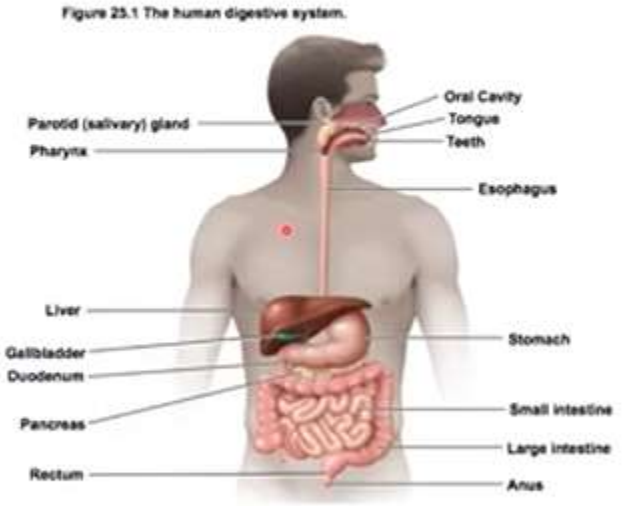
25 slides

Wednesday, December 3, 2025 4:36 PM

Structure of the Digestive System

- Mouth
- Pharynx
- Esophagus
- Stomach
- Small and large intestine.



Normal Microbiota of the Digestive System

- Stomach and small intestine have few microorganisms
  - HCl
  - Rapid movement of food
- Large intestine has enormous microbial population
  - Mostly anaerobes and facultative anaerobes

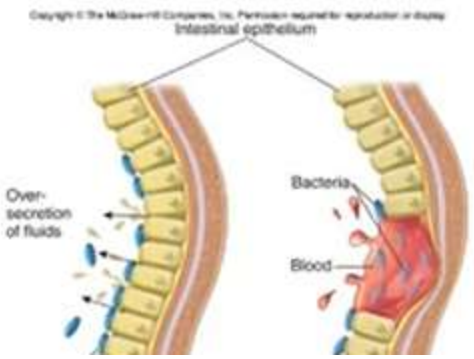
population
- Mostly anaerobes and facultative anaerobes
- >100 billion bacteria/g feces.

Diarrheal Disease

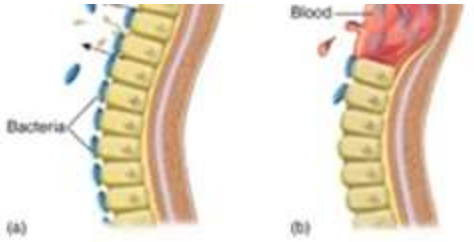
- Acute syndrome of intestinal tract
- Volume, fluid content, frequency of bowel movement increases
- Usually a symptom of gastroenteritis
  - Inflammation of lining of stomach and intestine
- Infectious diarrhea has two basic mechanisms
  - Toxigenic
  - Invasive .

Diarrheal Disease: Toxigenic

- Bacteria release enterotoxins
- Bind surface receptors on small intestine
- Disrupts physiology of epithelial cells
- Stimulates hypersecretions of fluids and electrolytes

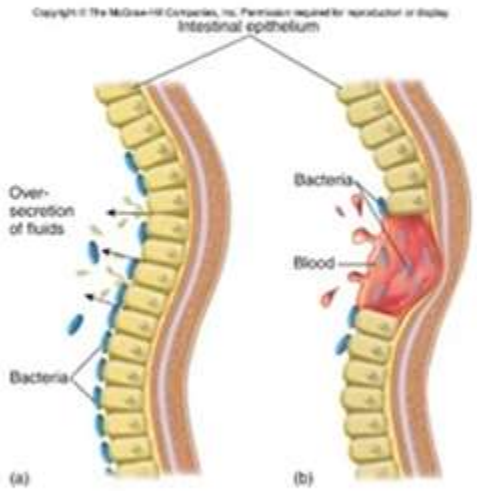


- Stimulates hypersecretions of fluids and electrolytes
- Organism does not invade tissues
- Large volume
- No blood in stool.



Diarrheal Disease: Invasive

- Microbes invade wall of small or large intestine
- Damages cells that line mucosa
- Blood in stool
- Results in severe dehydration
- 40% of worldwide infectious disease
- 18% of deaths worldwide.

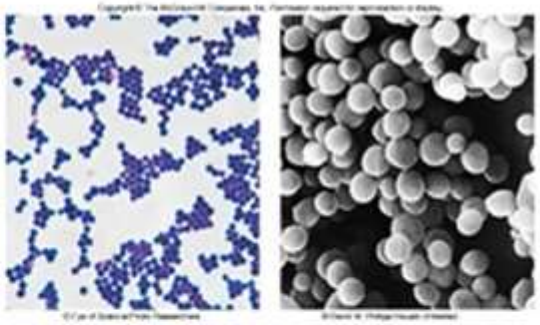


Staphylococcus aureus: Toxigenic Staph Diseases

- Food poisoning
  - Due to enterotoxins
- Transmission
  - Contact with food workers who carry it
- Associated with
  - Contaminated custards, sauces, processed meats, sandwiches, chicken salad left unrefrigerated
- Enterotoxins are heat stable
  - A superantigen
  - Stimulates nerves
    - Causing cramping, nausea, vomiting, diarrhea
- Recovery in 24 hours..

Staphylococci

- Common skin, mucous membranes inhabitant
- Considerable portion of human "staph" infections
- Spherical cells, irregular clusters
- Lack spores, flagella
- May be encapsulated ..



S. aureus: Characteristics

- Most serious of staph pathogens
- Large number of nosocomial infections
- Facultative anaerobe
- Very resistant non-spore forming pathogen
- Can withstand
  - High [salt] (7-10%)
  - Extremes in pH
  - High temps
  - Remains viable after months of air drying..

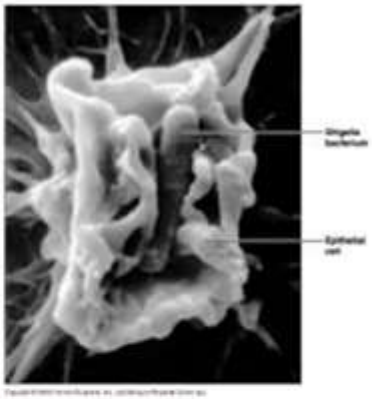
S. aureus: Virulence

- Virulence factors include enzymes and toxins
- Pathogenic *S.aureus*
- Coagulase
  - Causes fibrin to be deposited around cells
  - Inhibits phagocytosis
  - Allows *staph* to adhere to tissues
  - Enzyme present in 97% of all human isolates
- Penicillinase
  - Methicillin resistant *S. aureus* (MRSA)
- Hemolysins..

S. aureus: Pathogenesis

- 25-30% of population has it colonized in nose
  - Also in skin, nasopharynx, intestine
  - Colonization of infants can occur at birth
- Sometimes causes infection
- Most are minor
  - Pimples, boils
- Some are serious
  - Surgical wound infections, bloodstream infections..

Shigella



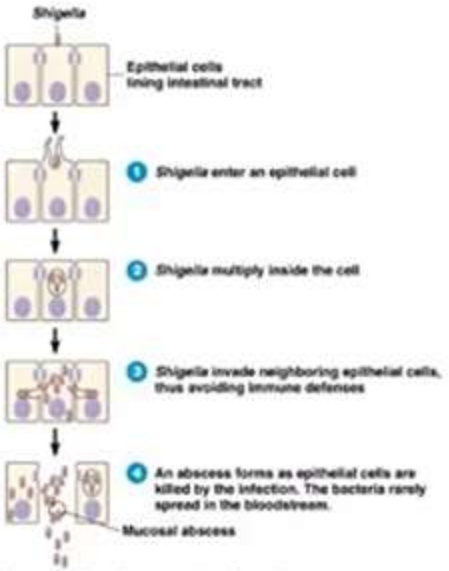
- Background:
- Discovered 100 years ago
  - Kiyoshi Shiga
- Facultative anaerobe, gram negative
- 4 sub-species
- *Shigella sonnei*
  - Most common form in the US (72%)
- *Shigella flexneri*
  - Makes up the rest (28%)
  - Predominant in developing countries
- *Shigella dysenteriae*
  - Causes the most severe form of shigellosis
  - Primarily in Eastern Hemisphere
- *Shigella boydii*..

Shigellosis
(Bacillary Dysentery)

- Incapacitating dysentery
- Abdominal cramps
- Watery, mucous, bloody stool
- Primarily a pediatric disease
  - 70% of cases are children under 15
  - Mostly in children not toilet trained
- Transmission:
  - Fecal-oral
  - Spread only person-to-person
  - Infectious dose is low!
    - 10-200 cells..

Shigellosis: Pathogenesis

- Shigella ingested
  - (not affected by stomach HCl)
- Invades villus cells of small intestine
- Triggers phagocytosis
- Replicates inside intestinal cells
  - Shigella is non-motile
- Invades neighboring cells
- Avoiding immune system
- Shiga toxin destroys tissue
- Does not perforate intestine or invade blood.

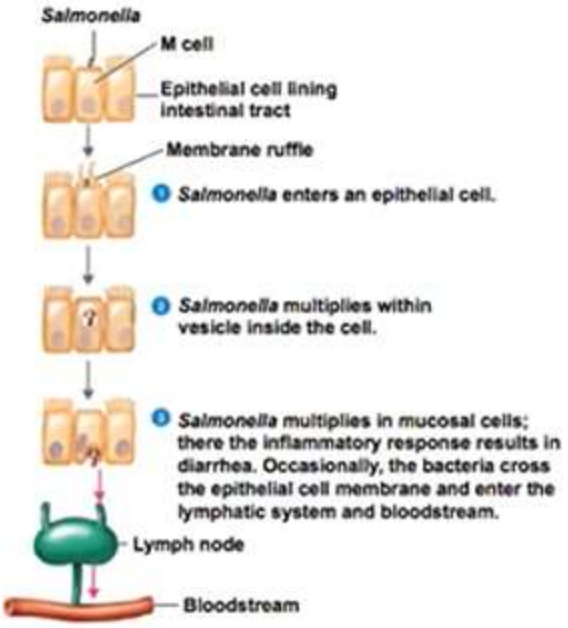


Shigella: Virulence Factor

- *S. dysenteriae*
  - The most virulent species of *Shigella* genus
- Produces Shiga Toxin exotoxin
- Binds intestinal and renal cells and kills them
- Results in decreased absorption in large intestine, fluid loss, renal failure
- Dysentery results from damage to intestinal cell wall
- *E. coli* O157:H7 produces similar toxin..

Salmonella

- Gram negative, facultative anaerobe
- Invade and multiply in intestinal mucosa
- Can enter blood
- Nausea, abdominal pain, diarrhea
- Death rate low (1%)
  - Higher in infants, elderly
  - Death from septic shock
- Antibiotics not useful
  - Oral rehydration therapy
- Members of genus cause 2 diseases
  - Typhoid fever
  - Salmonellosis..

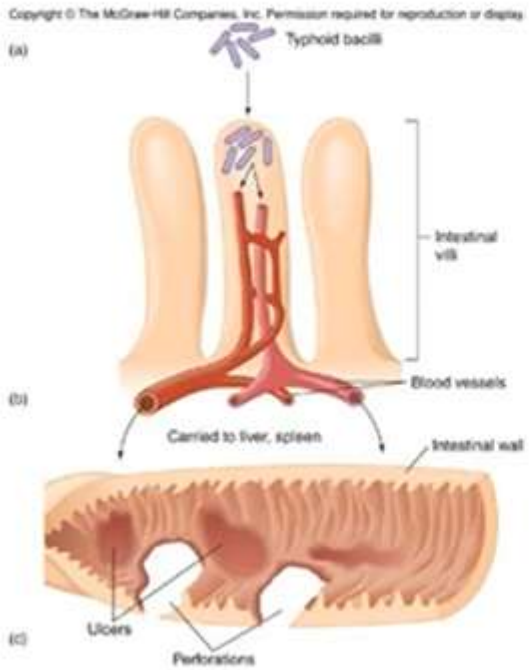


Typhoid Fever

- Causative agent
  - *Salmonella typhi*
- Humans are exclusive host
  - Carried in blood and intestinal tract
- Obtained fecal-orally

- About 400 cases per year in US
  - 70% acquired while traveling abroad (India, Bangladesh, Pakistan)
  - But serious problem in other regions (E and SEA, Africa, Caribbean, Central and S America)
    - 21.5 million cases each year
    - 25,000 deaths each year..

Typhoid Fever



- During the infection:
  - The organisms are carried systemically to other organs via the blood and/or lymph (liver, spleen, gallbladder)
    - A small percentage of people can carry *S. typhi* in their gallbladders (and infect others!)
    - Surgical removal of the gallbladder may be necessary in people who are chronic carriers
- Hallmark of infection:
  - 103-104° F fever
  - Diarrhea
  - Abdominal pain..

Typhoid Fever: Treatment

- Vaccine available
- Three commonly prescribed antibiotics
  - Ampicillin
  - Trimethoprim-sulfamethoxazole
  - Ciprofloxacin
  - Deaths rarely occur
- BUT if no treatment:
  - Fever for weeks
  - 20% die from complications of infection..

Typhoid Mary

- Mary Mallon: known as "Typhoid Mary"
- Was the 1st person in the U.S. identified as a healthy carrier of Typhoid Fever
  - NYC cook
  - Infected 47 people
  - Her claim to fame: Her denial and refusal to stop working
  - She died in quarantine..

Salmonellosis

- Also referred to as enteric fever, *Salmonella* food poisoning, gastroenteritis
- Causative agent
  - One of the many types of *S. enteritidis*
  - ALL strains are considered zoonotic in origin
- Reservoir of Infection
  - Intestinal flora of cattle, poultry, rodents, & reptiles
  - Animal products (meat, milk) can be contaminated during slaughter, processing..

Salmonellosis

- Transmission:
  - Contaminated food,, water, fecal/oral
- Currently: Salmonellosis is the most common food-bourne transmitted disease in the U.S.!
  - Common culprit: Contaminated eggs
    - (the ovaries of hens can become silently infected)
  - Another common culprit: Poultry (during slaughtering process)
  - Est. 1 out of 3 chickens is contaminated

- Symptoms:
  - Vomiting, diarrhea, fever, cramps (12-72 hrs)
  - Usually subside within 2-5 days
  - Death is infrequent (400/yr in the US)..

Salmonellosis: Common culprits…

Cholera

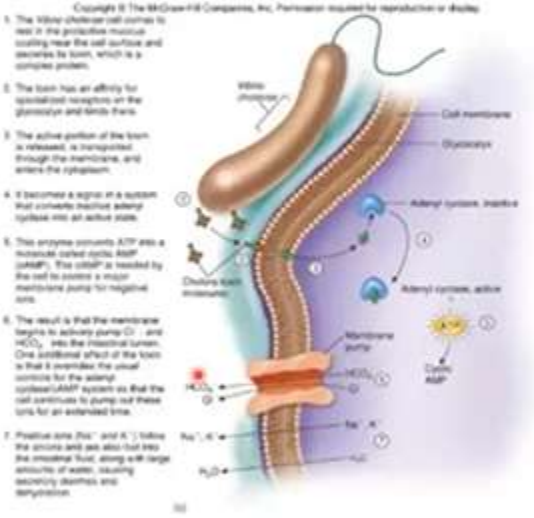
- Causative agent
  - *Vibrio cholerae*
- Infection often mild, asymptomatic
  - 1 in 20 has severe disease
- Profuse diarrhea ("rice-water stool"), vomiting, leg cramps
- If untreated, death can occur in less than 48 hours
- Affects millions in Africa and Asia

Cholera: Pathogenesis

- Ingested with food or water
- Spread rapidly in areas with poor sewage and drinking water
- Also from raw or undercooked shellfish, Gulf of Mexico.

Cholera: Pathogenesis

- Cells penetrate mucous barrier
- Rest on surface of the epithelial cells
  - Does not invade cell
- Enterotoxin: cholera toxin (CT)
- Disrupts normal physiology of intestinal cells
  - Activates Adenyl cyclase
  - cAMP (controls ion pump)
  - Electrolytes pumped out
  - Profuse water loss follows
    - As much as 1L/hour..



Cholera: Pathogenesis

- In children and compromised individuals
- Can be fast and furious
- If untreated
  - Up to 50% body weight loss
  - 50% mortality rate in 48 hours..

Cholera: Treatment

- Immediate replacement of fluids and salts lost
- Oral rehydration therapy
  - Prepackaged mixture of sugar and salts
  - Requires no medical facilities, equipment
- No vaccine available in US..

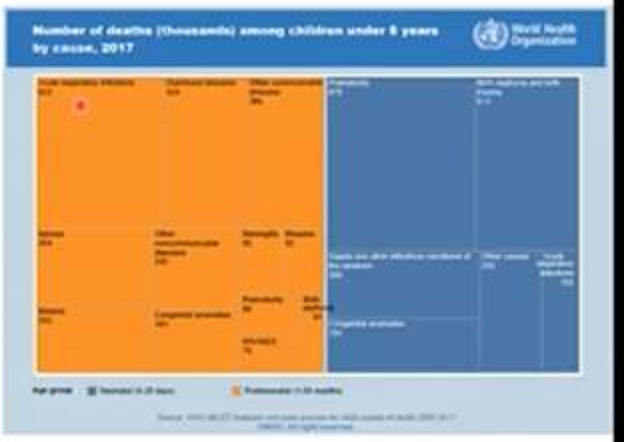
Escherichia coli

- The most prevalent enteric bacillus
- Enterotoxigenic *E. coli* causes severe diarrhea
- Causes up to 70% of traveler's diarrhea
- Due to two exotoxins
  - Heat labile toxin (LT)
  - Heat stable toxin (ST)
- Stimulates secretion and fluid loss.

Slumdog Millionaire

Escherichia coli

- Most clinical diseases of *E. coli* are transmitted exclusively among humans
- Pathogenic *E. coli*
  - Frequent agents of infantile diarrhea
  - The second leading cause of death among children
    - Babies have immature intestinal immune system..



Escherichia coli in Food Infections

- Most infamous is O157:H7
- Leads to intestinal hemorrhaging
- Virulence due to cell wall receptor that fuses with host cell
- Creates direct port to secrete toxins
- Has toxin similar to Shiga toxin (from *Shigella*)
  - Binds ribosomes, disrupts translation
  - Causes death and shedding of intestinal cells..

Escherichia coli in Food Infections

- Reservoir in cattle intestine
- Enters food chain via contaminated beef, water, fresh vegetables
- Infectious dose is only 100 cells!.

CHICKEN, YOU CAN LEAVE – I'VE GOT NO BEEF WITH YOU.

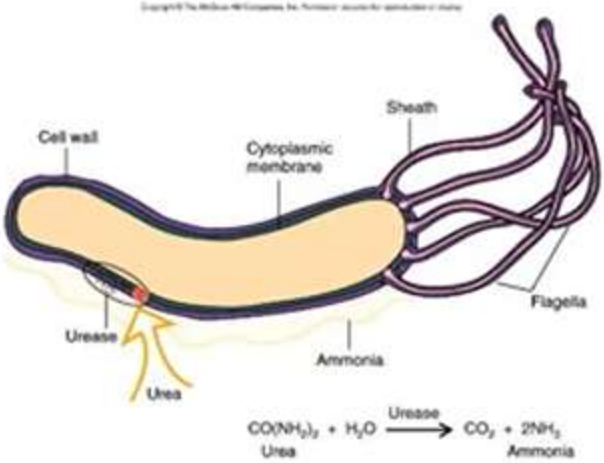
Escherichia coli

- Also causes 50-80% of UTIs
- Usually results when urethra invaded by own endogenous bacteria

- Indicator bacteria to monitor fecal contamination in water, food
- If present, likely that fecal pathogens like *Salmonella* or protozoa present..

Helicobacter Gastritis: Peptic Ulcer Disease

- Causative agent: *Helicobacter pylori*
- Signs and symptoms: Abdominal pain, vomiting
  - Erosion and ulceration of stomach lining.



Peptic Ulcer Disease

Background

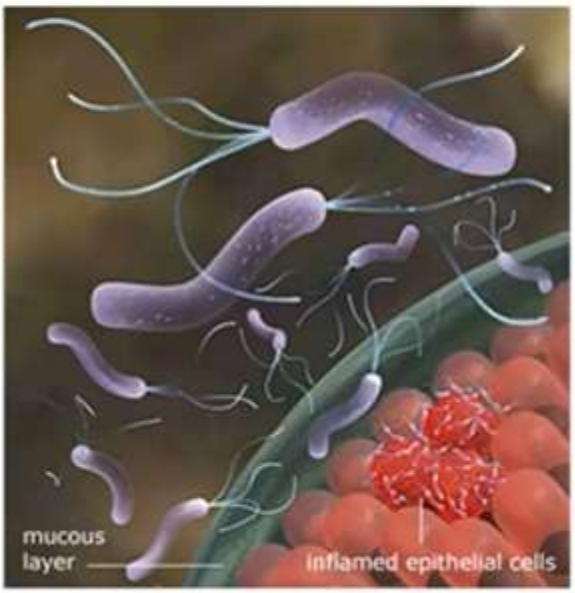
Causative Agent:
Helicobacter pylori

a) Isolated in culture in 1984 by Robin Warren & Barry Marshall
b) Humans and animals are the primary reservoir
c) Organism is gram negative, spiral bacilli, with a polar flagella
d) Colonizes as many as 45% of healthy adults in U.S. (only 15% develop ulcers).

Peptic Ulcer Disease

Characteristics of *H. pylori*

a) Infects epithelial cells of stomach
b) Most humans infected *never* develop symptoms
c) Only organism known to survive the acidity of our stomach.



Peptic Ulcer Disease

Background

Before 1982:

What did we think caused ulcers?

Now:

H. pylori causes more than 90% of duodenal ulcers and 80% of gastric ulcers!.

Peptic Ulcer Disease

Transmission:

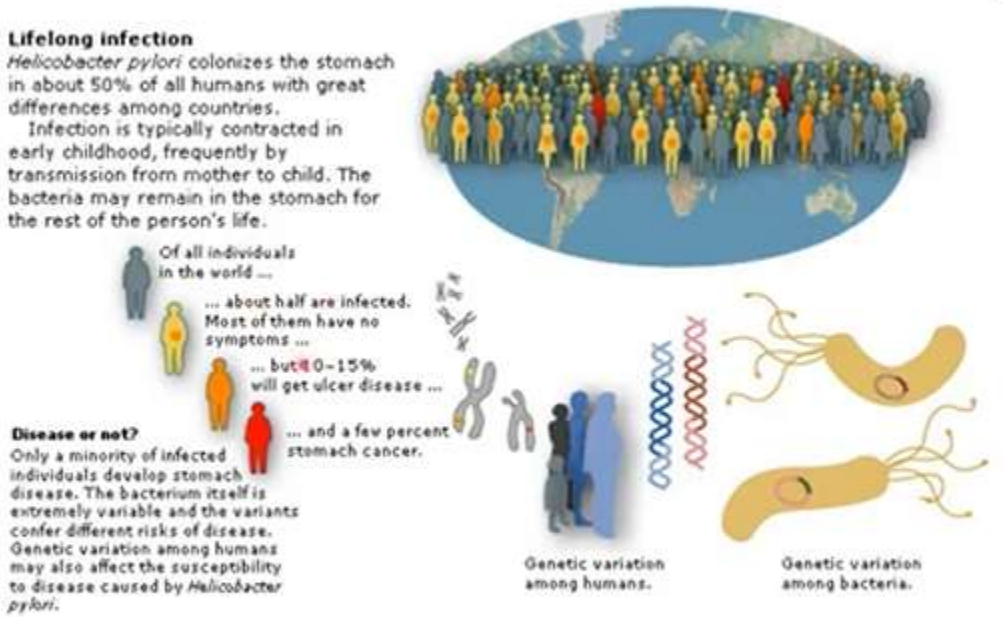
Unknown!

(Most likely spread via fecal/oral or oral/oral routes)

a) Long Term Consequences: *H. pylori* has been associated with gastric cancer!

- 6th most common cancer worldwide

(lung, breast, colorectal, prostate, skin).



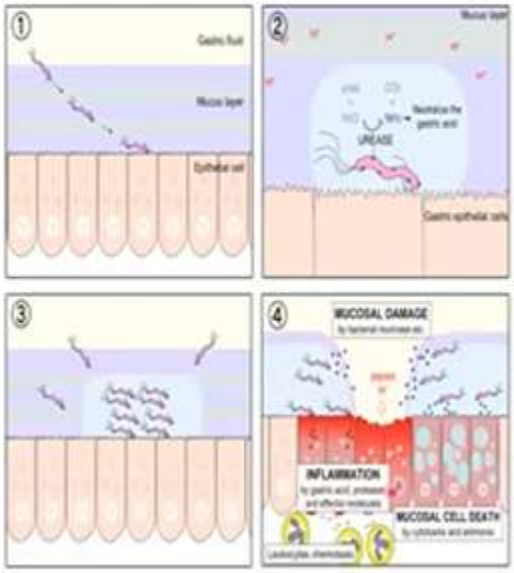
Peptic Ulcer Disease

Pathogenesis

Note: *H. pylori* is NOT an acidophile!

Development of Ulcers:

a) Organism is ingested & colonizes the stomach
b) Organism utilizes flagella to pass through mucus layer & attach to epithelial cells
c) Produces urease
d) Loss of mucus coating predisposes to gastritis
e) Elicits immune response; inflammation.



Diagnosis

- Blood test
  - Can detect Abs against *H. pylori* in the blood
- Urea Breath Test
  - Use ^{14}C or ^{13}C labeled urea
  - Measure labeled CO_2
- Endoscopy.

Treatment

"Triple Therapy Regimen"

- Administered over a long period of time (usually 14 days)
- Amoxicillin
- Clarithromycin
  - Inhibits translation
- Prilosec (acid blocker).