma pneumoniae

## Hemolytic anemia

- The pathogen attaches to the respiratory epithelium using surface antigens (**I-antigen**) that are also present on the plasma membrane of erythrocytes.
- Patients with *M pneumoniae* typically develop **cross-reactive IgM antibodies** that can attach to red blood cells, activate the complement system, and cause erythrocyte lysis. These cross-reacting antibodies are called **cold agglutinins** because they bind to erythrocytes most strongly at temperatures **below core body temperature**.
- IgM titers usually begin to fall approximately 4 weeks after initial infection leading to a resolution of the haemolytic anemia (within 8 weeks).



# Mycoplasma pneumoniae

## Diagnosis - Laboratory Diagnosis Overview

- Two Main Approaches:
  - **Direct Diagnosis:** Detecting the organism directly through microscopy or culture.
  - **Indirect Diagnosis:** Detecting the body's response (e.g., antibodies) or the organism's genetic material.



# Mycoplasma pneumoniae

## Laboratory Diagnosis - Direct Diagnosis

### 1. Microscopical Examination:

- *Mycoplasma pneumoniae* resists **Gram staining** due to the absence of a cell wall.
  - Sputum Gram stain shows numerous leukocytes but no organisms
- Giemsa staining can be used, but it's not commonly performed because the organism is difficult to visualize.

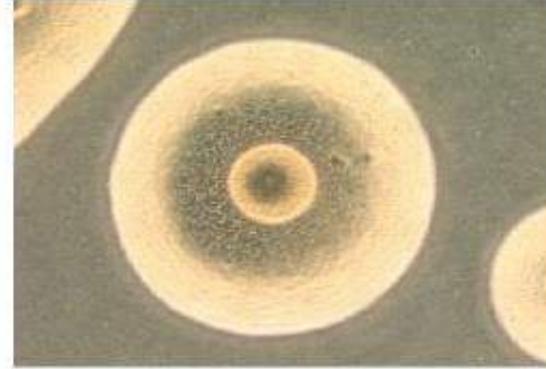
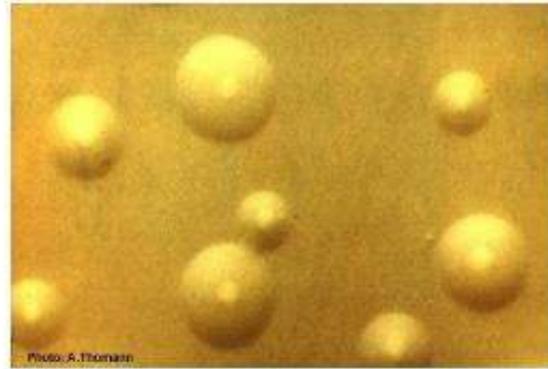
### 2. Culture:

- *Mycoplasma pneumoniae* can be cultured on special media containing cholesterol (Eaton's agar).
- Challenges of Culture:
  - It is **difficult** and **time-consuming**.
  - Cultures take **2-3 weeks** to grow.
  - Colonies have a characteristic **“fried egg” appearance** under a microscope.
- Due to these challenges, culture is rarely used in routine diagnostics.



# Mycoplasma pneumoniae

fried egg appearance



# Mycoplasma pneumoniae

## Laboratory Diagnosis - Indirect Diagnosis

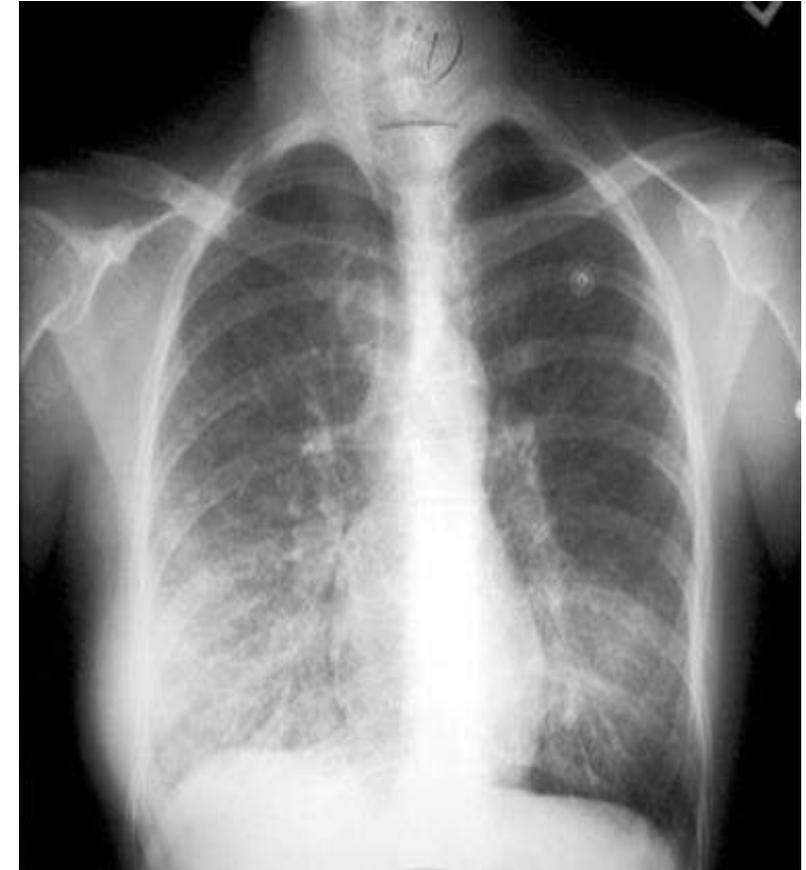
- 1. Serology:** Detecting antibodies (IgM, IgG) specific to *Mycoplasma pneumoniae*.
- 2. Cold Agglutinins Test:**
  - Detects autoantibodies that cause red blood cells to clump (agglutinate) at 4°C.
  - Present in about 50% of *Mycoplasma pneumoniae* infections, though not specific (can occur in other conditions).
- 3. Antigen Detection:**
  - Performed using immunofluorescence tests to detect specific antigens on the surface of *Mycoplasma pneumoniae*.
- 4. PCR:**
  - The most sensitive and specific method for detecting *Mycoplasma pneumoniae* DNA.
  - Useful in acute cases but not always available in all labs.



# Mycoplasma pneumoniae

## Other Diagnostic Tools

- **Chest X-ray:**
  - Shows **diffuse, patchy infiltrates** in atypical pneumonia.
  - Helps differentiate from typical pneumonia caused by organisms like *Streptococcus pneumoniae*, which shows segmental, lobar, or multilobar consolidation.



# Mycoplasma pneumoniae

## Summary of Diagnostic Techniques

Diagnostic Method	Details	Limitations
<b>Microscopical Examination</b>	Giemsa staining can visualize the organism	Rarely used, not very helpful
<b>Culture</b>	Slow growth, takes 2-3 weeks; Fried egg colonies	Time-consuming, not practical
<b>Serology (CFT/ELISA)</b>	Detects IgM or rising IgG titers	May not detect early infection
<b>Cold Agglutinins Test</b>	Detects autoantibodies that cause red blood cells to clump (agglutinate) at 4°C.	Non-specific, only positive in ~50%
<b>Antigen Detection (IF test)</b>	Detects antigens via immunofluorescence	Requires specific equipment
<b>PCR</b>	Detects bacterial DNA, highly sensitive	May not be widely available
<b>Chest X-ray</b>	Shows patchy infiltrates in lungs	Non-specific, supports diagnosis



# Mycoplasma pneumoniae

## Treatment

- Antibiotics:
  - Macrolides: (e.g., Azithromycin) are the first-line treatment.
  - Tetracyclines: (e.g., Doxycycline) used for older patients.
  - Fluoroquinolones: (e.g., Levofloxacin) can also be effective.
- **Note:** Mycoplasma pneumoniae is resistant to beta-lactams (penicillin, cephalosporins) due to the absence of a cell wall.

**So → Inhibitor of bacterial protein synthesis are used**



# Mycoplasma pneumoniae

## Complications

- **Pulmonary:** Bronchitis, exacerbation of asthma.
- **Cardiac:** Myocarditis, pericarditis (rare).
- **Neurological:** Encephalitis, Guillain-Barré syndrome.
- **Hematological:** Hemolytic anemia, thrombocytopenia.



# Mycoplasma pneumoniae

## Mycoplasma vs. Typical Pneumonia

Characteristic	Typical Pneumonia (e.g., <i>S. pneumoniae</i> )	Atypical Pneumonia (e.g., <i>Mycoplasma pneumoniae</i> )
Onset	Sudden	Gradual
Cough	Productive	Dry
Fever	High	Mild
Chest X-ray Findings	Lobar consolidation	Diffuse, patchy infiltrates
Response to Penicillin	Sensitive	Resistant



# Mycoplasma pneumoniae

## Summary

- *Mycoplasma pneumoniae* causes atypical, often mild, respiratory infections.
- The absence of a cell wall allows pleomorphism and resistance to certain antibiotics.
- Diagnosis relies on clinical symptoms, PCR, or serological tests.
- Treated primarily with macrolides and tetracyclines.





# Legionella pneumophila



# Legionella pneumophila

## Introduction

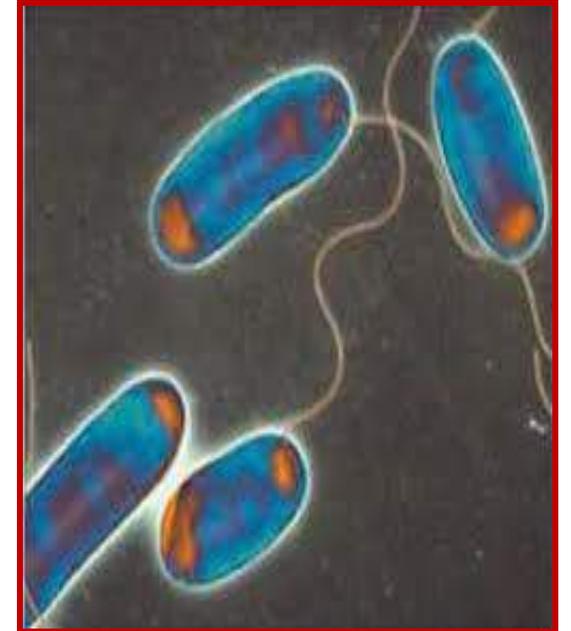
- **Definition:** Legionella pneumophila is a Gram-negative bacterium causing Legionnaires' disease.
- **Discovery:** First identified in 1976 following an outbreak at an American Legion convention.



# Legionella pneumophila

## Morphology

- Slender, pleomorphic rods.
- Gram-negative staining (thin peptidoglycan layer).
  - Stains very weakly as gram-negative → best visualized using silver stain
- Motile with a single polar flagellum.
- Facultative intracellular pathogen.

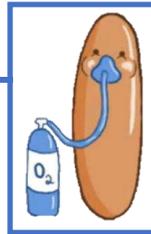


# Legionella pneumophila

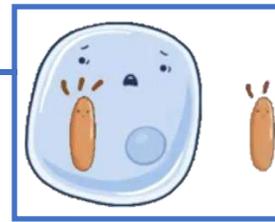
## Characteristics

- **Requires special media:** Buffered Charcoal Yeast Extract (BCYE) agar.
  - it has cysteine and iron which are required to grow the *Legionella pneumophila*
  - Colonies have a ground-glass appearance on BYCE.
- **Slow-growing:** visible colonies in 3-5 days.

• Aerobic



• Facultative intracellular



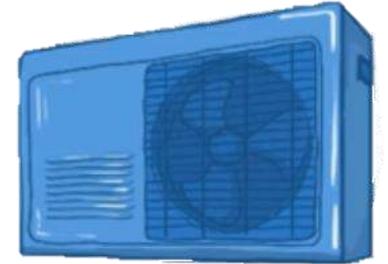
• Catalase & Oxidase +ve



# Legionella pneumophila

## Epidemiology

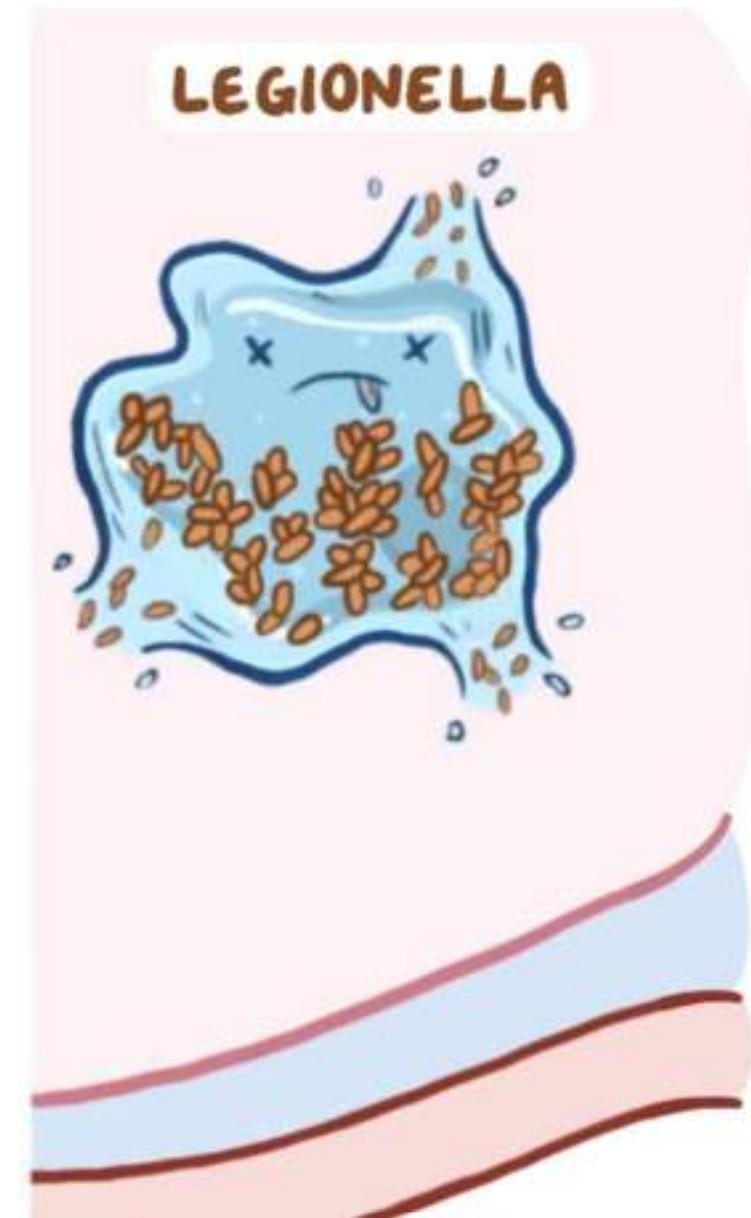
- **Reservoirs:** Man-made water systems.
  - Bacteria present in water system, slow moving / stagnant water, adequate food source, temperature range 20-50°C, aerosol formed, people present.
- **Transmission:** Inhalation of aerosolized contaminated water.
- **Risk Factors:** Age >50, smoking, chronic lung disease, immunosuppression.



# Legionella pneumophila

## Pathogenesis

1. Inhalation:
  - Aerosolized bacteria are inhaled and enter the lungs.
2. Attachment and Invasion:
  - Binds to alveolar macrophages via specific surface receptors.
  - Internalized into a phagosome, but prevents phagosome-lysosome fusion.
3. Intracellular Replication:
  - Bacteria multiply within macrophages, forming a protective vacuole.
4. Cell Lysis:
  - Infected macrophages eventually rupture, releasing bacteria and causing inflammation.
5. Immune Response:
  - Inflammatory response leads to lung damage and pneumonia.



# Legionella pneumophila

## Clinical Manifestations

- Legionella pneumophila causes legionellosis (2 forms)
  1. **Legionnaires' Disease** (named after the 1976 outbreak):
    1. Severe atypical pneumonia with high fever ( $> 39\text{ C}$ )
    2. Dry cough
    3. Dyspnea
  2. **Pontiac Fever:** Mild, flu-like illness without pneumonia (first case was recognised in Pontiac, Michigan).
- **Extrapulmonary Symptoms:** Diarrhea, **confusion**, hyponatremia.



# Legionella pneumophila

## Diagnosis

- **Laboratory Tests:**

- Culture on BCYE agar.
- Urinary antigen test (legionella polysaccharide antigen).
- Direct fluorescent antibody staining.
- PCR assays.
- Blood analysis: **Hyponatremia**, leukocytosis, and thrombocytopenia

- **Imaging:** Chest X-ray showing pneumonia (lobar infiltrate).



# Legionella pneumophila

## Treatment

- Antibiotics:
  - Macrolides (e.g., azithromycin)
  - Fluoroquinolones (e.g., levofloxacin)
- Duration: Typically, 10-14 days.
- Note: Beta-lactam antibiotics are ineffective.
- Pontiac fever → self-limiting → no treatment



# Legionella pneumophila

## Summary

<i>Legionella pneumonia</i>	
<b>Epidemiology</b>	<ul style="list-style-type: none"><li>Contaminated water<ul style="list-style-type: none"><li>Hospital</li><li>Travel (cruise, hotel)</li></ul></li></ul>
<b>Clinical features</b>	<ul style="list-style-type: none"><li>Fever &gt;39 C</li><li>Gastrointestinal: diarrhea, vomiting, cramps</li><li>Pulmonary: delayed symptoms</li></ul>
<b>Diagnosis</b>	<ul style="list-style-type: none"><li>Culture of organism on BCYE</li><li>Hyponatremia</li><li>Chest x-ray: lobar infiltrate</li><li>Sputum Gram stain: PMNs, few/no organisms</li><li>Urine <i>Legionella</i> antigen</li></ul>
<b>Treatment</b>	<ul style="list-style-type: none"><li>Respiratory fluoroquinolone or newer macrolide</li></ul>
PMNs = polymorphonuclear leukocytes.	





Thank You

