

**SEROLOGICAL CLASSIFICATION**

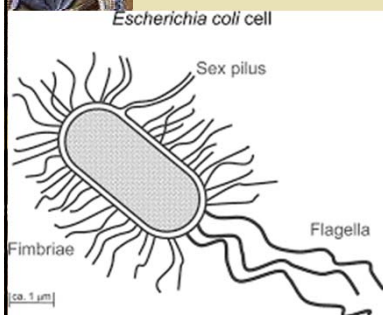
- ◆ *E. coli* → over 200 recognized O serotypes ← **more heterogeneous carbohydrate side chains** of O antigen (lipopolysaccharide of cell wall)
- ◆ Flagellar proteins are less heterogeneous → Fewer H antigenic types
- ◆ *E. coli* O157:H7

## THE RECOGNIZED VIRULENCE GROUPS

- ◆ Five virulence groups of *E. coli* are recognized:
  - Enteroaggregative (腸聚集性)(EAggEC)
  - enterohemorrhagic (腸出血性) (**EHEC**)
  - Enteroinvasive (腸侵襲性) (EIEC)
  - Enteropathogenic (腸致病性) (EPEC)
  - Enterotoxigenic (腸毒性) (**ETEC**).
- ◆ **→ Food infection**
- ◆ **EHEC and ETEC : Toxin-mediated infection**

## Enteroaggregative *E. coli*

- ◆ **aggregative adherence**
- ◆ a **60-Mda plasmid** is need for the production of **fimbriae** and **outer membrane protein (OMP)**
- ◆ The distinguishing clinical feature of EAggEC strains is a **persistent diarrhea** that lasts **> 14 days**, especially in children.



Fimbriae 繖毛  
pili 線毛

A fimbria is a short pilus that is used to attach the bacterium to a surface.



## Enterohemorrhagic *E. coli*

- ◆ Similar to EPEC in
  - the possession of the chromosomal gene *eae A* (encodes **the intimin protein** that is essential for A/E )
    - the intimin protein is a virulence factor (adhesin黏附素) of EPEC and EHEC
  - the production of attachment-effacement (A/E) lesions (附著-微絨毛消失病變)



## Enterohemorrhagic *E. coli*

- ◆ Disimilar to EPEC in
  - affect only the **large intestine** (in piglet models)
  - produce large quantities of **Shiga-like toxins**
- ◆ EHECs produce fimbriae by a 60-Mda plasmid → attach to culture cells
- ◆ ***E. coli* O157:H7**



## The Toxins of EHEC

- ◆ *Shigella dysenteriae* produces a potent toxin → **Shiga toxin (Stx)**
- ◆ The toxins of EHEC strains of *E. coli* have been referred as Shiga-like toxin → SLT-1 and SLT-2 → **Stx1 and Stx2** ← new terminology



## The Toxins of EHEC

- ◆ Stx1 differ from **Shiga-toxin (Stx)** by **three nucleotides** and **one amino acid**, and neutralized by antibodies to Stx.
- ◆ Toxin gene is chromosomal.
- ◆ Stx-sensitive cells possess a **toxin receptor**.



## The Toxins of EHEC

- ◆ The mechanisms of Stx, Stx1, and Stx2 are the same.
  - They are **N-glycosidase** that cleave a specific adenine residue from the 28S subunit of eukaryotic rRNA, leading to the **inhibition of protein synthesis**.



## Growth and Stx production

- ◆ In general, Stx was produced at all temperatures that supported growth.
- ◆ Unlike most strains of *E. coli*, the **O157:H7 strains do not grow at 44.5°C** and their **maximum in EC medium is around 42°C**.





## Effect of Environmental and Physical Agents

- ◆ Studies of EC O157:H7
  - Survived at least **5 hours at pH 3.0 –2.5** in HCl-adjusted Luria broth at 37°C.
  - Survived for **35 days at 5°C or 7°C** in commercial mayonnaise with **pH of 3.65**.
  - no growth occurred at  $\geq$  **8.5% NaCl**.



## Effect of Environmental and Physical Agents

- ◆ EHEC strains are more **heat sensitive** than most salmonellae. **D<sub>60°C</sub> values are less than 1 minute** in various products (page 642). D values increased with increasing fat content.



## EHEC Prevalence in Foods

- ◆ **Meat, milk, poultry, and seafood products**
- ◆ Using **DNA probes** for detection of EC O157:H7

Comparison: **Eggs, milk, poultry, meat, and meat products** → most common food vehicles of **salmonellosis** to humans



## EHEC Prevalence in Dairy Cattle

- ◆ Most EHEC syndromes are linked to beef → **dairy herds** are the primary reservoirs of EHEC strains.
- ◆ In a risk assessment study of EC O157:H7 → three highest factors can lead to illness by EC O157:H7 → **concentration of EC O157:H7 in animal feces, host susceptibility, and carcass contamination**



## EHEC-Human Disease Syndromes/Prevalence

- ◆ The first **EC O157:H7** strain was recovered in 1975 from a patient with **bloody diarrhea**.
- ◆ **HUS** (hemolytic uremic Syndrome, 溶血性尿毒症) and **HC** (Hemorrhagic colitis, 出血性結腸炎) are caused by Stx-producing strains of *E. coli*.
- ◆ From 2 to 7 % of EC O157:H7 infections may develop HUS. HUS consists of hemolytic anemia (溶血性貧血), thrombocytopenia (血小板過低), and acute renal failure (急性腎衰竭).



## EHEC-Human Disease Syndromes/Prevalence

- ◆ For patients with a foodborne disease HC, all have **bloody diarrhea** and **severe abdominal cramps**, some will have nausea, vomiting, or fever (rare). **The bloody red stool is the telling symptoms for HC.**
- ◆ **EC O157:H7** causes most cases of HC. The infectious is believed **as low as 10 cfu.**





## Enteroinvasive *E. coli*

- ◆ Do not produce enterotoxins
- ◆ Enter and multiply in colonic (結腸的) epithelial cells → spread to adjacent cells.
- ◆ EIECs possess a 140-MDa plasmid that is essential for their invasiveness.
- ◆ Bloody or nonbloody but **voluminous diarrhea** (大量腹瀉)



## Enteroinvasive *E. coli*

- ◆ Although foods are a proven source, **person-to-person transmission** is known.
- ◆ EIEC strains have been shown to be common in diarrheal stools from **children**.



## Enteropathogenic *E. coli*

- ◆ **Do not produce enterotoxins**, although they can cause diarrhea.
- ◆ EPEC strains **cause diarrhea in children generally under 1 year of age**.
- ◆ Plasmidborne **adherence factor** → enable adherence to the intestinal mucosa → colonizing in the intestinal mucosa → produce attachment-effacement (att-eff, A/E) lesions.



## Enterotoxigenic *E. coli*

- ◆ **Attach to and colonize the small intestine** by means of fimbrial (繖毛的) **colonization factor antigens (CFAs)** (定植因子抗原).
- ◆ Four types of **plasmid encoded CFA** — I, II, III, and IV. The **heat-stable enterotoxin generally is encoded on the same plasmid**, and they are **not produced under 20°C**.
- ◆ ETEC strains cause diarrhea in both children and adults. → **the leading cause of travelers' diarrhea**.



## The ETEC Enterotoxins

1. **heat-labile (LT) toxins:**  
**destroyed at 60°C in about 30 minutes.**
2. **heat-stable (STa or ST-1, and STb or ST-II) toxins:** withstand **100°C for 15 minutes**



## The ETEC Enterotoxins

- ◆ ETEC gastroenteritis → ingestion of **10<sup>6</sup> – 10<sup>10</sup> viable cells per gram** → **colonize the small intestines and produce enterotoxin(s)**
  - The colonizing factors are generally fimbriae (繖毛) or pili. (線毛)
- ◆ The syndrome
  - **non-bloody watery diarrhea without inflammatory exudates (分泌物) in stools.**
  - Similar to that caused by *V. cholerae*.



## PREVENTION

- ◆ Same as in chapter 23.
- ◆ The heat sensitivity of these organisms is such that cases should not occur when foods are **properly cooked**.
- ◆ Once cooked, meats should not be held between **40°F (4.4°C)** and **140°F (60°C)** for more than 3 – 4 hours.



## TRAVELERS' DIARRHEA

- ◆ *E. coli* is one of the leading causes of **acute watery diarrhea** (急性水様腹瀉) that often occurs among new arrivals in certain foreign countries.
- ◆ **ETEC and EPEC strains**



- ◆ 生食牛肉致命 日本2死57中毒(2011/5/4)
  - 大腸桿菌O111
  - 引起的溶血性尿毒症(hemolytic uremic syndrome, HUS)
  - 建議同學們儘量避免生食肉類
- ◆ 毒黃瓜已奪14命 比俄禁西班牙蔬菜進口(2011/5/31)
  - 由具有潛在致命的出血性大腸桿菌致病株所引發，是全球最嚴重溶血性尿毒症疫情之一
  - 不要生食蔬菜
- ◆ 生機飲食夯！九成七芽菜類 大腸桿菌全超標(2015/5/6)
- ◆ 天氣熱吃剉冰消暑 注意生菌數超標 2018-6-8
- ◆ 北市稽查涼麵 4件大腸桿菌群超標 2018-07-31