CITRATE UTILIZATION

1. *Citrobacter freundii*
2. *Enterobacter aerogenes*
3. *Escherichia coli*
4. *Proteus mirabilis*
5. *Proteus vulgaris*

The reaction shown is the ionization of citric acid to the salt (citrate). The pKa of the carboxylic acid functional groups are 3.13, 4.76 and 6.40. Citric acid is ionized at physiological pH. If an organism can use citrate as the sole carbon source, the pH will increase as the organism grows and the indicator dye present will change color.
METHYL RED/VOGES PROSKAUER

METHYL RED

**MR** (Methyl Red)
Test for Mixed Acid Fermentation (not on Api strip)

Methyl Red is red below pH 4.8. The production of mixed acids causes this relatively large pH change.

1. *Citrobacter freundii*
2. *Enterobacter aerogenes*
3. *Escherichia coli*
4. *Proteus mirabilis*
5. *Proteus vulgaris*
VOGES PROSKAUER

VP (Voges-Proskauer)
Test for Butanediol

1. **Citrobacter freundii**
2. **Enterobacter aerogenes**
3. **Escherichia coli**
4. **Proteus mirabilis**
5. **Proteus vulgaris**
ACID AND GAS PRODUCTION FROM GLUCOSE AND LACTOSE

Phenol Red Lactose & Glucose Broths

(Tube growth tests for acid &/or gas production from glucose or lactose)

ACID: \[ \text{pH} \rightarrow \text{YELLOW} \]

GAS: \[
\begin{align*}
\text{Formic Acid} & \xrightarrow{\text{Formate}} \text{Formate Lyase} & \text{H}_2 + \text{CO}_2
\end{align*}
\]

Which gas do you see in the Durham tube?

GLUCOSE

LACTOSE

1. *Citrobacter freundii*
2. *Enterobacter aerogenes*
3. *Escherichia coli*
4. *Proteus mirabilis*
5. *Proteus vulgaris*
1. Citrobacter freundii
2. Enterobacter aerogenes
3. Escherichia coli
4. Proteus mirabilis
5. Proteus vulgaris

Motility of each organism is evaluated based on movement of growth away from the stab line. Motile organisms move away from the stab.
INDOLE
Indole production from tryptophan

1. Citrobacter freundii
2. Enterobacter aerogenes
3. Escherichia coli
4. Proteus mirabilis
5. Proteus vulgaris

Visualize by
RED/VIOLET color
**UREASE**

Demonstrates the presence of the enzyme urease

\[
\text{H}_2\text{N} = \text{NH}_2 + \text{H}_2\text{O} \rightarrow 2\text{NH}_3 + \text{CO}_2
\]

\[\text{pH} \uparrow\]

Color change

1. *Citrobacter freundii*
2. *Enterobacter aerogenes*
3. *Escherichia coli*
4. *Proteus mirabilis*
5. *Proteus vulgaris*