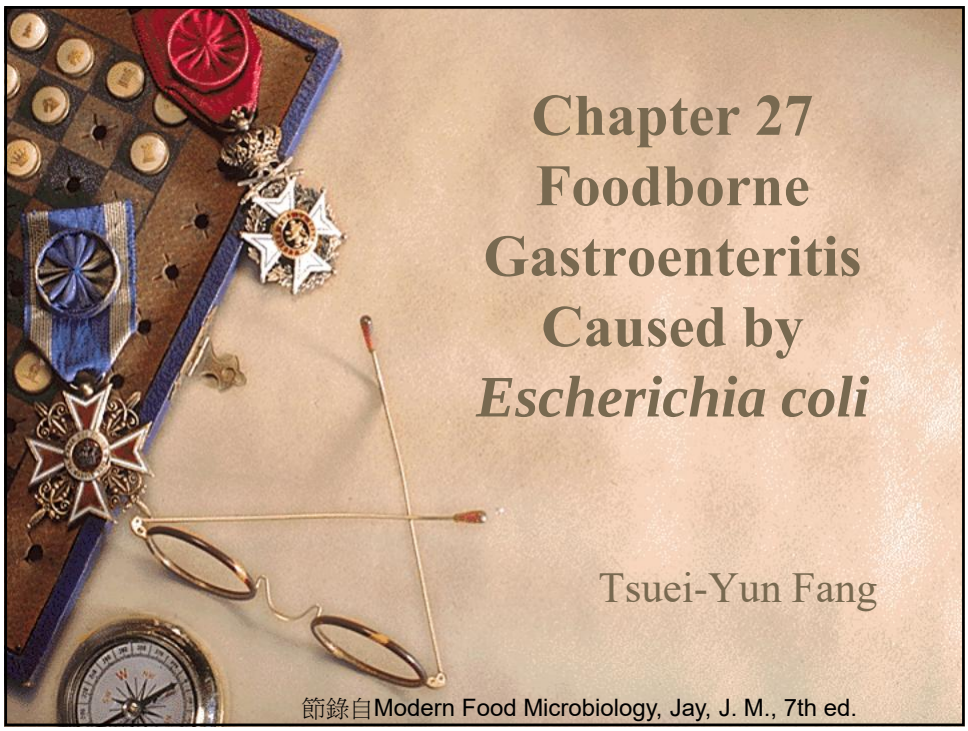
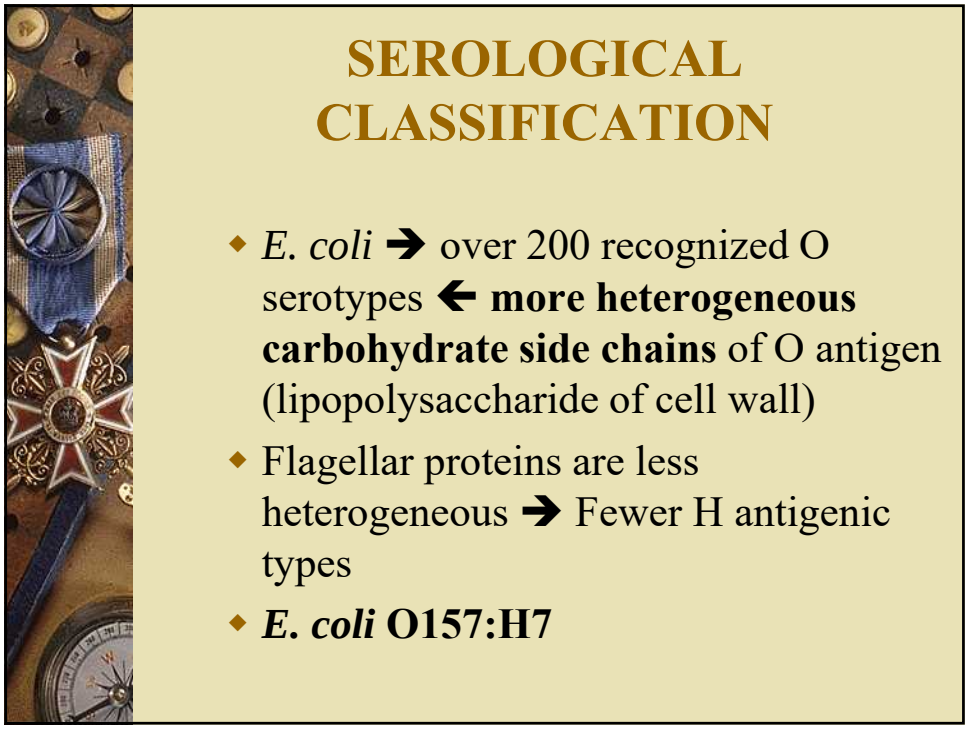

Chapter 27
Foodborne
Gastroenteritis
Caused by
Escherichia coli
Tsuei-Yun Fang
節錄自Modern Food Microbiology, Jay, J. M., 7th ed.

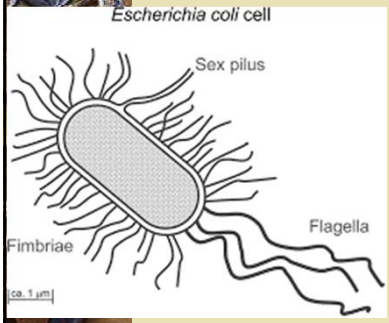

SEROLOGICAL
CLASSIFICATION
E. coli ➔ over 200 recognized O serotypes ➔ **more heterogeneous carbohydrate side chains** of O antigen (lipopolysaccharide of cell wall)
Flagellar proteins are less heterogeneous ➔ Fewer H antigenic types
***E. coli* O157:H7**

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 纖毛
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 ≥ **8.5% NaCl**.

Effect of Environmental and Physical Agents

- EHEC strains are more **heat sensitive** than most salmonellae. **$D_{60°C}$ 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** (**ST**a or ST-1, and STb or ST-II) toxins: withstand **100°C for 15 minutes**

The ETEC Enterotoxins

- ETEC gastroenteritis ➔ **ingestion of 10^6 – 10^{10} 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 (急性水樣腹瀉)** 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0111
  - 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