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Escherichia coli

HansN.

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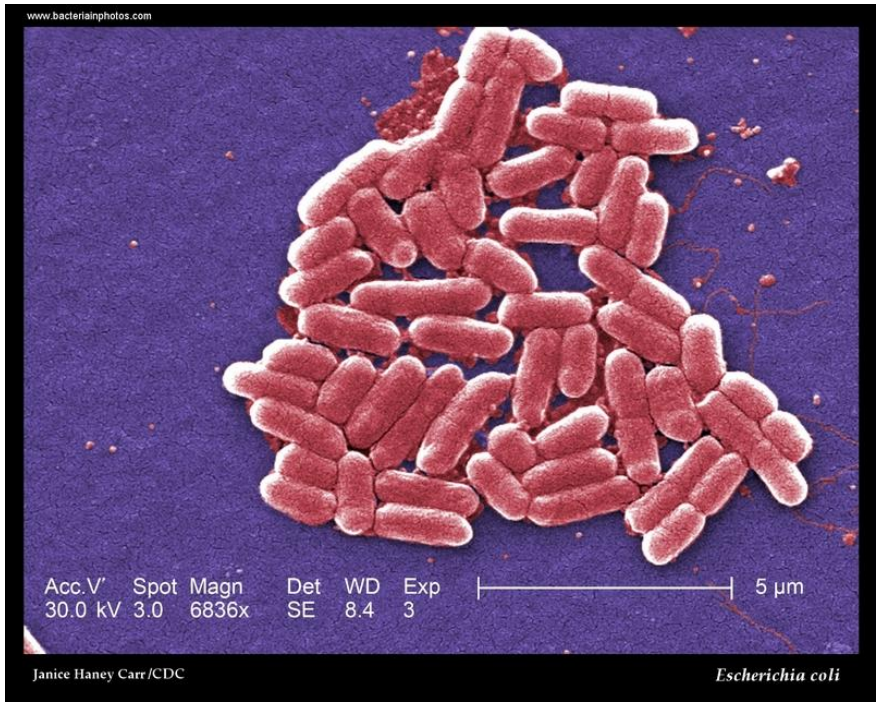
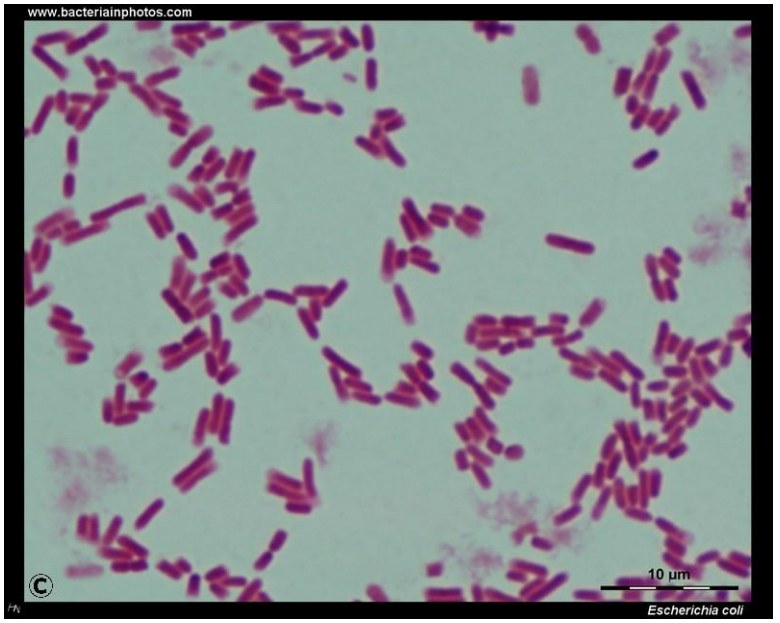
Escherichia coli (commonly abbreviated *E. coli*) is a Gram-negative, rod-shaped bacterium that is commonly found in the lower intestine of warm-blooded organisms (endotherms). Most *E. coli* strains are harmless, but some serotypes can cause serious food poisoning in humans. The harmless strains are **part of the normal flora of the gut**, and can benefit their hosts by producing vitamin K2, and by preventing the establishment of pathogenic bacteria within the intestine. *E. coli* and related bacteria constitute about 0.1% of gut flora, and **fecal-oral transmission** is the major route through which pathogenic strains of the bacterium cause disease.





Antigens of E. coli

O-ag – lipopolysaccharide, thermostable.

K-ag – polysaccharide, separate on L,A, B ag.

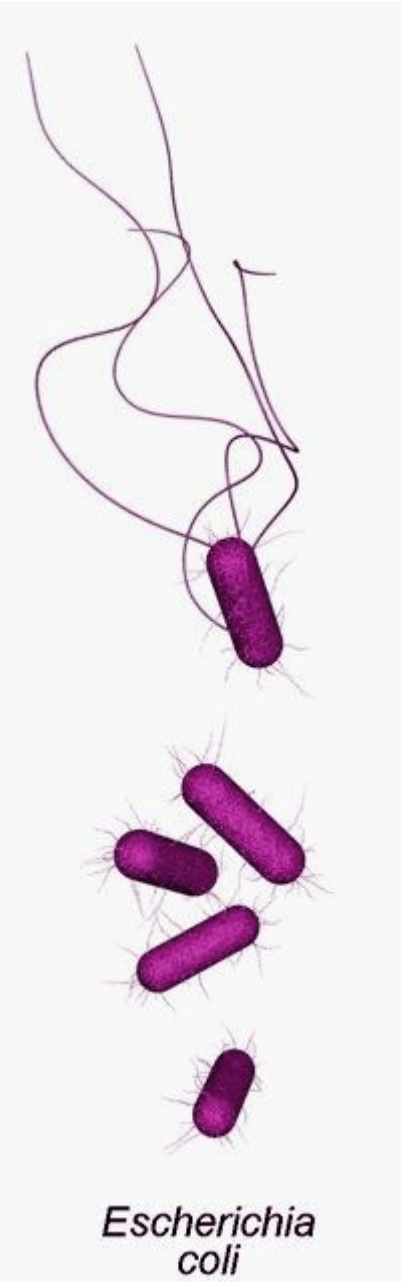
L-ag – thermostable toxin.

A-ag – thermostable (100ºC 2,5 h)

B-ag – thermostable, is contained in pathogenic stamps.

H-ag – is contained in pathogenic active thermostable stamps.

O(1-150):K(1-88):H(1-49)



Enteric *E. coli* (EC) are classified on the basis of serological characteristics and virulence properties:

Enterotoxigenic *E. coli* (ETEC)
Enteropathogenic *E. coli* (EPEC)
Enteroinvasive *E. coli* (EIEC)
Enterohemorrhagic *E. coli* (EHEC)
Enteroaggregative *E. coli* (EAEC)

Escherichia coli and Urinary Tract Infections (UTIs)

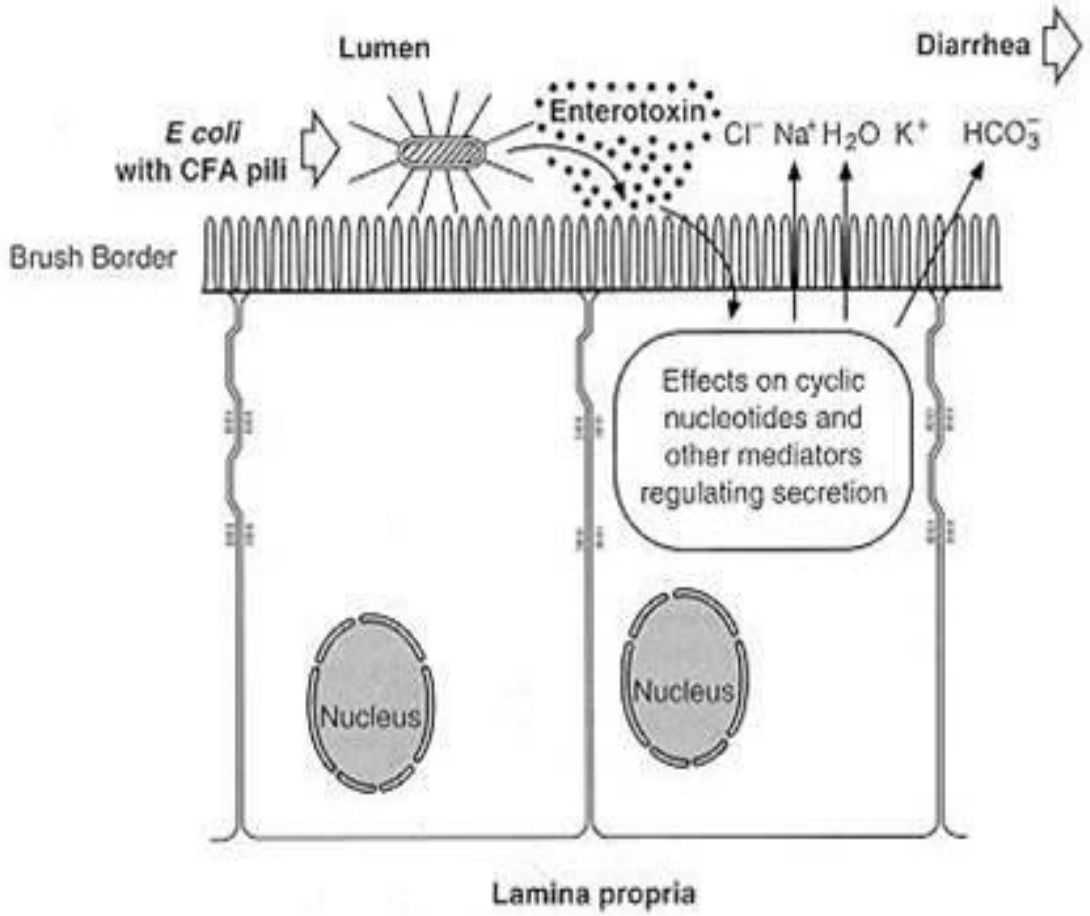
Escherichia coli and urinary tract infections are often discussed together as *E. coli* (uropathogenic *E. coli*, **UPEC**) is often indicated as the major cause of UTIs. Basically, the urinary tract comprises the parts of the body responsible for the removal of body waste and excess water, and the maintenance of electrolyte balance in the body. The urinary tract includes the kidneys, the bladder, the urethra and the ureters.

Causes of UTIs

Naturally, the urinary system is immune to infections; therefore, certain microorganisms must invade it before it can be infected. In ascending infections, fecal bacteria colonize the urethra and spread up the urinary tract to the bladder as well as to the kidneys (causing pyelonephritis), or the prostate in males. Because women have a shorter urethra than men, they are more likely to suffer from an ascending UTI.*Escherichia coli* are **the main causative bacteria of UTIs**; they are responsible for 4 out of 5 cases of the infections. Uropathogenic *E. coli* use **P fimbriae** (pyelonephritis-associated pili) to bind urinary tract endothelial cells and colonize the bladder. Uropathogenic *E. coli* often produce alpha- and beta-hemolysins, which cause lysis of urinary tract cells.

Apart from *E. coli*, other bacteria like *Pseudomonas aeruginosa*, *Staphylococcus saprophyticus*, *Neisseria gonorrhoeae*, *Klebsiella pneumoniae*, *Enterococcus faecalis*, *Proteus* spp. are also capable of causing urinary tract infections. The most common yeasts causing complicated and uncomplicated urinary tract infections are *Candida albicans* and other *Candida* species (e.g., *C.glabrata*). Rarely they may be due to viral or parasitic infections.

Enterotoxigenic E. coli



Laboratory diagnosis of Escherichiosis

1. Bacteriological method. Examine the bowel movements and vomit to identify the pathogen. The Endea, Levin environment is selective. The final answer is in 48-72 hours.

2. The serological method allows to identify specific antibodies in the blood from the 5th-7th day of the disease. Diagnostic is the growth of antibody titer in the dynamics of the disease 4 and more times.

3. Coprological method. The presence in the stool of mucus in the form of cords and lumps, and in it of leukocytes, erythrocytes, cells of the intestinal epithelium in the absence of detritus and fat masses, indicates an inflammatory process in the large intestine; the presence of a large number of undigested fiber, starch, muscle fibers, fat is observed mainly in the defeat of the small intestine.

Symptoms of UTIs

- In some cases, urinary tract infections and other *Escherichia coli* infections are often unnoticed as they show no symptoms. However, their common symptoms include:

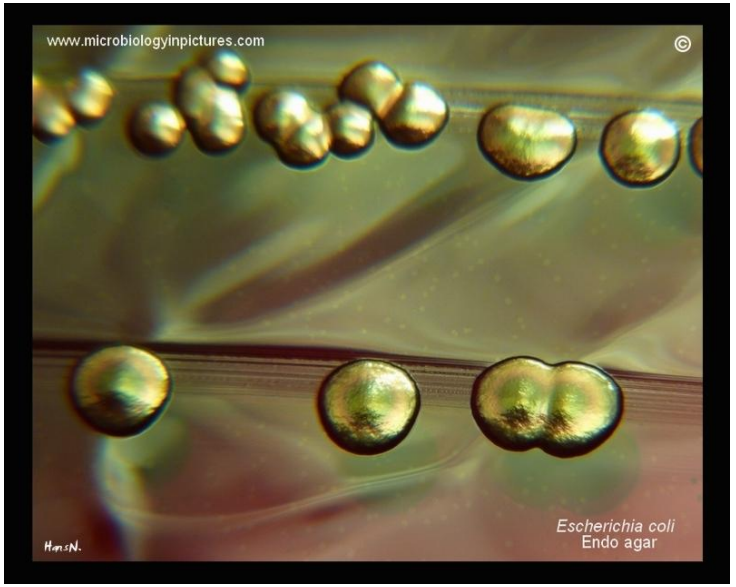
  Burning sensations during urination
- Feverish conditions
- Constant, strong urge to urinate
- In male – pain in the rectal region
- In female – pain in the pelvis
- Frequency, intense passing out of small amounts of urine
- Urine with appearances of blood and/or foul odor
- Pain around the hips, abdomen, or lower back region

Complications

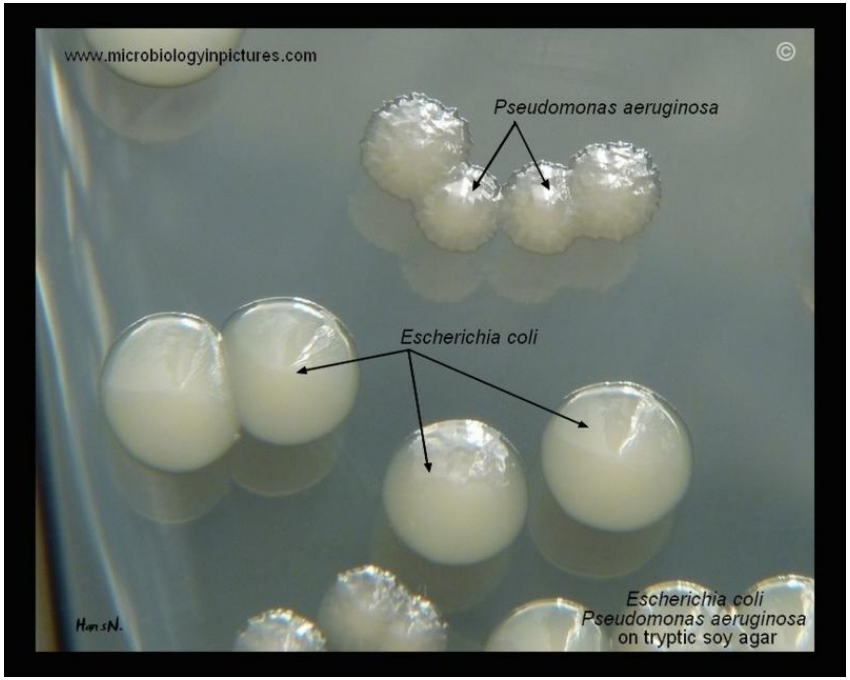
There are rarely any major complications associated with urinary tract infections. However, if the infections are left untreated for long, **chronic infections may develop** with conditions such as kidney stone, abscesses, fistulas and, in some rare cases, cancer of the bladder, **kidney damages** or death.

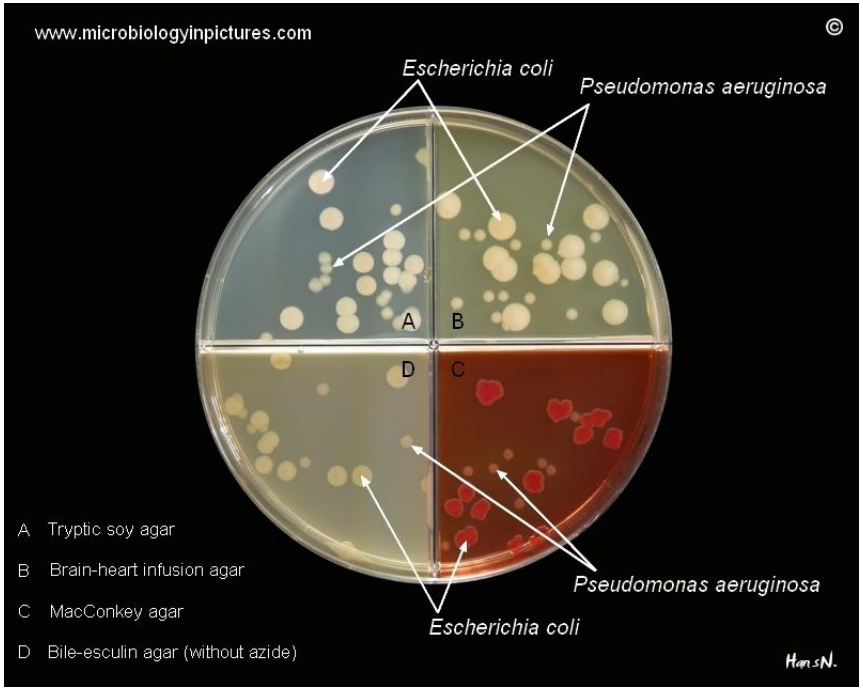
Cultural properties

Lac+



- Escherichia grows well on ordinary nutrient media at a temperature of 37 ° C and pH 7.2-7.4.
- *Escherichia coli* on Endo agar, cultivation in an aerobic atmosphere, 37°C, 24 hours. *E.coli* and some other bacteria from the family *Enterobacteriaceae* metaboliz e lactose with the production of aldehyde and acid. The aldehyde liberates fuchsin from the fuchsin-sulfite compound, the fuchsin then colors the colonies red. In the case of *Escherichia coli*, this reaction is so intense that the **fuchsin crystallizes out** giving the colonies **a greenish metallic sheen**



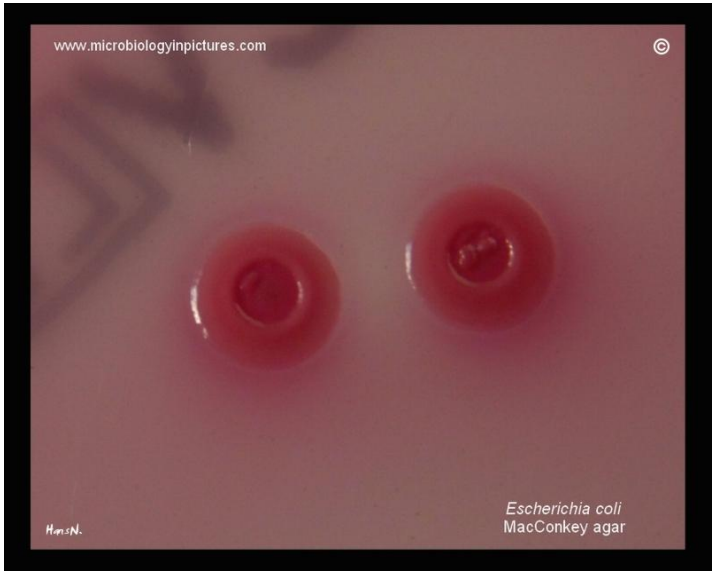


Detail of colonies of *E.coli* and *Pseudomonas aeruginosa* on tryptic soy agar (TSA).

Cultivation 24 hours, 37°C in an aerobic atmosphere.

Escherichia coli **on MacConkey agar**. There are many variations of MacConkey agar depending on the need (here MacConkey Agar, MacConkey agar contains bile salts (cholate, taurocholate) as inhibitor of the Gram-poitive flora and neutral red as acid production from lactose indicator. In the picture you can see red **lactose-positive colonies** of *E.coli* with bile precipitation around them.

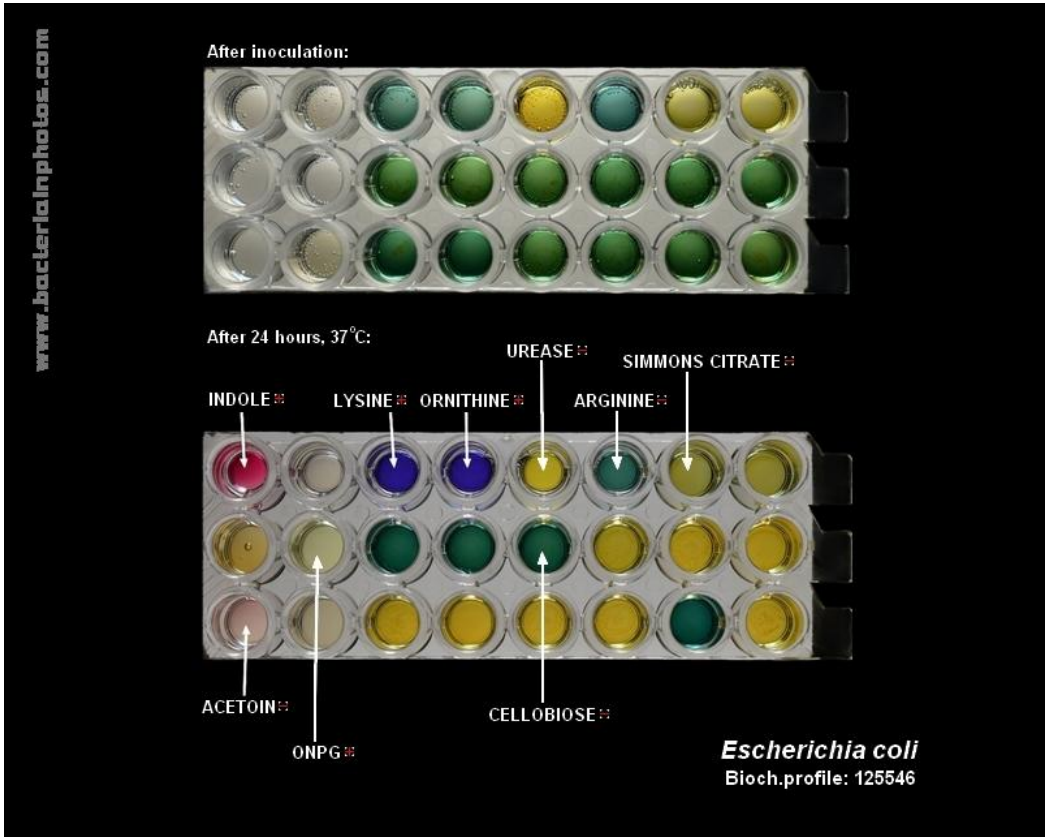
Cultivation 24 hours, 37°C in an aerobic atmosphere.



Biochemical properties

Typically positive results with *E.coli*:**Indole production**
Lysine decarboxylase
Ornithine decarboxylase (positive or negative)
ONPG
Motility

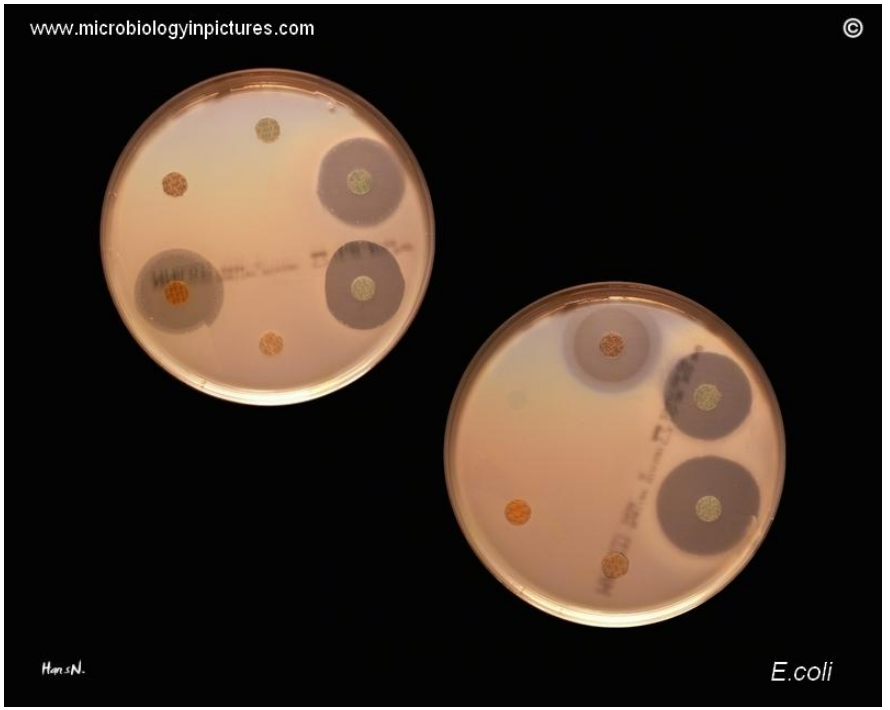
Typically negative results with *E.coli*:
Hydrogen sulfide
Urea hydrolysis
Arginine dihydrolase
Simmons citrate
Malonate utilization
Phenylalanine deaminase
Cellobiose
Voges-Proskauer test (acetoin)



E.coli sensitivity to antibiotics

Good susceptibility of *E.coli* to all tested antibiotics (Kirby-Bauer test). Tested on Mueller-Hinton agar.

Cultivation 18 hours, 37°C in an aerobic atmosphere



E.coli resistant to **quinolones** (nalidixic acid = **NA** and norfloxacin = **NOR**), **Trimethoprim-Sulfamethoxazole** (Co-trimoxazole) = **SXT**, **tetracyclines** = **TE** and **amplicillin** = **AM**. Kirby-Bauer test on Mueller-Hinton agar.

Cultivation 18 hours, 37°C in an aerobic

Treatment of Urinary Tract Infections

- The infections are generally treated with the aid of antibiotics which are substances capable of destroying bacteria and other related organisms in the body. Antibiotics can either be given orally (e.g., nitrofurantoin) or intravenously based on the severity of the infections. They are given orally if the infections are still at their mild state, while they would be given via the vein (intravenous mode) in severe cases.

Preventions of Urinary Tract Infections

- Urinary tract infections can be prevented through:Avoidance of contraceptive devices with spermicidal productsTaking of enough fluids, especially waterEnsuring of proper hygiene, especially around the genitals when urinating or after sexPrevention of *E. coli* spread through keeping raw food clean, preventing contamination of cooking utensils, proper washing of foods, avoiding raw milk etc.

Antibiotic treatment of *Escherichia coli* infections

- Should be always guided by in vitro susceptibility tests!!
- Selection of appropriate antibiotics depends on diagnosis!!
- **IF SUSCEPTIBLE:**
  - Cephalosporins I, II, III (e.g., ceftriaxone)
  - Ampicillin
  - Aminoglycosides
  - Trimethoprim-sulfamethoxazole
  - Doxycycline
  - Nitrofurantoin
  - **ALTERNATIVES:**Quinolones (e.g., norfloxacin, ofloxacin, ciprofloxacin)
  - Imipenem
  - Meropenem
  - AMP + GEN