

# Gastrointestinal gram negative Rods

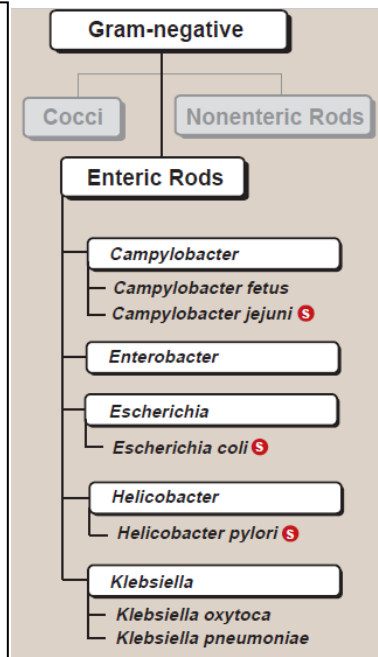
Different enteric gram-negative rods cause diseases within the GI tract, outside the GI tract, or in both locations:

Diseases caused by members of the genera *Escherichia*, *Salmonella*, *Yersinia*, and *Campylobacter* can be both GI and extraintestinal

Those caused by members of the genera *Shigella*, *Helicobacter*, and *Vibrio* are primarily GI

Those caused by members of the genera *Enterobacter*, *Klebsiella*, *Serratia*, and *Proteus* are primarily extraintestinal.

Fecal contamination is commonly important in the transmission of those organisms that cause GI diseases.



## ***ESCHERICHIA COLI***

*Escherichia coli* is part of the normal flora of the colon in humans and other animals but can be pathogenic both within and outside of the GI tract.

The differences in the degree of virulence of various *E. coli* strains is correlated with the acquisition of plasmids, integrated prophages, and pathogenicity islands.

*E. coli* has fimbriae or pili that are important for adherence to host mucosal surfaces, and different strains of the organism may be motile or nonmotile.

Most strains can ferment lactose (that is, they are Lac+) in contrast to the major intestinal pathogens, *Salmonella* and *Shigella* which cannot ferment lactose (that is, they are Lac -).

*E. coli* produces both acid and gas during fermentation of carbohydrates.

Facultative anaerobes, oxidase negative.

Typing strains is based on differences in three structural antigens: O, H, and K.

### **Clinical significance: intestinal disease**

Transmission of intestinal disease is commonly by the fecal–oral route, with contaminated food and water serving as vehicles for transmission.

At least five types of intestinal infections that differ in pathogenic mechanisms have been identified.

**Enterotoxigenic *E. coli*:** ETEC are a common cause of traveler's diarrhea. ETEC colonize the small intestine (pili facilitate the binding of the organism to the intestinal mucosa). And produces enterotoxins which include a heat-stable toxin (ST) and heat-

labile toxin (LT). In a process mediated by enterotoxins, ETEC cause prolonged hypersecretion of chloride

ions and water by the intestinal mucosal cells, while inhibiting the reabsorption of sodium. The gut becomes full of fluid, resulting in significant watery diarrhea that continues over a period of several days.

**Enteropathogenic E. coli:** EPEC are an important cause of diarrhea in infants, especially in locations with poor sanitation. The newborn becomes infected perinatally. The EPEC attach to mucosal cells in the small intestine by use of bundle-forming pili (BfpA). Characteristic lesions in the small intestine called attaching and effacing lesions (A/E) in addition to destruction of the microvilli, are caused by injection of effector proteins into the host cell by way of a type III secretion system (T3SS).

**Enterohemorrhagic E. coli:** EHEC bind to cells in the large intestine via BfpA and, similar to EPEC, produce A/E lesions. However, in addition, EHEC produce one of two exotoxins (Shiga-like toxins 1 or 2), resulting in a severe form of copious, bloody diarrhea (hemorrhagic colitis) in the absence of mucosal invasion or inflammation. Serotype O157:H7 is the most common strain of E. coli that produce Shiga-like toxins.

**Enteroinvasive E. coli:** EIEC cause a dysentery-like syndrome with fever and bloody stools. Plasmid-encoded virulence factors are nearly identical to those of Shigella species. These virulence factors allow the invasion of epithelial cells (Ipa) and intercellular spread by use of actin-based motility. In addition, EIEC strains produce a hemolysin (HlyA).

**Enteragggregative E. coli:** EAEC also cause traveler's diarrhea and persistent diarrhea in young children. Adherence to the small intestine is mediated by aggregative adherence fimbriae. The adherent rods resemble stacked bricks and result in shortening of microvilli. EAEC strains produce a heat-stable toxin that is plasmid encoded.

### **Clinical significance: extraintestinal disease**

**Urinary tract infection:** E. coli is the most common cause of urinary tract infection (UTI), including cystitis and pyelonephritis.

Uncomplicated cystitis is caused by uropathogenic strains of E. coli, characterized by P fimbriae (an adherence factor) and, commonly, hemolysin, colicin V, and resistance to the bactericidal activity of serum complement.

**Neonatal meningitis:** E. coli is a major cause of this disease occurring within the first month of life. The K1 capsular antigen, which is chemically identical to the polysaccharide capsule of group B Neisseria meningitidis, is particularly associated with such infections.

**Nosocomial (hospital-acquired) infections:** These include sepsis/ bacteremia, endotoxic shock, and pneumonia.

### **Laboratory identification**

**1. Intestinal disease:** Because E. coli is normally part of the intestinal flora, detection in stool cultures of disease-causing strains is generally difficult. EIEC strains often do not ferment lactose and may be detected on media such as MacConkey agar.

EHEC, unlike most other strains of *E. coli*, ferment sorbitol slowly, if at all, and may be detected on MacConkey sorbitol agar.

Current molecular techniques, such as polymerase chain reaction, may be employed to identify *E. coli* strains producing Shiga-like toxins.

**2. Extraintestinal disease:** Isolation of *E. coli* from normally sterile body sites (for example, the bladder or cerebrospinal fluid) is diagnostically significant. Specimens may be cultured on MacConkey.

### **Prevention and treatment**

Intestinal disease can best be prevented by care in selection, preparation, and consumption of food and water. Maintenance of fluid and electrolyte balance is of primary importance in treatment. Antibiotics may shorten duration of symptoms, but resistance is nevertheless

widespread. Extraintestinal diseases require antibiotic treatment. Antibiotic sensitivity testing of isolates is necessary to determine the appropriate choice of drugs.

## **SALMONELLA**

Members of the genus *Salmonella* can cause a variety of diseases, including gastroenteritis and enteric (typhoid) fever.

Although *Salmonella* classification has undergone numerous revisions, currently, all strains affecting humans are grouped in a single species, *Salmonella enteritidis*, which has approximately 2,500 different serotypes, or serovars, including the clinically significant serotypes Typhimurium and Typhi. Most strains of *Salmonella* are Lac- and produce acid and gas during fermentation of glucose. They also produce H<sub>2</sub>S from sulfur-containing amino acids.

### **Pathogenesis**

*Salmonella* invade epithelial cells of the small intestine. Disease may remain localized or become systemic, sometimes with disseminated foci. The organisms are facultative, intracellular parasites that survive in phagocytic cells. (steps in pathogenesis as illustrated in the figure)

### **Clinical significance**

*Salmonella* infection can cause both intestinal and extraintestinal diseases.

**1. Gastroenteritis:** This localized disease (also called salmonellosis) is caused primarily by serovars Enteritidis and Typhimurium.

Salmonellosis is characterized by nausea, vomiting, and diarrhea (usually nonbloody), which develop generally within 48 hours of ingesting contaminated food or water.

Fever and abdominal cramping are common.

In uncompromised patients, disease is generally self-limiting (48 to 72 hours), although convalescent carriage of organisms may persist for a month or more.

**2. Enteric or typhoid fever:** This is a severe, life threatening systemic illness, characterized by fever and, frequently, abdominal symptoms. It is caused primarily by serovar Typhi.

About 30 percent of patients have a faint and evanescent (transient) maculopapular rash on the trunk (rose spots). The incubation period varies from 5 to 21 days.

Untreated, mortality is approximately 15 percent.

### **Laboratory identification**

In patients with diarrhea, *Salmonella* can typically be isolated from stools on MacConkey agar or selective media.

For patients with enteric fever, appropriate specimens include blood, bone marrow, urine, stool, and tissue from typical rose spots (if they are present).

## Prevention

Two different vaccines are available to prevent typhoid fever:

One vaccine is delivered orally and consists of live attenuated *Salmonella* serovar Typhi.

The other vaccine consists of the Vi capsular polysaccharide and is delivered parenterally.

Vaccination is recommended for people who travel from developed countries to endemic areas including Asia, Africa, and Latin America.

