

Enterobacteriaceae (part 1)

By

Dr. Thaer Abdullah Hasan

General Properties of the Family

Members of the family Enterobacteriaceae **should have** the following properties:

- ✓ They are gram-negative bacilli, Aerobes and facultative anaerobes
- ✓ Non-fastidious: can grow in ordinary media like nutrient agar
- ✓ Ferment glucose to produce acid with or without gas.
- ✓ Reduce nitrate to nitrite and they do not produce **oxidase**.
- ✓ They produce catalase (except *Shigella dysenteriae* type-1)
- ✓ They are generally motile with peritrichous flagella, except some members which are non-motile, such as *Shigella* and *Klebsiella*.
- ✓ Natural habitat: Most of them are commensals in human intestine, called **coliform bacilli**, e.g. *Escherichia*, *Klebsiella*, *Proteus*, *Morganella* and *Citrobacter*, etc. **the exceptions are *Shigella*, *Salmonella* which are enteric pathogens, **not** commensal.**

1. *Escherichia coli*

- ✓ It was described first by Escherich in 1885.
- ✓ *E. coli* is the most important species encountered as human pathogen.
- ✓ It is also the most common aerobe to be found in the gut of humans and animals.
- ✓ After excreted in feces, it remains viable only for some days in the environment.
- ✓ Hence, detection of *E. coli*, especially a variant called **thermo-tolerant *E. coli*** (survives at 44°C) is taken as an indicator of recent contamination of drinking water with human or animal feces.
- ✓ Other species are less important as human pathogens.



Virulence factors of *E. coli*

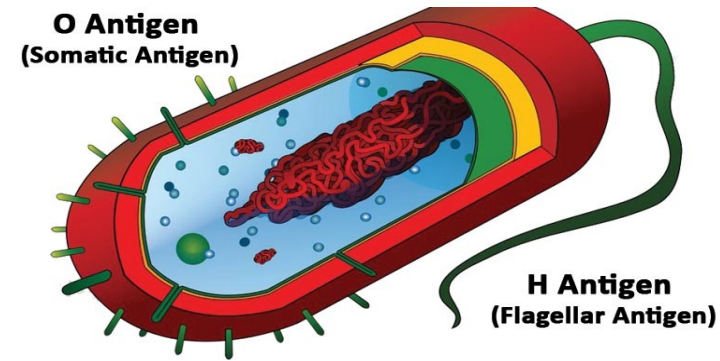
Virulence factors of *E. coli* may be grouped into **surface antigens** and **toxins**:

1- Surface antigens: *E. coli* has four surface antigens:

- ✓ Somatic (O)
 - ✓ Flagellar (H)
 - ✓ Capsular antigens (K)
 - ✓ Fimbrial antigen.
- Serotyping of *E. coli* is **based on agglutination with the specific antisera directed against each surface antigen.**
- So far more than 170 O serotypes, 100 K serotypes and 75 H serotypes of *E. coli* have been recognized.
- The strain of *E. coli* is designated based **on the serotype number of its antigens**; for example, *E. coli* O121:K37:H8

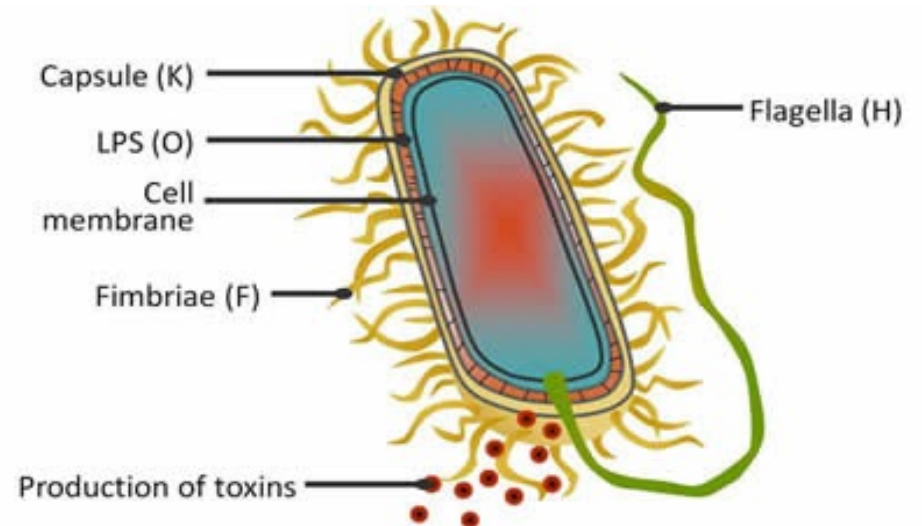
1. Somatic or O antigen:

- ✓ It is the lipopolysaccharide (LPS) antigen.
- ✓ It is heat-stable.
- ✓ Occasionally, it cross reacts with O antigens of other species.
- ✓ Serotyping is done by slide agglutination with specific O antisera
- ✓ O antigen is the most important virulence factor, responsible for endotoxic activity; it protects the bacteria from phagocytosis and bactericidal effect of complement



2. Flagellar or H antigen

- ✓ It is heat labile
- ✓ Presence of H antigen (flagella) makes the bacteria motile, hence contributing to their virulence.



3. Capsular or K antigen

- ✓ It is the polysaccharide capsular antigen present on the envelope or microcapsule of a **few strains of *E.coli***.
- ✓ When present, it encloses the O antigen and renders the strain **in agglutinable** by the O antiserum.
- ✓ It may also contribute to virulence by inhibiting phagocytosis.
- ✓ **It is expressed by only few strains** of *E.coli* e.g. those causing neonatal meningitis and septicemia.

4. Fimbrial antigen

Pilus is the organ of adhesion, helps in attachment and colonization. **It is expressed by a few strains of *E.coli***.

Several fimbrial antigens are:

- ✓ **CFA (colonization factor antigen):** It is a type of fimbriae expressed by **enterotoxigenic *E.coli***.
- ✓ **P fimbriae** bind specifically to the P blood group antigens present on human RBCs and uroepithelial cells.

2- Toxins

The exotoxins secreted by *E.coli* are several types:

- ✓ **Enterotoxins:** They are produced by diarrheagenic strains of *E. coli*.
- ✓ **Hemolysins:** They are produced more commonly by virulent strains of *E.coli*
- ✓ **Cytotoxic necrotizing factor :** They are cytotoxic to bladder and kidney cells.

Clinical Manifestations

E.coli is one of the most common pathogen encountered clinically and has been associated with various manifestations

➤ **Urinary tract infection (UTI): it is caused by Uropathogenic *E.coli* (UPEC)**

➤ **Diarrhea:** It is caused by six types of diarrheagenic *E.coli*

1. Enteropathogenic *E. coli* (EPEC)

2- Enterohemorrhagic *E. coli* (EHEC)

3- Enterotoxigenic *E. coli* (ETEC)

4- Enteroaggregative *E. coli* (EAEC)

5- Enteroinvasive *E. coli* (EIEC)

6- Diffusely adherent *E. coli* (DAEC)

1. Enteropathogenic *E. coli* (EPEC)

- ✓ EPEC frequently causes **infantile diarrhea** (outbreaks) and occasionally in adults.
- ✓ Person-to-person spread is seen.
- ✓ **It is non-toxigenic and noninvasive.**
- ✓ **Mechanism of diarrhea:**
 1. **Adhesion to intestinal mucosa**, mediated by plasmid coded bundle-forming pill, which form cup-like projections.
 2. **A/E lesions** (attaching and effacing lesions): these are typical lesions produced on the intestinal epithelium; which leads to **disruption of brush border epithelium causing increased secretion and watery diarrhea.**

2. Enterotoxigenic *E. coli* (ETEC):

- ✓ ETEC is the most common cause of **traveler's diarrhea** causing 25- 75% of cases.
- ✓ It causes **acute watery diarrhea** in infants and adults.
- ✓ **It is toxigenic, but not invasive.**
- ✓ Pathogenesis of ETEC is by:
 1. Attachment to intestinal mucosa is mediated by fimbrial protein called CFA (colonization factor antigen)
 2. Toxin production:- (1) heat-labile toxin or LT (acts by cAMP), (2) heat-stable toxin or ST (acts by cGMP).
- ✓ Diagnosis: is done by **detection of toxins by in vitro and in vivo methods**

3. Enteroinvasive *E. coli* (EIEC)

- ✓ Common serotypes associated with EIEC are O28, O 112, O114, O124, O136, O 152, etc.
- ✓ **Pathogenesis:** EIEC is not **toxigenic**, but **invasive**.
 1. The epithelial cell invasion is mediated by a plasmid coded antigen called **virulence marker antigen (VMA)**.
 2. EIEC is biochemically, genetically and pathogenically closely related to *Shigella*.
- ✓ **Manifestations:** These include ulceration of bowel, dysentery (**diarrhea with mucus and blood**, called **bacillary dysentery** resembling **shigellosis**).
- ✓ **Diagnosis:** Detection of VMA by ELISA + Compared with other *E. coli* strains, EIEC are biochemically atypical being non motile, lactose non fermenters and negative for lysine decarboxylase.

4. Enterohemorrhagic *E. coli* (EHEC)

- ✓ Serotypes associated with EHEC are: **O 157:H7** (most common serotype)
- ✓ EHEC is usually **transmitted by contaminated food**
- ✓ It is prevalent mainly in industrialized countries (in contrast to other diarrheagenic *E. coli* which are common in developing regions).
- ✓ **Low infective dose:** the **infective dose of EHEC is very low**. (Only few organisms are required to initiate the infection)
- ✓ **Pathogenesis:** EHEC secretes a toxin called **Shiga -like toxin**.
- ✓ **Manifestations:** it manifests as **gross bloody diarrhea**, abdominal pain and fecal leukocytosis but **no fever**.

5. Enteroaggregative *E. coli* (EAEC)

- ✓ It is so named because it adheres to Hep-2 cells (HEp-2, human epithelial cell) in a distinct pattern, layering of the bacteria aggregated in a stacked-brick fashion. Most strains are "O" non-typeable **but "H typeable**.
- ✓ Intestinal colonization is mediated by aggregative adhesion fimbriae I.
- ✓ It also produces EAST 1 toxin (entero-aggregative heat stable enterotoxin 1).
- ✓ **Manifestations:** Persistent and acute diarrhea are commonly seen; especially in developing countries.
- ✓ *E.coli* O104: H4 It is an enteroaggregative strain that has caused major outbreaks in Germany in 2011.

6- Diffusely-adherent *E.coli* (DAEC)

✓ It is characterized by:

- Ability to adhere to Hep-2 cells in a diffuse pattern.
- Expresses diffuse adherence fimbriae which contribute to the pathogenesis.

✓ DAEC is capable of causing diarrheal disease, primarily in children aged **2 - 6years**.

LABORATORY DIAGNOSIS of *Escherichia coli*

- **Sample collection:** Depends on the site of infection- urine, stool, pus, wound swab etc
- **Direct smear:** Gram-negative bacilli, and pus cells
- **Culture:**
 - ✓ Blood agar: Circular, grey, moist colonies, hemolysis variable
 - ✓ MacConkey agar: Flat, pink colonies
- **Culture smear and motility testing:** Motile gram-negative bacilli
- **Biochemical identification:**
 - ✓ Catalase positive, oxidase negative and Nitrate is reduced to nitrite
 - ✓ **indole(+)**, Citrate (-), Urease(-), gas (+), H₂S (-)
 - ✓ Sugar fermentation test: Ferments most sugars

Thank you for your attention

Any questions??

