Charcuterie and Food Safety

Dr. Karen Killinger
Washington State University

WASHINGTON STATE UNIVERSITY

Overview

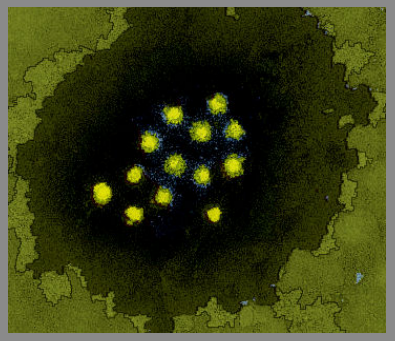
- General Food Micro
  - Types and Roles of microorganisms, susceptible populations, foodborne Illness
- Factors of Food Affecting Microbial Growth
- Bacterial Foodborne Pathogens
  - Types of illnesses, Organism overviews
- Viral & Parasitic Foodborne Pathogens
- Meat Processing Safety and Hurdle Technology

Types of Microorganisms

- Viruses
- Bacteria
- Parasites
- Mold
- Yeasts

Cryptosporidium parvum

Salmonella



Hepatitis A Virus

Sacchromyces cervisiae

- In foods, microorganisms can be beneficial, cause spoilage or cause disease

WASHINGTON STATE UNIVERSITY

Contaminated foods that can cause illness are difficult to identify

- Spoiled foods that look, smell or taste bad may not contain pathogens

- Foods that appear “safe” to eat may contain pathogens!

Why is food a good vehicle for pathogens?

- Microorganisms are present everywhere
  - Soil, water, countertops, hands, hair, etc.

- All raw foods contain microorganisms
- Food handling from farm to table can increase levels of contamination
- Foods are nutritious for humans and pathogens!

Understand what you want to prevent

- The better we understand how pathogens function, the better we can prevent their survival and growth in our food and water

- Food safety goggles

WASHINGTON STATE UNIVERSITY

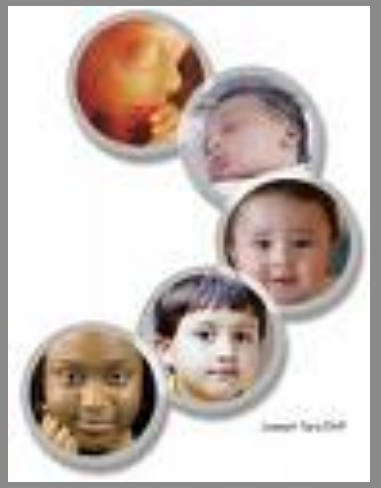
Frequency of Foodborne Illness (FBI) in the United States per year

- Total FBI 48 million
- Hospitalizations 128,000
- Deaths 3,000

- Outbreaks and Sporadic Cases

Most Susceptible Populations

- Very Young
  - Infants and young children
- Elderly
- Immunosuppressed
- Pregnant Women



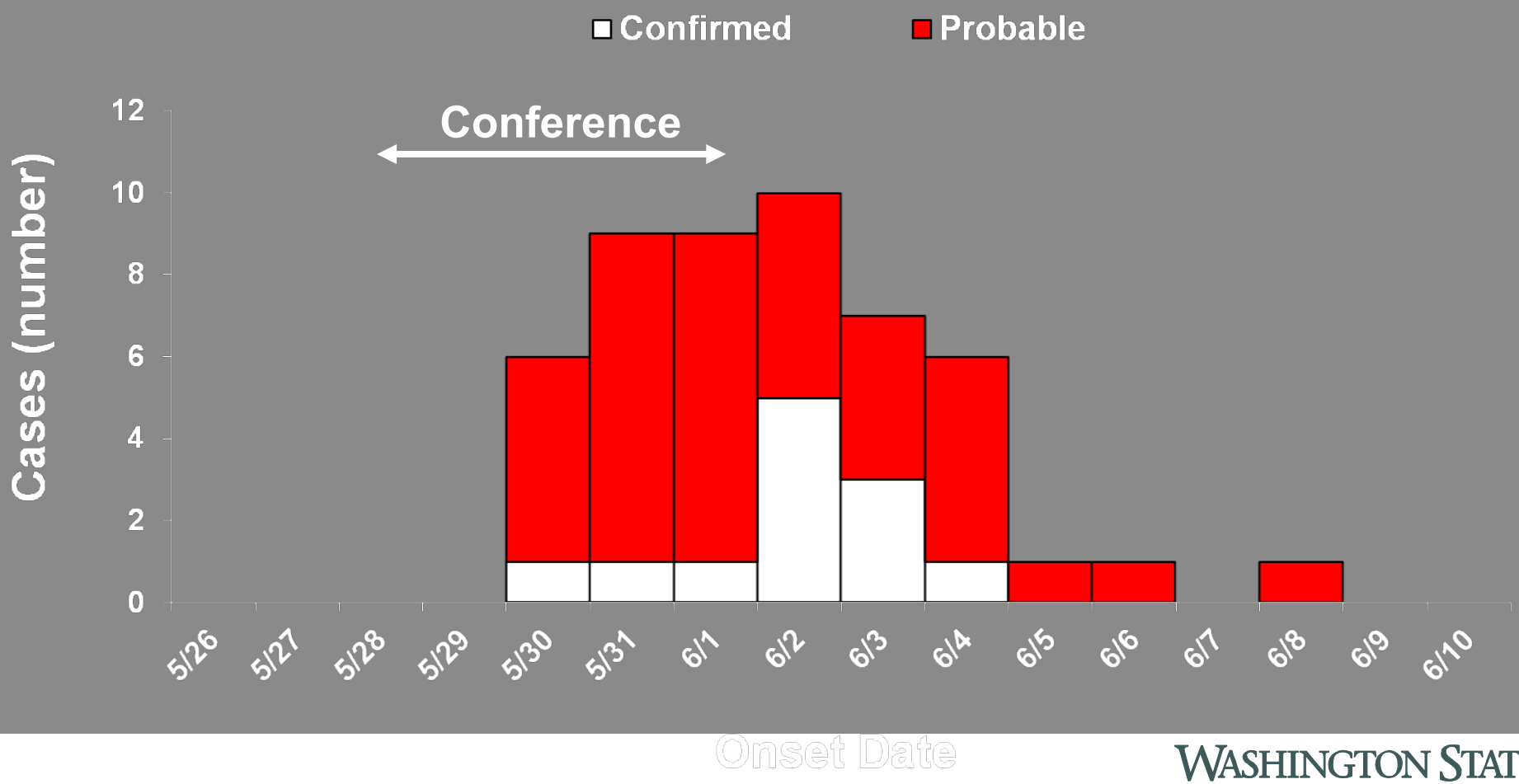
Foodborne Disease: General Characteristics

- Incubation Period – time between ingestion and onset of symptoms
  - 6 hours – 3 days
- Symptoms:
  - Initial symptoms flu-like: Fever, Fatigue, Headache, Muscle aches
  - GI symptoms: Nausea, Vomiting, Abdominal Cramps and Pain, Diarrhea
- Duration for mild to moderate illness
  - 24 hrs – 3 days

Symptoms excluding workers from food handling

- Fever
- Diarrhea
- Vomiting
- Sore Throat
- Jaundice

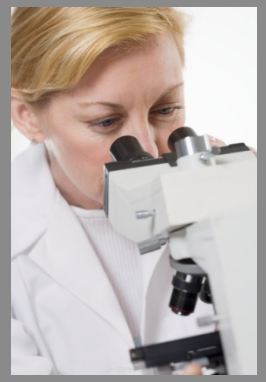
Confirmed and Probable Cases by Onset Date (n=50)



WASHINGTON STATE UNIVERSITY

Why does it take so long??

1.	2500 People with gastroenteritis (V and D)	Day 1
2.	250 People sick enough to see their doctor	Day 3
3.	50 people - Doctor takes a stool sample	Day 4
4.	20 people test positive for Salmonella	Day 7
5.	19 Labs report to County Health Dept (each County may only have 1 or 2)	Day 8
6.	8 patients interviewed by County Health Dept	Day 10
7.	6 isolates Co HD sends with interview info to DOH	Day 11
8.	6 Isolates serotyped at State lab	Day 13 to Day 27
9.	5 isolates PFGE matched at State lab	Day 15 to Day 29

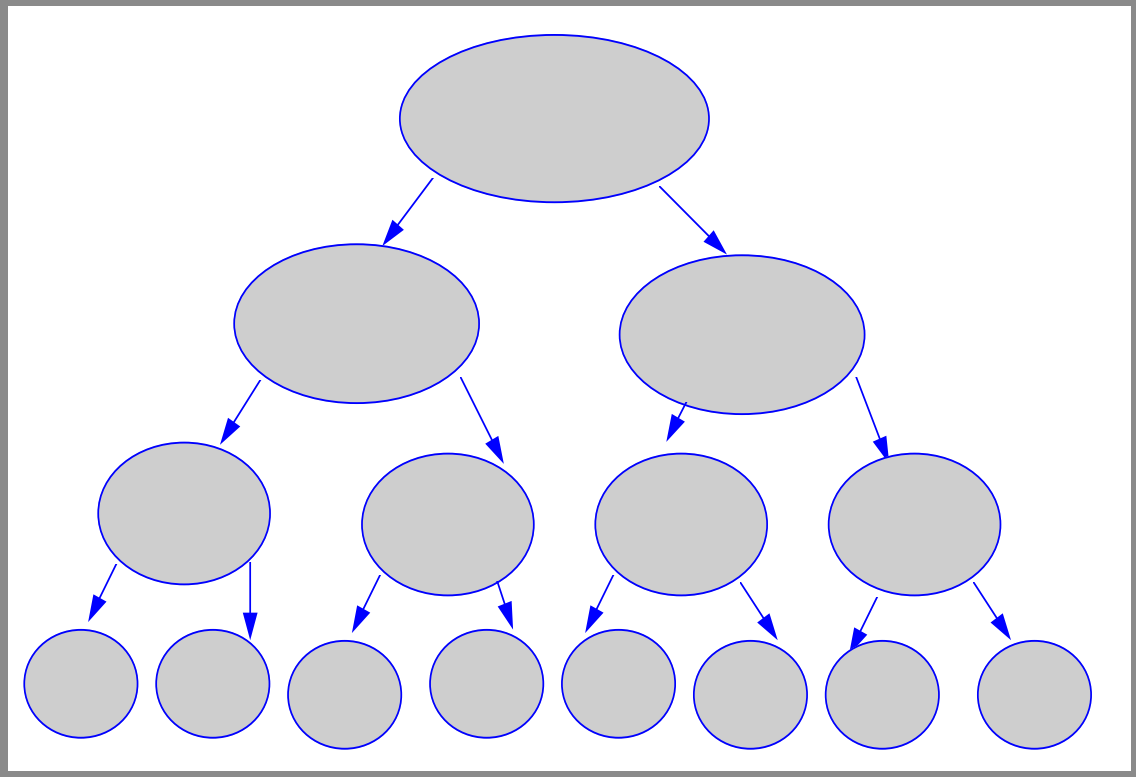


Anderberg, 2008

WASHINGTON STATE UNIVERSITY

Bacterial Foodborne Pathogens

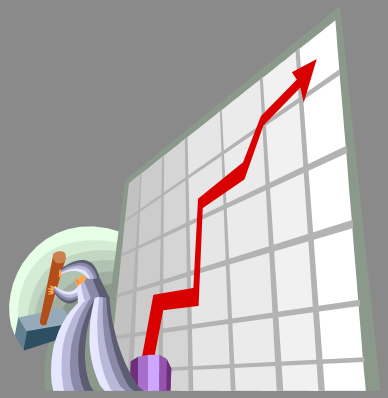
Bacterial Growth



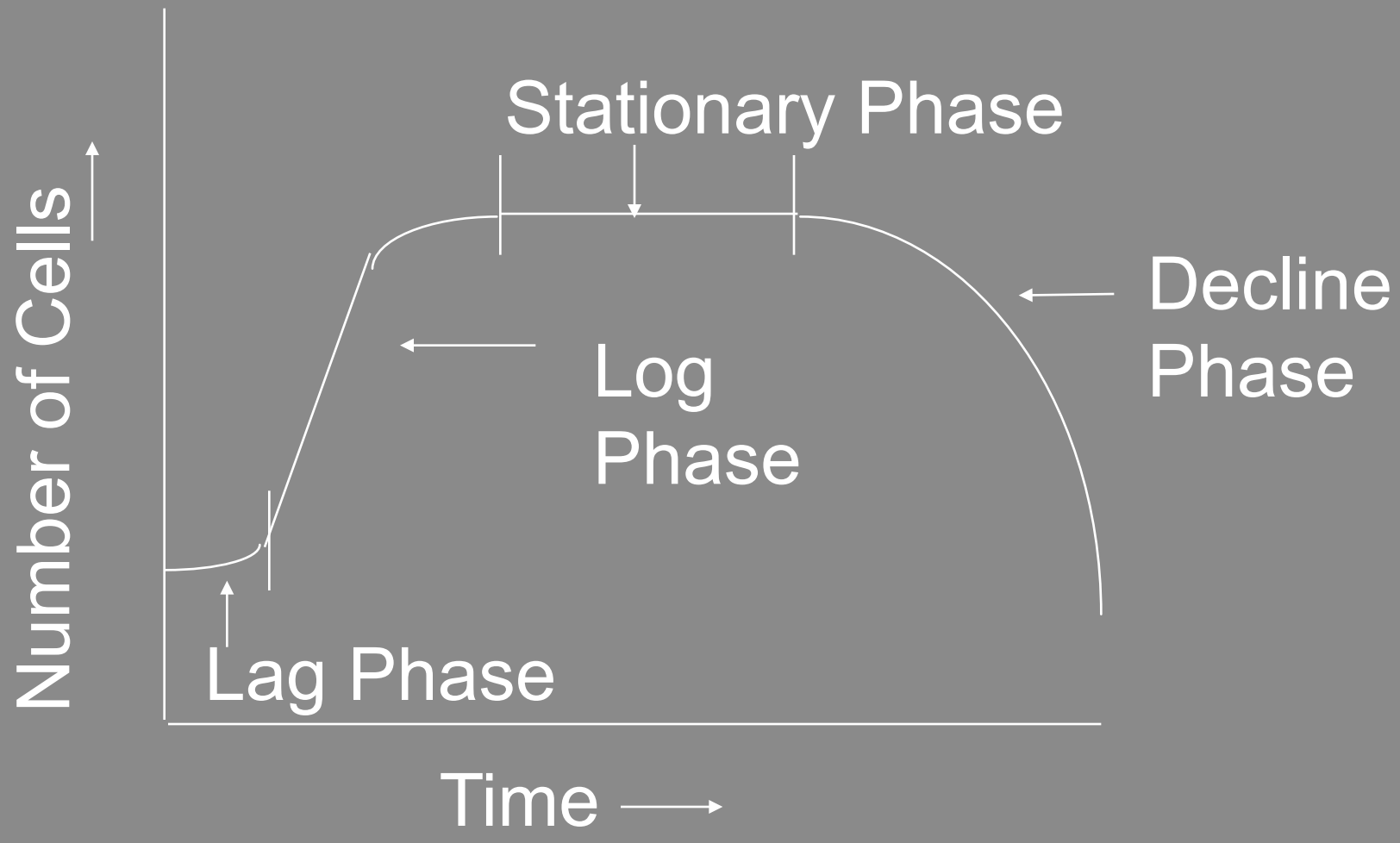
Under ideal conditions, bacteria can double in number every 15 - 30 minutes.

Exponential Growth

- 30 Minute Generation Time
  - Time 0 1000/g
  - 30 min 2000/g
  - 1 hour 4000/g
  - ……..
  - 5 hours 1,000,000/g



Bacterial Growth Curve



Factors affecting microbial growth (FAT TOM)

- F Food
- A Acidity
- T Time
- T Temperature
- O Oxygen
- M Moisture

Antimicrobial Factors

Food

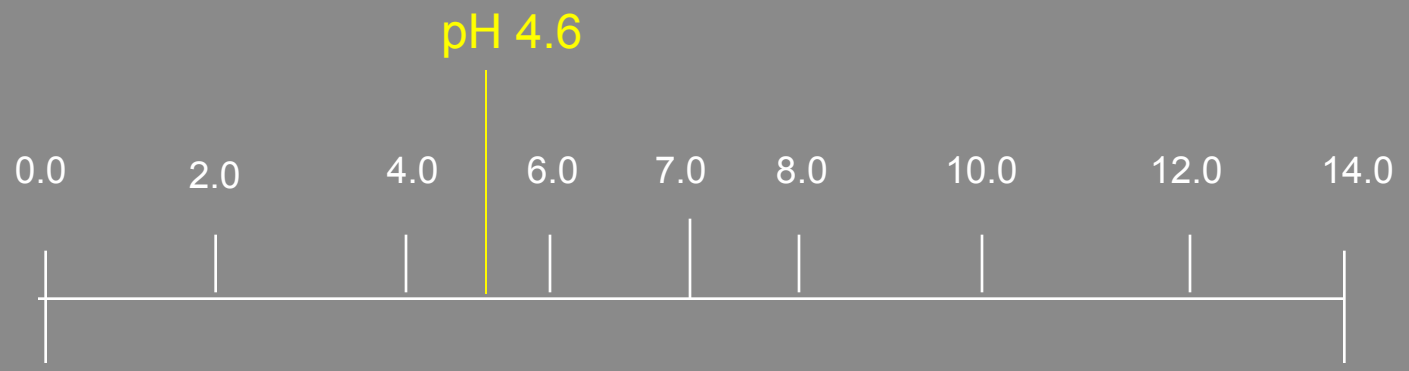
- Microorganisms require
  - Water
  - Source of energy
  - Source of nitrogen
  - Vitamins
  - Minerals

Acidity

- Adjust pH to prevent bacterial growth
  - Use acids in formulation
  - Fermented products
  - High protein foods will resist change in pH (buffer)

Acidity

- pH: measure of acidity
  - Scale 0 – 14
  - pH of < 4.6 used to define “acid” foods
  - Pathogens grow best between 4.6 - 9



Water Activity (a_w)

- Scale of water activity 0 – 1
- Most pathogenic microorganisms grow in the A_w range : 0.85 to 0.97
- Control moisture by:
  - Drying products
  - Adding water binding agents (humectants) like sugar, salt, glycerol or alcohol

Temperature

- Thermoduric – survive high temperatures
- Mesophilic –
  - 60 º - 110 ºF optimal growth
  - Most pathogens are mesophilic
- Psychrophilic – cold-loving
  - 32 ºF - 45 ºF
  - Often responsible for spoilage
  - *Listeria monocytogenes*

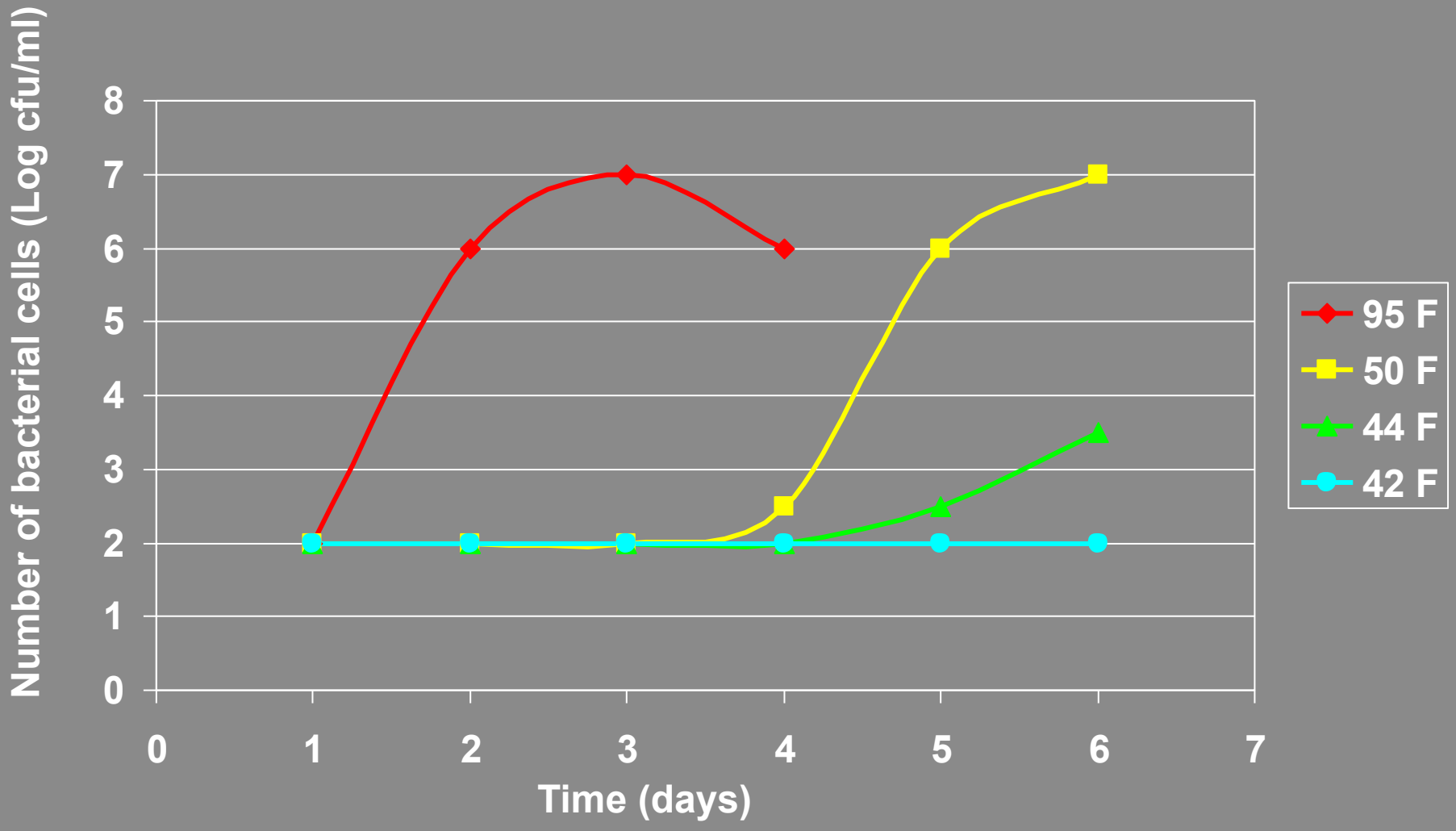
Temperature

- Most pathogens cannot GROW at cold temperatures but they can SURVIVE
- Keeping food out of the temperature danger zone does not kill microorganisms and may not even inhibit some organisms, especially spores
- Many practices only slow or control growth
  - Food must be handled properly

Time

- If given sufficient time, bacteria can grow to harmful levels
- The longer bacteria are held under optimal conditions, the more likely they will finish lag phase and enter log phase

Time & Temperature Relationship



WASHINGTON STATE UNIVERSITY

Oxygen (O_2)

- Bacteria require specific levels of oxygen for growth
  - Aerobes – grow in the presence of O_2
  - Anaerobes – cannot grow in the presence of O_2
  - Facultative – grow in the presence or absence of O_2
  - Microaerophilic – require small quantities of O_2

Oxygen

- Anaerobes can be found in canned foods, vacuum packaged foods, the center of large pots or cuts of meat
- Anaerobes can grow in thick, heat-treated plant material that has been temperature abused
  - Garlic-in-oil mixtures, foil wrapped potatoes
- Packaging can be used to adjust oxygen levels

Antimicrobial Factors

- Curing and Smoking
  - Nitrite contributes cured meat color and antimicrobial effects
  - Smoking can add antibacterial and antifungal properties to the surface of meat

Bacterial Foodborne Pathogens

Bacterial Spores

- Spores – protective, dormant, thick walled structures formed by some bacteria during unfavorable conditions
- Spores can survive conditions vegetative cells cannot
  - Resistant to heat, cold, chemicals, harsh environmental conditions
- Germinate to vegetative cells capable of growth under favorable conditions

Types of Foodborne Illness

- Foodborne Intoxication
  - ingest pathogen-produced toxin (chemical poison) in the food, toxin causes illness, ex. *Clostridium botulinum, Staphylococcus aureus*
- Toxin-mediated infection
  - ingest pathogen, toxin produced in GI tract that causes illness, ex. *Clostridium perfringens*
- Foodborne Infection: (ex. *Salmonella* spp.)
  - ingest pathogen, pathogen causes illness

Bacterial Pathogens causing Foodborne Intoxications

Clostridium botulinum

- Habitat: soil, air and water
  - spores present everywhere
- Spores germinate and cells grow in the absence of oxygen (anaerobe)
- Produces potent neurotoxin
  - Symptoms: Double vision, difficulty swallowing, dry mouth, paralysis, respiratory and cardiac failure

Clostridium botulinum

- Implicated foods
  - Foods held in anaerobic environment (cans, vacuum packages)
  - Foods of animal origin
  - Vegetables, especially those grown underground
    - Potatoes, onions, garlic

Control of *Clostridium botulinum*

- Heat treatment
  - Destruction of spores (retort/canning)
  - Toxin is heat sensitive (boiling for 10 minutes)
- pH – typically does not grow at pH <4.6
- Nitrites – control growth in cured meats

Staphylococcus aureus

- Habitat: Humans, animals, dust, soil
  - Nose, skin, hair, cuts, pimples, boils
- High infectious dose
  - Must grow in the food in order to produce toxin and illness
- Toxin is heat stable

Staphylococcus aureus

- Implicated Foods
  - Heavily handled cooked foods
  - High protein foods
  - Salads, gravies, processed meats, custards
- Not affected significantly by the presence of nitrites
- Once the toxin is formed, it cannot be destroyed

Control of *Staphylococcus aureus*

- Proper personal hygiene
- Proper time-temperature relationships
- Rate of drying and consistent drying throughout the product important factors

Bacterial Pathogens causing Foodborne Infections

Carrier State

- Apparently healthy individuals can transmit the disease to others
- Individuals recover from a foodborne illness, symptoms subside but they continue to shed the organism
- Carriers may not have exhibited symptoms but they were exposed to and carry the organism

Salmonella spp.

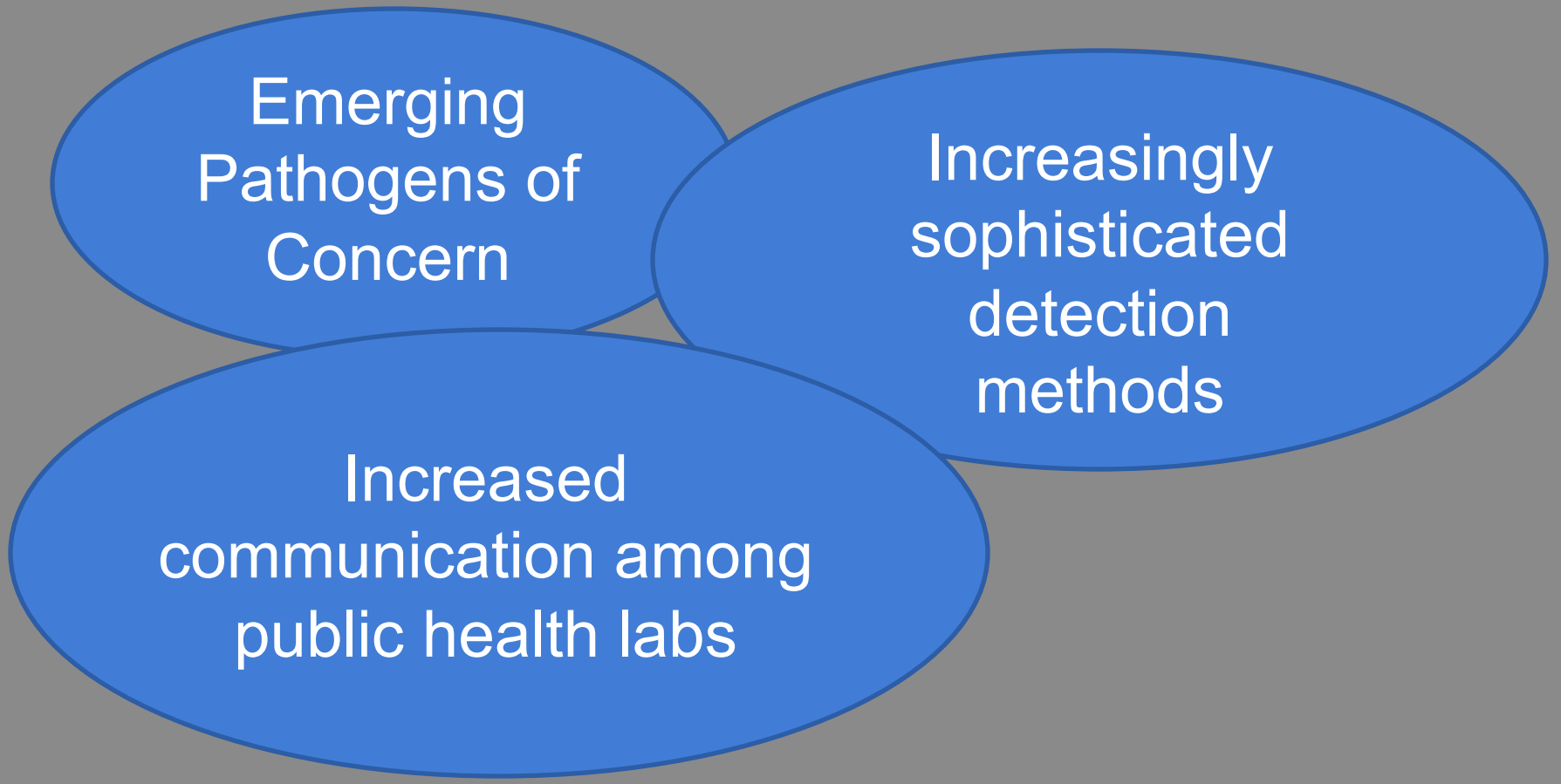
- 2400 types of *Salmonella*
  - All are pathogenic to humans
  - Many characteristics depend on the type
- Habitat/Source: GI tracts of a wide variety of animals
- Low infectious dose (ex. 100 cells)

Salmonella spp.

- Implicated Foods
  - Foods of animal origin – meat, dairy & egg products
  - Raw vegetables & fruits
  - Unpasteurized Orange juice
  - Nuts
  - Alfalfa sprouts

Control of *Salmonella* spp.

- Proper temperature relationships
  - Proper cooking will eliminate (ex. 160 for 1 s)
  - Appendix A time-temperature relationships
- Avoid cross-contamination
- Good personal hygiene



Increased likelihood that foodborne outbreaks and contaminated food products will be identified and linked

Shiga-Toxin Producing *E. coli* (STEC) ex. *E. coli* O157:H7

- Habitat: GI tract of animals and man, especially ruminants
- Low infectious dose: 1 – 10 cells
- Complications
  - Hemolytic uremic syndrome (HUS)

Enterohemorrhagic *E. coli*, ex. *E. coli* O157:H7

- Implicated Foods
  - Foods of animal origin – meat & dairy products
  - Raw vegetables & fruits
  - Apple cider

Control of STEC and *E. coli* O157:H7

- Proper temperature relationships
  - Keep product and processing areas cold
  - Decrease moisture in the plant
  - Proper cooking temperatures
- Avoid cross-contamination

Listeria monocytogenes

- Habitat: ubiquitous (everywhere)
  - Soil, vegetation, water, damp environments, GI tract of man and animals
- Incubation Period: 3 – 70 days
- Symptoms:
  - Initial: Typical GI and flu-like symptoms
  - Complications: Meningitis, Encephalitis, Septicemia, Abortion and Stillbirth

Listeria monocytogenes

- Implicated Foods
  - Unpasteurized milk
  - Cheese
  - Ice cream
  - Raw vegetables
  - Processed meats

Listeria monocytogenes

- Listeria is a psychrophile, it can grow at refrigeration temperatures
- Listeria can survive, grow and form biofilms in food processing plant environments
  - Establish a niche in hard-to-clean areas
  - Difficult to remove once established

Control of *Listeria monocytogenes*

- Aggressive sanitation in food processing plant
- Proper Cooking
- Avoid Cross-Contamination

Stress Response of non-sporeforming pathogens

- Acid Tolerance Response
  - *Salmonella* and *E. coli* O157:H7
- Resistance to drying
  - *Listeria monocytogenes*
- Resistance to salt/nitrite
  - *Listeria monocytogenes/Staphylococcus aureus*
- Thermotolerance

Bacterial Pathogens causing Toxin-mediated infections

Clostridium perfringens

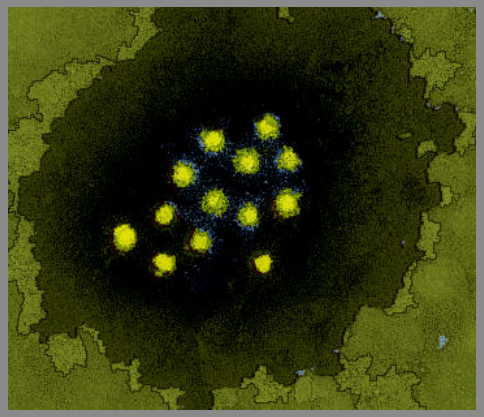
- Habitat & Characteristics same as botulinum
- Spores typically survive cooking process, growth is controlled with proper cooling
- High Infectious dose, rapid generation time

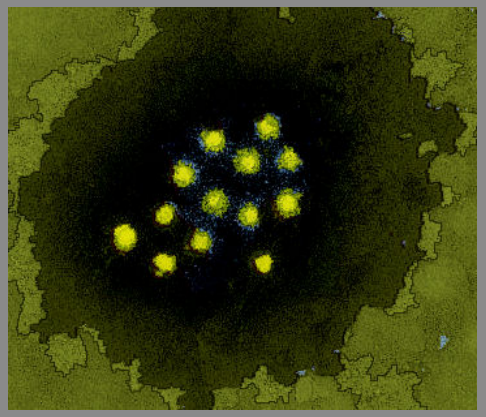
Clostridium perfringens

- Implicated Foods:
  - Cooked meats, especially turkey and chicken
    - Large pieces of cooked meat (hard to cool)
  - Gravy
  - Beans
  - Starchy foods
  - Cooked foods prepared in advance

Control of *Clostridium perfringens*

- Proper cooling temperatures
  - Appendix B time-temperature relationships
- Avoid cross-contamination

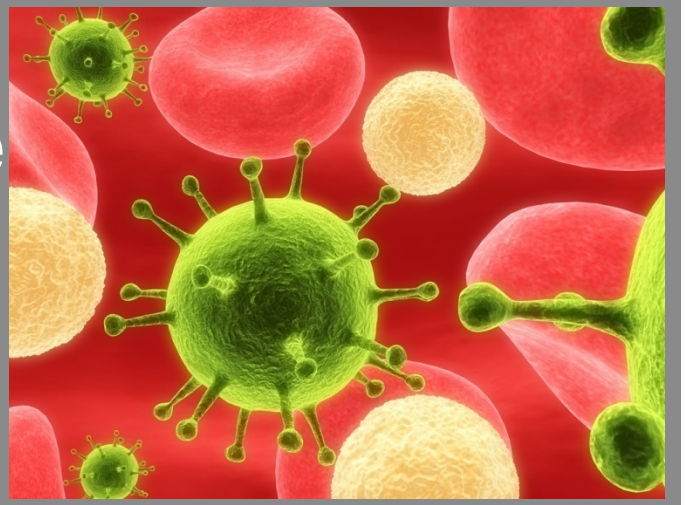




Viruses

Viruses

- Smallest microorganism
  - Genetic information protected by a protein coat
- May be present in foods or water
- Require a host to reproduce
- Do NOT replicate in food



Viruses

- DIFFICULT to eliminate or destroy in foods
- May not be destroyed by freezing or cooking
- The MOST COMMON foodborne illness in the US is a virus
  - Norovirus

Norovirus

- Sources: Humans and polluted water
- Highly contagious: 1 – 10 viral units
- Carrier state after illness– Apparently healthy individual can transmit the disease to others
- Resistant to chlorine sanitizers

Control of Viruses

- Good personal hygiene practices
  - minimize contact between ready-to-eat foods and bare hands
- Exclude infected workers
- Use sanitary water sources

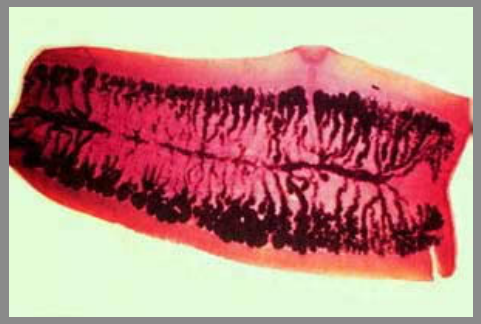
Pathogenic Mold

Pathogenic Mold

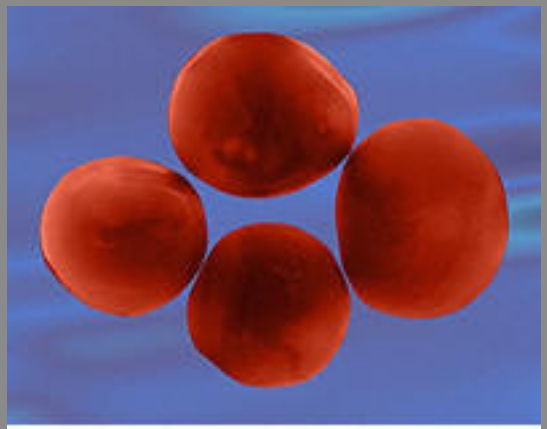
- Symptoms range from mild to severe:
  - eye, ear and sinus infections
- Mycotoxins - potent toxins produced by molds that can cause severe illness such as cancer and liver disease

Recommendations

- Wash hams free of mold with a stiff vegetable brush
- Wash with 10% acetic acid in water



Parasites



WASHINGTON STATE UNIVERSITY

Parasites

- Require a host to live on or in
- Host - an animal, plant or human used by another organism to live on and obtain nutrients
- Can contaminate food or water

Parasites

- *Toxoplasma gondii*
  - Implicated foods: beef, pork, lamb, raw milk
- *Trichinella spiralis*
  - Pork, bears, deer, other game animals
  - Freezing an effective control for pork but not necessarily other game meat

Control of Parasites in Foods

- Use sanitary water sources
- Proper cooking and freezing
- Practice good personal hygiene
- Prevent cross-contamination

Pathogens have been observed in dried/ cured/fermented meats*

Type of Processed Meat	Associated Pathogens
Salami (uncooked, fermented, dry sausage) and Genoa Salami	*Salmonella* (multiple), *E. coli* O157:H7, *Listeria monocytogenes*
Pre-Sliced, dry, fermented sausage	*E. coli* O157:H7
Mettwurst- uncooked, fermented, semi-dry sausage	*E. coli* O157:H7
Fermented Sausage and Lebanon Bologna	*Salmonella*
Ham (dried, cured, smoked)	*Salmonella, Trichinella, Cl. botulinum, Staphylococcus aureus, Listeria monocytogenes*
Bacon	*Listeria monocytogenes*

* Not a complete list and equivalent information not supplied in all cases

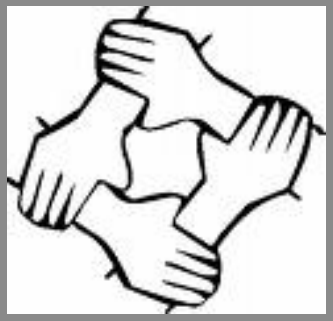
WASHINGTON STATE UNIVERSITY

Outbreaks and Recalls occur when…

- Multiple failures occur
- Failure to be realistic about your risks
- Lack of vigilance or adherence to food safety plan

Food Safety Culture and Commitment to Food Safety

- Everyone in the company affects food safety



- Are you “living” your food safety and sanitation programs?

Do not take environmental safety programs for granted

- Water Quality
- Premises and Equipment integrity & maintenance
- Pest Control
- Prevention of Cross-Contamination
- Worker Health and Hygiene
- Chemical Inventories

Do not take environmental safety programs for granted

- SANITATION
  - Grounds and Employee Areas outside production facility
  - Storage Areas
  - Maintenance Tools and Cleaning Supplies
  - Production Areas

WASHINGTON STATE UNIVERSITY

Use your food safety goggles
Think like bacteria!

WASHINGTON STATE UNIVERSITY

Hurdle Technology

- Utilizes a combination of factors to achieve microbial control through synergistic effects
  - High Temperature
  - Low Temperature
  - Reduced Water Activity
  - Reduced pH
  - Competitive microflora
  - Reduced redox potential- Oxygen availability
  - Preservatives

Factors to Consider

- Raw versus Ready-to-Eat
- Processing Steps
- Rate of Drying/Fermentation
- Water Activity
- Time and Temperature Relationships
- pH and Fermentation process
- Packaging
- Relative Humidity

Hurdle technologies and Heat Treatment

- Effective use of hurdle technology reduces pathogen levels or controls pathogen growth; however, pathogen survival may still occur

- Many dried products in the US utilize a heat step to ensure pathogen lethality

Examples of Products

- Identify the hurdles utilized in your process

Things to Remember

- Know your risks and your product
- Microbial quality of raw materials
- Prevent cross-contamination
- Proper Sanitation Procedures

Go Cougs!

Dr. Karen Killinger-Mann
Washington State University
PO Box 646376
Pullman, WA 99164-6376
(509) 335-2970
karen_killinger@wsu.edu

WASHINGTON STATE UNIVERSITY