

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.
- The smallest prokaryotic organism
- 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:**

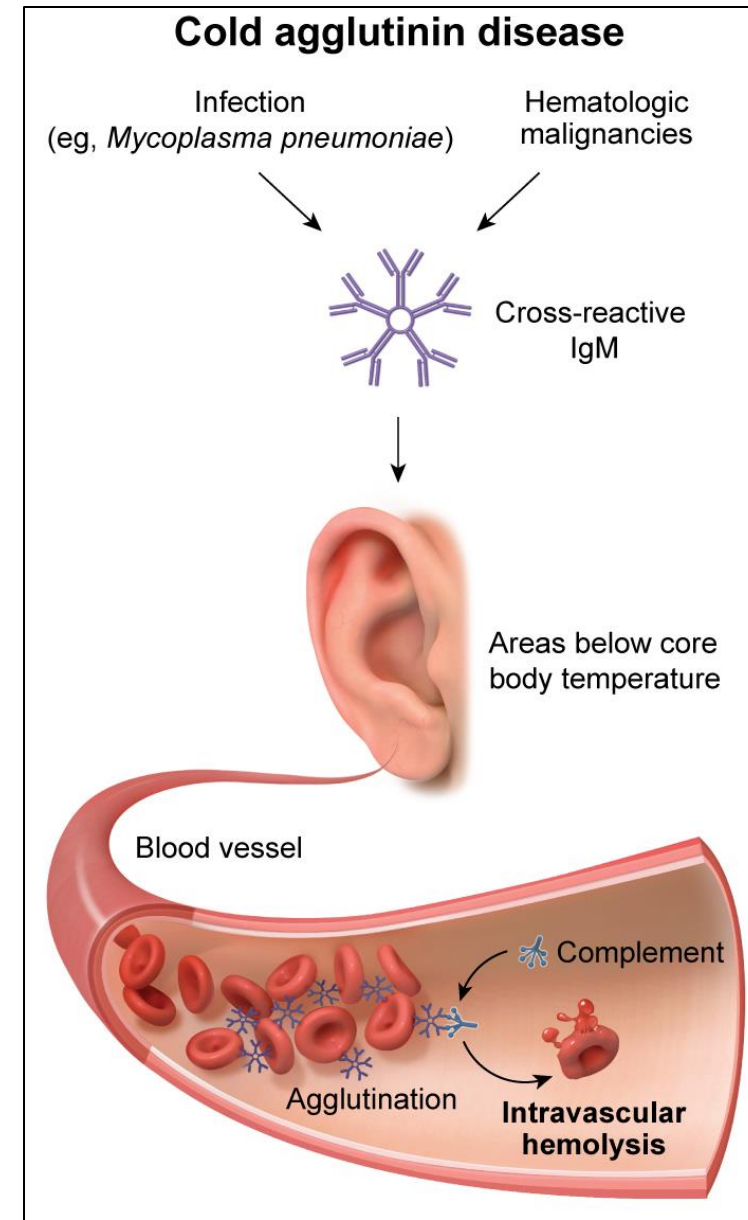
- Rare but can include skin rashes, joint pain, **hemolytic anemia**, and neurological complications (e.g., encephalitis).



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.

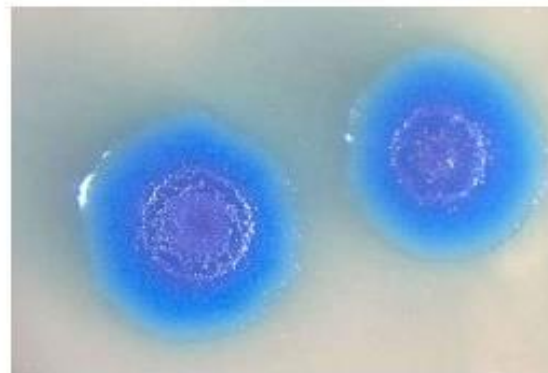
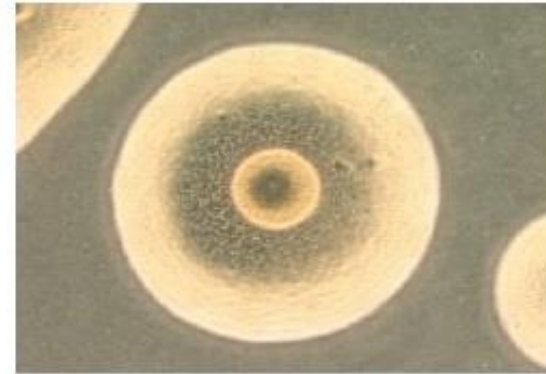
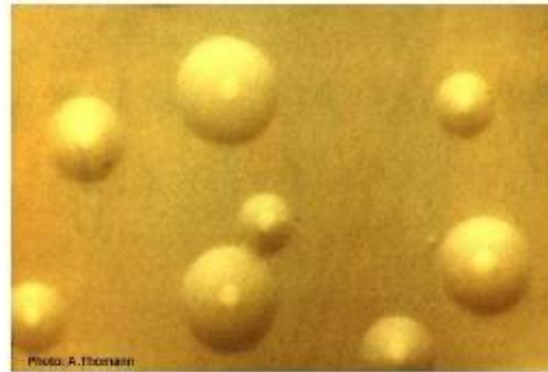
2. Culture:

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

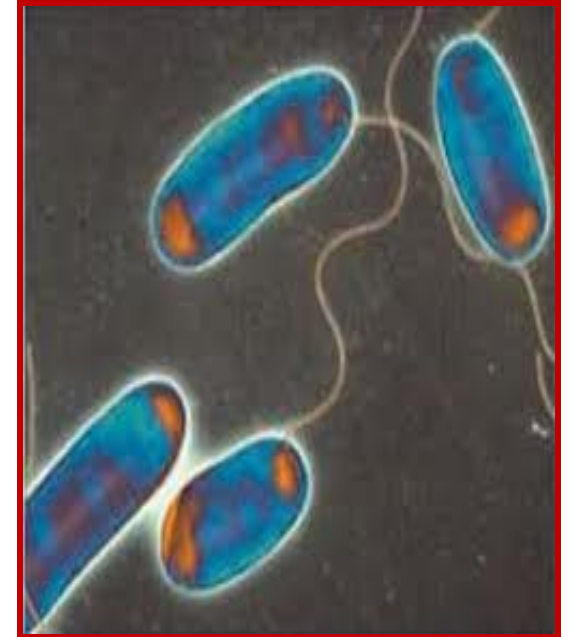
- **Definition:** Legionella pneumophila is a Gram-negative bacterium causing Legionnaires' disease.
- **Discovery:** First identified in 1976 following an outbreak at an American Legion convention.



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



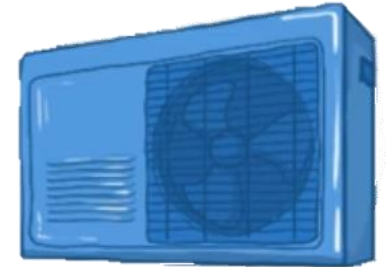
• Catalase & Oxidase +ve



Legionella pneumophila

Epidemiology

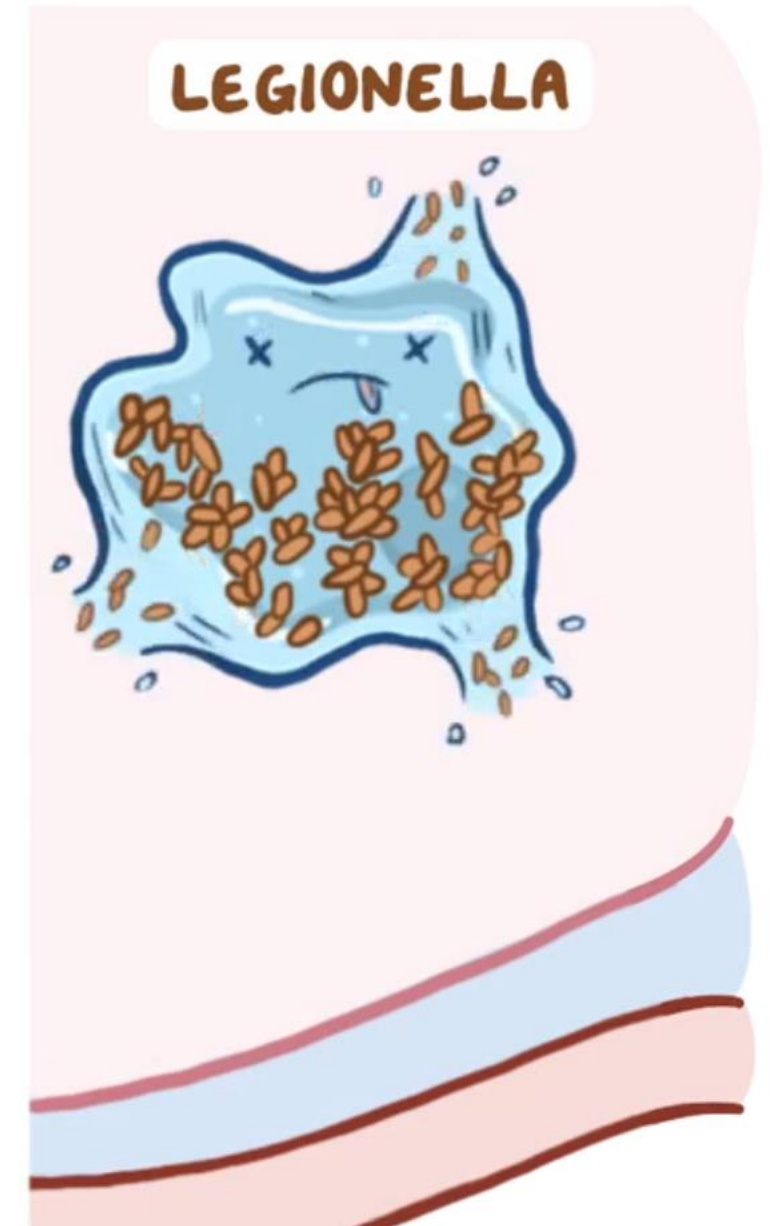
- **Reservoirs:** Natural freshwater environments, man-made water systems.
 - Bacteria present in water system, slow moving / stagnant water, adequate food source, temperature range 20-50°C, aerosol formed, people present.
- **Transmission:** Inhalation of aerosolized contaminated water.
- **Risk Factors:** 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 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>	
Epidemiology	<ul style="list-style-type: none">Contaminated water<ul style="list-style-type: none">HospitalTravel (cruise, hotel)
Clinical features	<ul style="list-style-type: none">Fever >39 CGastrointestinal: diarrhea, vomiting, crampsPulmonary: delayed symptoms
Diagnosis	<ul style="list-style-type: none">Culture of organism on BCYEHyponatremiaChest x-ray: lobar infiltrateSputum Gram stain: PMNs, few/no organismsUrine <i>Legionella</i> antigen
Treatment	<ul style="list-style-type: none">Respiratory fluoroquinolone or newer macrolide
PMNs = polymorphonuclear leukocytes.	



Thank You

