# **Pseudomonas and Other Non-Glucose-Fermenting Gram-Negative Rods**

* **aerobic Gram-negative rods that do not ferment sugars** (in contrast to Enterobacteriaceae).
* often opportunistic pathogens, many found in water, soil, or hospital environments.
* Key genera: **Pseudomonas, Burkholderia, Stenotrophomonas, Acinetobacter,** and others like *Alcaligenes, Achromobacter, Elizabethkingia,* etc.
* They are typically **oxidase positive** (with some exceptions) and metabolize sugars oxidatively if at all.

**General Traits:**

* On **TSI agar**, non-fermenters will often give an **K/K reaction** (red slant/red butt or red/ orange, as they don’t ferment glucose so butt stays alkaline or unchanged).
* Many are **oxidase positive** (purple on oxidase test), except notable ones like *Stenotrophomonas* and *Acinetobacter* which are oxidase negative.

**Pseudomonas aeruginosa:**

* **Oxidase positive**
* **motile** (single polar flagellum).
* **Characteristic pigments:** Produces **pyocyanin** (blue-green pigment) and pyoverdin (yellow-green fluorescent pigment).
* Colonies often have a metallic sheen and a **grape-like or tortilla odor**.
* Grows well at **42°C** (a distinguishing test: *P. aeruginosa* can grow at 42°C, many other non-fermenters cannot). -
* **Hemolysis:** Often β-hemolytic on blood agar.
* **Nitrate reduction:** Positive (reduces nitrate to nitrogen gas).
* On cetrimide agar (selective medium), *P. aeruginosa* will grow and produce green pigment.
* It is **arginine dihydrolase positive** (differentiating it from *Stenotrophomonas* which is negative).
* Causes a wide range of infections: wound, burn infections, malignant otitis externa, hot-tub folliculitis, ventilatorassociated pneumonia, and is notorious in cystic fibrosis lung disease.
* Identification is often straightforward with pigment, oxidase, odor, and 42°C growth tests.

**Burkholderia cepacia complex:**

* **Oxidase positive** (often weakly).
* Motile.
* Does not have the distinct pigments of Pseudomonas, though some strains produce yellow or greenish diffusible pigment.
* Selective media: PC (Pseudomonas cepacia) agar or BCSA (Burkholderia cepacia selective agar) are used especially for CF patient specimens.
* Colonies often have a dirt-like odor.
* Biochemically, *B. cepacia* is **lysine decarboxylase positive** (unusual for nonfermenters) and **oxidizes glucose and lactose** (in OF media) but is still considered nonfermentative in the sense of no acid on TSI slant.
* It is a significant pathogen in cystic fibrosis (cepacia syndrome) and is inherently resistant to many antibiotics. - Other *Burkholderia*:
  + *B. pseudomallei* (agent of melioidosis) grows wrinkled colonies, earthy odor, and is arginine dihydrolase positive, oxidase pos.
  + *B. mallei* (glanders) is non-motile.

**Stenotrophomonas maltophilia:**

* **Oxidase negative** (distinguishing it from Pseudomonas).
* Motile (polar flagella).
* Often **colonies have a lavender-green or gray color** and an ammonia-like odor.
* **Catalase positive**, **DNase positive**, **esculin positive**.
* Name “maltophilia” – it oxidizes **maltose strongly** (OF test turns yellow in open tube with maltose). - It does not grow at 42°C (unlike Pseudomonas).
* Resistant to many antibiotics except often sensitive to trimethoprim-sulfamethoxazole (the drug of choice).
* Causes opportunistic infections in immunosuppressed, especially line infections, pneumonia, etc., often in hospital environments.

**Acinetobacter species:**

* Often appear as **Gram-negative coccobacilli** (may resist decolorization and be misread as Gram-positive cocci sometimes – but they are oxidase negative, which helps).
* **Oxidase negative**, **catalase positive**.
* Non-motile (can show twitching motility).
* Two main groups: *A. baumannii* complex (glucose-oxidizing, often multidrug-resistant) and *A. lwoffii* (glucose negative, less virulent).
* On MacConkey, *Acinetobacter* can grow and sometimes has a purplish hue (but it's not fermenting lactose, it’s just utilizing peptones – can look like an “LF” to an inexperienced eye). Socalled “purple on Mac, oxidase neg” clue for Acinetobacter.
* *A. baumannii* often causes nosocomial pneumonias, bacteremias, etc., especially in ICU settings. It’s hardy on surfaces and famously drugresistant.
* Identification is by automated systems or MALDI, but a Gram-negative coccobacillus, oxidase-negative from a hospital infection, think Acinetobacter.

**Others:**

*Alcaligenes faecalis/Achromobacter*:

* oxidase positive rods
* motile (peritrichous or polar),
* often produce a fruity odor.
* *Alcaligenes* may alkalinize OF media (no acid, may even cause a blue color in OF due to peptone use).

*Elizabethkingia (Chryseobacterium) meningoseptica*:

* Oxidase positive,
* **non-motile**
* weak yellow pigment.
* It’s notable for causing neonatal meningitis outbreaks.
* indole positive (for a Gram neg rod, unusual).

*Shewanella* putrefaciens:

* A rare one that *can produce H₂S* in TSI (only nonfermenter that does so significantly).
* Oxidase positive.

*Chromobacterium violaceum*:

* Causes rare tropical infections (melioidosis-like illness).
* Fermentative rod often grouped with nonfermenters in discussion
* a distinctive **purple pigment** (violacein).
* Oxidase positive,
* motile.

*Pseudomonas stutzeri*:

* Dry
* wrinkled colonies
* oxidase positive
* Nonfluorescent
* nitrate pos.
* Notable if encountered.

*Aeromonas* and *Vibrio* are oxidase-positive fermenters (discussed separately); *Aeromonas* can sometimes be confused with Pseudomonas if you don’t realize it ferments glucose (but on TSI or in OF, Aeromonas will ferment).

**Identification Strategy for Non-Fermenters:**

1. Suspect a non-fermenter if you have a Gram-negative rod that is **oxidase positive**, fails to ferment in KIA/TSI (alkaline butt), or a culture from a moist hospital source with multi-drug resistance.
2. Do an **oxidase test**:
   1. Oxidase positive likely Pseudomonas, Burkholderia, Alcaligenes, etc.
   2. Oxidase negative think Stenotrophomonas or Acinetobacter (or an Enterobacteriaceae after all).
3. **Motility**:
   1. If oxidase neg and non-motile, *Acinetobacter* is high on list.
   2. If oxidase neg and motile, *Stenotrophomonas* likely
   3. If oxidase pos and non-motile, consider *Elizabethkingia* or a misoxidased Acinetobacter (rare).
4. Look for **pigments/odors**:
   1. Diffusible green/blue pigment and sweet odor (pyocyanin) *P. aeruginosa*.
   2. Deep purple pigment *Chromobacterium*.
   3. Yellow pigment, oxidase pos, nonmotile *Elizabethkingia*.
   4. No pigment, but ammonia smell, oxidase neg *Stenotrophomonas*.
   5. No pigment, oxidase neg, coccobacilli *Acinetobacter*.
5. Special tests:
   1. Growth at 42°C: *P. aeruginosa* (yes), *Burkholderia cepacia* (no), *Stenotrophomonas* (no).
   2. OF glucose: differentiate oxidizers vs non-utilizers. *Pseudomonas, Burkholderia, Steno* will oxidize glucose (open tube yellow, closed green). *Alcaligenes* will not (both tubes green or blue). -
   3. Lysine decarboxylase: *B. cepacia* is pos, most others neg.
   4. *Stenotrophomonas* is DNase positive (helpful, as Pseudomonas is DNase neg).
   5. Polymixin susceptibility: Pseudomonas but not Stenotrophomonas or Burkholderia

**Clinical:** Non-fermenters often cause nosocomial infections (Pseudomonas in burns and pneumonia, Stenotrophomonas in catheters, Acinetobacter in war wounds or ventilators, Burkholderia in CF patients). Correct identification guides therapy since these organisms have very different susceptibility patterns (e.g., Pseudomonas often needs antipseudomonal β-lactams or aminoglycosides; Stenotrophomonas is inherently resistant to carbapenems and needs SXT; Acinetobacter is often multidrug resistant requiring colistin, etc.). On exams, expect Pseudomonas as the classic with pyocyanin/ grape odor, and maybe Acinetobacter or Stenotrophomonas as notable oxidase-negative exceptions.