PATHOGENIC ESCHERICHIA COLI

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**Genus Escherichia - Species coli**

- Commonly referred to as E. coli
- Gram-negative
- Rod-shaped
- Facultatively anaerobic
- Some are motile meaning they possess flagella
- Live in the lower intestine of warm blooded animals
- Most are non-pathogenic and are beneficial part of normal gut flora

Photo Source: www.microbeworld.org
There are many strains of *E. coli* – focus today is only on the pathogenic strains (serotypes)

*E. coli* that cause disease in healthy hosts are referred to as pathogenic *E. coli* or diarrheagenic *E. coli*

- These *E. coli* are divided into 6 groups based on virulence factors
Six Pathotypes

Pathogenic E. coli

- STEC (EHEC) enterohemorrhagic
  - O157:H7/“big 6”, shiga toxins stx1/stx2, Intimin adhesion virulence factor
  - LT and ST enterotoxins

- ETEC enterotoxigenic
  - LT and ST enterotoxins

- EPEC enteropathogenic
  - Virulence factor is Intimin adhesion (eae and tir genes)

- EAEC enteroaggregative
  - Shigella enterotoxin 1, plasmid-encoded toxin, stacked adhesion

- EIEC enteroinvasive
  - Highly invasive, produce no toxins, adhesin proteins

- DAEC Diffusely Adherent
  - Diffuse adherence pattern
STEC/EHEC

- This is the pathotype we will be learning about today
- Cattle are the main source
- It’s the most common in E. coli foodborne illness and it’s a BAD guy!
ETEC – Enterotoxigenic E. coli

- **Not common in the U.S.**
  - Mainly found in areas of the world with poor sanitation
  - “Travelers Diarrhea”
  - Production of LT (heat-labile) and ST (heat-stable) toxins as well as colonization virulence factors

- Caused by consuming food and water contaminated by fecal matter

- Disease resembles cholera because it can cause severe diarrhea and dehydration - Mostly affects children

- Mortality: WHO estimates
  - ~380,000 deaths worldwide, mostly children

- Onset of symptoms range from 8-44 hours
**EIEC — Enteroinvasive E. coli**

- **Humans** are the only carriers therefore, contamination comes from contact with food or water contaminated with infected human feces.

- Closely resembles *Shigella* because of their ability to invade colonic epithelial cells and cause mild dysentery.

- Not frequent in U.S. and can be misdiagnosed as Shigellosis (disease caused by *Shigella* spp.).

- Disease is mild and includes diarrhea, stomach cramps, fever, vomiting – typically lasts a few days.

- Onset of symptoms range from 12-72 hours.
EHEC – Enterohemorrhagic E. coli

- Most common type of disease producing E. coli

- Main difference between this pathotype and the others we talked about is that EHEC produce Shiga toxins (Stx1, Stx2)

- O157:H7 gets the most press but non-O157 serotypes are just as virulent and cause severe illness!
# EHEC O104:H4

## IN FENUGREEK SPROUTS

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<th>Country</th>
<th>Deaths</th>
<th>HUS cases</th>
<th>Non-HUS cases</th>
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<tr>
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</table>

Data Source: WHO, EHEC outbreak: Update 30 (22 July 2011)
Foods Implicated

- Raw, undercooked beef (mainly O157)
- Raw milk, juices
- Fresh produce (bagged lettuce, spinach and sprouts have all causes outbreaks and lately of non-O157 strains)
- Cheeses, mayonnaise, yogurt
- Cookie dough
Disease Caused by EHEC

- Children and people with weakened immune systems are at high risk

- Symptoms typically appear 3-4 days after ingestion of organism

- Severe stomach cramps

- Bloody, watery diarrhea = hemorrhagic colitis

- Symptoms last ~7 days with hemorrhagic colitis

- May progress (~3% of cases) to a life-threatening disease called HUS (hemolytic uremic syndrome)
THROMBOTIC THROMBOCYTOPENIA PURPURA (TTP)

- "Thrombotic" (throm-BOT-ik) refers to the blood clots that form

- "Thrombocytopenic" (throm-bo-cy-toe-PEE-nick) means the blood has a lower than normal number of platelets

- "Purpura" (PURR-purr-ah) refers to purple bruises caused by bleeding under the skin
Pathogenesis of HUS

- Shiga toxins enter circulatory system through intestinal mucosa
  - Research shows that Stx2 and intimin may be associated with severe disease progression

- Localizes in kidneys and damages or kills endothelial cells (interior layer of blood vessels)

- Activates a clotting cascade resulting in blood clots in small blood

- Platelets and clotting factors are consumed and severe bleeding and multiple organ damage and death can occur
<table>
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<th>INGESTION</th>
<th>COLONIZATION</th>
<th>TOXIN RELEASE</th>
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**Ingestion**

- **E. coli** colonizes the intestine

**E. coli** secretes Shiga toxins into blood

- **Shiga toxin 1** (Stx1)
  - bloody diarrhea
  - severe abdominal pain
  - hemolytic anemia
  - thrombocytopenia
  - 30% hospitalization

- **Shiga toxin 2** (Stx2)
Hemolytic Uremic Syndrome (HUS)

- Decreased urine
- Blood in urine
- Thrombocytopenia (low platelets)
- Kidney failure/permanent kidney damage
Testing for EHEC in Foods

1. Pre-enrichment 24 hr
2. DNA Extraction
3. rtPCR screening for Stx1, Stx2
4. Selective media isolation Can take days

Serotyping

Confirmation 8-12 hr

Identification Takes Days

Slide adapted from FDA CVM
WHAT IF YOU DON’T HAVE O157 AND YOU NEED TO ISOLATE A NON-O157 STEC?
Typical EMB agar plate where STEC are picked from – cannot distinguish from generic E. coli

Raise your hand if you know which E. coli colony on this plate is producing shiga toxins
Support bacteria.

It's the only culture some people have.

THANK YOU!