Slide 1

Microbial Diseases of the Digestive System

Lecture 28

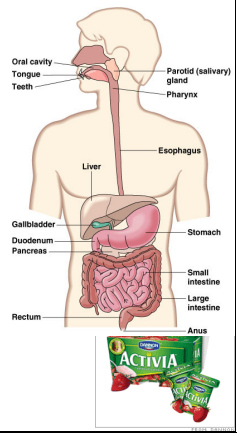
Slide 2

Learning Outcomes

- Food Poisoning
- Typhoid Fever
- Cholera
- Protozoal infections
- Stomach Flu – It is not the flu and does not infect the stomach
- Hepatitis

Normal Microbiota

- >300 species in mouth
- Large numbers in large intestine, including:
  - *Bacteroides*
  - *E. Coli*
  - *Enterobacter*
  - *Klebsiella*
  - *Enterococcus faecalis*
  - *Proteus*
- **Probiotics**



Bacterial Diseases of Lower Digestive Tract

- 2009 estimated
  - 1.1 million deaths > 5 years old
  - 1.5 million deaths < 5 years old
- Rapid loss of fluids → drop in blood pressure → coma
- Loss of 10% of body fluids fatal

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Treatment

- Treated with fluid and electrolyte replacement
- Oral Rehydration Salts
  - 6 tsp sugar plus 0.5 tsp salt in 1 liter clean water

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Symptoms

- Symptoms usually include diarrhea, gastroenteritis,
- Diarrhea is a response triggered by immune symptoms
- Rate of peristalsis increases intestines
  - No water is reabsorbed
  - Loss of Sodium and electrolytes
- Vomit reflex
- Triggered by immune system
- purge GI tract of pathogens
- Infection caused by growth of pathogen
- Incubation from 12 hr to 2 wk
- Intoxication caused by ingestion of toxin
  - Symptoms appear 1-48 hr after ingestion
  - Diarrhea
  - vomiting

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Transmission of GI Diseases

- Fecal-Oral route
- Vehicle Transmission
- Feces contaminated water or food
  - Poor sanitation
  - Food preparation and storage
  - Undercooked meat and shellfish
- Transmission
  - 4 F's
  - Fingers, flies, food, feces
- Capable of surviving outside of host until ingested
  - Protozoal cysts

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Prevention of Foodborne Pathogens

- Fecal-oral cycle can be broken by:
- Sanitation
  - Proper sewage disposal
  - Disinfection of drinking water
- $10 Billion per year to bring sanitation to 2.4 billion
- Proper food preparation and storage
- Hand washing

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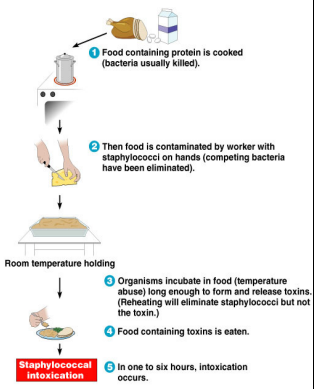
Food Intoxication

- High protein foods
  - Often viscous or salty
- Food contaminated by handling **after** cooking
- Staphylococcus aureus grows in food held at warm temperature
  - *Staphylococcus aureus* enterotoxin is a superantigen
  - Heat stable toxin
- Stimulates vomiting reflex center of brain
- 1-6 hours incubation
- Spectacular vomiting



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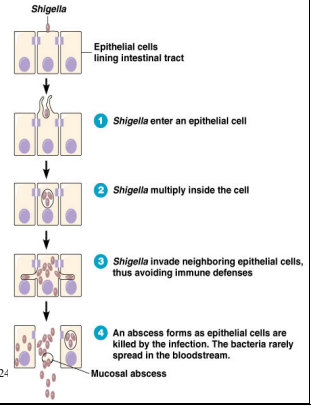
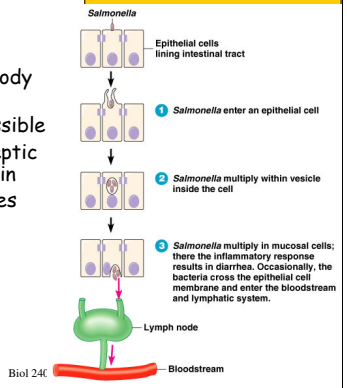
Shigellosis

- Bacillary Dysentery
- Infection 12 hours – 2 weeks incubation
- ID_{50} - 100
- Invasion causes inflammation and bleeding
- Abdominal cramps and fever
- *Shigella* sonnei, *S. dysenteriae* producing Shiga toxin
- Halts protein synthesis in host cells by breaking ribosomes
- Abscess formation
  - Diarrhea with blood



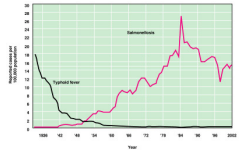
Salmonellosis

- *Salmonella enterica (2000 serovars)*
  - ID_{50} 100,000
  - Incubation 12-48 hours
- Vomiting, fever, cramps, inflammation and non-bloody diarrhea
- Invasive - bacteremia possible
- Mortality (<1%) due to septic shock caused by endotoxin
- Estimated 1.4 million cases and 400 deaths per year
- Common resident of GI tracts of animals
- Reservoirs include pets, reptiles,
- Eggs and undercooked chicken



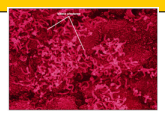
Typhoid Fever

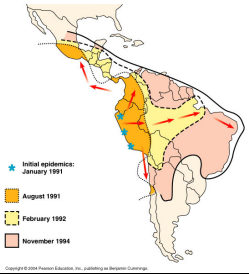
- *Salmonella typhi*
- No animal reservoirs
- Invade from GI tract via Peyer's patches
- Bacteria spread throughout body in macrophages
- Symptoms appear after 2-3 weeks
- Macrophages lyse →bacterimia → fever
- 1-3% recovered patients become carriers, harboring *S. typhi* in their gallbladder
- Typhoid Mary



Cholera

- *Vibrio cholerae*
  - ID_{50} 100 million
    - Sensitive to acidity
- Colonizes small intestine
- Adheres to microvilli
  - Mucinase
- Choleragen toxin
  - causes host intestinal cells to secrete Cl^-, HCO^-, and water
- No fever, no blood
- Rice-water stool
- 1L per hour
- 50% mortality if untreated
- Endemic to Bay of Bengal
- Epidemic elsewhere





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Escherichia coli Gastroenteritis

- Occurs as traveler's diarrhea and epidemic diarrhea in nurseries
- Enteroinvasive strain
  - Dysentery-like symptoms
- Enteroaggregative strain
  - E.coli stacked together
- Enterotoxigenic strain
  - Cholera like toxin
- Enterohemorrhagic strain
  - produce Shiga-like toxin

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Escherichia coli O157:H7

- Enterohemorrhagic strain
- *E. coli* O157:H7 produce Shiga-like toxin
  - ID_{50} – 100
  - Acid stable
- **O** = cell wall antigen
- **H** = flagellar antigen
- 6% hemorrhagic colitis
  - Blood in stool
- Hemolytic Uremic syndrome
  - Blood in urine due to toxin damage to glomeruli
- Common in GI tract of cattle
- Beef contaminated during processing
- Vegetables contaminated by animal feces

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Food Safety

- Beef
  - Muscle tissue is sterile
  - Rare steak safe to eat
  - Hamburger meat not 100% muscle (may be 100% beef) contains connective tissue, mucus membranes in center
  - Undercooked burgers may harbor pathogens:
    - Tapeworm, Toxoplasma, *E.coli* O157:H7
- Pork
  - Undercooked pork:
    - parasites: Trichinella, tapeworms
- Chicken
  - Bacteria: Campylobacter (100% retail chicken) Salmonella,
- Cooked to 165°F internal temperature
- Separate surface and utensils for raw and cooked meats
- Fish and shellfish
  - *Vibrio* ssp, Toxic Dinoflagellates, Ciguatera, helminths

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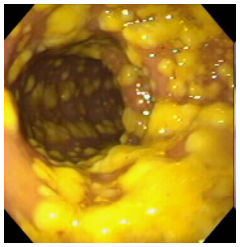
Clostridium difficile

- Gram-positive, endospore forming, obligate anaerobe
- Asymptomatic carrier state
  - Present in 2-3% adults and 70% of infants
- Fecal oral transmission, of resistant endospores
- Toxins
  - A enterotoxin
  - B cytotoxin
- Both bind to and enter mucosal cells
- Inflammation and damage of mucus membranes of gut lining
- Pseudomembranous colitis



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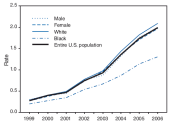
C.diff

- The most serious cause of antibiotic associated diarrhea
- Nosocomial Infection
- 20% of patients infected
- Broad Spectrum antibiotics reduce normal flora of GI tract
- Precautions:
- Hand washing
- Contact Precaution
- Wear disposable gloves and gowns



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Mumps Virus

- Paramyxovirus
- Enters through respiratory tract
- Replicates and infects parotid (salivary) glands
- Swell 17 days after exposure
- Mild epidemic childhood disease
- Orchitis in ~30% post pubertal males can lead to sterility
- Ovaries occasionally affected
- Meningitis a rare complication
- Prevented with MMR vaccine

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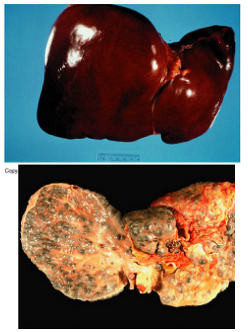
Hepatitis

- Inflammation of the liver
- Hepatitis may result from
  - drug or chemical toxicity,
  - or Hepatitis viruses



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Hepatitis

	Transmission	Causative agent	Chronic liver disease	Vaccine
Hepatitis A	Fecal-oral	Picornaviridae	No	Inactivated virus
Hepatitis B	Parenteral, STD	Hepadnaviridae	Yes	Recombinant
Hepatitis C	Parenteral	Flaviviridae	Yes	No
Hepatitis D	Pareteral, HBV coinfection	Deltaviridae	Yes	HBV vaccine
Hepatitis E	Fecal-oral	Caliciviridae	No	No

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Viral Gastroenteritis

- Stomach Flu?
  - Not influenza virus
  - Does not affect stomach
- Rotavirus
- Double stranded RNA – Reoviridae
- Endemic worldwide
- Fecal-oral route
  - 10 trillion viral particles per gram of feces
- Unwashed hands and fomites
  - Outbreaks due to lapses in hygeine
  - 3 million cases annually
  - Most common cause of severe child diarrhea
  - Responsible for 50% of childhood diarrheal fatalities worldwide
  - 1-2 day incubation, 1 week illness
  - Oral vaccine live attenuated
- Treated with rehydration

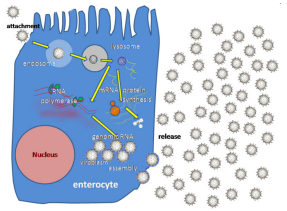


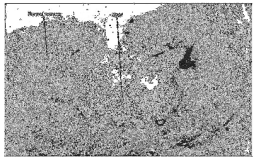
Figure 25.17

Viral Gastroenteritis

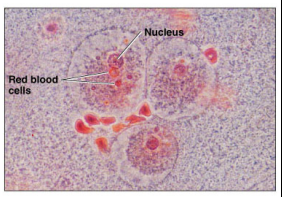
- Norovirus or Norwalk virus
- Fecal-oral transmission
- Aerosols (vomit)
- 20 million cases US per year
- Short term immunity
  - < 3 years
  - 50% of U.S. adults have antibodies
  - 1-2 day incubation, 1-3 day illness
- Hardy and stable in the environment
- Difficult to completely decontaminate surfaces
  - Cruise ships
  - Nursing homes
- Treated with rehydration

Figure 25.17

Amoebic Dysentery



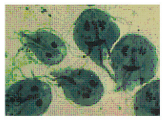
- *Entamoeba histolytica*
- Cysts ingested
- Trophozoites invade epithelial lining of colon
  - feeds on RBCs and GI tract tissues
  - Bloody stools
  - Abscess formation
- Previous infection does not prevent reinfection
- No animal reservoir
- Treated with metronidazole



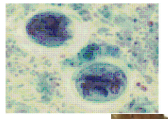
(b) ***Entamoeba histolytica***

Giardiasis

- *Giardia lamblia*
- Cyst forming protozoan with multiple flagella
  - Fermenters
- Symptoms include diarrhea, bloating, sulfury, gassy, mucusy stools
  - healthy carrier state 7% population
  - Beaver animal reservoir contaminating streams
- Fecal-Oral Route
- Spread by ingestion of cysts in untreated drinking water
- Daycare facilities
- Most frequent cause of non-bacterial diarrhea in US
- Treatment: Metronidazole



(c) *Giardi lamblia*



(d) Giardialamblia cyst

Figure 12.17b-d