

### ❖ Part 3: Gastrointestinal Gram-Negative Rods:

All of the organisms covered in this part are routinely found in the gastrointestinal (GI) tract of humans or other animals. Many also have alternative habitats in soil or water. All are relatively hardy but are sensitive to drying, and all grow in the presence or absence of oxygen, being facultative anaerobes. Fecal contamination is important in the transmission of organisms cause GI diseases ,Gram-negative enteric rods discussed in this part are listed in bellow:-

- 1- Compylobacter spp.
- 2- Escherichia spp.
- 3- Helicobacter spp.
- 4- Klipseilla spp.
- 5- Protues spp.
- 6- Salmonella spp.
- 7- Shigilla spp.
- 8- Vibrio spp.
- 9- Yersinia spp.

### ❖ Genus :- Escherichia Species :- 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.

### ❖ 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:** cause Watery diarrhea
- **Enteropathogenic *E. coli* EPEC:** Watery diarrhea
- **Enterohemorrhagic *E. coli* EHEC:** Bloody diarrhea and Hemorrhagic colitis
- **Enteroinvasive *E. coli* EIEC:** EIEC cause a dysentery-like syndrome with fever and bloody stools.(Bloody diarrhea)
- **Enteroggregative *E. coli* EAEC:** Persistent watery diarrhea in children and patients infected with HIV

### ❖ Clinical significance: extraintestinal disease:

1. Urinary tract infection
2. Neonatal meningitis
- 3-Nosocomial (hospital-acquired) infections

**Gram (-) rods**

**Escherichia species**

Gram-negative rods

*E. coli* (Gram stain)

MacConkey agar

- Short rods
- Facultative anaerobe
- Ferments glucose
- Most strains ferment lactose
- Catalase positive
- Oxidase negative
- Culture on MacConkey agar

**Escherichia coli**

- Urinary tract infection (UTI)
  - 1 Ciprofloxacin
  - 1 Trimethoprim/sulfamethoxazole
- Local or systemic disease
  - Test for sensitivity
  - Empiric therapy may include:
    - 1 Ampicillin
    - 1 Cefotaxime
    - 1 An aminoglycoside
    - 1 Ciprofloxacin
    - 1 Trimethoprim/sulfamethoxazole
- Meningitis in infants
  - 1 Cefotaxime

## ❖ 2- Genus: Salmonella

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

### Epidemiology

*Salmonella* are widely distributed in nature. Serovar Typhi is an exclusively human pathogen, whereas other serovars are associated with animals and foods (eg, eggs and poultry), Fecal-oral transmission occurs,

**Pathogenesis :** *Salmonella* invade epithelial cells of the small intestine. Disease may remain localized or become systemic,

### Clinical significance

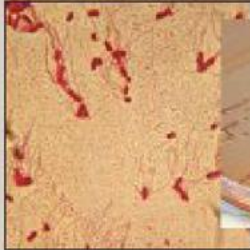
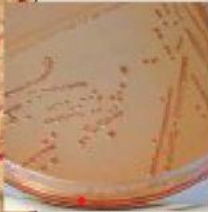
#### 1. Gastroenteritis.

#### Enteric or typhoid fever

#### 3. Other sites of *Salmonella* infection

**Gram (-) rods**

## Salmonella species

- Short, flagellated rods
- Facultative anaerobes
- Ferment glucose
- Do not ferment lactose
- Catalase positive
- Oxidase negative
- Culture on MacConkey agar

*Salmonella enterica serovar Typhi*

*Salmonella species on MacConkey agar*

**Serovars Enteritidis and Typhimurium**

- Enterocolitis (gastroenteritis, food poisoning)

Antibiotics are not normally used except in immunocompromised individuals to prevent systemic spread of the infection. They may be used in individuals older than age 50 years to prevent seeding of atherosclerotic plaques.

**Serovar Typhi**

- Enteric (typhoid) fever and paratyphoid fever

**1** Ceftriaxone

**1** Ciprofloxacin

### ❖ 3- Genus: Campylobacter

*Campylobacter* infect the intestine and can cause ulcerative, inflammatory lesions in the jejunum, ileum, or colon. Rarely, bacteremia may occur.

#### ❖ Epidemiology


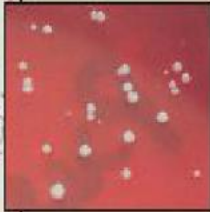
*Campylobacter* are widely distributed in nature as commensals of many different vertebrate species, including mammals and fowl, both wild and domestic.

#### ❖ Pathogenesis and clinical significance

*Campylobacter* may cause both intestinal and extraintestinal disease. Symptoms may be both systemic (fever, headache, myalgia) and intestinal (abdominal cramping and diarrhea, which may or may not be bloody). *Campylobacter jejuni* is associated with both traveler's diarrhea and pseudoappendicitis .

**Gram (-) rods**

## Campylobacter species

- Curved, spiral, or S-shaped rods
- Single, polar flagellum, resulting in characteristic darting motion
- Microaerophilic
- Do not ferment carbohydrates
- Culture on selective medium (blood agar containing antibiotics to inhibit growth of other fecal flora)

**Campylobacter jejuni**

- Acute enteritis
- Traveler's diarrhea
- Pseudoappendicitis

**1** Erythromycin

**1** Ciprofloxacin

*Campylobacter jejuni*

*Campylobacter jejuni* (Preston selective medium)

### ❖ 4- Genus: Shigella

Shigella species cause shigellosis , S. dysenteriae cause bacillary dysentery ,an intestinal disease that occurs most commonly among young children.

❖ **Epidemiology (Q/ways of spreading the disease?)**

*Shigellae* are typically spread from person to person, with contaminated stools serving as a major source of organisms. Humans are the only natural host for *Shigella* species. Flies and contaminated food or water can also transmit the disease.

❖ **Pathogenesis and clinical significance**

*Shigellae* invade and destroy the mucosa of the large intestine. Infection rarely penetrates to deeper layers of the intestine and does not lead to bacteremia, *Shigellae* cause classical bacillary dysentery, characterized by diarrhea with blood, mucus, and painful abdominal cramping.

**Gram (-) rods** **Shigella species**

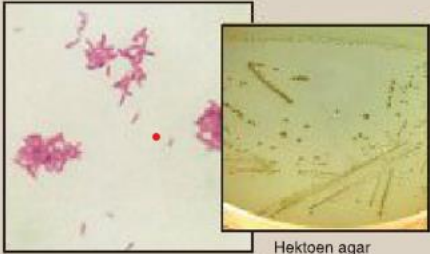
**Shigella sonnei**

- Diarrhea (shigellosis)

1 Azithromycin

1 Ciprofloxacin

1 Ceftriaxone



Gram stain Hektoen agar

- Nonmotile and nonencapsulated
- Cannot ferment lactose
- Most strains do not produce gas in a mixed-acid fermentation of glucose
- Culture on selective medium such as Hektoen agar

❖ **5- Genus: Vibrio**

Pathogenic vibrios include:-

- 1- **Vibrio cholera** are associated with epidemic cholera,
- 2- **Vibrio parahaemolyticus** cause gastroenteritis and extraintestinal infections.

❖ **Epidemiology**

*V. cholerae* is transmitted to humans by contaminated water and food.

❖ **Pathogenesis and clinical significance (Q/ what the pathogenesis of *Vibrio* spp. in diagram?)**

*V. cholerae* infects the small intestine , noninvasive but adheres to the epithelium by pili after that producing enterotoxin (cholera toxin) causing watery diarrhea , **sometime causing milder illness can be treated** but also **causing hypovolemic shock , untreated and death from severe dehydration.**

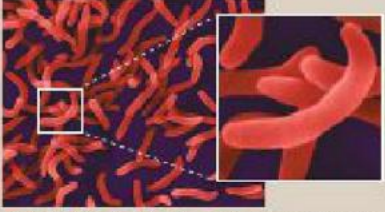
**Gram (-) rods** **Vibrio species**

**Vibrio cholerae**

- Cholera

1 Doxycycline

1 Ciprofloxacin



Vibrio cholerae (colorized scanning electron micrograph)

- Short, curved, rod shaped
- Rapidly motile as a result of single polar flagellum
- Facultative anaerobes
- Growth of many *Vibrio* strains requires or is stimulated by NaCl
- Culture on blood or MacConkey agar

## ❖ 6- Genus: Helicobacter

### Species : Helicobacter pylori ( *H. pylori* )

The genus *Helicobacter* are causes acute gastritis and duodenal and gastric ulcers. *H. pylori* are unusual in their ability to colonize the stomach, where low pH normally protects against bacterial infection.

### ❖ Pathogenesis and Clinical significance

Transmission of *H. pylori* is thought to be from person to person, because the organism has not been isolated from food or water. Initial infection with *H. pylori* causes acute gastritis, sometimes with diarrhea that lasts about 1 week. Both duodenal ulcers and gastric ulcers are closely correlated with infection by *H. pylori*.

**Gram (-) rods**

### **Helicobacter species**

**Helicobacter pylori**


- Acute gastritis<sup>1</sup>

1 Amoxicillin


1 Clarithromycin

1 Proton pump inhibitor

<sup>1</sup>A number of alternate multi-drug regimens have been shown to be effective in eradicating *H. pylori*.



*Helicobacter pylori*  
(Note: Young cultures grown *in vitro* frequently stain gram-positive)



*Helicobacter pylori* colonies on an agar plate

- Curved or spiral rods
- Multiple polar flagella, which give organism rapid, corkscrew motility
- Urease positive
- Culture on selective medium containing antibiotics

## ❖ 6- Genus: Yersinia

The genus *Yersinia* includes three species of medical importance *Yersinia enterocolitica* and *Yersinia pseudotuberculosis*, both potential pathogens of the GI tract

### ❖ Pathogenesis and clinical significance

Infection occurs via ingestion of food that has become contaminated through contact with colonized domestic animals, or raw meat (especially pork). *Y. enterocolitica* is a relatively uncommon cause of enterocolitis.

**Gram (-) rods**

### **Yersinia species**


**Yersinia enterocolitica**

- Yersiniosis (gastroenteritis)
- Septicemia

1 Ciprofloxacin<sup>1</sup>

1 Trimethoprim/sulfamethoxazole

<sup>1</sup>Antibiotic therapy is essential for systemic disease (sepsis).



Gram stain of *Yersinia enterocolitica*

- Motile
- No capsule
- Found in contaminated water supplies, unpasteurized milk, contaminated food.

- **OTHER ENTEROBACTERIACEAE**

Other genera of Enterobacteriaceae, such as *Klebsiella*, *Enterobacter*, *Proteus*, and *Serratia*, which can be found as normal inhabitants of the large intestine, include organisms that are primarily opportunistic and often nosocomial pathogens.

**A. Enterobacter spp.**

*Enterobacter* species rarely cause primary disease in humans but frequently colonize hospitalized patients, especially in association with antibiotic treatment, indwelling catheters, and invasive procedures. These organisms may infect burns, wounds, and the respiratory and urinary tracts.

**B. Klebsiella spp.**

*Klebsiellae* species are cause necrotizing lobar pneumonia in individuals compromised by alcoholism, diabetes, or chronic obstructive pulmonary disease. *K. pneumoniae* also causes UTI and bacteremia, particularly in hospitalized patients.

**C. Serratia spp.**

The species of *Serratia* that most frequently causes human infection can cause extraintestinal infections such as those of the lower respiratory and urinary tracts, especially among hospitalized patients.