# Pseudomonas

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## 🔷 PSEUDOMONAS – Overview

### 🔷 I. Important Species & Synonyms

- Pseudomonas aeruginosa (also called Burkholderia aeruginosa)
- Pseudomonas cepacia → now Burkholderia cepacia
- Pseudomonas maltophilia → renamed Xanthomonas maltophilia → now Stenotrophomonas maltophilia
- Pseudomonas pseudomallei → now Burkholderia pseudomallei (causes *melioidosis*)

### 🔷 II. Diseases Caused

- Common in immunocompromised patients and hospital settings
- ✳️ Pneumonia (especially *ventilator-associated pneumonia* – most common cause)
- 🍩 Sepsis
- 🫧 Urinary tract infections

- 🔥 Wound infections (cellulitis in *burn patients* – blue-green pus)

- 👂 Malignant otitis externa (especially in *diabetics*)

- 🧬 Chronic lower respiratory tract infections in *cystic fibrosis* patients

  🔁 *P. aeruginosa = major pathogen; others (e.g. B. cepacia, S. maltophilia) = less frequent*

## 🔳 III. Morphology & Basic Properties

- Gram-negative rods

- Strict aerobes
  ↪ Derive energy via oxidation, not fermentation (nonfermenters)

- Oxidase-positive
  ↪ Use cytochrome c for electron transport

- Resistant to many disinfectants
  ↪ Can grow in trace nutrients (e.g., tap water, antiseptics, detergents)
  ↪ Found in hospital soaps and antiseptics (e.g., hexachlorophene)

### ◈ IV. Pigment Production (for ID purposes)

- Pyocyanin
  ↳ *Blue pigment* → can color pus blue-green in wounds
  ↳ *Unique to P. aeruginosa*

- Pyoverdin (Fluorescein)
  ↳ *Yellow-green pigment* → fluoresces under UV light
  ↳ Useful for early detection in *burn patients*

🧪 *Both pigments diffuse into agar → help ID colonies (blue-green colonies)*

### ◈ V. Slime Layer (Glycocalyx) in CF Patients

- Prominent mucoid colonies due to thick glycocalyx

- Helps adherence to mucosal surfaces (esp. respiratory tract)

- Prevents antibody binding → contributes to chronic infections

## Pseudomonas aeruginosa – Pathogenesis & Epidemiology

### ◈ Reservoir & Colonization

- Natural Habitat: Primarily found in soil and water.

- Human Carriage:

    - ~10% of individuals carry it in the colon (gut flora).
    - Found on moist areas of skin.
    - Can colonize upper respiratory tract of hospitalized patients.

- Contamination Sources:

    - Simple aqueous solutions (can grow with minimal nutrients).
    - Frequently contaminates:
        - Respiratory therapy equipment
        - Anesthesia equipment
        - Intravenous fluids
        - Even distilled water

### ◈ Nature of Pathogen

- Opportunistic pathogen — primarily infects individuals with compromised host defenses.

- Common in hospital-acquired (nosocomial) infections.

### ◈ High-Risk Populations

- Burn patients – skin barrier is disrupted.
- Cystic fibrosis patients – impaired mucociliary clearance.
- Immunosuppressed individuals
- Neutropenia – neutrophil count < 500/μL
- Patients with indwelling catheters
- Ventilated patients – major cause of ventilator-associated pneumonia (VAP)

  🧠 Remember: Causes 10–20% of all nosocomial infections.

## 🔶 Virulence Factors

### 🔑 1. Endotoxin (LPS)

- Typical of gram-negative bacteria.
- Induces sepsis and septic shock.

### 🔑 2. Exotoxin A

- Major virulence factor.
- Inhibits protein synthesis by:

- ADP-ribosylation of elongation factor-2 (EF-2)
- Same mechanism as diphtheria toxin

- Leads to tissue necrosis

### 3. Enzymes

- Elastase and Proteases:
  - Cause tissue destruction
  - Aid in bloodstream invasion

- Pyocyanin:
  - Blue-green pigment (also gives color on agar)
  - Damages respiratory cilia and mucosal cells

### 4. Type III Secretion System

- Direct injection of exotoxins into host cells (avoids antibody neutralization).

- Enhances virulence significantly.

- Mechanism: Protein transport pumps in bacterial membrane.

### Key Exoenzyme:

◈ Exo S – Most associated with virulence

◈ Action: ADP-ribosylation of Ras proteins → cytoskeletal damage

📸 Visual Clue

- Blue-green pigment on agar = Pyocyanin
- Helps visually identify *P. aeruginosa* in lab cultures.

Pseudomonas aeruginosa – Clinical Findings, Diagnosis, Treatment & Prevention

◈ A. Clinical Findings

- Common Sites of Infection:
  - Urinary tract infections (UTIs)
  - Pneumonia
    - Especially in cystic fibrosis patients
    - Also common as ventilator-associated pneumonia (VAP)
  - Wound infections, especially burn wounds
- Sepsis:
  - Can follow infection at any of the above sites
  - High mortality (>50%) if bacteremia/sepsis occurs

- Ecthyma Gangrenosum:
    - Black, necrotic skin lesions
    - Characteristic cutaneous sign of Pseudomonas septicemia
- Endocarditis:
    - Seen particularly in IV drug users
- Skin & ENT Infections:
    - Malignant otitis externa (severe external otitis)
    - Hot tub folliculitis
        - Seen in users of under-chlorinated pools/hot tubs
- Osteomyelitis of the Foot:
    - Most common cause when due to puncture wounds through gym shoes
- Ocular Infections:
    - Corneal ulcers seen in contact lens users
- Other Related Organisms in Cystic Fibrosis:

- Stenotrophomonas maltophilia
- Burkholderia cepacia
  - Both also cause chronic lung infections in CF patients

### B. Laboratory Diagnosis

- Culture Characteristics:
  - Grows as non-lactose fermenting (colorless) colonies on:
    - MacConkey agar
    - EMB agar
  - Oxidase-positive
  - Metallic sheen on Triple Sugar Iron (TSI) agar
  - Blue-green pigment (pyocyanin) on nutrient agar
  - Distinct fruity (grape-like) odor

- Definitive Identification:
  - Confirmed by biochemical tests

- Epidemiological Typing:
  - Pyocin typing or bacteriophage typing
    - *Pyocins = bacteriocins (toxin-like proteins)* produced by different strains
    - Used to differentiate between isolates

## ◈ C. Treatment

- Resistance Alert:
    - Intrinsically resistant to many antibiotics
    - Emergence of resistance during therapy is common
    - Always do culture and sensitivity
- First-line Treatment:
    - Antipseudomonal β-lactam + aminoglycoside
        - e.g. Piperacillin/tazobactam + gentamicin
        - or Ticarcillin/clavulanate + amikacin
- Other Effective Drugs:
    - Ceftazidime (3rd gen cephalosporin)
    - Ciprofloxacin → drug of choice for UTIs
- For MDR Strains:
    - Colistin (Polymyxin E) used as last resort
- Other Organisms:
    - Burkholderia cepacia & Stenotrophomonas maltophilia →

➤ Trimethoprim-sulfamethoxazole (TMP-SMX) is drug of choice

### ◈ D. Prevention

- Neutropenic Precautions:
    - Maintain neutrophil count > 500/µL
- Device Management:
    - Prompt removal of indwelling catheters
- Wound Care:
    - Meticulous care of burned skin to prevent colonization
- General Precautions:
    - Limit exposure in immunocompromised patients
    - Strict infection control protocols in hospitals