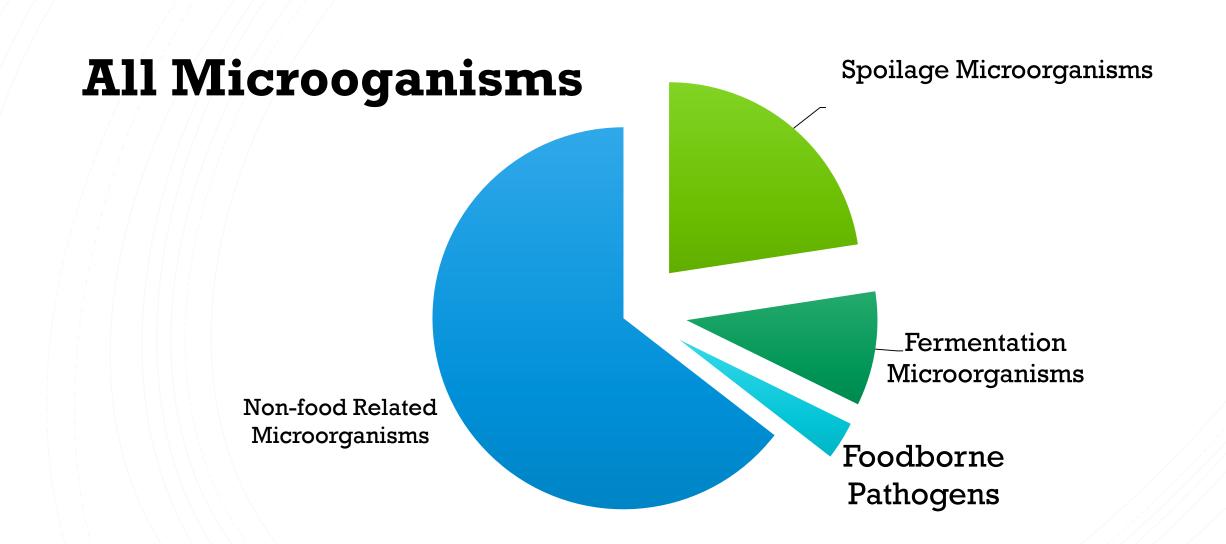
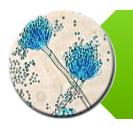
Food Safety Lessons from the Past





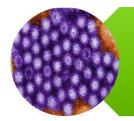




Molds



Yeasts



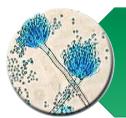
Viruses



Parasites







Molds

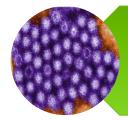


 Some organisms in these groups cause spoilage



Yeasts





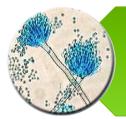
Viruses



Parasites



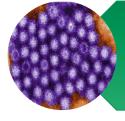




Molds



Yeasts



Viruses





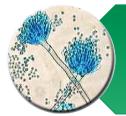
Parasites



- Some organisms in these groups cause foodborne illness
 - aka foodborne pathogen







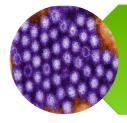
Molds





Yeasts





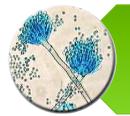
Viruses



Parasites

 Can grow (increase in numbers) in the environment (water, soil, plants, fruit)

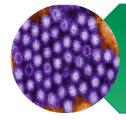




Molds



Yeasts



Viruses





Parasites



 Cannot grow in the environment (water, soil, plants, fruit), but can survive long periods of time

Sources of Microorganisms in Foods



Environment

Air

Water

Soil



Plants - Fruits & Vegetables

Soil

Irrigation Water

Animal/Insect Feces



Animals

Hides, Intestinal Tract

Eggs

Raw Milk

Sources of Microorganisms in Foods



Humans

Field

Processing Plant

Food Service Operations



Food contact surfaces

Processing

Sources of Microorganisms in Foods



Cross-Contamination

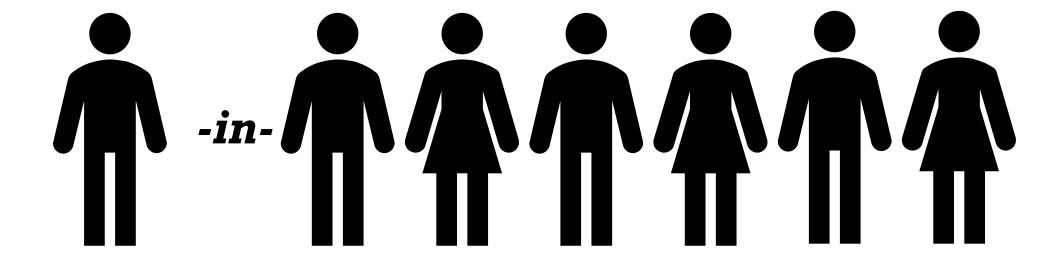
- Food contact surfaces to food
- Humans and animals to foods
- Contaminated food to uncontaminated food



Introduction to Foodborne Illness

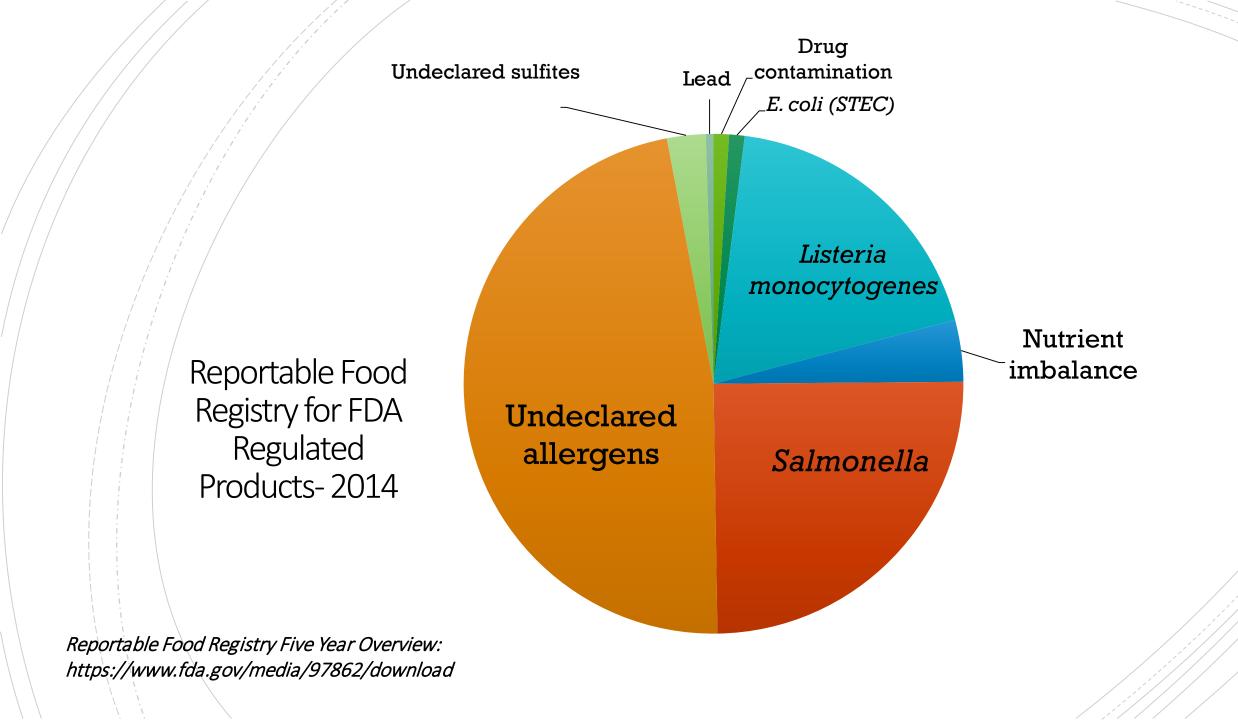
Foodborne Illness in the US

- 48 million cases of foodborne illness
- 127,839 hospitalizations
- 3,037 deaths

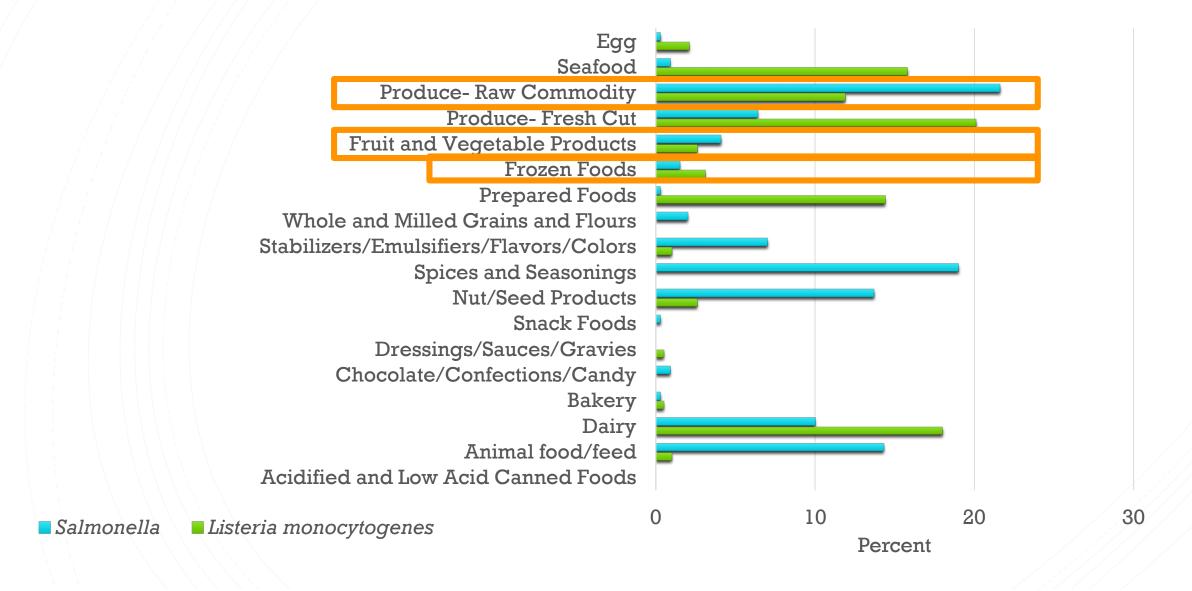


	Cases	Hospitalizations	Death Rate (%)	Deaths
Bacteria				
Campylobacter	1,322,137	13,240	0.1	119
Salmonella	1,229,007	23,128	0.5	452
Shigella	494,098	5,491	0.1	38
Other STEC (non-O157)	168,698	405	0.3	-
E. coli O157	96,534	3,268	0.5	31
Listeria monocytogenes	1,662	1,520	15.9	266
Parasites				
Cryptosporidium spp.	748,123	2,725	0.3	46
Cyclospora cayetanensis	19,808	20	0	0
Giardia intestinalis	1,221,564	3,581	0.1	34
Toxoplasma gondii	173,995	8,889	0.2	656
Viruses				
Norovirus	20,865,958	56,013	<0.1	571
Hepatitis A	35,769	2,255	2.4	171

Estimated Frequency of Microbial Foodborne Illness in Humans in the U.S.



Reportable Food Registry for FDA Regulated Products Foodborne Pathogens 2009-2014



Past Decade of Berry Outbreaks

Year	Organism	Number Ill	Berry	Possible Cause
2016	Norovirus	12	Strawberries	Ill food handler
2016	Hepatitis A	143	Strawberries	Frozen imported from Egypt
2013	Hepatitis A	162	Frozen berry mix	
2012	Hepatitis A	8	Frozen berry mix	
2011	E. coli O157:H7	7	Strawberries	Fresh- deer contamination
2009	Cyclospora	8	Blackberries and Raspberries	Home garden
2009	Salmonella	14	Blueberries	
2008	Cyclospora	3	Mixed berries	Associated with banquet
2008	Cyclospora	59	Mixed berries	Associated with banquet
		Total 413		

FDA Frozen Berry Assignment

- Total of 2,000 frozen berry samples will be collected in total
 - Both domestic and imported
- Testing for Norovirus and Hepatitis A
- Sampling began in November 2018
- Ceased pulling product at retail to lessen the amount of implicated product in commerce
- More to come from Dr. Jaykus

Introduction



Case - An individual



Outbreak - 2 or more individuals

Outbreak case – Ill person in an outbreak

Sporadic case – Ill person not associated with an outbreak

Foodborne Disease Outbreak

- Presence
 - Historical Association
- Growth
 - Infective dose
- Survival
 - Holding, Processing, Cooking
- Consumption of Contaminated Food
 - Spoilage

Foodborne Disease Outbreak

- Virulence
 - Can It Make You Sick?
- Susceptible Individual
 - Target Groups
 - Elderly, Infants, Immunocompromised, Chronically Ill, Pregnant Women
- Recognition
- Documentation by Medical Personnel

Reported to CDC

Reported to Health Dept.

Laboratory
Confirmed case

Laboratory Test for Microorganism

Specimen Obtained

Person Seeks Care

Person Becomes Ill

Exposure in General Population

Foodborne Disease Surveillance

- Centers for Disease Control and Prevention (CDC)
 - DocumentedOutbreaks/Cases
 - FoodNet
 - PulseNet



Bacterial Foodborne Pathogens

Escherichia coli



Habitat/Distribution

- Gastrointestinal tract of warmblooded animals
 - Same as Escherichia coli Biotype Ie.g. "generic E. coli"



Characteristics/Tolerances

- Growth
 - Optimum: 86-107.6°F (30-42°C)
 - No growth at 112.1°F (44.5°C)
 - Minimum 46.4-50°F (8-10°C)

Characteristics/Tolerances

- Heat resistance
 - $D_{145^{\circ}F (62.8^{\circ}C)} = 24 \text{ sec}$
 - $D_{147.7^{\circ}F(64.3^{\circ}C)} = 9.6 \text{ sec}$
 - Ground beef (17%-30% fat)
 - Requirement: 15 sec at 155°F (68.3°C)
- Survives freezing well
- **p**H: 4.0-9

Foods implicated

- Ground beef, roast beef, raw milk, fresh produce, apple cider, meat sandwiches, mayonnaise, lettuce, dry salami
- Water, Manure
- Person-to-person transmission

- Symptoms/duration
 - Onset time: 3-9 days; average 4 days
 - Primary
 - Diarrhea (often bloody)
 - Abdominal cramps



Symptoms/duration

- Sequelae
- Hemolytic Uremic Syndrome (HUS)
 - 2-7% of patients
 - Hemolytic anemia
 - Thrombocytopenia (low circulating platelets)

Symptoms/duration

- HUS
 - Renal failure
 - Damage to renal endothelial cells
 - Blood clotting in capillaries of kidney
 - Accumulation of waste products in blood which results in need for dialysis
 - Death rate: 3-5%

- Symptoms/duration
 - •TTP Thrombotic (clotting) thrombocytopenic (low circulating platelets) purpura (purplish patches on skin or membranes)
 - Involvement of the central nervous system
 - Primarily in elderly adults
 - Can lead to blood clots in brain
- Duration: 2-9 days; average4 days



Pathogenesis

- Infectious dose -10-100 cells
- Site of attack: colon
 - Bloody diarrhea
 - Attachment and effacement of cells
 - eae gene required for virulence



- Salmonella enterica subsp. enterica
 - 1,454 serovars
 - Salmonella enterica susp.
 enterica serovars: Dublin,
 Enteritidis, Heidelberg,
 London, Montevideo, Pullorum,
 Tennessee, Typhi, Typhimurium
 - CDC Salmonella enterica subsp. enterica serovar Typhimurium

Salmonella

Habitat/Distribution

- Intestinal tract of animals such as birds, reptiles, farm animals, humans and insects, water, soil
- Animal feeds
- Foods e.g., raw milk, poultry (up to 70%), raw meats, eggs, raw seafood, fruits and vegetables

Salmonella

Tolerances

- **□**pH: 4.0-9.0
 - 1995 outbreak in Florida orange juice; ACID SHOCK); optimum
 6.5-7.5
- A_w/salt: minimum
 approximately 0.93; NaCl at >
 9% is bactericidal
- Most heat resistant strain
 - S. Senftenberg: $D_{140^{\circ}F(60C)} = 7-10$ min; $z = 10-12^{\circ}F$

Salmonella

Gastroenteritis(salmonellosis)

- Symptoms/duration
 - Onset time: 12-14 hr
 - Primary symptoms: nausea, vomiting, abdominal pain, headache, chills, mild fever, diarrhea
 - Duration: 1-3 days
 - Mortality Rate: low (<1%); age related

Salmonella

- Gastroenteritis (salmonellosis)
 - Number required for symptoms
 - 10⁷-10⁹ CFU/g; varies with individual and strain
 - As low as 1/g for an outbreak of S.
 Eastbourne in chocolate; as low as 15-20 cells FDA
 - Target population population in general, especially infants, elderly, sick
- Sequela Reiter's Syndrome

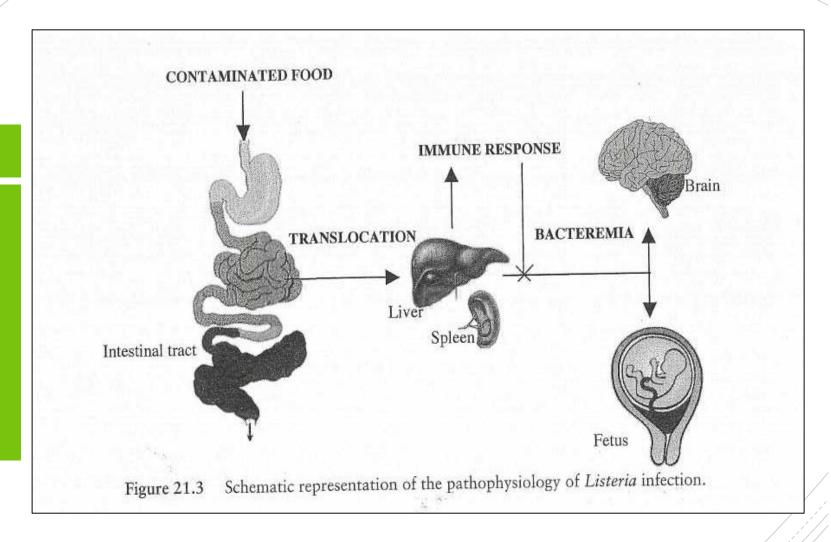
Salmonella

- Pathogenesis
 - Enterotoxin
 - Heat labile 212°F(100°C)
 - Similar to *E. coli* and *V. cholerae* toxins
 - Induces fluid accumulation
- Cytotoxin heat stable; tissue damage
- Cells adhere to and invade GI tract cells
- Some serovars require plasmids for virulence
- Treatment: None

- Habitat/Distribution ubiquitous
 - Human carriers: 1-10%
 - Healthy domestic animals
 - Normal and mastitic milk
 - Silage
 - Especially improperly fermented (high pH)
 - Soil
 - Leafy vegetables

Tolerances

- $D_{161^{\circ}F(71.7^{\circ}C)} = 1.0 \text{ sec}$
- **■**pH: 5-9
- Growth in 15% salt
 - Survival in saturated salt solution



Swaminathan et al. 2007. Listeria monocytogenes. In Food Microbiology: Fundamentals and Frontiers, 3rd Ed. Amer. Soc. Microbiol., Washington, DC.

- Listeriosis syndromes
 - Most healthy persons probably show no symptoms
 - Abortion
 - Mother's symptoms
 - Organism localizes in uterus in amniotic fluid
 - Fetus aspirates microorganism
 - Fetus is stillborn or acutely ill (septicemia)
 - Once fetus is aborted, mother asymptomatic

Listeriosis syndromes

- Perinatal septicemia –Newborns
 - Causes death in minutes to hours due to septicemia involving central nervous system, circulatory system, respiratory system
 - May lead to meningitis and mental retardation

- Listeriosis syndromes
 - Meningitis
 - Primarily elderly patients, immunocompromised (AIDS, cancer)
 - Onset 4 days to 3 weeks
 - Attacks central nervous system
 - Symptoms: severe headache, dizziness, stiff neck or back, incoordination
- Treatment
 - Parenteral antibiotics

Target populations

- Pregnant women/fetus
- Persons immunocompromised by corticosteroids, anticancer drugs, graft suppression therapy, AIDS
- Cancer patients leukemia patients particularly

Target populations

- Less frequently reported diabetic, cirrhotic, asthmatic, and ulcerative colitis patients
- Elderly
- Healthy people antacids or cimetidine may predispose; large doses

Recalls

- No. 1 microbiological reason for food recalls by FDA
- Zero tolerance
 - Less than 1 in 25 g
- Foods: dairy products (e.g., ice cream bars, soft cheeses), meats (hot dogs, etc.), shellfish, salads
- Canadian regulations tolerances





- Reproduce only within a living cell
- Only <u>carried</u> by foods
- Spread via fecal-oral route
- Can persist in the environment for quite awhile
- Two major foodborne viruses
 - Norovirus
 - Hepatitis A



- Leading cause of foodborne illness
 - >8 million cases/yr
- Rapid onset of illness, 24-48h sometimes as little as 8-10h
- Nausea, vomiting, watery diarrhea (1-3 days duration)
- Can shed at the high rates in feces after symptoms have subsided

Hepatitis A



- **3,500** cases/yr
- Jaundice, anorexia, vomiting, malaise
- Symptoms appear 15-50 days (median 29 days)
- Active shedding 10-14 days before symptoms appear
- Exposure confers durable immunity > people can be immunized

Prevention

- Personal hygiene
- Typically associated with food service vs. food packing/manufacturing
- Contaminated water has caused outbreaks in foods consumed raw
- Rapidly inactivated by heat, sanitizers





- Organisms that need a host grow and replicate (like viruses)
- Two groups
 - Protozoa 45,000 species
 - Helminths worms



- Single-cell organisms
- Typically associated with waterborne infections or foods that have come in contact with contaminated water



- Cryptosporidium spp.
- Cyclospora cayetanensis
- Toxoplasma gondii
 - Intermediate animal reservoirsheep, goats pigs, poultry
- Giardia intestinalis



- Avoid contaminated water
- Personal hygiene
- Proper cooking
- •Freeze/thaw for inactivation in raw materials (sushi)
 - -4°F for 7 days
 - -31°F for 15 hr

How can we prevent contamination?

- Water management
 - Difficult as we typically do not have alternative sources of water
 - Will water treatment at the farm level become a common practice?
 - Can we reduce application directly to the fruit?
 - Sprays, cooling
- Postharvest
 - Are there processing steps which can effectively reduce target pathogens beyond heat?
 - Gaseous sanitizer treatments for fresh (chlorine dioxide, ozone)
 - Antimicrobial spray treatments for frozen
- Sanitation
 - Equipment and tool sanitation- establish clean breaks
- Worker health and hygiene
 - Ill worker policy which is enforced

When faced with developing food safety management practices

- Substantiate your decisions on past outbreaks and recalls
- 2) Develop control strategies which can be implemented to control for these targets
- 3) Keep an eye out for new information

We hope you will be able to use some of this information to refine and build your food safety systems

Summary-Know your enemy!

