

Introduction to Food Safety: Microbiology and Horticulture

Sarah Allard
University of Maryland
sallard@umd.edu

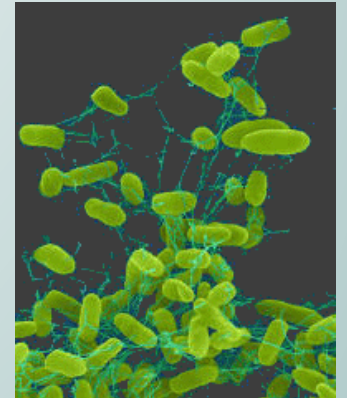
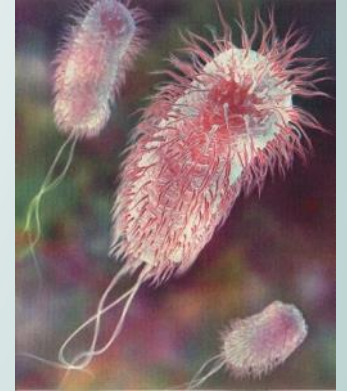
Modified, Carol Allen
March 2020
callen12@umd.edu

Hazards in Foods

A hazard is something that could cause harm to the consumer.

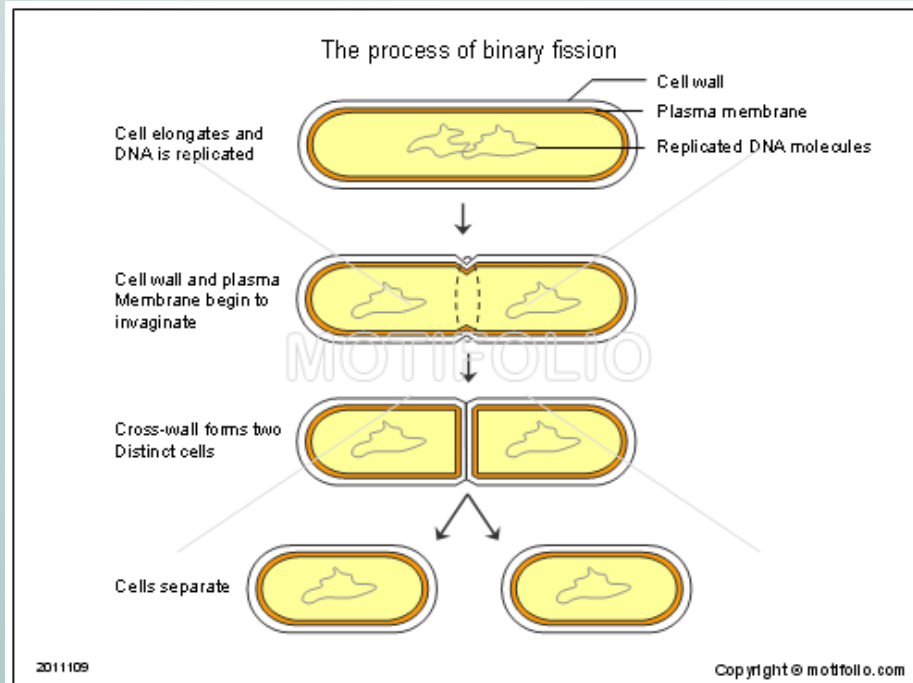
Hazards commonly associated with fresh produce are:

- **Biological hazards**
- Chemical hazards
- Physical hazards



Microbiology: Bacterial Growth

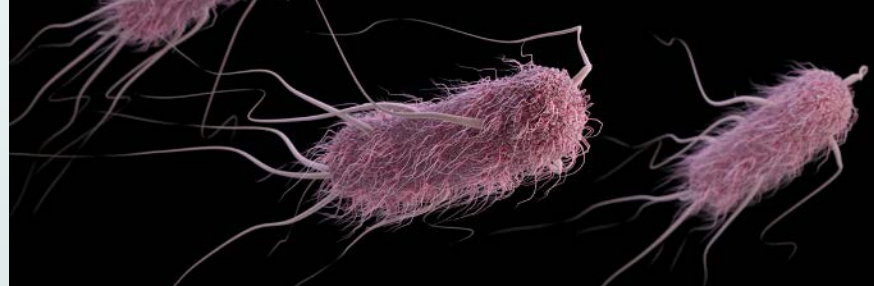
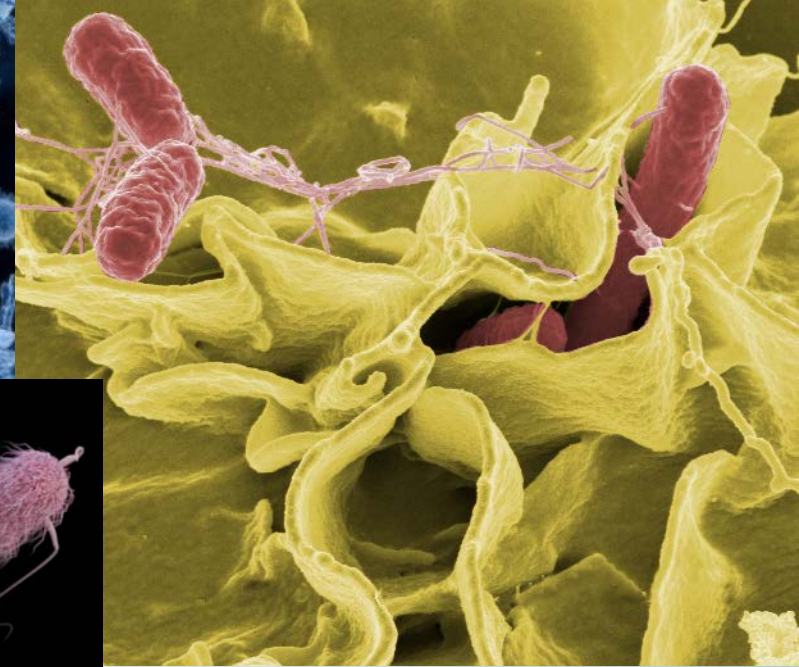
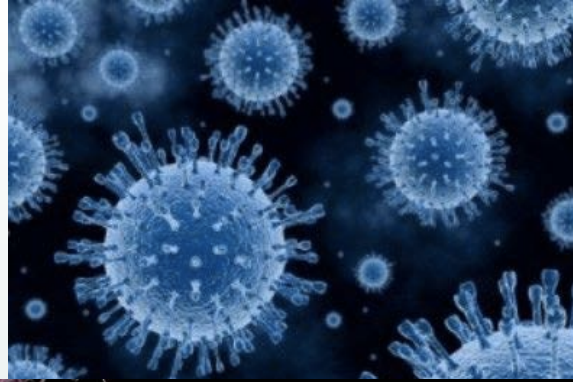
- Bacteria reproduce through binary fission
 - Can split every 15 minutes
 - 1 cell to 1 billion in less than 10 hours



Time	Number of Bacteria
0	1
20 minutes	2
40 minutes	4
1 hour	8
1 hour 20 minutes	16
1 hour 40 minutes	32
2 hours	64
2 hours 20 minutes	128
2 hours 40 minutes	256
3 hours	512
3 hours 20 minutes	1,024
3 hours 40 minutes	2,048
4 hours	4,096
4 hours 20 minutes	8,192
4 hours 40 minutes	16,384
5 hours	32,768
5 hours 20 minutes	65,536
5 hours 40 minutes	131,072
6 hours	262,144
6 hours 20 minutes	524,288
6 hours 40 minutes	1,048,576
7 hours	2,097,152
7 hours 20 minutes	4,194,304
7 hours 40 minutes	8,388,608
8 hours	16,777,216

Enteric Pathogens

- Major players in food safety:
 - Norovirus
 - *E. coli* 0157:H7
 - *Salmonella enterica*
 - *Listeria monocytogenes*



- Common symptoms: Intestinal distress: diarrhea, vomiting, pain
- But in serious cases: reactive arthritis, hemolytic uremic syndrome, chronic kidney disease, miscarriage, neurological disorders, or even death
- 1 in 6 Americans estimated to be sick from foodborne illness each year
 - 48 million people get sick
 - 128,000 hospitalizations and 3,000 deaths

What Caused the Shift to Produce-Related Outbreaks?

- Change in dietary habits
 - Yearly consumption of produce increased by 24% (1970-1997)
 - 711 pounds of produce eaten per capita
- Variability in methods of fruit production and processing
- Emergence of new pathogens associated with fresh produce
- Better documentation of outbreaks
 - PulseNet (CDC) – national outbreak reporting system
 - More people are aware of the issue



Fresh Fruit and Vegetable Concerns

- Grown in an open environment
- Multiple opportunities for contamination
- No absolute kill step without damage
- Likely to be consumed raw



But... can't I just wash them off?

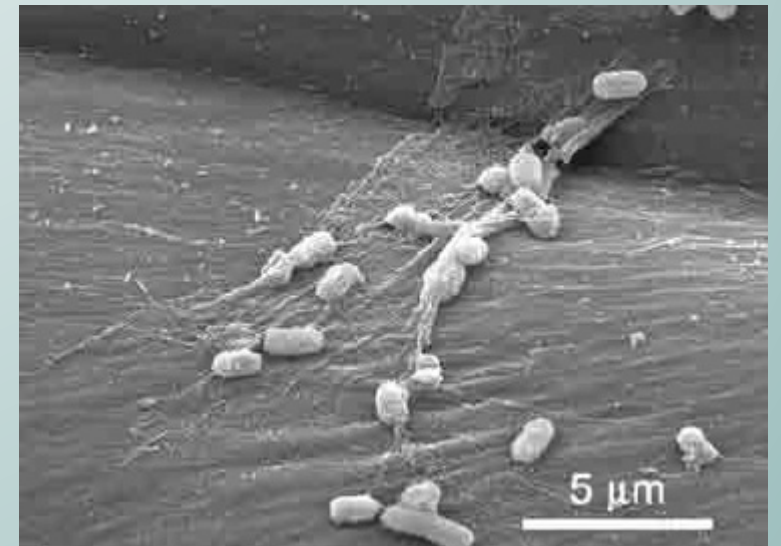
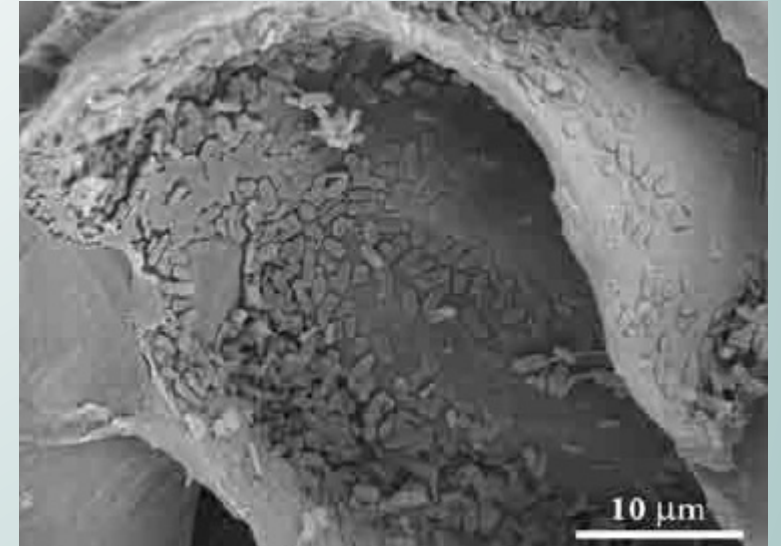


Image: www.ift.org, redorbit.com, www.ipt.us.com, gothamgreens.com



Pathogen Infiltration:
washing the surface
doesn't cut it



What can we do to Prevent Food Safety Outbreaks?

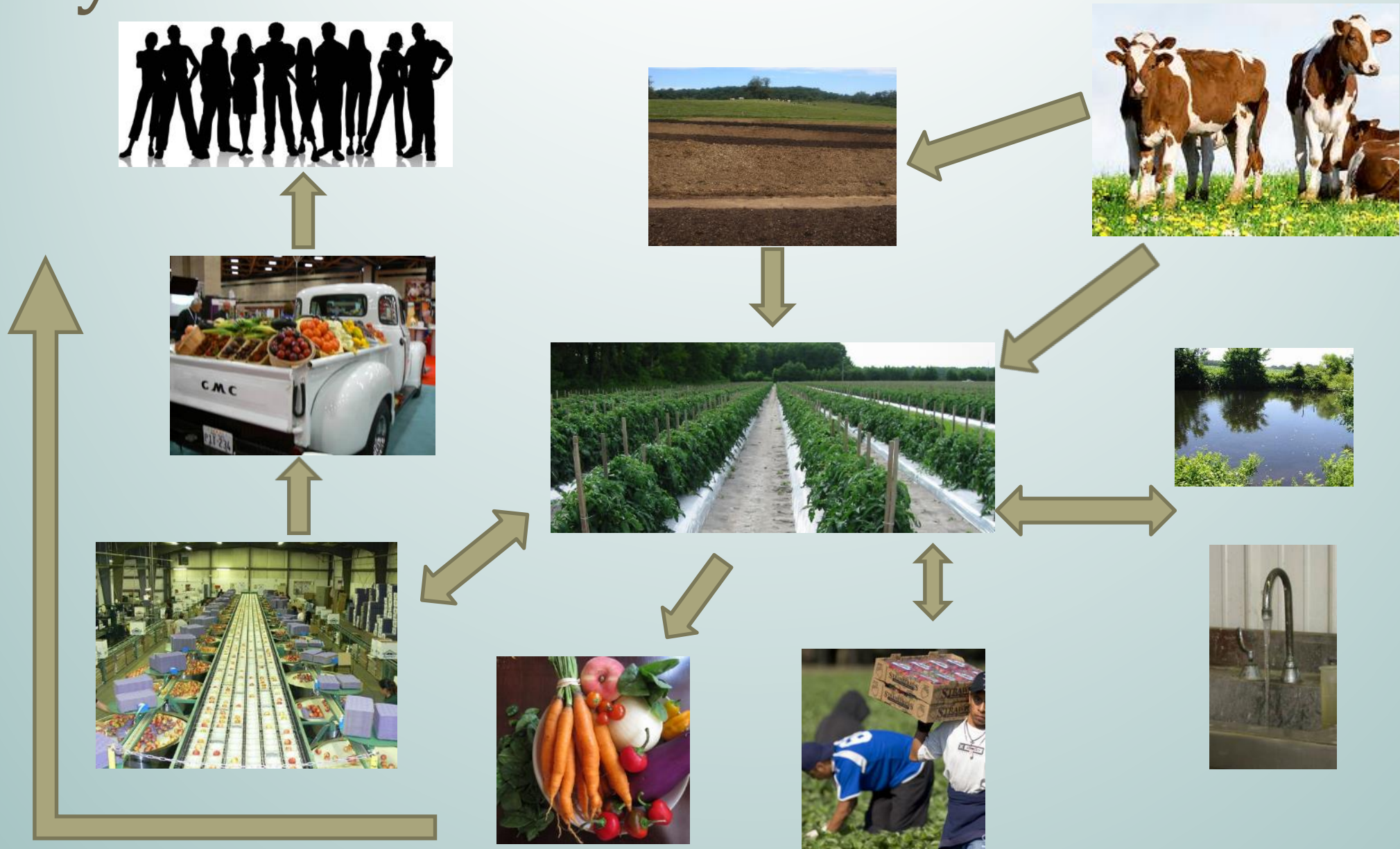
- Good Agricultural Practices (GAPs) & Good Handling Practices (GHPs)
 - Ways to Reduce Contamination on the Farm
 - Preharvest AND Postharvest
 - Voluntary. May be required by the wholesale buyer

1998 US Food and Drug Administration published the “Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables”

2002 USDA implemented the Good Agricultural Practice audits

2011 FDA Food Safety Modernization Act. Producers and handlers are now required to meet standards.

Why do we need GAPs?



Cross contamination



Photo from www.hydrocoolerchiller.com



www.VagabondJourney.com



Focus on the 4 W's – The Areas Most Likely Where Contamination Could Occur

Waste

Wildlife

Workers

Water



Animal Manure

- Abundant supply
- Great source of nutrients
- Great way to recycle waste
- Great for soil health



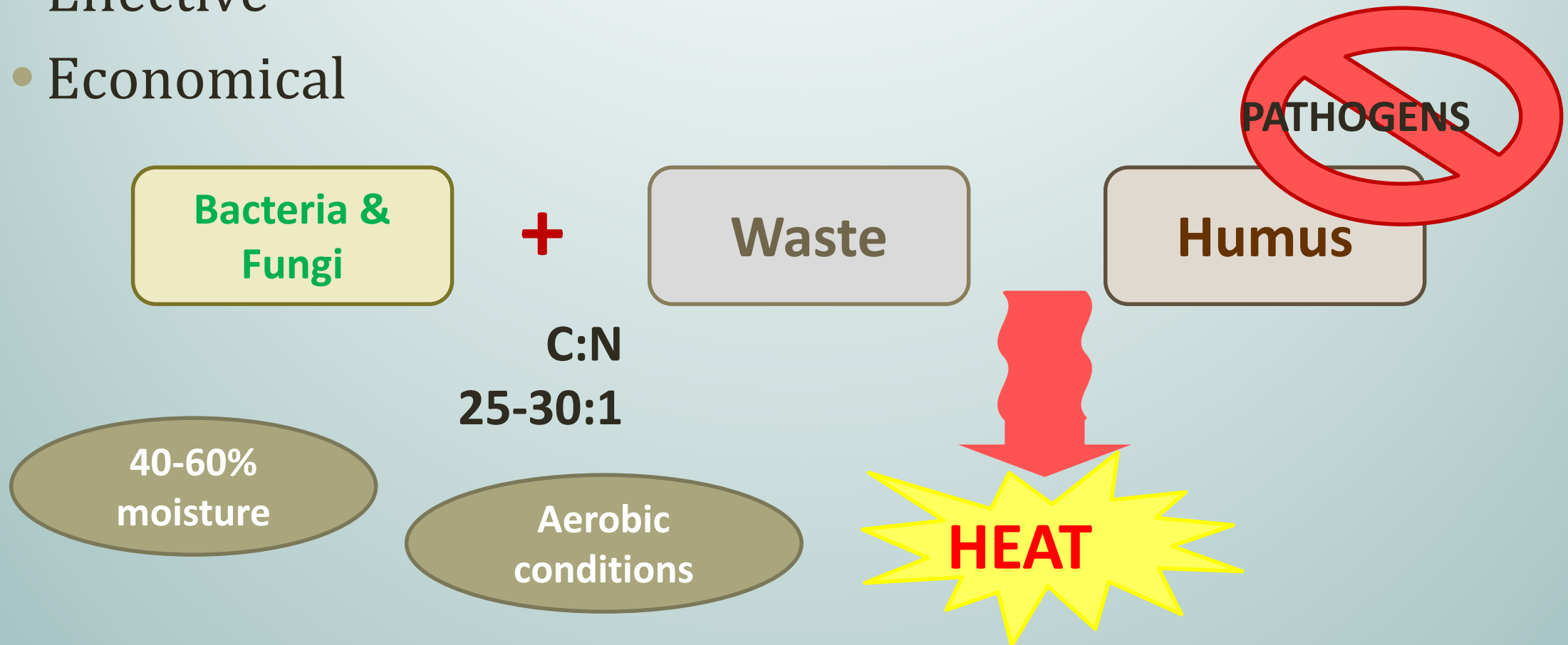
BUT ...

- **Can harbor human pathogens**

COMPOSTING!

Composting

- Converts plant/animal waste into organic fertilizer
- Effective
- Economical



Compost vs. Manure

Unless the compost has been produced under very strictly regulated circumstances then treat it as manure

“An aerated static pile reaching 131 degrees Fahrenheit for three consecutive days, or a turned compost pile reaching 131 degrees F for 15 days not necessarily consecutive, which must be turned at least five times to ensure processing to completion”

Current Manure Standards

- National Organic Program Standards

Manure	Contact	Time Interval
Untreated	Contact	120 days
Untreated	Non-contact	90 days

- FDA is still taking testimony on this issue



Focus on the 4 W's – The Areas Most Likely Where Contamination Could Occur

Waste

Wildlife

Workers

Water



Wildlife... Animals – wild and domestic



Wildlife – Direct Contamination



Domestic animals on farm



Hazards from Animals

- Poultry can carry *Salmonella* and *Campylobacter*



- Livestock can carry *E. coli* 0157:H7, *Shigella*, *Listeria* and *Salmonella*

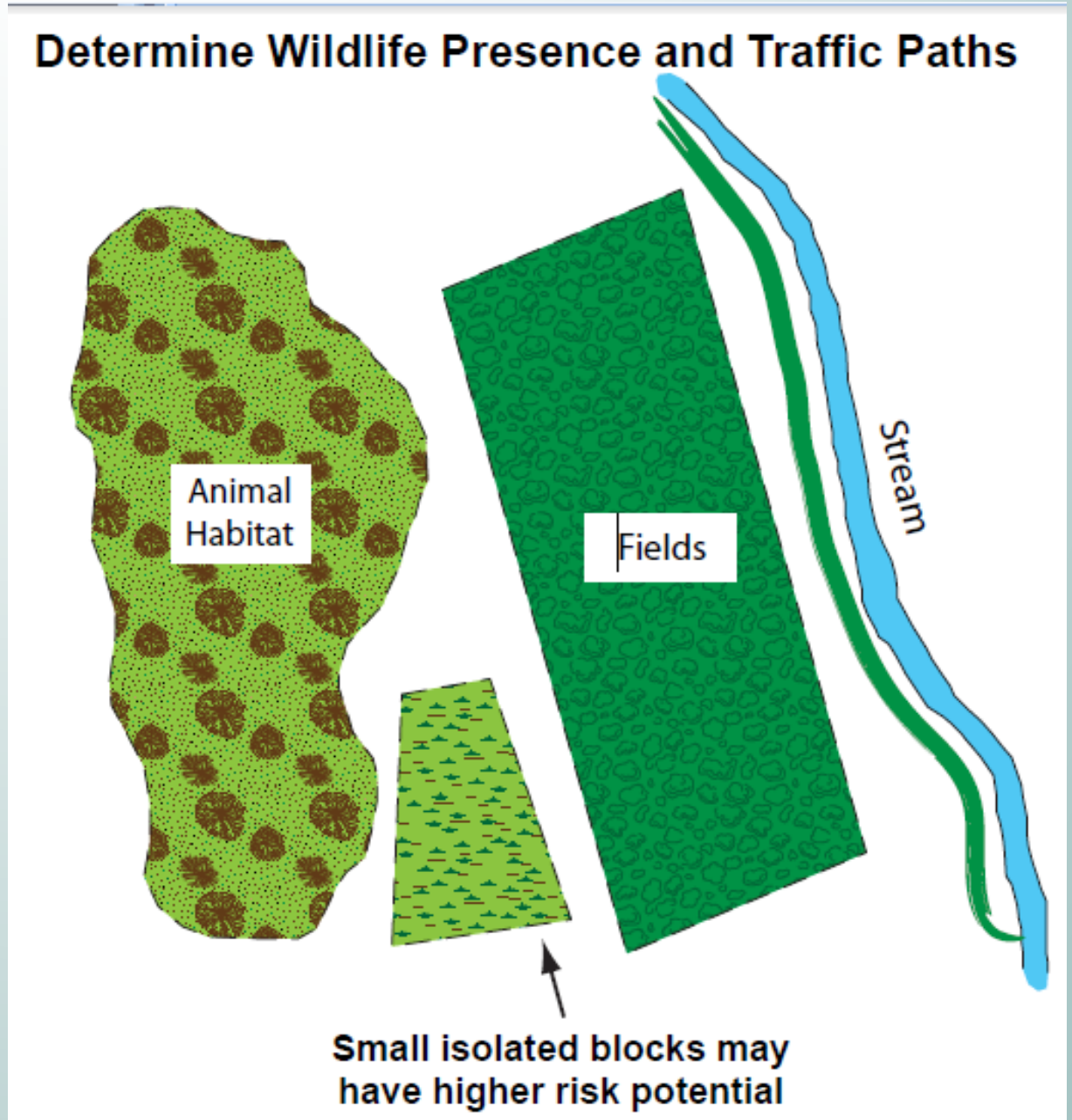


Animal Exclusion and Control

- **Depredation (killing)**
 - controlled hunting of hogs, deer and other wild animals may be permitted
- **Control**
 - Traps eg. rodent control
 - Restrictions on poison (away from produce)
- **Buffer zones around fields**
- **Construction of barriers**
 - fences, deer gates, electric fences
- **Deterrent devices**
 - scarecrows, propane cannons

Field Location

Adjacent streams and wooded areas will support wildlife





Pre-Harvest Inspection of Fields
Evidence of Animals Requires Vigilance
During the Production Period



Focus on the 4 W's – The Areas Most Likely Where Contamination Could Occur

Waste

Wildlife

Workers



Water



Worker Health and Hygiene

- Worker hygiene training
 - Washing hands
 - Using restrooms
 - Screening sick workers
- VERY important in food safety!



How to wash your hands

1. Wet hands with warm water
2. Apply soap to hands
3. Lather hands for 20 sec.
4. Rinse thoroughly
5. Towel dry thoroughly with disposable paper towel



Food Safety does not need to be sophisticated!



Two examples of hand-washing stations

Focus on the 4 W's – The Areas Most Likely Where Contamination Could Occur

Waste

Wildlife

Workers

Water



Water: Uses of water in agriculture

- ***Preharvest***

- Irrigation
- Pesticide application
- Frost protection



- ***Postharvest***

- Washing and processing
- Refrigeration and cooling



Water Sources

- Water for agricultural use may come from:
 - Municipal water systems
 - Wells
 - Surface sources
 - Rivers, streams, irrigation ditches, ponds, and canals

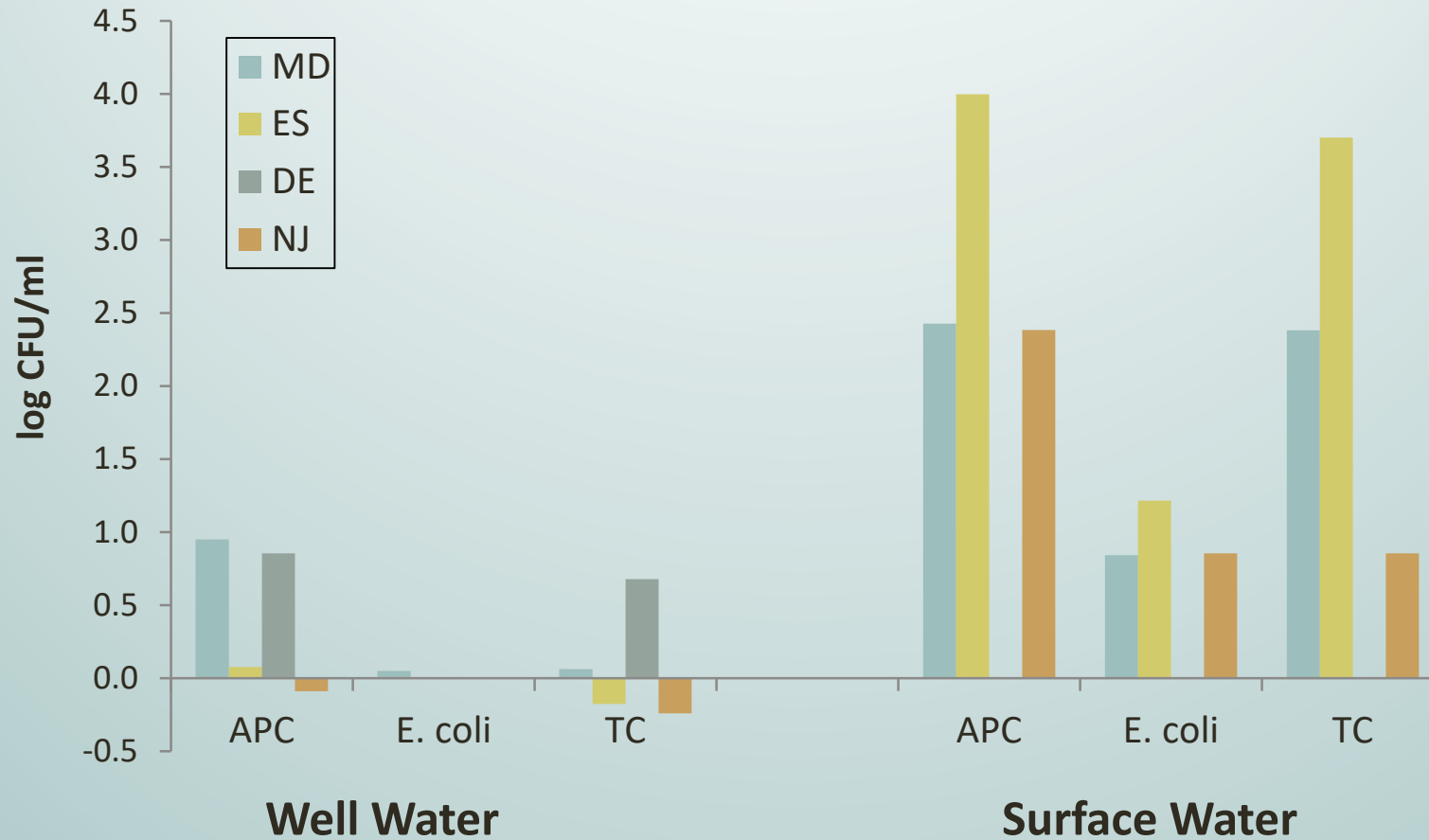


- Choose the **application method** and treatment to reduce risk
 - Drip irrigation
 - Overhead irrigation, pesticide applications, packinghouse water



Quality varies by source:

Bacterial Counts in well vs. surface water

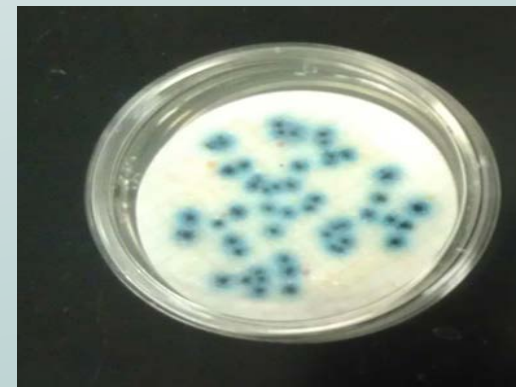
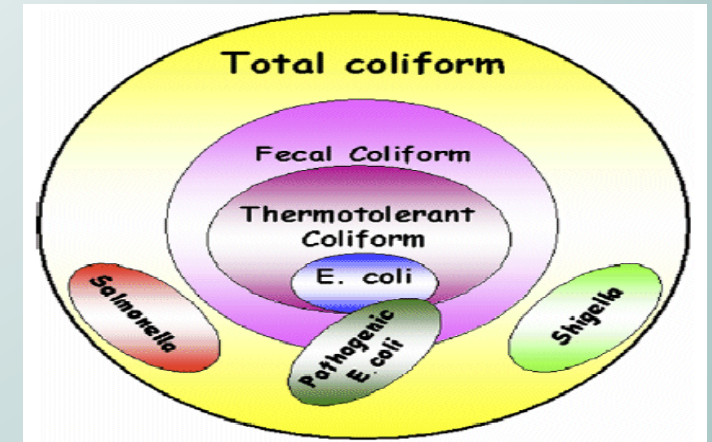




- How do you know if your water is suitable for agricultural use?
- Test it!
 - Send to an MDA accredited lab and test for generic *E. coli*.

Why Monitor Generic *E. coli* ?

- Species within the fecal coliform group
- Indigenous member of the intestinal flora in warm-blooded animals
- Used by EPA for drinking and recreational water standards
- Not considered to be an environmental organism
- Considered the most reliable indicator organism of fecal contamination



What if water tests results are too high?

- **Investigate what is causing the elevated microbial counts**
Obvious animal contamination or runoff?
Is the irrigation intake sucking up sediment?
- **Consider an alternative water source**
- **Use less risky irrigation methods**
- **Investigate mitigation steps to lower bacterial populations**
Sand filters
Shocking the well
Antimicrobial chemicals

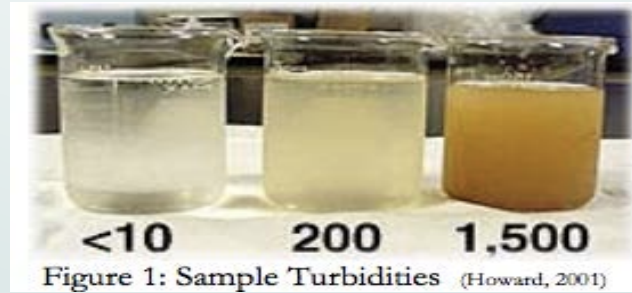
Post Harvest Water Use

Must be **potable** (drinkable)

No coliforms

Low turbidity (<10 NTU)

Low nitrates (<10 mg/L)



Why is it important?

Touching the crop directly before sale

Water can amplify contamination problems



A small problem can become much larger when water is used!

Where Must I Use Potable Water?

Hand washing

Washing food contact surfaces

In spray tanks

Washing produce that is eaten raw



Where Must I Use Potable Water?

- Hand washing
- Washing food contact surfaces
- In spray tanks
- Washing produce that is eaten raw



What are the food safety risks in each of the following pictures?

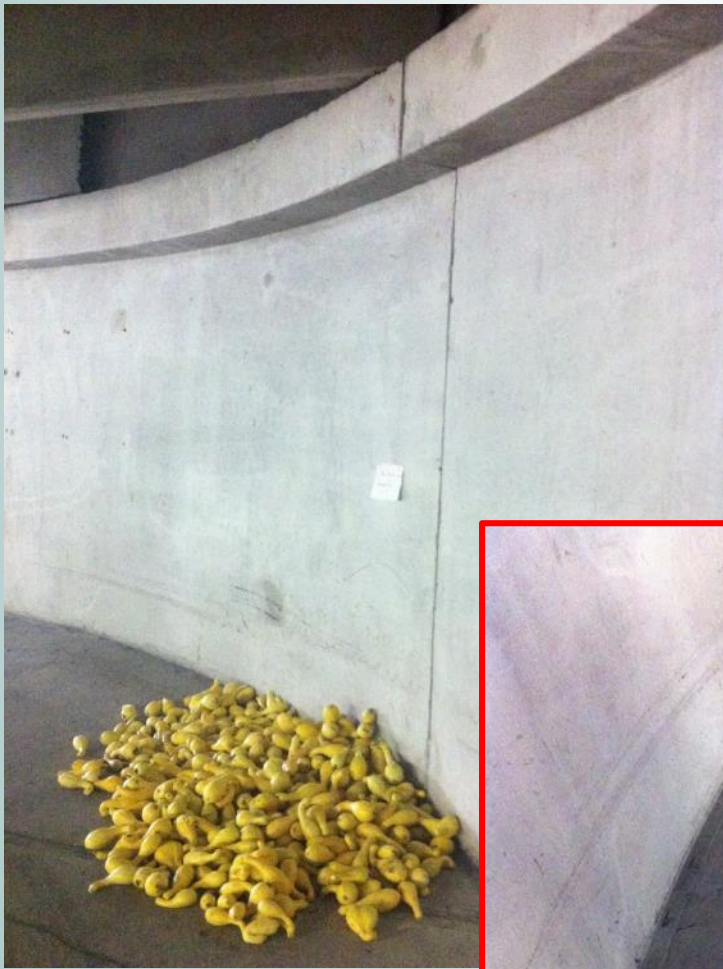
How would you decrease the risk from these practices?

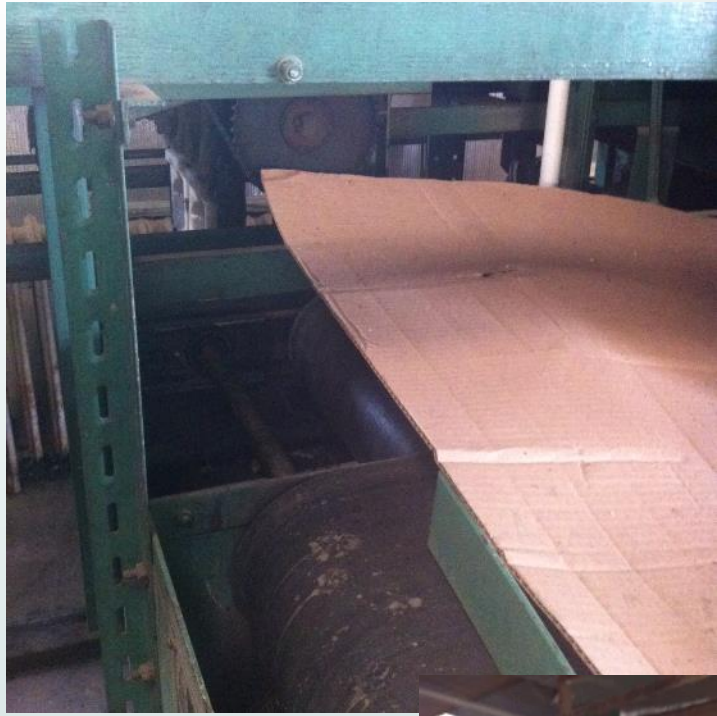








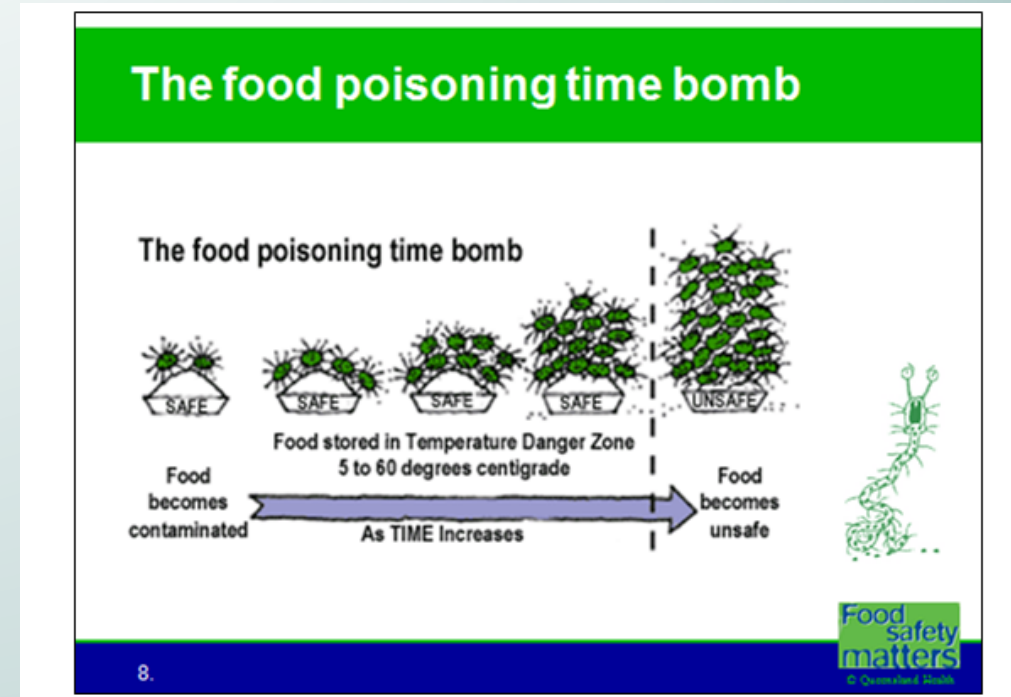






Fun stuff to think about at home!

- Cross-contamination
 - Cutting boards, sink
- Microbial growth
- Food cooling and storage
- Thawing
- Hand-washing
- Proper meat cooking temps





QUESTIONS?