

# SLIDE 8

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P.S: ALL ADDITIONS TO  
THE SLIDES WERE TAKEN  
FROM THE BOOK

## *Enterobacteriaceae*

- *E.coli*
- *Klebsiella-Enterobacter species*
- *Proteus-Providencia species*
- *Salmonella and Shigella*

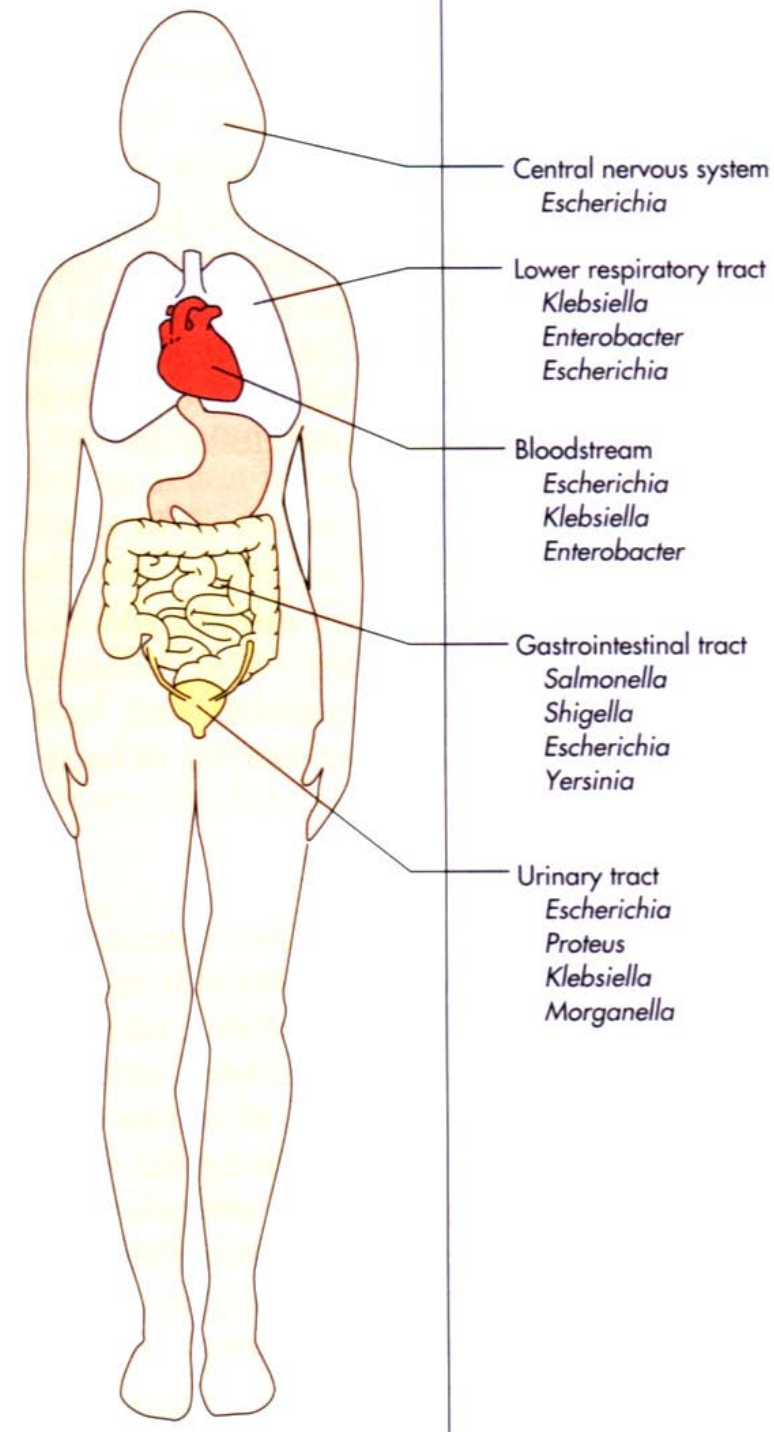
*Pseudomonas aeruginosa*

*Vibrio cholerae*

*Campylobacter*

*Helicobacter*

*Brucella*



# Enteric Bacteria (Escherichia, Klebsiella, Enterobacter, Proteus, Salmonella, Shigella, Yersinia )

- **General Characteristics:**

- Gram - ve bacilli,
- Facultative anaerobes,
- Intestinal normal flora..
- Humans, animals, birds..
- Found Commonly in waste water, natural water, soil, vegetation.
- Classified to : Lactose fermenters –E.coli- and Lactose non fermenters –Salmonella,Shigella,P.aurgionsa-
- Catalase +ve & Oxidase –ve

- **Opportunistic Pathogens & Obligate Pathogens**

- Causing all types of human infection and diarrhea, and they can be common nosocomial infections –hospital acquired pathogens-.

- **Pathogenicity:**

- Various Enterotoxins,
- Endotoxins
- Capsule, **K-antigen**
- Flagella, **H-antigen**
- **O-antigen, the most Out antigen.** All of the O-H-K-Antigens.  
Develop specific antibodies following blood infections

- 1. **Escherichia coli**: Causes :

1. Common Urinary Tract Infection (40-80%).
2. Septicemia, Wounds.
3. Neonatal Meningitis-3 causes this : **E.coli, Listeria, group B Streptococcus-**

# *Diarrheagenic E. coli Types*

6 major types causing diarrhea: 3 Common types depend on what virulence factors E.coli possesses.

## **1- Enteropathogenic (EPEC)**

- Caused by Numerous strains (mostly infants 1-6 months), Watery diarrhea, less Vomiting.
- Chronic cases/ fatal.

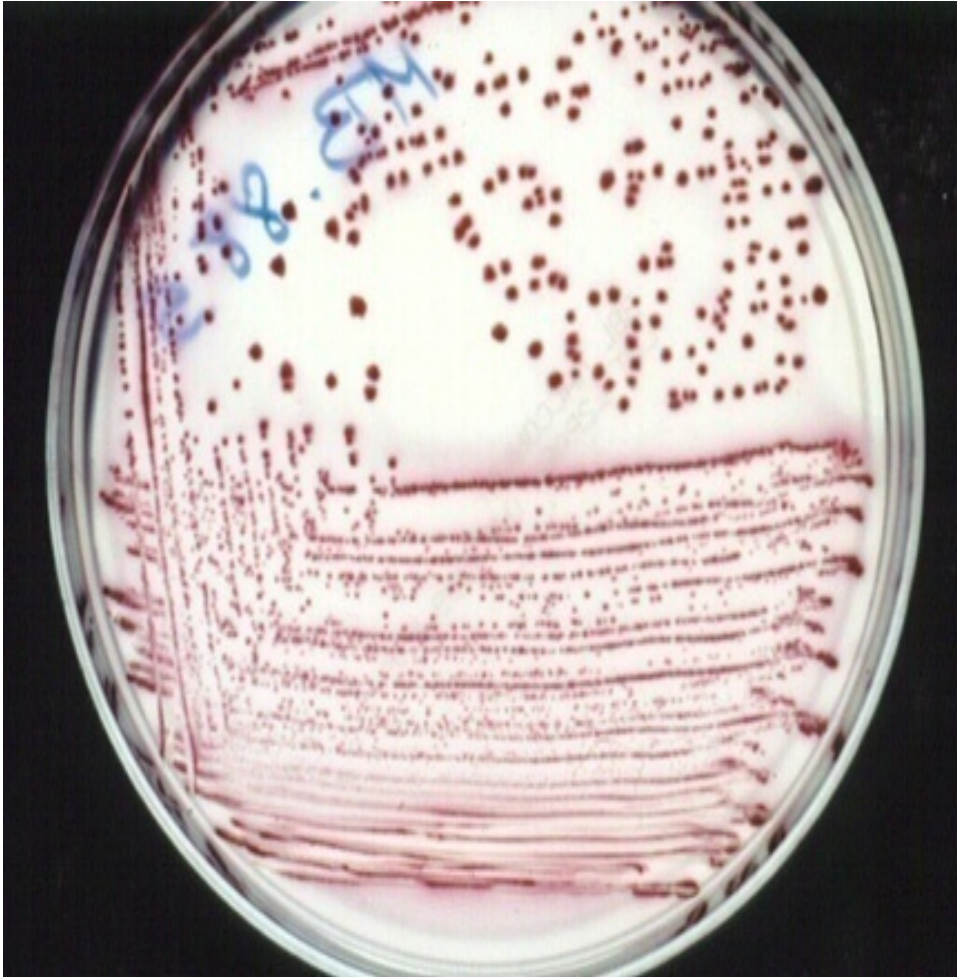
## **2-Enterotoxigenic (ETEC): 'like rice water'**

- Virulence factors are: Heat-labile and heat-stable enterotoxins, these inhibit the reabsorption of Na<sup>+</sup> and stimulate secreting of Cl<sup>-</sup> and HCO<sub>3</sub><sup>-</sup> and water follows the osmotic pull of these ions ending up with a severe watery diarrhea. Happens in Children more than adults, and called Traveler's diarrhea.
- Happens because of fecal water contamination /vegetables / fresh food so it's an Indicator standard of hygiene,
- Self-limited diarrhea and no antibiotics treatment.

**3 Enterohaemorrhagic (EHEC):** caused by a strain called E.coli O157:H7, virulence factor is chiga-like toxin which is similar to that found in shigella and also called Verotoxins. These toxins are inhibiting protein synthesis in the epithelium so leading to intestinal cell death.

- Common in intestinal Cattle.
- Contamination Ground meat/Hamburger, Dairy products
- Results in bloody diarrhea, Haemolytic-uremic syndrome (HUS) -uremia and anemia, ...-
- fatal.

*E. coli* Culture — Red color on MacConkey agar indicates Lactose positive & Gram-stain



## 2. *Klebsiella - Enterobacter species* :

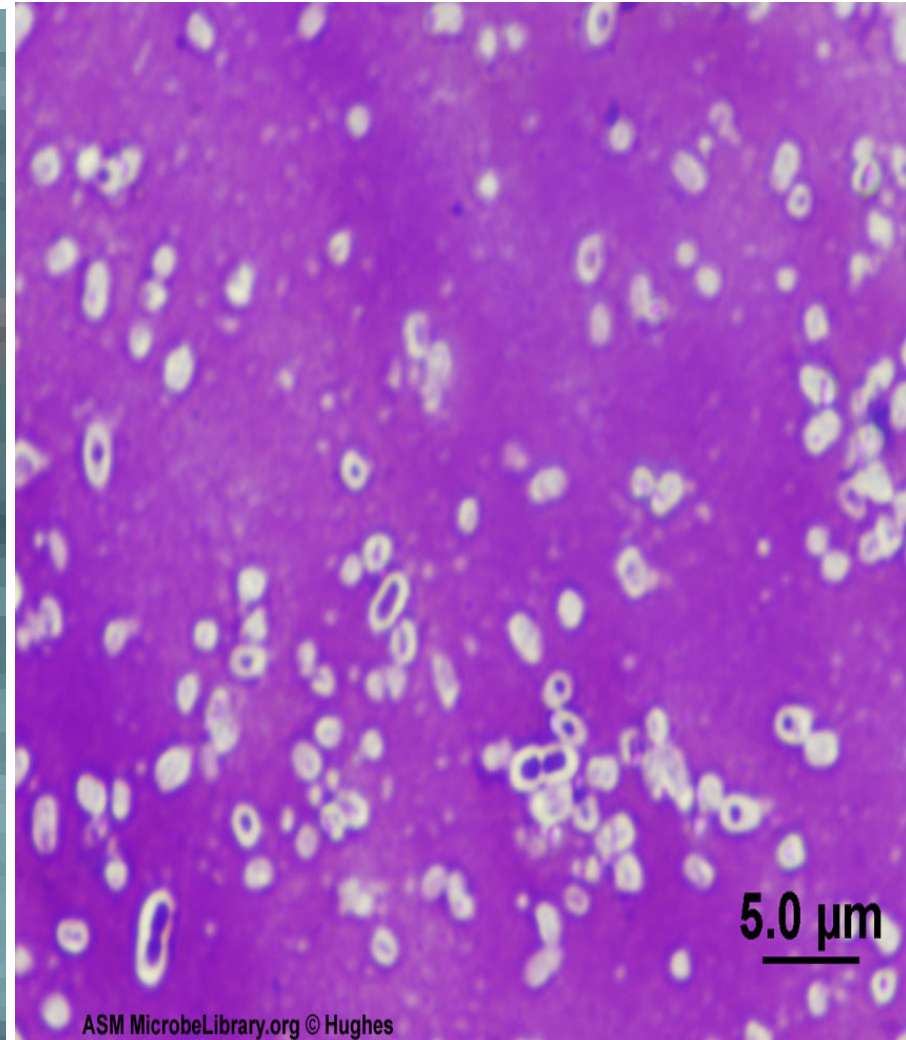
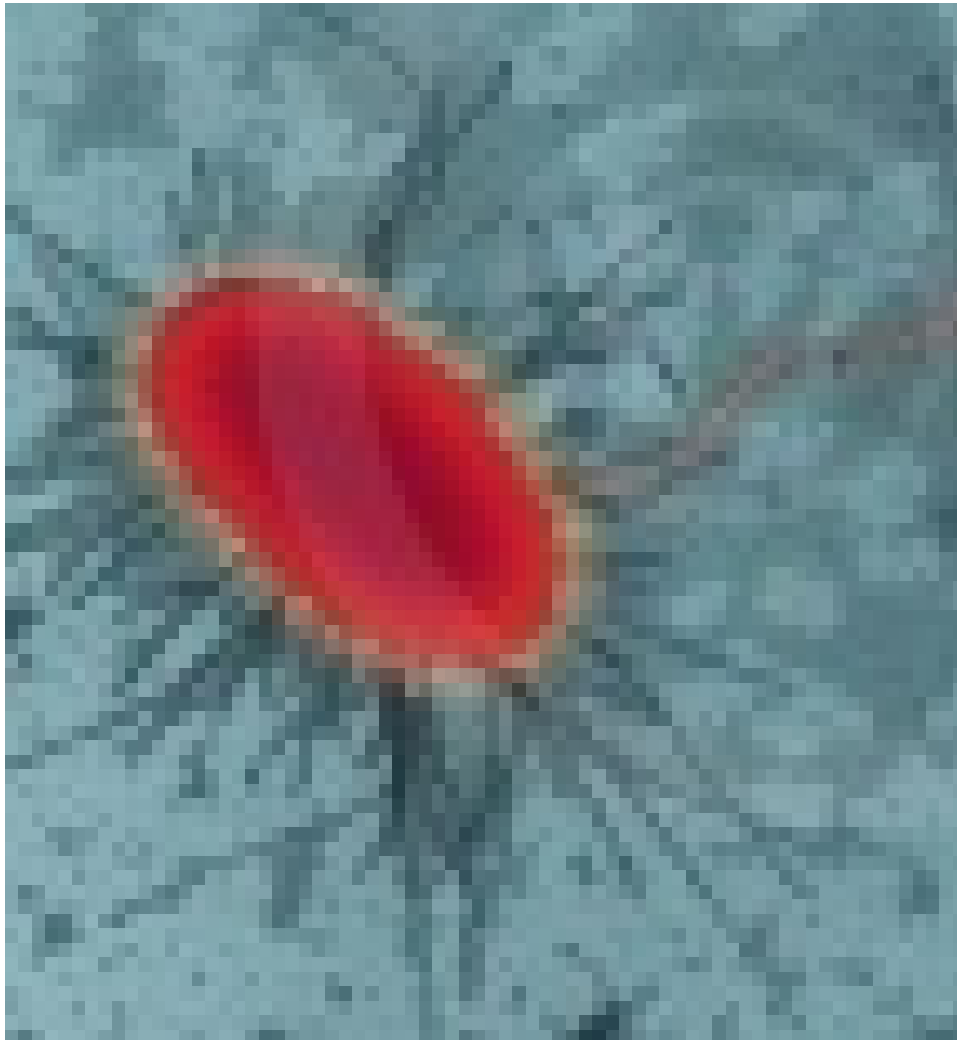
- Causes UTI, Septicemia-second cause after E.coli-, Wounds.
- Rarely cause Meningitis.
- Common in Hospitalized patients.
- Encapsulated *K. pneumoniae* –k antigen- causes Nosocomial infections and Pneumonia.

## 3. *Proteus-Providencia species*:

- common cause of UTI and hospital acquired infections - nosocomial- and causes Septicemia, Wounds.
- Proteus causes renal stones. Urease positive –it is able to break down urea and examination of urine will reveal an alkaline pH because of Urease activity-.



*E. coli*- Flagella- Fimbriae - Pili  
*Klebsiella pneumoniae*-Capsule





# 3. Pseudomonas group

## **Pseudomonas species :**

- Gram-ve bacilli.
- Facultative anaerobe.
- oxidase+ve and Lactose-ve.
- Found in soil, water, plants , animals.
- Survive under harsh condition, including Alcohol used in aseptic procedure. More than 20 pseudomonal species can cause human infections.
- ***P. aeruginosa*** : is an opportunistic pathogen –it won't infect a healthy person, only sick and immunocompromised patients.-
- Colonize in URT & intestine humans.
- Produce blue-green pigmentation / pyocyanin-the blue one's name- and fluorescein.
- Release many enzymes.
- It is the most common species causes a clinically significant infection.'you will hear so much about this bugthatyou'll wish god had never conjured it up'
- **often causing nosocomial infections, serious and often life-threatening diseases.**
- Wound-burn wounds-, blood sepsis, pneumonia, External ear infection, Urinary catheters, endotracheal tubes. Common in intravenous [IV] line abusers.
- **BE PSEUDO** : Burns > Endotracheal tubes > Pneumonia > Sepsis > External otitis media > Uti > Diabetic psteomyelitis
- Innate resistance to many antibiotics and Develop rapidly resistance to antimicrobial agents. Resistant to almost every antibiotic

## 4. *Shigella* group

Common serotypes: ***S. Sonnei, S. boydii, S. dysenteriae***

- Gram -ve, Lactose-ve and doesn't produce H<sub>2</sub>S with S-S agar.
- Susceptible to dryness, acidity, Low-High Temperature.
- Fecal-Oral infection through contaminated Water and fresh Vegetations.
- Few serotypes.
- Infect only humans. Incubation 1-2 Days
- **Pathogenicity:**
  - Endo/Enterotoxins released in intestine –like EHEC inhibit protein synthesis so killing the cells by shiga toxins- causing Purulent-Bloody-Diarrhea. (bacillary dysentery) with abdominal pain, fever, not invasive.
  - No chronic or healthy carriers.
- ***S. dysenteriae (Shiga type toxins)***
  - Enterotoxin /Neurocytotoxin, causes Severe intestinal Necrosis, Fever, Severe Purulent-Bloody-Diarrhea, Abdominal Cramps, CNS. Rare Septicemia.. Can be fatal without treatment.

### **Lab Diagnosis:**

Rapid culture Feces/rectal swabs on S-S Agar, Hektoen –Enteric Agar.. Recommended Antimicrobials Treatment.. Prevention through Control Sanitation & hygiene food and Foodhandlers.

# 5. Salmonella group

- Gram-ve bacilli.
- Facultative anaerobes.
- Lactose-non fermenters.
- Virulence factors like (Endotoxin / LPS).
- Common in Nature (water and soil), Humans, Animals, Birds.
- They are not part of the normal human flora.-according to the book this is not really true except for salmonella typhi, because it's part of the normal GI animals flora and transmitted to us through contaminated food or uncooked eggs! Only typhi ones are found only in human – not zoonotic-.
- O/H Antigens with specific antibodies. –O is protection it from antibodies and H is for motile 'like salmon'-
- Pathogenic when ingested causing enteritis-gastroenteritis-, systemic infections and enteric fever.
- Types : 1- S.typhi 2-S.enterecia 'non typhi'

- **1. *S. enterica/enteritidis* : causes Nontyphoidal Salmonellosis / Gastroenteritis from Food-poisoning.**
- This group contains almost 2000 Serotypes.
- Zoonotic –infectious disease of animals that can be transmitted to man-.
- Common in Birds, Farm Chickens, Pets, Reptiles.
- Food borne disease: Contamination in fresh food, Chicken, Meat-Eggs, Dairy products.
- Large number of Salmonella cells causing diarrhea, Mild-severe watery-bloody diarrhea, Vomiting, Fever.–mostly watery and caused by cholera like toxin-
- Incubation 8-24 h.
- Self-Limiting in healthy persons, but infect Immunocompromised patients.
- Rarely Septicemia - Meningitis Infant / young Children..
- Human healthy carriers: Short periods. Animals carriers: Long period.

### ■ **Lab Diagnosis**

Culture Feces or Food.

Prevention and Control through Sanitation & hygiene in restaurants & slaughter houses and food-handlers.

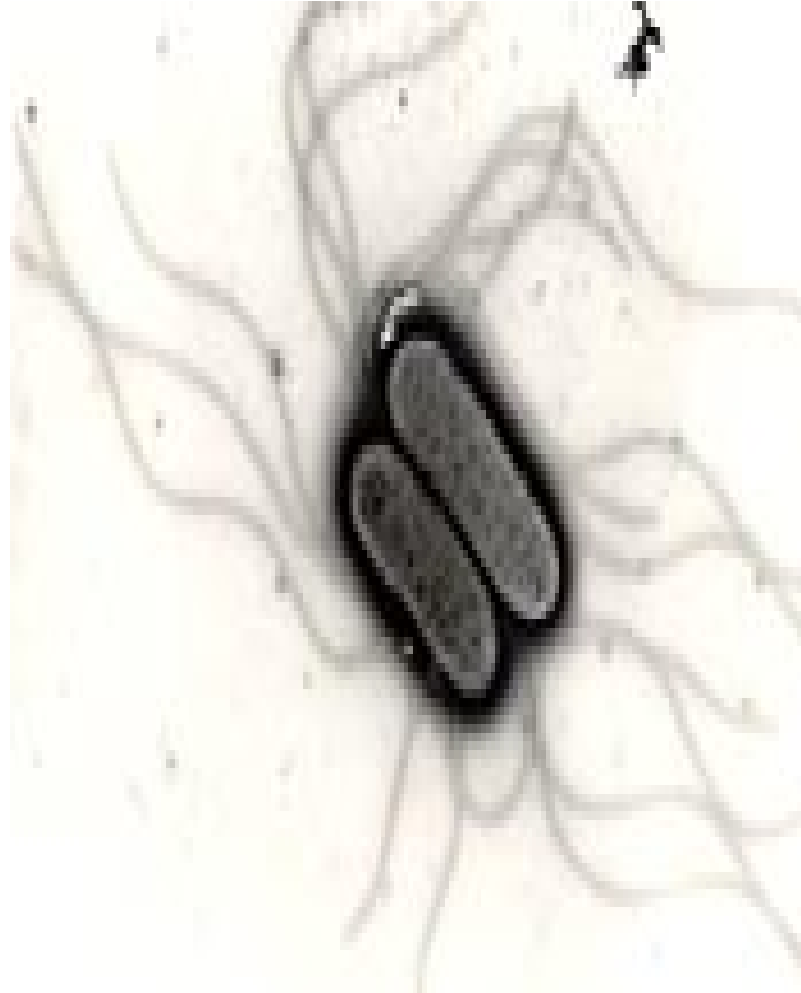
Treatment : no antibiotics only fluid and electrolyte replacement.

# Typhoidal Salmonella

## 2- Typhoidal Salmonella: (Human Enteric Fever)

- *Serotypes: Salmonella enterica /typhi & paratyphi A, B, C.*
  - Few cells Invasive, Only infect human.
  - transmitted Fecally –Orally through Water and Food.
  - Incubation:1-3 Weeks
  - High continuous fever, Bloody Diarrhea and constipation, Septicemia, Meningitis, osteomyelitis, Hepatosplenomegaly, Intestinal perforation.
  - Healthy Carriers: in Gallbladder, Intestine, Short period or Life Long .
  - Human Healthy Carriers are mostly women in Gallbladder (1-3%)
- Lab Diagnosis: Culture Feces, blood, Urine, CSF, Bone marrow, Selective Media: S-S Agar, Hektoen-enteric.
- and Serological **Widal Test –from serum-** for detection of specific antibodies against O & H antigens (Titer > 160)
- Antibiotics –**ciproflaxin and ceftriaxone-**, Human vaccine is available.

# Salmonella/ Flagella



Hektoen–Enteric agar: *Salmonella* transparent colonies, +H<sub>2</sub>S Lactose-ve. *Shigella* :  
transparent, lactose-ve

*E. coli* : orange colonies, Lactose-ve

*to distinguish between E.coli and Shigella “lactose fermenters”*  
*between Shigella and Salmonella “H<sub>2</sub>S”*





**SS agar for Salmonella & Shigella**  
**Salmonella..Transparent colonies+H<sub>2</sub>S.. Others fecal**  
**flora will be inhibited to 98%**



*Salmonella*

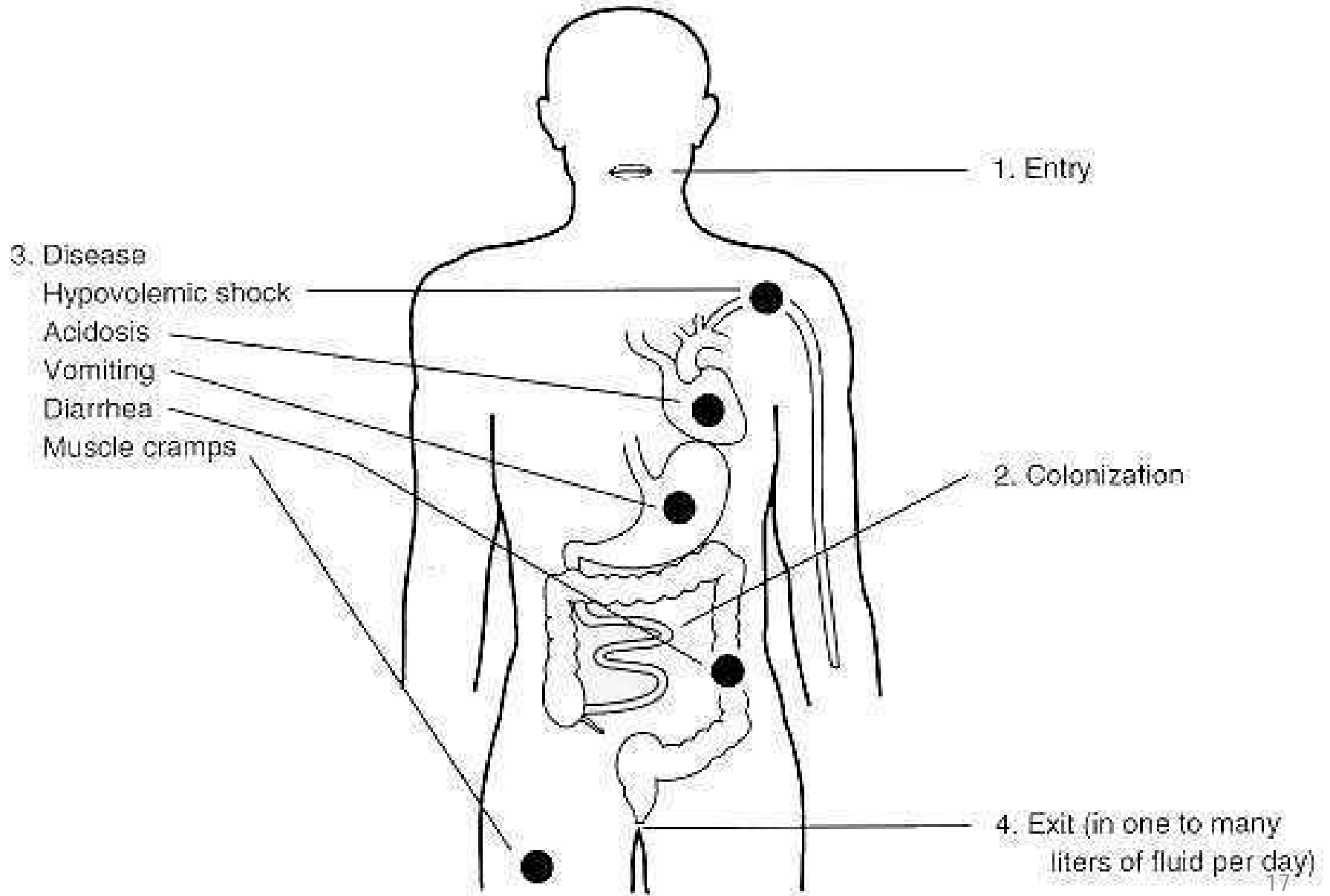


*Shigella*

# 6- *Vibrio cholerae*

- Gram-ve Vibrios 'comma shaped' like a hilal with tale, motile by flagellum.
- Lactose-ve, oxidase positive.
- Aerobic Growth and alkaline medium (pH >8-9) "infect intestin".
- Transmitted through contaminated Water, Fresh Food and Reservoir contaminated water/Raw Sea. And it's a Salt tolerant.
- Endemic In India/Bangladish but epidemic Disease, causing human Outbreaks.
- Asymptomatic/symptomatic person
- **V. cholerae-01**: Type El-Tor.. ???!!
- Only Human is infected through Fecal-oral infection.
- Small Intestine Infect.
- Produce Cholera toxin- enterotoxin which do like ETEC-, Heat labile toxin
- Incubation 8-48 h.
- Results in Severe water diarrhea (rice water stool), Severe dehydration, Blood acidosis which can lead –if the patient is not rehydrated- to Shock, Death within hours.
- No invasion.
- **Lab Diagnosis**: Feces Culture and Selective TCBS agar.
- **Treatment**: Rapid replacement fluids & electrolytes with Antibiotic –doxycyclin- to shorten the illness duration.
- Control through :Public Heath sanitation measurements and Human Vaccine.

# Cholera



# TCBS agar for isolation of *V. cholerae*



# 7- Brucella species

## Brucellosis/Malta Fever

- Gram-ve coccobacilli, Microaerophilic.
- Produce Endotoxins and it's highly infectious.
- Primarily pathogens of animals (Zoonosis), causes Localized Infection in animal reproductive Organs, Sepsis and Abortions for cows.
- **Species:** *B. abortus* (Cattle-causes abortion for cows), *B. melitensis* (infect Goats/Sheep), and there are Rare other species in Jordan & Arab countries.

- **Transmitted to Humans:**

The bacteria are transmitted from animals to humans by ingestion infected food products (Dairy ), direct contact with an infected animal or by inhalation of aerosols.

- **Pathogenicity:**

Enter through GI, skin abrasions, eye or via inhalation/Droplets.

then it's phagocytosed and lives Intracellular (macrophages).

Incubation:1-6 Weeks.

Symptoms: Intermittent fever-elevated in night and then slowly returns too normal by morning-, headaches, fatigue, joint and bone pain, GI Symptoms, Sweats, septicemia, meningitis, chronic disease with complication on CNS.

- **Lab Diagnosis:** from Blood, CSF, Bone marrow cultures.
- Brucella :1-4 weeks culture incubation.
- Test for : agglutination Test, Specific Antibodies (IgM and IgG).
- **Treatment:** 6-8 Weeks with Antimicrobial drugs.

## 8- Campylobacter Species

- **Many species.. Most human infection *C. jejuni*, *C. infantis***
- Microaerophilic, Optimal Growth 42 C.
- Gram-negative thin- curved, Motile Bacilli/Bipolar flagella.
- Grow slowly over 3-6 days in vitro culture.
- This bacterium became important enteric pathogen since 1976.
- Widely spread in small animals, dogs, cats, birds. It is primarily an animal pathogen causing **abortion and enteritis in sheep and cattle.**
- **Human illness** usually occurs 2-5 days after ingestion of the contaminated Chicken meat, Milk, fresh food , water.
- Multiply in the small intestine → invade the epithelium → produce mild inflammation → cause bloody-watery/ mild-moderate diarrhea. And Few fecal **leukocytes found** in feces.
- causes occasionally blood sepsis in children
- Other symptoms often present are fever, abdominal pain, nausea, headache and muscle pain and Infection may be associated with arthritis
- **Diagnosis:** Stool culture .. **Selective Campylobacter Media** including 3 antibiotics/ biochemical tests.. Or direct detection of bacteria by PCR.

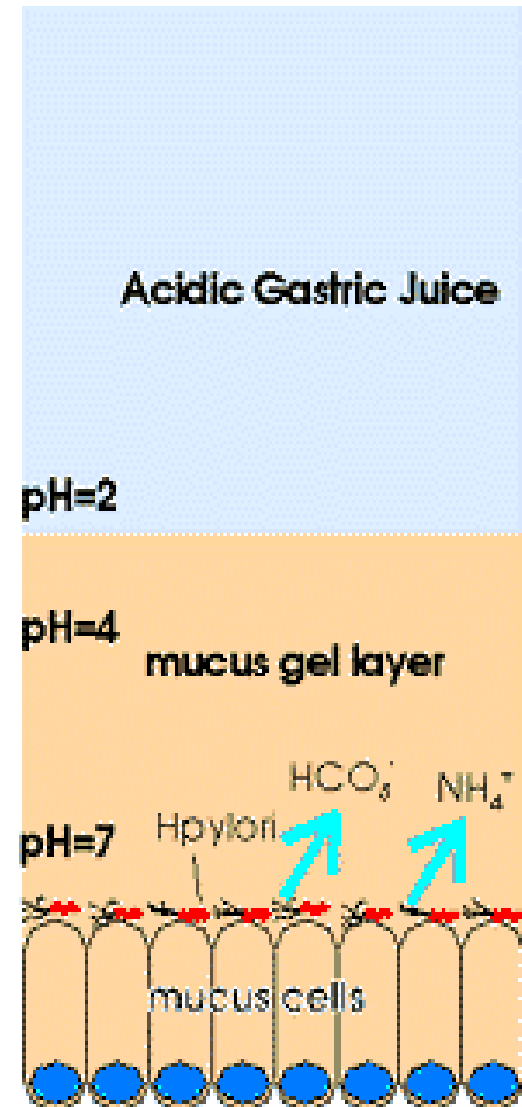
# Flagella of *Helicobacter pylori* & *Campylobacter jejuni* , Modified G-stain





# 9- Helicobacter Species

- *Helicobacter pylori*
  - Spiral shaped bacterium with multiple flagella.
  - Lives in the mucus lining stomach & duodenum causes chronic inflammation their like **Gastritis and Ulcers.**
  - Only pathogenic in human
- Release urease which convert urea into  $\text{CO}_2$ /bicarbonate & ammonia → neutralize stomach acidity and protects its colonies.
- *H.pylori*
  - Found worldwide, up to 10% of children - 80% of adults can have evidence of an *H. pylori* colonization/ mild infection - usually without having any clinical signs or symptoms..
- **Transmission route:**
  - Close personal contact.



# Helicobacter Species-2

- **Common symptoms:**
  - Gastritis /Peptic ulcer, Painful sores or ulcers in Stomach or duodenum (Duodenal ulcers), Nausea, Vomiting.
- Persistence of ulcers → increased risk of stomach cancer and Lymphoma.
- *H. pylori* can be successfully eradicated (95%) using a combination of certain antibiotics and medicines that suppress stomach acid production.
- Common Re-occurrence within few weeks - months.
- No vaccine
- **Diagnosis:**
  - Urea Breath test, Culture biopsy stomach.
  - Selective Medium with 3 antibiotics.
  - Incubation 37C, 4-6 days.
  - Serological test: *H. pylori* antibodies not significant for clinical diagnosis alone.

# 10- *Acinetobacter* group

- Many species.. Pleomorphic aerobic gram-negative bacillus –they change their appearance to cocci or diploid like *Neisseria*-, aerobic.
- Catalase +, Oxidase-ve, lactose-ve.
- Commonly found in water, moist hospital environment –nosocomial infection-.
- contaminate irrigating solutions and intravenous solutions and respiratory equipments, catheters -because it can survive for extended periods on surfaces so they're easily transmitted-.
- Asymptomatic skin carriage, nasopharyngeal carriage.
- Commensal, low virulence.(**Opportunistic pathogen**)

## ***A. baumannii*** :

- Common species of Acinobacter.
- often represent colonization rather than infection
- Found in skin, urine, wound & sputum hospitalized patients.
- **Nosocomial infections:** in Immunodeficient patients & others ICUs Patients .
- **Infections:** Pneumonia, Bloodstream Wound, Meningitis.
- Develop rapidly resistance to most used antibiotics, it's a Multidrug-resistant.
- ***A.baumannii*** is a new emerging pathogen in hospitals worldwide with high mortality.