Klebsiella

The genus was originally divided into 3 main species based on biochemical reactions. Today, 7 species with demonstrated similarities in DNA homology are known. These are (1) *Klebsiella pneumoniae*, (2) *Klebsiella ozaenae*, (3) *Klebsiella rhinoscleromatis*, (4) *Klebsiella oxytoca*, (5) *Klebsiella planticola*, (6) *Klebsiella terrigena*, and (7) *Klebsiella ornithinolytica*

Klebsiella pneumoniae

General characteristics:

- *K. pneumoniae* is typically colonizes **human mucosal** surfaces of the **oropharynx** and **gastrointestinal** (GI) tract. It is recorded to be associated with **pneumonia** in the alcoholic and diabetic patient population. *K. pneumoniae* is also a well-known cause of **community-acquired** pneumonia.
- It is mostly commonly isolated **Gram-negative**, **non-motile** bacteria possesses a **polysaccharide capsule**, which **protects against phagocytosis** and antibiotics and makes the colonies **moist** and **mucoid**. has a distinctive "**yeasty**" odor.

Antigenic Structure

Members of the genus *Klebsiella* form large capsules consisting of **polysaccharides (K antigens)** covering the **somatic** (O or H) antigens and can be identified by capsular swelling tests with specific antisera.

Cultural and biochemical characteristics

Klebsiella species exhibit **mucoid** growth, large polysaccharide capsules Table 3.1 and Figure 3.1, and **lack of motility**, and they usually give **positive test** results for **lysine decarboxylase** and **citrate**. *Klebsiella*, species usually give positive **Voges-Proskauer** reactions Table 3.2.

Table 3.1 Cultural Characteristics of *Klebsiella pneumoniae* on some laboratory media

Cultural Characteristics	Nutrient Agar Medium (NAM)	MacConkey Agar medium	Blood Agar Medium	EMB Agar medium
Shape	Circular	Circular	Circular	Circular
Size	2-3 mm	2-3 mm	2-3 mm	2-3 mm
Elevation	Dome-shaped	Convex	Dome-shaped	Convex
Surface	Mucoid	Mucoid	Mucoid	Mucoid
Color	Greyish white	Pink – Red	Greyish white	Pink – Purple
Structure	Translucent–Opaque	Opaque	Translucent–Opaque	Translucent–Opaque
Hemolysis	-----	-----	γ-Hemolysis (Non-hemolytic)	-----

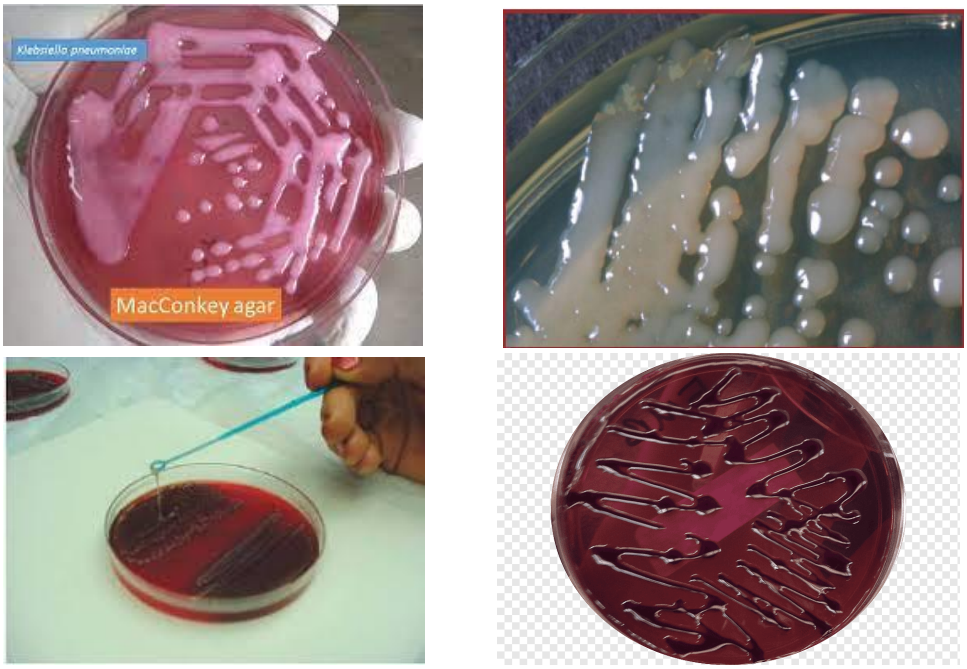


Figure 3.1 *Klebsiella pneumoniae* Growing on MacConkey, Nutrient, Blood and Eiosin Methylene Blue agar plates respectively.

Table 3.2 Biochemical tests of *Klebsiella pneumoniae*

Characteristics	*Klebsiella pneumoniae*
Capsule	+ve
Catalase	+ve
Citrate	+ve
Gelatin Hydrolysis	-ve
Gram Staining	-ve
H_2S	-ve
Indole	-ve
Motility	-ve
MR (Methyl Red)	-ve
Nitrate Reduction	+ve
Oxidase	-ve
Pigment	-ve
Shape	Rod
Spore	-ve
TSIA (Triple Sugar Iron Agar)	A/A
Urease	+ve
VP (Voges Proskauer)	+ve

Pathogenesis and Clinical Findings

Klebsiella species are present in the nasopharynx and feces of about 5% of normal individuals. The most commonly isolates species are *K. pneumoniae* and *K. oxytoca*. While *K. pneumoniae* may be isolated more frequently than *K. oxytoca* by clinical laboratories, both species are important human pathogens.

- *K. pneumoniae* can produce a **lobar pneumonia**, the production of "**currant jelly**" sputum.
- *Klebsiella* species also cause **urinary tract infections**, **wound** and **soft tissue infections**, and **bacteremia**/sepsis.
- *K. pneumoniae* has emerged as a cause of **community-acquired pyogenic liver abscess.**
- *Klebsiella* species responsible for **hospital-acquired infections**.
- *Klebsiella granulomatis* (formerly *Calymmatobacterium granulomatis*) causes a **chronic genital ulcerative disease**, and is thought to be a **sexually transmitted disease**.

Proteus, Morganella and Providencia

- Normal flora of the GI tract (except Providencia).
- Non-lactose ferment
- **All motile**, with Proteus **swarming** (Figure 3.2) motility with **peritrichous** flagella, **non-spore** forming,
- **Phenylalanine Deaminase** Test Positive (PA+**Phenylalanine Agar**)
- Lysine deamination + (LIA (**Lysine Iron Agar**) Lysine Iron Agar (LIA) is used to **differentiate** enteric bacilli based on their ability to **decarboxylate** or **deaminate** lysine and produce **hydrogen sulfide** (H_2S). LIA also is used in combination with **Triple Sugar Iron Agar** to identify members of *Salmonella* and *Shigella* R/A)
- **Urea**se production was positive for most members and it's **strongly** + for **Proteus**
- TSI variable for every genus
- Indole test positive except ***P. mirabilis*** **is -ve**

Proteus species

- *P. mirabilis* and *P. vulgaris* are widely recognized human pathogens.
- The **spot-indole test** is useful for differentiation between the two most common Proteus species: is *P. vulgaris* indole **positive**, whereas *P. mirabilis* is **negative**.
- Isolated from urine, wounds, and ear and rarely from bacteremia
- Both produce **swarming** (Rauss phenomenon) colonies on **non-selective media** and have a distinctive "**burned chocolate**" odor
- Both are **strongly urease positive**
- Both are **phenylalanine deaminase positive**

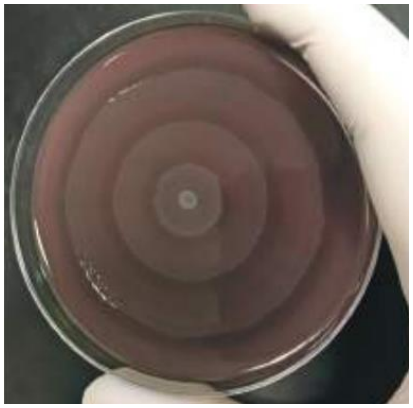


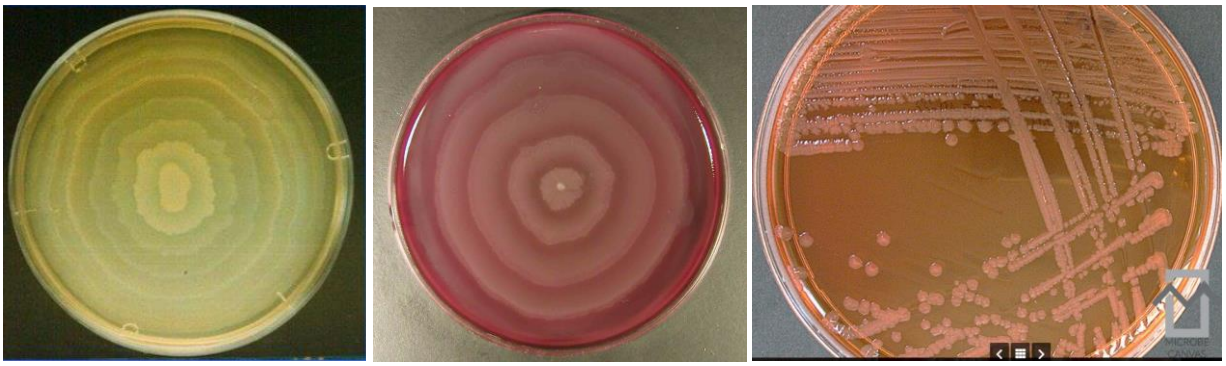
Figure 3.2 Swarming phenominon of *Proteus* species

The swarming of Proteus can be inhibited by:

- **Increasing** the concentration of **agar** from 1-2% to 6%.
- **Incorporation** of **sodium azide**, **boric acid**, or **chloral hydrate** in the medium.
- The addition of **growth inhibitors** like **sulphonamides** to the medium.
- Addition of **Teepol** (a surface-active agent), which is present in **Teepol Lactose agar** medium.

Table 3.3: Culture Characteristics of *Proteus vulgaris*

Cultural Characteristics	Nutrient Agar Medium (NAM)	MacConkey Agar medium	Blood Agar Medium	EMB Agar medium
Shape	Irregular (due to swarming)	Circular	Irregular (due to swarming)	Circular
Size	1-2 mm	2-3 mm	1-2 mm	2-3 mm
Elevation	Effuse	Low Convex	Effuse	Effuse
Surface	Glistening	Smooth	Glistening	Glistening
Color	Greyish white	Colorless or Pale colored	Greyish white	Colorless
Structure	Translucent	Transparent	Translucent – Opaque	Transparent
Hemolysis	-----	-----	γ-Hemolysis (Non-hemolytic)	-----



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Antigenic Structure

The Proteus possess **thermostable**, somatic (O), and **thermolabile** flagellar (H) antigens upon which, several serotypes have been recognized.

Pathogenicity and Pathogenesis

The two species to most commonly produce infections in humans are ***P. mirabilis*** and ***P. vulgaris***. Both species produce **urease**, resulting in rapid **hydrolysis** of **urea** with liberation of **ammonia**.

- Thus, in urinary tract infections with *Proteus* species, the urine becomes **alkaline**, promoting **stone** formation and making **acidification** virtually impossible.
- The rapid **motility** of Proteus may also contribute to its **invasion** of the urinary tract.
- *P. mirabilis* causes urinary tract infections and occasionally other infections, such as **bloodstream** infection (frequently secondary due to a UTI) and respiratory tract infections.
- *P. vulgaris* is probably more frequently implicated in **wound** and **soft tissue infections** than UTIs.

Biochemical tests and identification

Basic Characteristics	Properties (Proteus mirabilis)
Capsule	Negative (-ve)
Catalase	Positive (+ve)
Citrate	Positive (+ve)
Flagella	Positive (+ve)
Gas from Glucose	Positive (+ve)
Gelatin Hydrolysis	Positive (+ve)
Gram Staining	Negative (-ve)
H_2S	Positive (+ve)
Indole	Negative (-ve)
Motility	Positive (+ve)
MR (Methyl Red)	Positive (+ve)
Nitrate Reduction	Positive (+ve)
Oxidase	Negative (-ve)
Pigment	Negative (-ve)
Shape	Rods
Spore	Negative (-ve)
Urease	Positive (+ve)

Basic Characteristics	Properties (Proteus mirabilis)
VP (Voges Proskauer)	Negative (-ve)
Fermentation of	
Glucose	Positive (+ve)
Lactose	Negative (-ve)
Enzymatic Reactions	
Acetate Utilization	Negative (-ve)
Esculin Hydrolysis	Negative (-ve)
Lipase	Positive (+ve)
Lysine decarboxylases	Negative (-ve)
Phenylalanine Deaminase	Positive (+ve)
Tryptophan Deaminase	Negative (-ve)