# Enterobacteriaceae (Part 1)

A large family of Gram negative, facultative anaerobic or aerobes, non-spore forming rods, with the exception of *Shigella* and *Klebsiella* which are non motile, these bacteria motile with peritrichous flagella. Enterobacteriaceae contains a large number of genera that are biochemically and genetically related to one another, some of them are normal inhabitant in small and large human gastrointestinal tracts, therefore sometimes referred to as enterics, but may also be called coliforms. This group of organisms includes several that cause primary infections of the human gastrointestinal tract.

This family includes many genera like (*Escherichia, Shigella, Salmonella, Enterobacter, Klebsiella, Serratia, Proteus*, and others). Some enteric organisms, such as *Escherichia coli*, are part of the normal microbiota and incidentally cause disease, but others, the salmonellae and shigellae, are regularly pathogenic for humans, possess a complex antigenic structure, and produce a variety of toxins and other virulence factors.

## The main genera in Enterobacteriaceace include:

### 1. Genus: *Salmonella*

**Morphology**

Gram-negative bacilli, non spore forming, facultative anaerobic, motile with peritrichous flagella.

## Identification:

In addition to special selective media and biochemical tests, the related antigens (cell wall (O), flagellar (H), and capsular (Vi)) are important for taxonomic and epidemiologic purposes. The O antigens,

which are the outer polysaccharides of the cell wall, are used to subdivide the salmonellae into groups A–I.

## Pathogenesis and Clinical Findings

Clinically, ***Salmonella*** **species** are often thought of in **two distinct categories**:

1. **Typhoidal species**: those that cause typhoid fever. The typhoidal species are ***Salmonella typhi*** and ***Salmonella paratyphi***.

2. **Non-typhoidal species**: those that cause diarrhea (enterocolitis) and metastatic infections, such as osteomyelitis, e. g. ***Salmonella typhimurium*.**

## Transmission

The *Salmonella* infections is related to the ingestion of food and water contaminated by human and animal wastes via **fecal-oral** route. *Salmonella typhi*, the cause of typhoid fever, is **transmitted only by humans,** but all other species have a significant animal as well as human reservoir. The most frequent **animal source is poultry and eggs,** but **meat products** that are inadequately cooked have been implicated. The infective dose to produce clinical infection in humans is 105–108 bacterial cells of salmonellae.

## Laboratory Diagnosis

In the typhoid fever, a **blood culture** reveal the organism during the first 2 weeks of illness. In enterocolitis, the organism is easily isolated from a stool sample.

*Salmonella* isolate can be identified and grouped by the **slide agglutination test** into serogroup A, B, C, D, or E based on its O antigen.

When the salmonellae is difficult to recover, the diagnosis can be made **serologically** by detecting a rise in antibody titer in the patient's serum **(Widal test).**

## Treatment

Enterocolitis caused by *Salmonella* is usually a self-limited disease that resolves without treatment. Fluid and electrolyte replacement may be required.

The treatment of choice for typhoid fever is either ceftriaxone or ciprofloxacin. **Antibiotics susceptibility test should be done.**

## 2. Genus: *Shigella*

## Morphology:

Shigellae are Gram-negative, non-motile, facultative anaerobic, non-spore forming rods. The genus is divided into four species:

1. ***Shigella dysenteriae***
2. ***Shigella flexneri***
3. ***Shigella boydii***
4. ***Shigella sonnei***

## Pathogenesis and Clinical findings

**Shigellosis or bacillary dysentery** is an infection of the intestines caused by *Shigella* species, symptoms generally start 1 to 2 days after exposure to and include diarrhea (sometimes bloody diarrhea), fever, abdominal pain. Symptoms last 5 to 7 days and it may take several months before bowel habits return entirely to normal.

Shigellosis is caused by four specific types of *Shigella*. These are spread by exposure to infected feces. This can occur via contaminated food, water, or hands.

Infection is initiated by ingestion of shigellae via fecal-oral contamination. An early symptom, diarrhea (possibly elicited by enterotoxins and/or cytotoxin), may occur as the organisms pass through the small intestine. The hallmarks of shigellosis are bacterial invasion of the colonic epithelium and inflammatory colitis.

**Treatment**

Most people recover without needing antibiotics, Antibiotics can shorten the duration of illness (by about 2 days) and might help reduce the spread of *Shigella* to others. Washing hands with soap can reduce infection.

## 3. Genus: *Proteus*

**Morphology**

*Proteus* are Gram negative rods that their species move very actively by means of peritrichous flagella, resulting in "swarming" on solid media, characterized by expanding rings (waves) of organisms over the surface of the agar.

In the clinical laboratory, these organisms are categorized to:

1. ***Proteus vulgaris***
2. ***Proteus mirabilis***
3. ***Proteus morganii***
4. ***Proteus rettgeri***

These four medically important species are urease-positive, which mean they produce the enzyme **urease,** which cleaves urea to form NH3 and CO2. Identification of these organisms in the clinical laboratory is based on a variety of biochemical reactions.

## Pathogenesis and Clinical Findings

These organisms primarily cause urinary tract infections (UTI), both community and hospital-acquired.

The organisms are present in the human colon as well as in soil and water. Their tendency to cause urinary tract infections is probably due to their presence in the colon and to colonization of the urethra, especially in women. The vigorous motility of *Proteus* organisms may contribute to their ability to invade the urinary tract. Production of the enzyme urease is an important feature of the pathogenesis of urinary tract infections by this group. Urease hydrolyzes the urea in urine to form ammonia, which raises the pH, producing an alkaline urine. This encourages the formation of stones (calculi) called **"struvite"** composed of magnesium ammonium phosphate. They obstruct urine flow, damage urinary epithelium, and serve as a nidus for recurrent infection by trapping bacteria within the stone. Because alkaline urine also favors growth of the organisms and more extensive renal damage, treatment involves keeping the urine at a low pH.

## Laboratory Diagnosis

*Proteus* are highly motile and produce a "swarming" overgrowth on blood agar, and urease production considered the good identification markers to these microorganisms.

## Treatment

Most strains are sensitive to aminoglycosides and trimethoprim (sulfa methoxazole) but because individual isolates can vary, antibiotic sensitivity tests should be performed.

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