

# The enterics

## General features

- They are all gram negative bacilli
- **Facultative anaerobes**
- Some are part of intestinal normal flora (animals or humans)
- Contaminates water, soil and vegetables (fecal oral route mostly)
- Most of these bacteria has more severe effects on children
- Fecal oral infection

## Types of diarrhea (MRS):

A, B are considered noninvasive (i.e. doesn't reach circulation) while C is invasive (many systemic effects)

- **No cell invasion:** the bacteria releases its endotoxin in the G.I tract, causing severe **watery diarrhea**. No systemic symptoms. **No pus or blood in stool.**

Mechanism of watery diarrhea:

Enterotoxins released by bacteria inhibit the reabsorption of Na<sup>+</sup> and Cl<sup>-</sup> (by activating adenylate cyclase) and stimulate secretion of Cl<sup>-</sup> and HCO<sub>3</sub><sup>-</sup> into intestinal lumen. Water follows by osmosis causing watery diarrhea.

**A- Invasion of the intestinal epithelial cells:** Bacteria can invade cells, and it can release toxins to destroy cells. Leukocytes reach the site of infection (immune-mediated inflammatory reaction). Stool that contains blood and pus. Fever occurs as well.

**B- Invasion of blood stream and lymph nodes:** in addition to B (blood and pus in stool and fever), these infections will cause systemic symptoms:

- 1- Fever and headache
- 2- High WBC blood count
- 3- Lymph node enlargement
- 4- Sepsis (bacteria might reach specific organs such as liver, bones etc...)

No cell invasion	Invasion of the intestinal epithelial cells	Invasion of blood stream and lymph nodes
1- Diarrheagenic (Enterotoxigenic) E.coli 2- Vibrio cholera	1- Enterohaemorrhagic E.coli 2- Shigella 3- Salmonella enteritis	1- Salmonella typhi 2- Campylobacter jejuni 3- Yersinia enterocolitica

## Lab diagnosis

(Refer to it as you go)

Media used inhibits growth of gram-positives

### MacConkey agar (slide 4):

- Bile salts in the medium to inhibit Gram+ve bacteria
- Lactose fermenters develop a **pink-purple** coloration, non-lactose fermenters are **colorless**.  
Example used in slides: E.coli which is a lactose fermenter

### CLED agar (mesh mohemm)

#### Wiki:

- Lactose fermenters produce yellow colonies on CLED agar.
- Non-lactose fermenters appear blue.

### TCBS agar (selective)

- Used for isolation of **salmonella, vibrio cholera and shigella** (non-lactose fermenters; slide 15)

### Hekton enteric agar (slide 10)

Lactose fermenters form orange or pink colonies (E.coli) and non-lactose fermenters (e.g. salmonella and shigella) form greenish colonies.

### Biochemical tests must be done for full identification

<b>Ferments lactose (lactose +ve) mnemonic:SEEK</b>	<b>Does not ferment lactose (lactose -ve)</b>	<b>Nonmotile (others are motile-flagella H antigen)</b>
Serratia Enterobacter E.coli Klebsiella	Pseudomonas aeruginosa Proteus Shigella Salmonella Vibrio cholera	Klebsiella Brucella Shigella

### Escherichia coli:

Multi-flagellated and ciliated

#### Diseases:

- 1- E.coli is the **most common cause of UTI** (40-70%). Five times more common in women.  
Hospitalized patients at higher risk.
- 2- **Sepsis** (not the enteric form). Mainly in hospitalized patients with urethral catheters.
- 3- **Neonatal meningitis**. Remember: E.coli, Strep B, and listeria are the most common cause of neonatal meningitis)
- 4- **Diahrrea** (see below)

## E.coli Diarrhea

Two main types: Diarrheagenic E coli strains and Enterohaemorrhagic. BOTH ARE NON INVASIVE (doesn't reach circulation)

### Diarrheagenic E.coli

- More common in children
- It's mild diarrhea (**enterotoxigenic**); **watery diarrhea**.
- Enterotoxins are: heat labile toxin **LT**, and heat stable toxin **ST**.
- Also called "**travelers' diarrhea**" (when travellers drink contaminated water during their travel)
- Contamination of vegetables, water etc...
- This type of diarrhea is **self-limited**; **antibodies are not used**.

### Enterohaemorrhagic E.coli

- Common in intestine of cattle's. Thus acquired from Ground meat (hamburger!!), or dairy products
- Toxin: **verotoxin (Shiga-like toxin)**
- **Bloody diarrhea** (WBC's and blood in stool and fever)... Does not reach circulation
- Hemolytic uremic syndrome HUS:  
**Wiki:** In the classical form of HUS (90% of cases), the STEC (Shigatoxigenic group of E. coli) toxin enters the bloodstream and causes damage to the body's vascular endothelium. This is especially damaging to the kidney, where the toxin attaches to the glomerular endothelium and initiates a noninflammatory reaction leading to acute renal failure. Moreover, the generalized endothelial damage leads to platelet activation that causes thrombocytopenia (low platelet count). The renal glomerular endothelial cells express a receptor for the toxin.

## Klebsiella, Enterobacter, Serratia, Proteus, Providencia and Morganella species.

(Underlined ones are in MRS)

Proteus is urease positive

In hospitalized patients:

- UTI
- Sepsis
- Can be acquired from wounds as well

Table of biochemical tests:

Lactose-ve, urease positive & oxidase-negative	Lactose+ve, urease-ve & oxidase-negative.
Proteus, Providencia and Morganella	Klebsiella, Enterobacter and Serratia

### Klebsiella pneumonia:

- Klebsiella has a **polysaccharide capsule**
- **Non motile**
- Diseases (hospital patients at risk):
  - 1- **UTI**: second most common cause (after e.coli) in hospitalized patients.
  - 2- **Pneumonia**: violent pneumonia that destroys lung tissue → bloody sputum.

## Pseudomonas aeruginosa

- Common in water and **moist environment**
- Can be acquired from **wounds** or **burns**.
- Also it is common in hospitalized patients and immunocompromised patients
- A **blue green pus** around wound or injury is almost diagnostic
- Symptoms include:
  - 1- **External otitis media**
  - 2- **Pneumonia** (ventilators)
  - 3- **Septicemia** (from burns and wounds or IV lines)
  - 4- **UTI infections** (Urethral catheters)
  - 5- **Osteomyelitis** (a complication of septicemia)
- Remember that pseudomonas aeruginosa is multidrug resistant and is difficult to treat

## Shigella

- Diseases:
  - 1- The enterotoxin, **shiga toxin**, causes symptoms similar to enteroinvasive e.coli, i.e. purulent bloody diarrhea with fever.(Sh.sonnei and Sh.boydii)
  - 2- Shigella dysenteriae: same as above, but also can produce a **neurocytotoxin** which has many effects on the CNS and G.I motility (abdominal cramps ...)
- S. dysenteriae, like other enterics, is spread by contaminated water and food (smoked fish).
- Shigella, unlike enteroinvasive e.coli, is **only found in humans and is always pathogenic!**
- Lab diagnosis:
  1. Culture bacteria within 30 minutes to stool sample, because bacteria is highly susceptible to environmental factors.
  2. S-S agar or heceton enteric agar
  3. **TCBS agar**
  4. Control with sanitation and hygiene

## Salmonella

### General features:

- Biochemical: Lactose –ve, urease –ve
- **Motile (flagella = H-antigen)**
- **O antigen (like other gram –ve's)**

- Two main species (S. enteritidis and S. typhi)

### Salmonella enteritidis

- Fecal oral; **zoonotic** (contamination from meat, eggs, pets water etc...)
- Incubation time of 8-24 hours
- Diarrhea varies from mild to severe with fever. But it's never invasive (except in immunocompromised patients → septicemia and meningitis).

### Salmonella typhi (and paratyphi A, B)

- Disease is called typhoid fever OR enteric fever
- **Not zoonotic**
- Fecal oral route
- Salmonella typhi is invasive and can cause many diseases after reaching the system circulation:
  1. Diarrhea (bloody and purulent of course)
  2. Intestinal perforation and **ulceration** aid in systemic reach
  3. **Hepatosplenomegaly** (the spleen is trying to get rid of the encapsulated bastards!)
  4. Bacteria in blood can reach (bone = osteomyelitis, CNS = meningitis and lungs = pneumonia)
- Healthy carriers harbor this bacteria in their gall bladder and can infect other people if they don't wash their hands when they poop!

### Lab diagnoses

- TCBS agar or Hekton–Enteric
- For S. enteritidis sample taken from stool. For S. typhi sample is taken from stool, blood or any infected tissue.

### Vibrio cholera

- Aerobic organisms, live in alkaline medium pH >8-9
- Contaminates water (fecal oral)
- **Endemic** in India and Bangladesh, and can cause **epidemics** as well
- V. cholera El-Tor is one strain
- Only a human pathogen
- **Cholera toxin** (cholera toxin) is **heat labile**. (see first page for how toxin works)
- It causes severe watery diarrhea that causes rapid loss of water (up to 1 liter per hour!) and death may occur as a result of dehydration.

Complications are:

- 1- Hypovolemic shock
  - 2- Vomiting and diarrhea
  - 3- Acidosis
  - 4- Muscle cramps
- Treat by supplying fluid and electrolytes. Use of antibiotics is to stop bacteria from appearing in feces (stop the epidemic)

- Lab diagnoses: Feces culture, TCBS agar

## Brucella

- Causes **brucellosis (malta fever)** malta fever in humans
- Non-motile, facultative intracellular bacteria.
- A pathogen of animals (**zoonotic**)
- Causes infections in reproductive organs and abortions in animals
- **Br.abortus** (abortion in cattle) and **Br.melitensis** (Goats and sheeps)
- Most infections in Jordan by Br.melitensis
- Means of transmission: [unpasteurized milk or milk products, direct animal contact (only few bacteria enter through skin abrasion, GI, eye or inhalation)]
- Symptoms include (has an incubation period of 1-6weeks):
  1. **Intermittent fever (undulant fever):** temperature rise at day and decline at night. (unlike typhoid fever which is consistent)
  2. **Lymphadenopathy** (bacteria can reach lymphatics and intracellular growth in macrophages)
  3. Headaches (**meningitis**), sweats, backpains, bone pain (**osteomyelitis**) and **arthritis**.
  4. If untreated, the disease can become **chronic** (in **bones** and **joints** mainly).
- Prevention: vaccination of animals, slaughtering infected animals and pasteurizing milk.

## Lab diagnosis

- Culture blood, CSF or Bone marrow (in chronic infection)
- Brucella agglutination test
- Treat with 6-8 weeks of antibiotics.

## Campylobacter

- Looks like V.cholera (slender and motile rod with single flagellum)
- **Microaerophilic**
- Animal pathogen (**zoonotic**) causes abortions in sheep and cattle
- Bloody purulent diarrhea accompanied with fever, nausea, headache and muscle pain
- Illness occurs 2-5 days after ingesting contaminated chicken meat, milk or water
- Diagnoses: stool sample

## Helicobacter pylori

- A spiral shaped bacterium that infects in stomach (**in the protective mucus lining of the stomach**) and duodenum
- Up to 10% of children and 80% of adults can have this infection without showing symptoms
- Symptoms:
  - 1- **Peptic (stomach) ulcer,gastritis or duodenal ulcer**

- 2- Burning abdominal pain, nausea and vomiting
- 3- Persistent ulcers may develop to **stomach cancer or lymphoma**
- Lab diagnosis: biopsy stomach/duodenal ulcer (42C), **urea breath test**  
**wiki:** urea breath test is based upon the ability of H. pylori to convert urea to ammonia and carbon dioxide. Urea breath tests are recommended in leading society guidelines as a preferred non-invasive choice for detecting H. pylori before and after treatment.