

# Gastrointestinal Infections

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# Gastrointestinal tract infection

- Infections with a variety of agents can occur in any part of the gastrointestinal tract.
- Infections can range in severity from self-limited to life-threatening, particularly if infection spreads from the gut to other parts of the body.
- Infections are typically caused by the ingestion of exogenous pathogens in sufficient quantities to evade host defenses and then cause disease by multiplication, toxin production, or invasion through the gastrointestinal mucosa to reach the bloodstream and other tissues. In other cases, members of the normal flora of the GI tract can cause disease.

# Diarrhea

- Diarrhea is defined by the World Health Organization as having 3 or more loose or liquid stools per day, or as having more stools than is normal for that person.
- People of all ages can get diarrhea, but it is more common in children below five years of age.
- Diarrhea is usually a symptom of an infection in the intestinal tract, which can be caused by a variety of bacterial, viral and parasitic organisms.

# Evaluation

Stool culture should be obtained from all patients with

- Severe diarrhea (passage > 6 unformed stools per day)
- Diarrhea of any severity that persists for longer than a week
- Fever
- Dysentery
- Multiple cases of illness that suggest an outbreak

Stool cultures are not routine in most cases of watery diarrhea or traveler's diarrhea because of the low yield of bacterial pathogens.

## The main genera inducing bacterial diarrhea are:

- *Escherichia coli*
- *Shigellae*
- *Salmonellae*
- *Campylobacter*
- *Vibrio cholera*
- *Clostridium difficile*

# ***Escherichia coli***

## **Important properties:**

- It is the most abundant facultative anaerobe in the colon and feces.
- Ferments lactose, a property that distinguishes it from the two major intestinal pathogens, *Shigella* and *Salmonella*.
- Has three antigens that are used to identify the organism, O, H, and the K antigen.
- There are more than 150 O, 50 H, and 90 K antigens, the various combinations result in more than 1000 antigenic types of *E. coli*.

# *Escherichia coli*

## Pathogenesis:

- The source of the *E. coli* that causes traveler's diarrhea is acquired by ingestion of food or water contaminated with human feces.
- The main reservoir of enterohemorrhagic *E. coli* O157 is cattle and the organism is acquired in undercooked beef, for example, hamburgers.
- *Escherichia coli* has several clearly identified components that contribute to its ability to cause disease: pili, a capsule, endotoxin, and three exotoxins (enterotoxins), two that cause watery diarrhea and one that causes bloody diarrhea.

## ***E. coli*–associated diarrheal diseases**

*E.coli* that cause diarrhea are extremely common worldwide. The strains causing gastroenteritis or enteritis can be grouped according to clinical presentation: **the most common are:**

- 1. Enterotoxigenic *E. coli* (ETEC)**, associated with chronic, persistent diarrhea and possibly a common cause of diarrhea in infants, young toddlers, and adults.



## ***E. coli*–associated diarrheal diseases**

- 2. Enteropathogenic *E. coli* (EPEC)**, the cause of infantile diarrhea worldwide that results in fever, vomiting, and watery diarrhea.
- 3. Enteroinvasive *E. coli* (EIEC)**, the *E. coli* type (pathovar) that is closely related to *Shigella* and that causes symptoms ranging from a mild form of diarrhea to a dysentery-like disease.
- 4. Enteroaggregative *E. coli* (EAEC)**, a cause of persistent, non-bloody watery diarrhea, which is implicated in traveler's diarrhea in the developed world

## ***E. coli–associated diarrheal diseases***

**5. Shiga toxin-producing *E. coli* (STEC) O157/enterohemorrhagic *E. coli* (EHEC) and non-O157**, a cause of hemorrhagic colitis which is implicated in hemolytic-uremic syndrome (HUS).

**6- Diffusely adherent *E. coli* (DAEC):** cause watery diarrhea and dysentery similar to that caused by EPEC but different in mechanism of induction

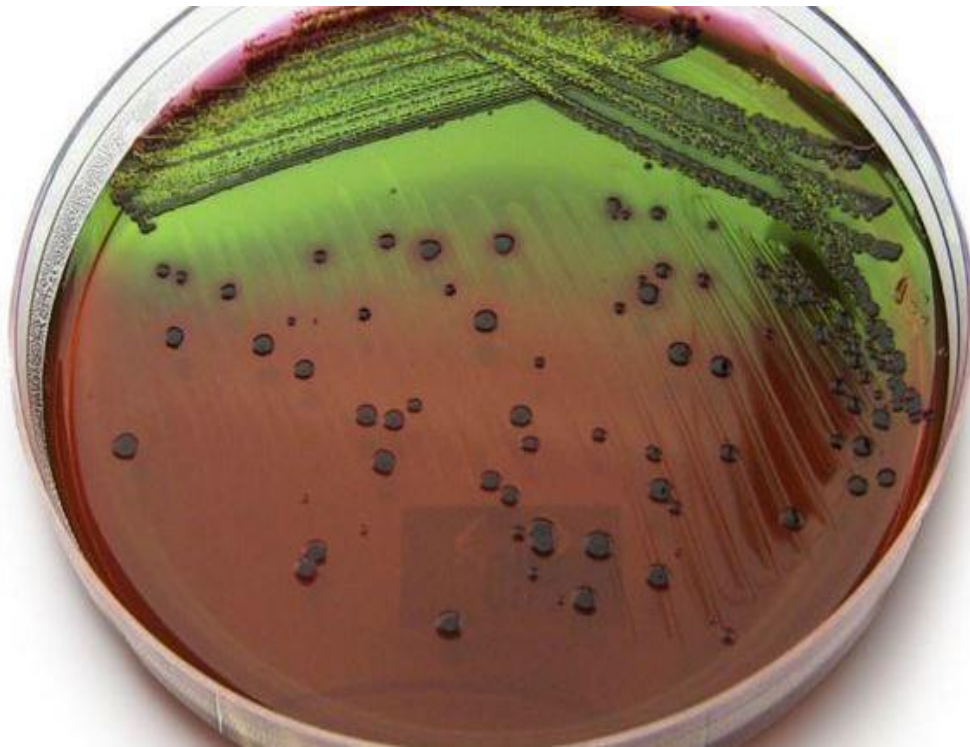
# Laboratory Diagnosis

- Timing of specimen collection from patients with suspected gastrointestinal infections is based on the onset of illness. For example, fecal specimens should be collected within 4 days of disease onset, when organisms are usually present in their greatest numbers.
- Specimens should be processed within 2 h of collection or stored at 4°C until processed.
- A Gram stain of fecal specimens is not useful? since the gram-negative bacilli cannot be distinguished from the normal Gram-negative intestinal microbiota.

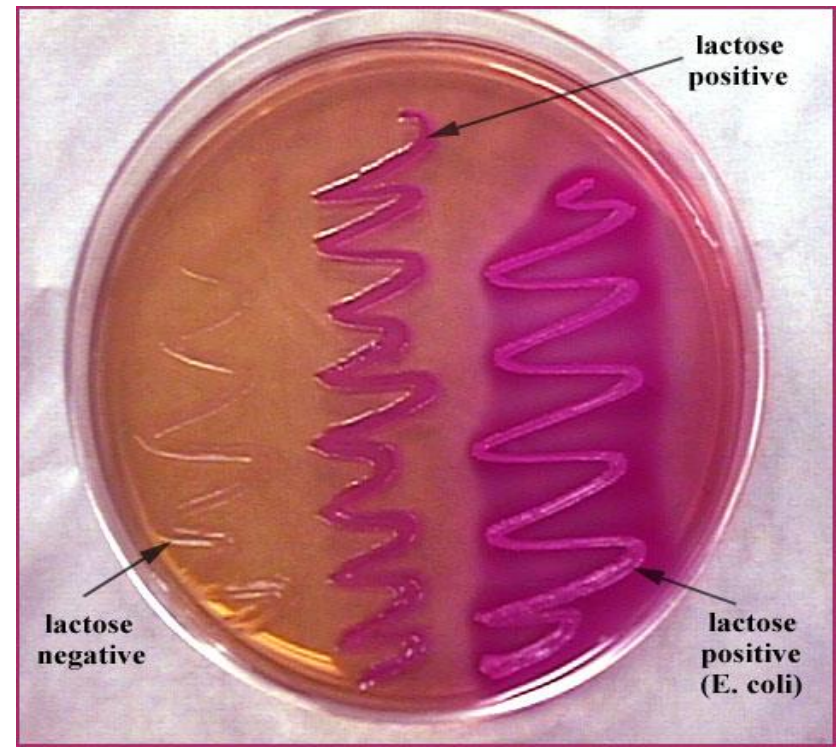
# Laboratory Diagnosis

- Specimens suspected of containing enteric gram-negative rods, such as *E. coli*, are grown initially on a blood agar plate and on a differential medium, such as EMB agar or MacConkey's agar.
- *Escherichia coli*, which ferments lactose, forms pink colonies, whereas lactose-negative organisms are colorless. On EMB agar, *E. coli* colonies have a characteristic **green sheen**.

# *E. Coli* on EMB agar &



# MacConkey agar



# Treatment

- Antibiotic therapy is usually *not* indicated in *E. coli* diarrheal diseases. However, administration of trimethoprim sulfamethoxazole or loperamide (Imodium) may shorten the duration of symptoms.
- Rehydration is typically all that is necessary in this self-limited disease.

# *Shigella* species

## Disease

- *Shigella* species cause enterocolitis (bacillary dysentery).  
The term *dysentery* refers to bloody diarrhea.

## Important properties

- They are facultative anaerobes but grow best aerobically
- Non–lactose-fermenting, gram-negative rods that can be distinguished from salmonellae by three criteria: they produce no gas from the fermentation of glucose, they **do not produce H<sub>2</sub>S**, and they are **nonmotile**.

## ***Shigella* species are classified into four serogroups:**

- All shigellae have O antigens (polysaccharide) in their cell walls, and these antigens are used to divide the genus into four groups: A, B, C, and D.
  - Serogroup A: *Shigella dysenteriae*
  - Serogroup B: *Shigella flexneri*
  - Serogroup C: *Shigella boydii*
  - Serogroup D: *Shigella sonnei*



# Pathogenesis

- Shigellosis is only a **human disease** (i.e., there is no animal reservoir). The organism is transmitted by the fecal–oral route.
- They have a very low ID<sub>50</sub>. Ingestion of as few as 100 organisms causes disease, whereas at least 10<sup>5</sup> *V. cholerae* or *Salmonella* organisms are required to produce symptoms.
- Shigellae produce bloody diarrhea by invading the cells of the mucosa of the distal ileum and colon. Local inflammation accompanied by ulceration occurs, but the organisms rarely penetrate through the wall or enter the bloodstream, unlike salmonellae. Although some strains produce an enterotoxin (called *Shiga toxin*)

# Clinical Finding

- After an incubation period of 1 to 4 days, symptoms begin with fever and abdominal cramps, followed by diarrhea, which may be watery at first but later contains blood and mucus.
- The disease varies from mild to severe depending on two major factors: the species of *Shigella* and the age of the patient, with young children and elderly people being the most severely affected.
- The diarrhea frequently resolves in 2 or 3 days; in severe cases, antibiotics can shorten the course..

# Laboratory Diagnosis

- Shigellae form non–lactose-fermenting colonies on MacConkey's or EMB agar. On TSI agar, they cause an alkaline slant and an acid butt, with no gas and no H<sub>2</sub>S.
- Confirmation of the organism as *Shigella* and determination of its group are done by slide agglutination.
- One important adjunct to laboratory diagnosis is a methylene blue stain of a fecal sample to determine whether neutrophils are present. If they are found, an invasive organism such as *Shigella*, *Salmonella*, or *Campylobacter* is involved rather than a toxin-producing organism such as *V. cholerae*, *E. coli*, or *Clostridium perfringens*.

# Triple Sugar Iron Agar (TSI)

**TSI agar**  
Triple Sugar Iron Agar

0.1% dextrose  
1.0% sucrose  
1.0% lactose

A B C D E

(a) **Red/red** (no sugar fermentation)  
(b) **Control**  
(c) **Red/yellow** (Glucose fermented but lactose and sucrose not fermented)  
(d) **Yellow/yellow** (Glucose fermented. Lactose and/or sucrose fermented)  
(e) **Red/yellow with H<sub>2</sub>S**

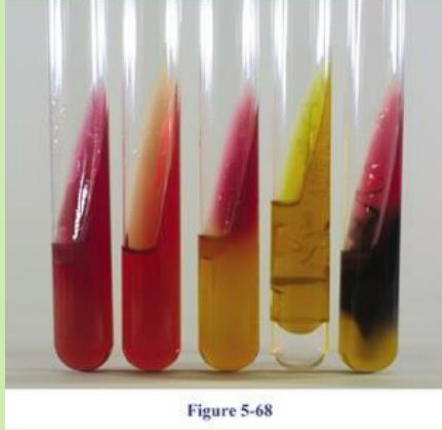


Figure 5-68



*Escherichia coli*  
*Shigella dysenteriae*  
*Proteus mirabilis*  
*Pseudomonas aeruginosa*

**KIA slants**

# Treatment

- Shigellosis is a self-limited illness, and many patients recover without treatment within 5–7 days.
- Oral fluid replacement is considered to be sufficient for treatment of uncomplicated shigellosis, but in high-risk patient populations intravenous fluid replacement may be required.
- Antidiarrheal medications should be avoided in *Shigella* dysentery, as such medications may worsen the symptoms of the illness.
- Antibiotic treatment is recommended for the treatment of severe infections.

# *Salmonella* spp

## Disease

- Cause **enterocolitis**, enteric fevers such as typhoid fever, and septicemia. They are one of the most common causes of **bacterial enterocolitis** in the United States.

## Important properties

- They are non-spore-forming, facultative anaerobic, Gram-negative bacilli that vary in length. Most isolates are motile
- **Not ferment lactose** but do produce H<sub>2</sub>S.

# Pathogenesis

- Cause clinical disease when acquired by the oral route. They are typically transmitted via contaminated water or food from animals and animal products to humans.
- In contrast to *Shigella* enterocolitis, in which the infectious dose is very small, the dose of *Salmonella* required is much higher, at least 100,000 organisms
- Enterocolitis is characterized by an invasion of the epithelial and subepithelial tissue of the small and large intestines. Strains that do not invade do not cause disease. The organisms penetrate both through and between the mucosal cells into the lamina propria, with resulting inflammation and diarrhea.

# Clinical Finding

- After an incubation period of 12 to 48 hours, enterocolitis begins with nausea and vomiting and then progresses to abdominal pain and diarrhea, which can vary from mild to severe, with or without blood.
- Usually the disease lasts a few days, is self-limited, causes nonbloody diarrhea, and does not require medical care except in the very young and very old.
- *Salmonella typhimurium* is the most common species of *Salmonella* to cause enterocolitis in the United States, but almost every species has been involved



# Laboratory Diagnosis

- In enterocolitis, the organism is most easily isolated from a stool sample.
- Salmonellae form non-lactose-fermenting (colorless) colonies on MacConkey's or EMB agar.
- On TSI agar, an alkaline slant and an acid butt, frequently with both gas and H<sub>2</sub>S (black color in the butt), are produced.

**TSI agar**  
Triple Sugar Iron Agar

0.1% dextrose  
1.0% sucrose  
1.0% lactose

A B C D E

(a) **Red/red** (no sugar fermentation)  
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(e) **Red/yellow with H<sub>2</sub>S**




Figure 5-68

# Treatment

- Enterocolitis caused by *Salmonella* is usually a self-limited disease that resolves without treatment.
- Fluid and electrolyte replacement may be required.
- Antibiotic treatment does not shorten the illness or reduce the symptoms; in fact, it may prolong excretion of the organisms, increase the frequency of the carrier state, and select mutants resistant to the antibiotic.

Antimicrobial agents are indicated only for neonates or persons with chronic diseases who are at risk for septicemia.

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