Gastrointestinal Tract Module
Bacterial infections

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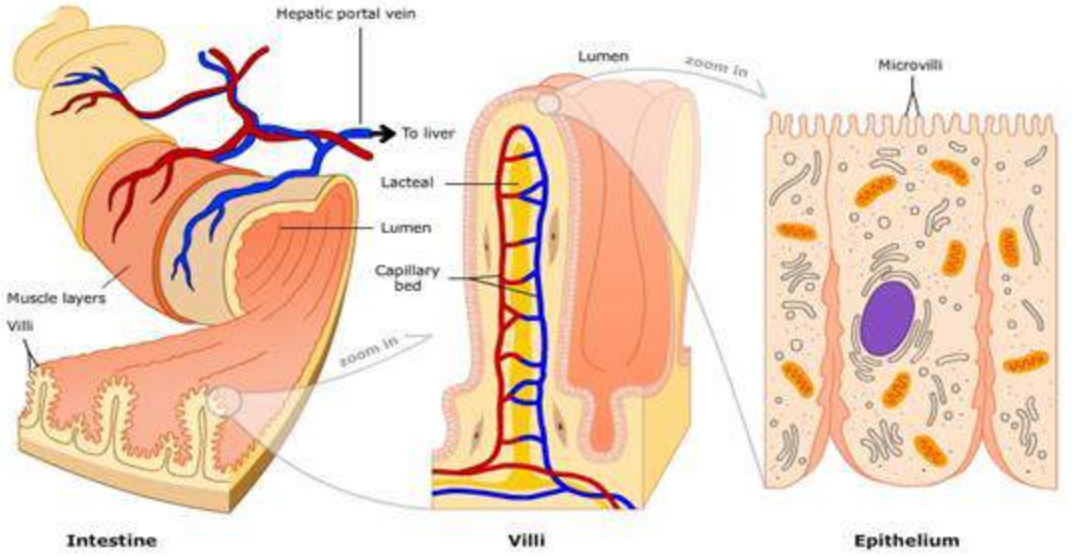
Bacterial infections of GIT

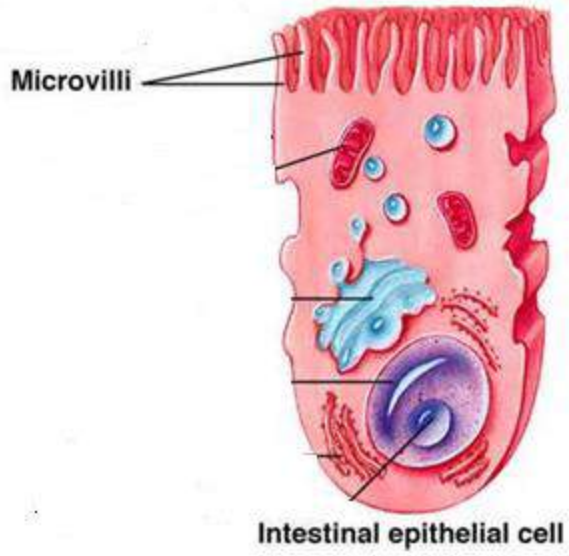
Introduction

GIT structure and histology

- Continuous tube, pathway of food through the body
- Four layers of tissue:

1. Mucosa – epithelial layer, secretes mucus
2. Submucosa – blood vessels, nerves
3. Muscularis – two or three muscle layers
4. Serosa – thin, slippery, connective tissue



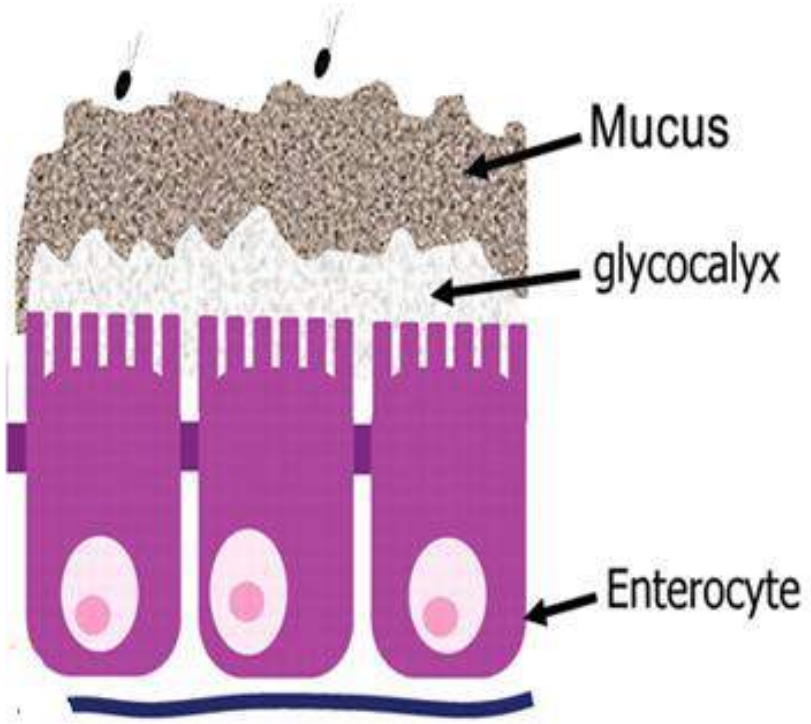


Bacterial infections of GIT

Introduction

Defense mechanisms of GIT

- **An unbroken mucosal epithelium**
- The **glycocalyx** is a glycoprotein and polysaccharide layer that covers the surface of the epithelial cells
- **Mucus** plays two roles in disease prevention:
  (1) It acts as a physical barrier
  (2) It coats the bacteria making it easier to remove via peristalsis
- **pH**
- **Bile**
- **Secretory IgA**
- **Peristalsis**
- **Peyer's patches**



Bacterial infections of GIT

Introduction

Factors that affect GIT

- Ingestion of antacids

Ex: Salmonella infective dose is about 1 million bacteria but with antacids or achlorhydria (1000 bacterial cell are enough)

- Antibiotic therapy
- Immunosuppressive drugs
- Cancer radiation therapy
- Ingestion of preformed toxins
- Ingestion of toxin producing microorganisms

Bacterial infections of GIT

Introduction

Impact of GIT infections:

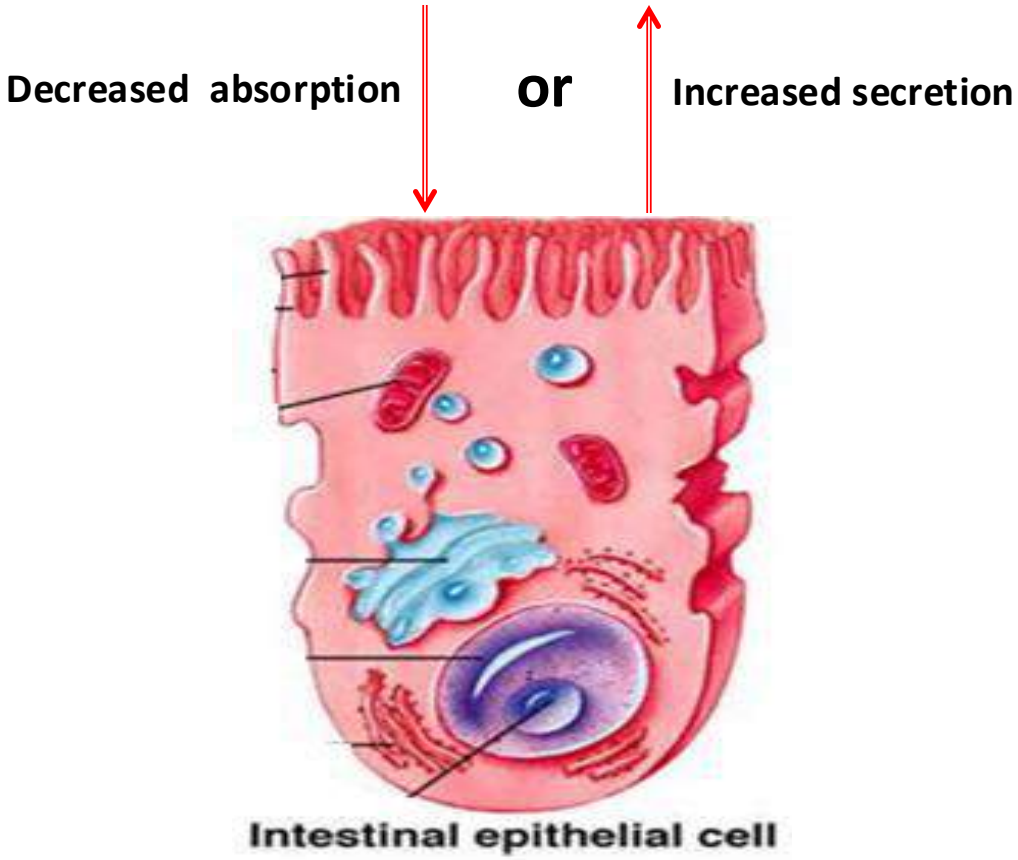
Diarrhea

- most common outcome of GIT infection
- Is the condition of having three or more loose or liquid defecation per day lasting less than 14 days
- High morbidity and mortality in the developing world
- Usually a self limiting condition

Bacterial infections of GIT

Introduction

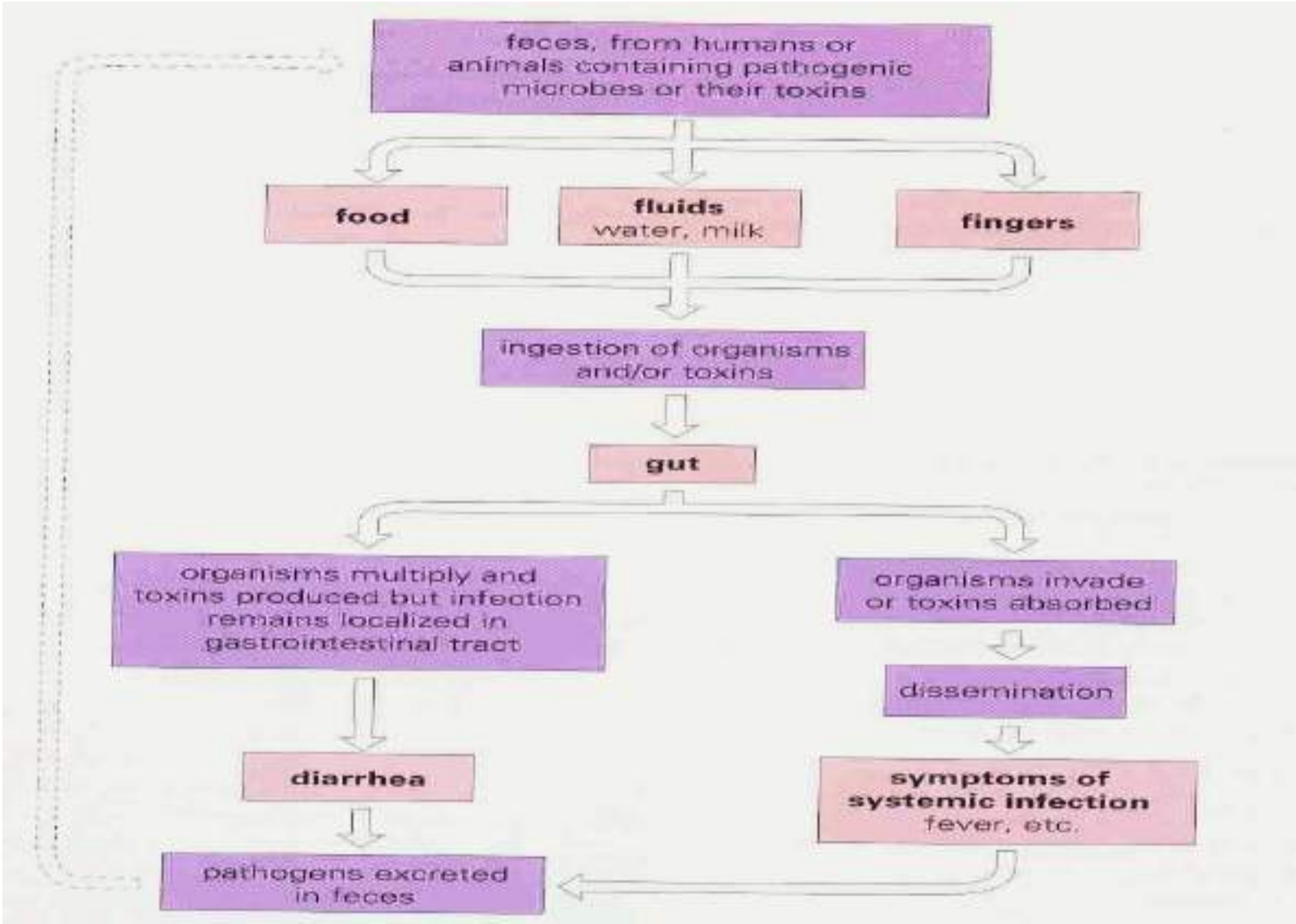
Pathophysiology of diarrhea



Bacterial infections of GIT

Introduction

General mechanism of GIT infection



Bacterial infections of GIT

Infectious diarrhea

Bacterial

S. aureus

Bacillus cereus

C. botulinum

C. perfringens

C. difficile

Shigella

Escherichia coli

Vibrio cholera

Salmonella

H. pylori

C. jejuni

Viral (stomach flu)

rotaviruses and others

hepatitis viruses

Parasitic

Protozoa and others

Bacterial infections of GIT

Classification of GIT associatd pathogens

Gastroenteritis/Food poisoning

S. aureus

C. botulinum

C. perfringens

B. Cereus

Watery (secretory) diarrhea

V. cholera

ETEC

EPEC

Cell invasion

Shigella

Nontyphoidal Salmonellosis

EHEC

EIEC

Antibiotic associated diarrhea

C. difficile

Cell invasion and bacteremia

C. Jejuni

Salmonella typhi

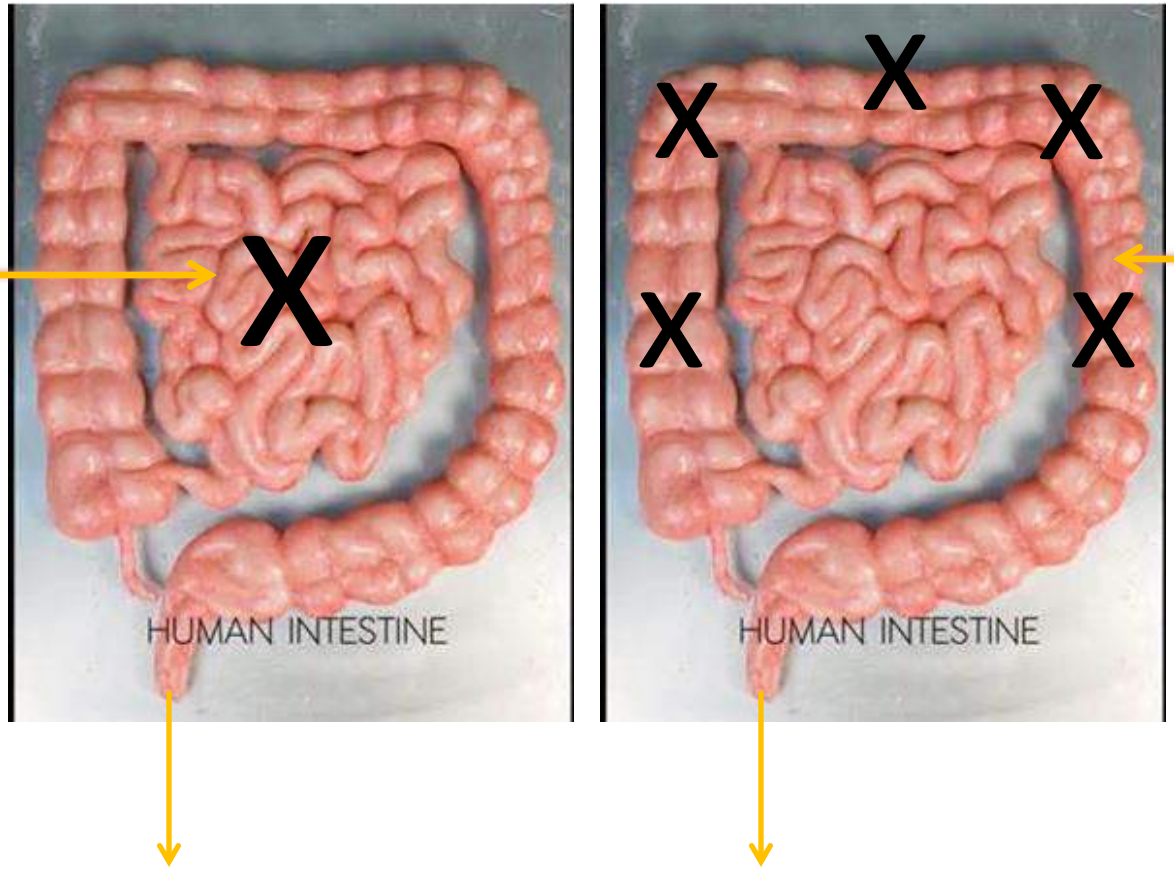
Gastritis and ulcers

H. pylori

Bacterial infections of GIT

Samll vs. Larg intestine

90% of fluids are absorbed from the small intestine



10% of fluids are absorbed from the large intestine

Small bowel diarrhoea : weight loss and large stool volume. Vomiting sometimes, changes in appetite, blood as melena, flatus, abdominal discomfort, ascites and oedema

Large bowel diarrhoea : small volume, often mucoid, more frequent, painful stools. Blood as hematochezia (is fresh). Tenesmus, Pain is lower-abdominal (left lower quadrant)

Gastroenteritis/Food poisoning

S. aureus

C. botulinum

C. perfringens

B. Cereus

Gastroenteritis/ Food Poisoning

General charactaristics of food poisoning

- Inflammation of GI tract
- Occurs due to consumption of food containing bacteria or their toxins
- Acute onset
- Self limiting

Gastroenteritis/ Food Poisoning

Staphylococcus aureus

- *S. aureus* is a gram positive cocci, catalase and oxidase positive

- It is a common bacterium found on the skin and in the anterior nares of up to 25% of healthy people and animals

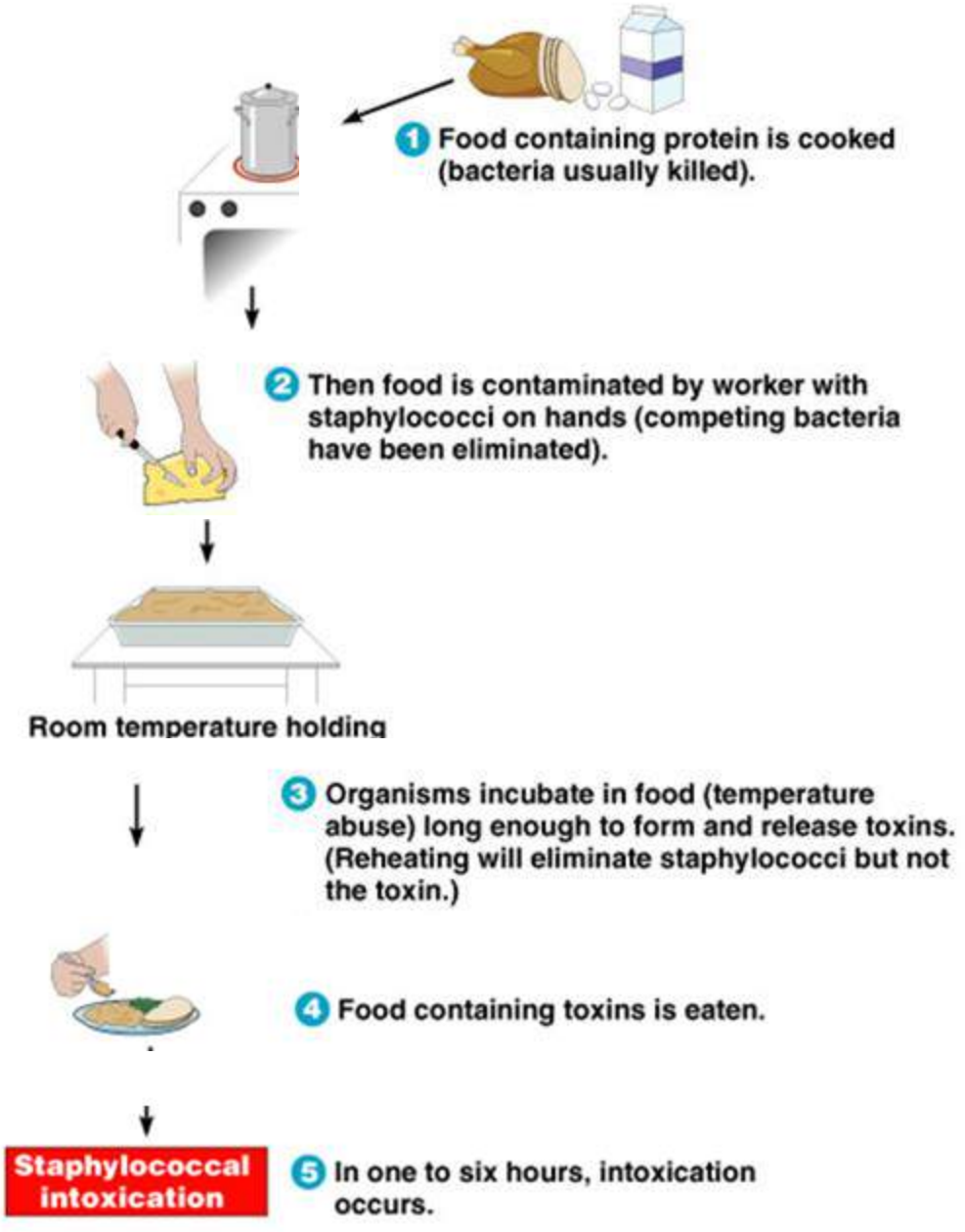
- Bakery, meat, poultry, egg products, mayonnaise-based salads, cream-filled pastries and cakes, and other dairy products.

Gastroenteritis/ Food Poisoning

Staphylococcus aureus

Mechanism of intoxication

Food contamination is either from dirty hands or through coughing or sneezing into foods that are ready to eat.

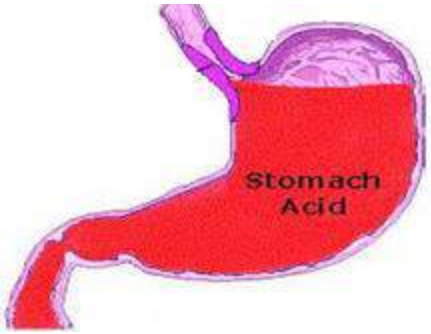


Gastroenteritis/ Food Poisoning

Staphylococcus aureus

Properties of staphylococcal enterotoxin

1. Resistant to gastric proteases



2. Resistant to heat (100°C for 30 minutes)

3. Stable at a wide pH range

Gastroenteritis/ Food Poisoning

Staphylococcus aureus

Associated clinical conditions & the mode of action

Vomiting

By stimulating neural receptors in the intestine rather than acting on the medulla directly

Diarrhea

Electrolyte imbalance across the mucosa which interferes with water absorption

Gastroenteritis/ Food Poisoning

Staphylococcus aureus

Associated clinical conditions & the mode of action

Clinically:

- Short incubation period of 1-6 hrs
- Nausea
- **Vomiting**
- Diarrhea
- Loss of appetite
- Severe abdominal cramps
- Mild fever
- Symptoms may last 12 hrs -2 days on average

Gastroenteritis/ Food Poisoning

Staphylococcus aureus

Diagnosis

- Clinically
- Detection of toxin (precipitin test) or bacteria in suspected food

Treatment

- Usually self limiting
- Rehydrating fluids
- Controlling fever (if any)
- Occasionally hospitalization, particularly when infants, elderly or debilitated people are concerned

Gastroenteritis/ Food Poisoning

Staphylococcus aureus

Control

- Hygienic measures
- Do not prepare food if you have a nose, eye, or skin infections
- Keep kitchens and food-serving areas clean and sanitized.
- If food is to be stored longer than two hours, keep hot foods hot (over 60°C) and cold foods cold (4°C or under).
- Store cooked food in a wide, shallow container and refrigerate as soon as possible.

Gastroenteritis/ Food Poisoning

Bacillus cereus

Characteristics

- Large Gram-positive bacillus, motile, non-encapsulated
- Resistant to penicillin
- Resistant to heat, light, drying and radiation
- Psychrotrophic (Germination and growth between 10 and 50 °C)

Epidemiology

Spores are present in

- Decaying organic matter
- Fresh and marine waters
- The intestinal tract of invertebrates, from which soil and food products may become contaminated as vegetables
- Most raw foods contain spores (dried herbs, spices and dehydrated foods)
- Human can be transiently carrier of spores (14-43%)

Gastroenteritis/ Food Poisoning

Bacillus cereus

Clinically

Two illnesses caused by two different strains:

1- The diarrheal illness associated strain:

- Ingestion of spores in contaminated meat, fish, and vegetables
- The diarrhea is caused by in vivo production of a heat-labile enterotoxin
- longer incubation (6-24 hours)
- Watery diarrhea, abdominal cramps
- Vomiting (25%)
- Duration of illness ranges from 20-36 hours, with a median of 24 hours
- Similar *C. perfringens*

Gastroenteritis/ Food Poisoning

Bacillus cereus

2- The emetic illness associated strain :

- 95% of cases are associated with rice dishes (Fried Rice Syndrome)
- Also linked with raw starchy foods such as pasta, potatoes, pastries and noodles)
- Caused by preformed toxin similar to *S. aureus* enterotoxin
- Short incubation period (1-6 hours)
- Vomiting and abdominal cramps
- Diarrhea (30 % of cases)
- duration of illness ranges from 8-12 hours

In both types fever is uncommon and disease is usually mild and self-limited

Gastroenteritis/ Food Poisoning

Bacillus cereus

Control

- By proper cooling and storage of food
- Ideally, all dishes should be freshly prepared and eaten. If not, then fridge and reheat thoroughly before serving
- Rice, in particular, should not be stored for long periods above 10°C.

Treatment

- Oral rehydration
- Occasionally, intravenous fluid with severe dehydration and vomiting
- Antibiotics are not indicated

(*B. cereus* = Be serious not to give antibiotics)

Diagnosis

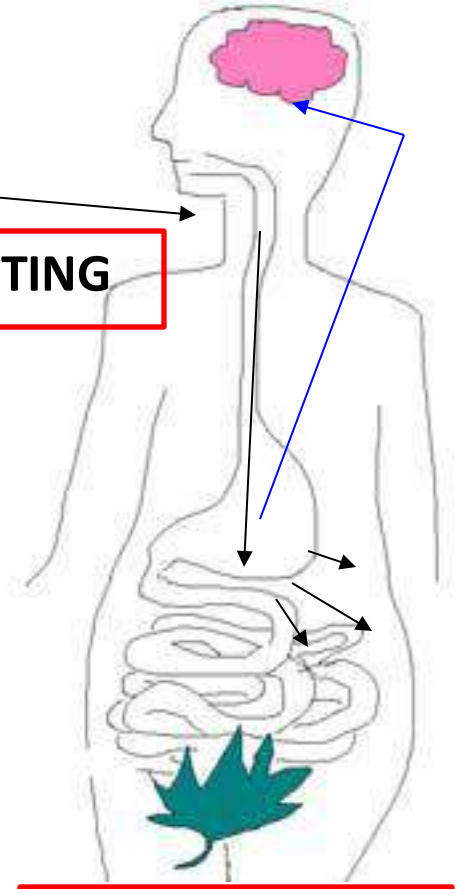
By the isolation of *B. cereus* from the implicated food, but such testing is often not done because the illness is relatively harmless and usually self-limiting

Gastroenteritis/ Food Poisoning

Staphylococcus aureus & Bacillus cereus (emetic)

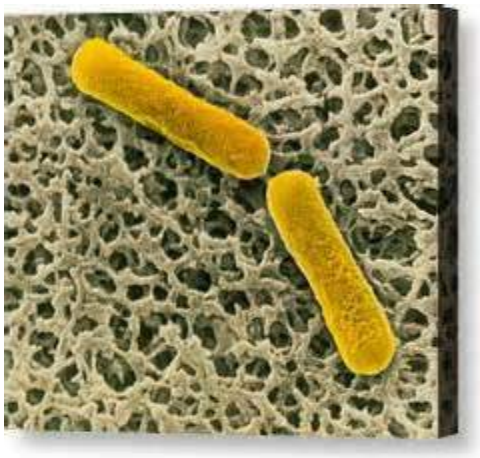
Short Incubation Period: 1-6 h

Bacterial enterotoxins



Gastroenteritis/ Food Poisoning

Clostridium botulinium



Special identification features

Rod-shaped, Gram positive, obligate anaerobic, spore-forming. (Botulus = Latin for sausage)

Distribution

- Ubiquitous
- Commonly found in soil and marine sediments throughout the world
- Since it is found in the soil, it may contaminate vegetables

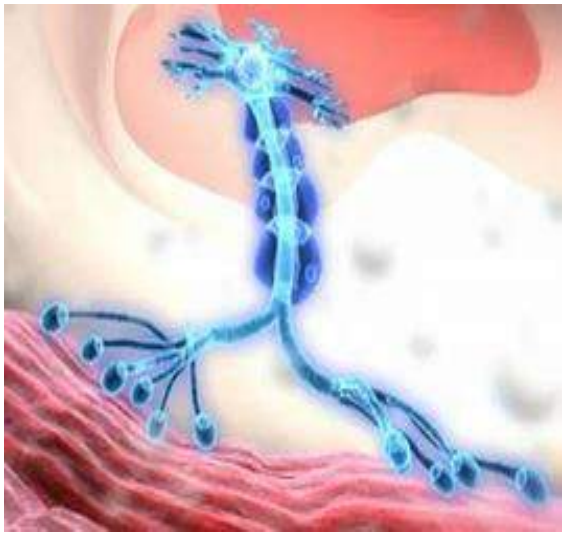
Specific conditions for germination

- Anaerobic conditions (canned food)
- Warmth (10-50^{o}C)
- Mild alkalinity (provided by vegetables as green beans, and mushroom)

Gastroenteritis/ Food Poisoning

Clostridium botulinium

Botulinium Neurotoxins



- Seven different types: A through G
- All cause flaccid paralysis
- Only a few nanograms can cause illness
- The most lethal known toxin
- Destroyed by boiling

Botulinium toxin mode of action

Neurotoxin production > stomach absorption > circulation > neuromuscular junction (NMJ) > inhibition of acetylcholine release at the neuromuscular junction > flaccid descending motor paralysis

Gastroenteritis/ Food Poisoning

Clostridium botulinium

Foodborne botulism

- Most common from home-canned foods
  - ✓ green beans, beets, corn, baked potatoes, and garlic
- Onset : 18 to 36 hours after exposure (range, 6 hours to 8 days)
- Early: nausea, vomiting, weakness, dizziness but no fever
- Late: double vision, difficulty in swallowing, and speaking
- In severe cases, death due to respiratory muscle paralysis

Gastroenteritis/ Food Poisoning

Diagnosis

- The initial diagnosis should be made on the basis of history and physical findings
- Serum, stools and suspected food should be tested for the presence of organism or toxin

Treatment:

Gastric wash

Antitoxin (A, B, E)

Supportive: ICU and respiratory support, wound cleaning and debridement

Prevention:

Proper cooking and heating of food

Avoid suspicious canned food

Proper processing, preservation and canning of food

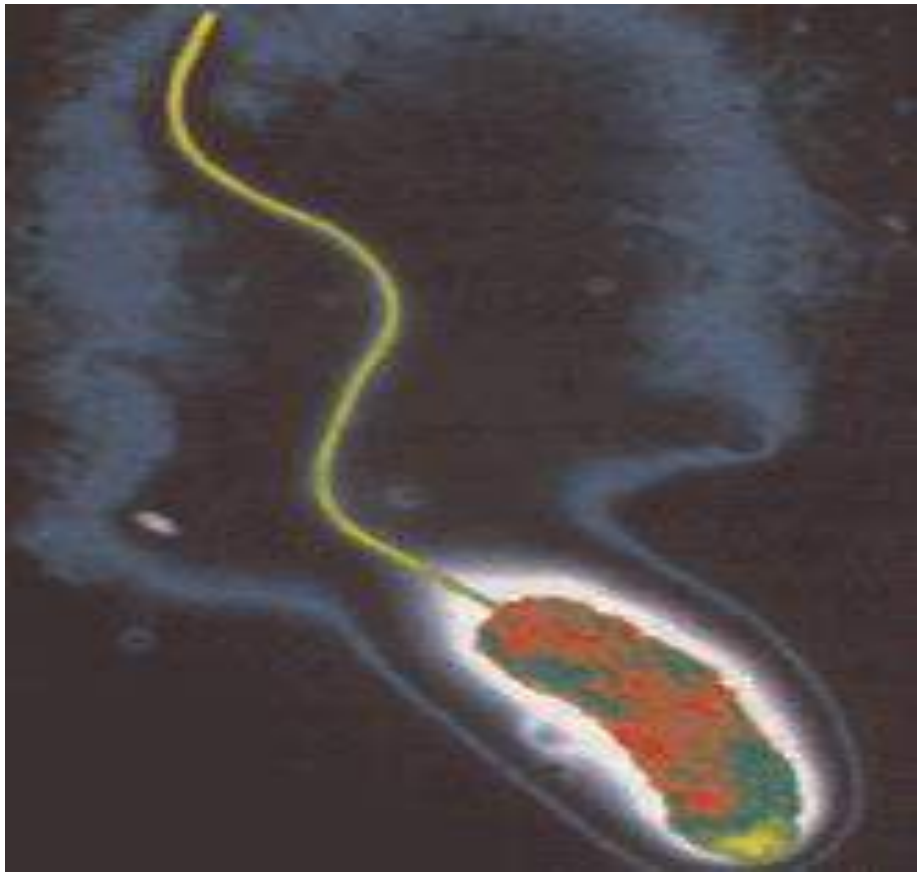
Watery (secretory) diarrhea

V. cholera

ETEC

EPEC

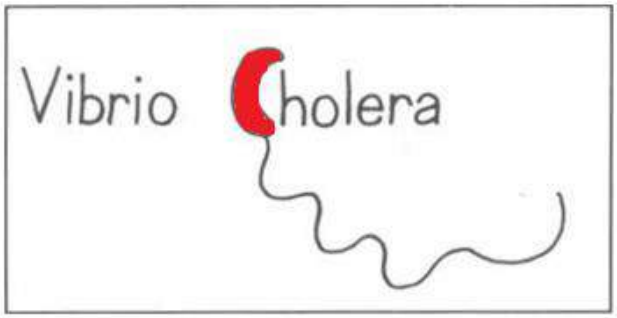
Vibrio Cholera



Vibrio Cholera

Bacteriology

- Curved, Gram-negative rods
- Highly motile (single polar fllagelum)
- Optimum growth at alkaline pH (8-8.5)



Habitat

- It normally lives in water attached to the outer surfaces of crustaceans
- Crustaceans: crabs, lobsters and shrimp

Infective dose

must ingest > 10 million organisms to get colonization of intestine using pili (no invasion)

Vibrio Cholera

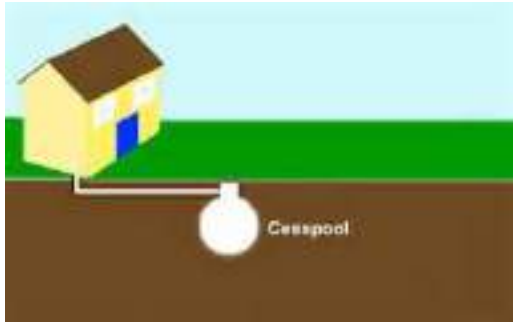
Transmission

1- contaminated water and food

2- consumption of raw or undercooked seafood

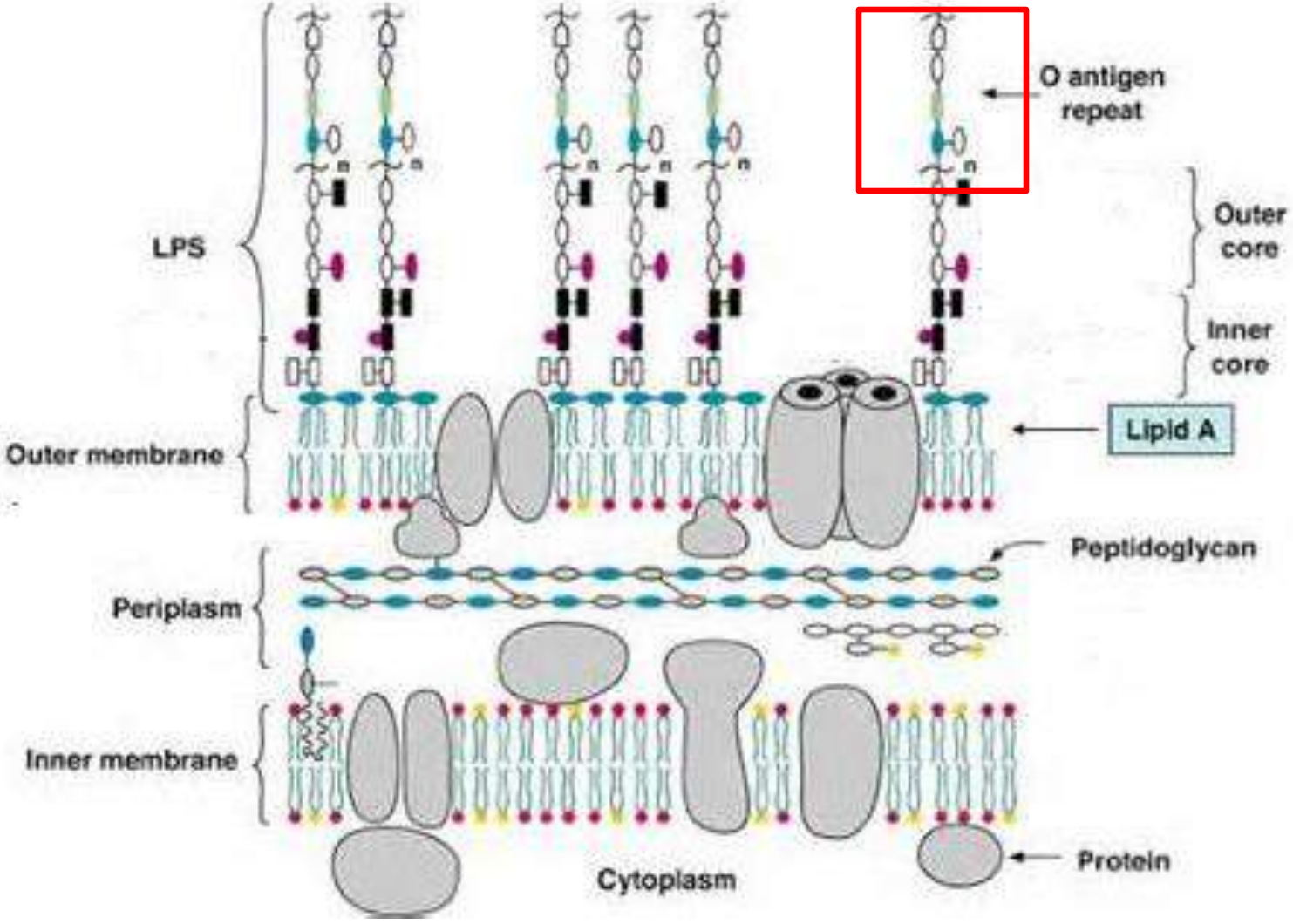
3- contaminated vegetables from fields fertilized with cesspools

4- Not transmissible from person-to-person



Vibrio Cholera

Classification



Vibrio Cholera

Classification

Serological classification

Based on Lipopolysaccharide (LPS)

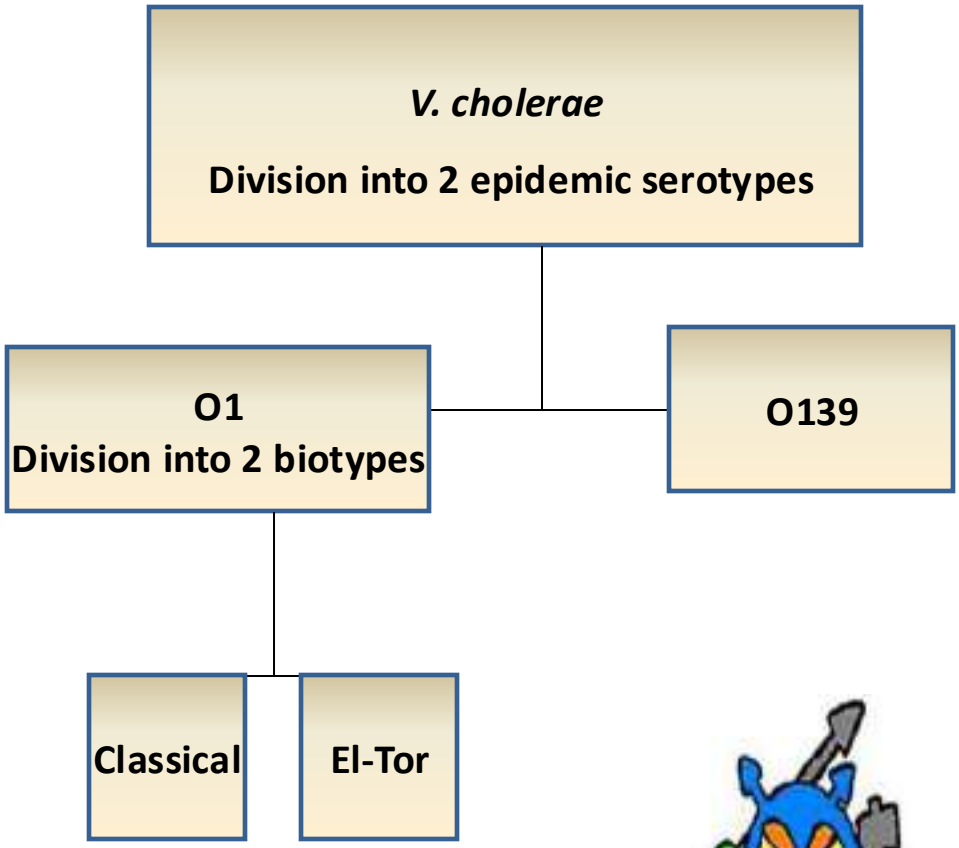
O antigen structure

1- Toxigenic strains

- O1 (Classical and EL Tor strains)
- O139
- Produce cholera toxin

2- Nontoxigenic strains (>150 exist):

- Called nontoxigenic O1 strains
- Rarely associated with epidemic
- Do not produce cholera toxin
- Produced other virulence factors associated with diarrhea



Vibrio Cholerac

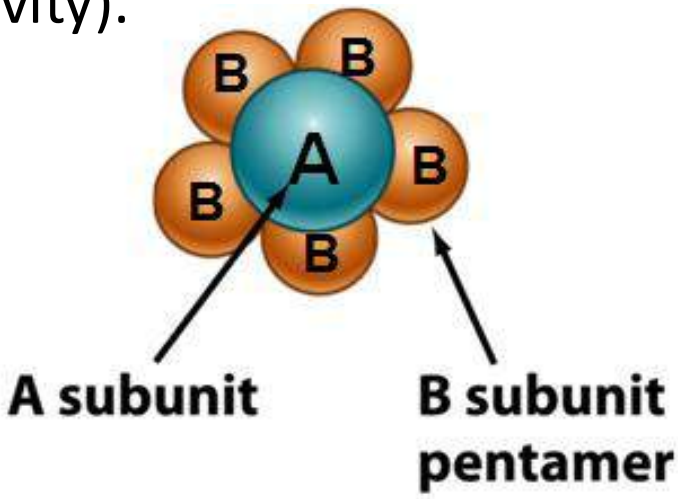
Clinically

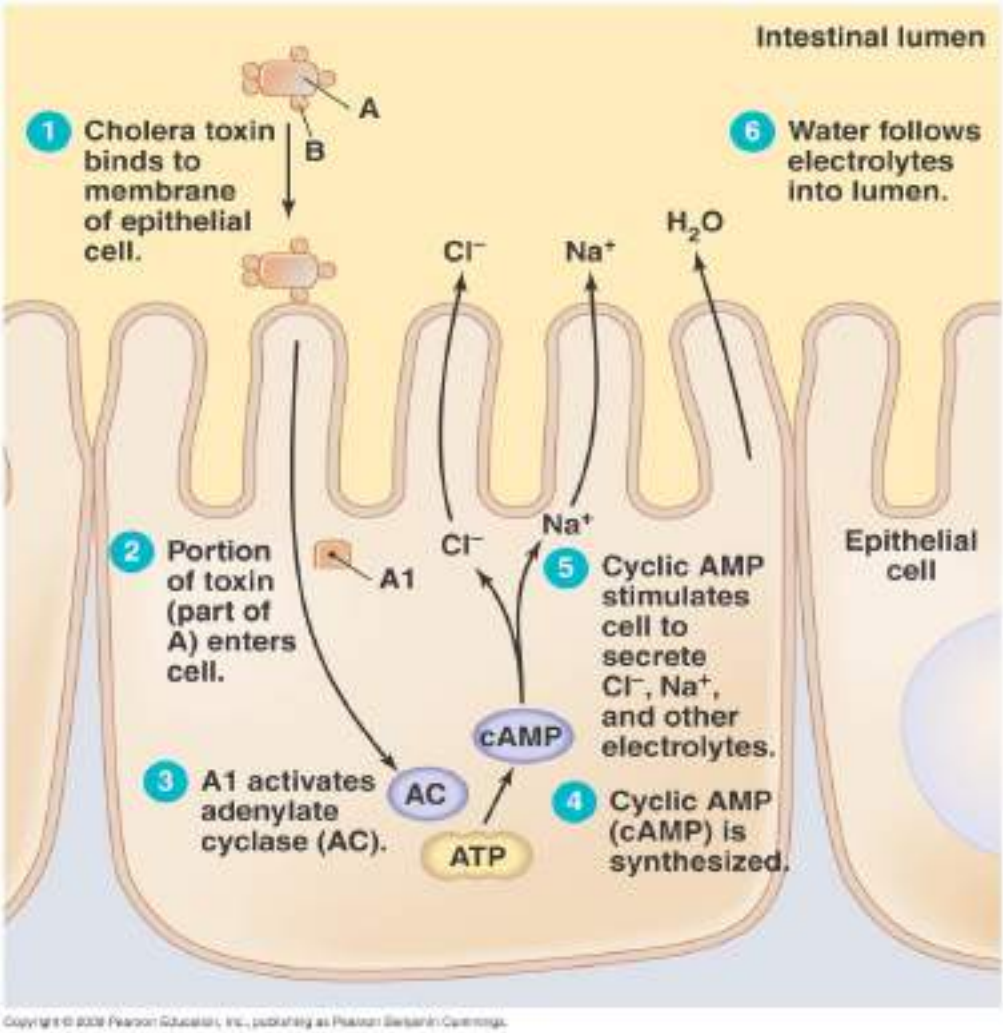
- **Watery diarrhea** flecked with mucus and dead cells and resembles rice water (rice-water stool).
- Nausea, **vomiting,** and **muscle cramps**
- **Dehydration**, a dry mouth, extreme thirst, low blood pressure, and an irregular heartbeat (arrhythmia).
- **Shock**.
- **Visible Symptoms :** sunken eyes, poor skin turgor (elasticity), and little or no urine output.

Vibrio Cholera

Toxin structure and mode of action

The cholera toxin is composed of five B subunits (for binding) and one A subunit (has the toxic enzymatic activity).





Vibrio Cholera

Treatment:

- The course of treatment is decided by the degree of dehydration
  - Oral Rehydration
  - ✓ 80% of cases can be treated through oral rehydration salts
  - ✓ Used when the dehydration is less than 10% of body weight
  - Intravenous Rehydration

    Used in patients who lost more than 10% of body weight from dehydration or are unable to drink due to vomiting
  - Antimicrobial Therapy
  - ✓ antibiotics are reserved for more severe cholera infections
  - ✓ antibiotics can diminish duration of diarrhea, reduce volume of rehydation fluids needed, and shorten duration of *V. cholera* excretion
- No antitoxin

Vibrio Cholera

Diagnosis

- Rice-water diarrhea
- Gram negative curved rods
- Vibrios often detected by dark field or phase contrast microscopy of stool
- Isolation of bacteria using special media
- Additional methods including PCR

Prevention:

- Hygiene and clean water
- Avoid eating raw or undercooked fish and shellfish
- Vaccine: Oral killed vaccine for O1 Ag type

Thank you