

A photograph of a basket filled with fresh vegetables. The basket contains several large purple eggplants, a bunch of green cucumbers, a bunch of fresh green basil leaves, several bright red tomatoes, a green bell pepper, and two onions (one purple and one yellow). A small white bowl containing sliced onions is also visible. The basket is lined with a green patterned cloth and sits on a wooden surface. The text "The Microbiology of Food Pathogens" is overlaid in large white font across the top half of the image.

The Microbiology of Food Pathogens

Cindy Brison, MS, RD
Nebraska Extension in Douglas
and Sarpy Counties

Produce Outbreaks

- Tainted cantaloupes left 29 people dead
- Texas, 2010, four dead due to Listeria in celery
- 1442 people infected in 43 states with salmonella from Mexican grown peppers
- 2006 Spinach outbreak of E.coli, 230 people infected, 5 dead
- 2005/2006 4 outbreaks of salmonella in tomatoes in 21 states





- 2004—three outbreaks with Roma tomatoes infected 429 people
- Salmonella and cantaloupe—2011, 50 people infected, 2 died



- By Jacque Wilson, CNN ,Thu November 3, 2011

2004-2013

- The Center for Science in the Public Interest found that fresh produce:
 - Cilantro, cucumbers, cantaloupes and peppers
 - Lettuce, tomatoes, green onions, raspberries
 - Strawberries
 - **Caused 629 outbreaks**
 - **Almost 20,000 illnesses**



- September 17, 1984
- 750 sickened in Oregon restaurants as cult known as the Rajneeshees spread salmonella in town of The Dalles
- Salad-bar attack by followers of Bhagwan Shree Rajneesh was the **largest act of bioterrorism on U.S. soil**

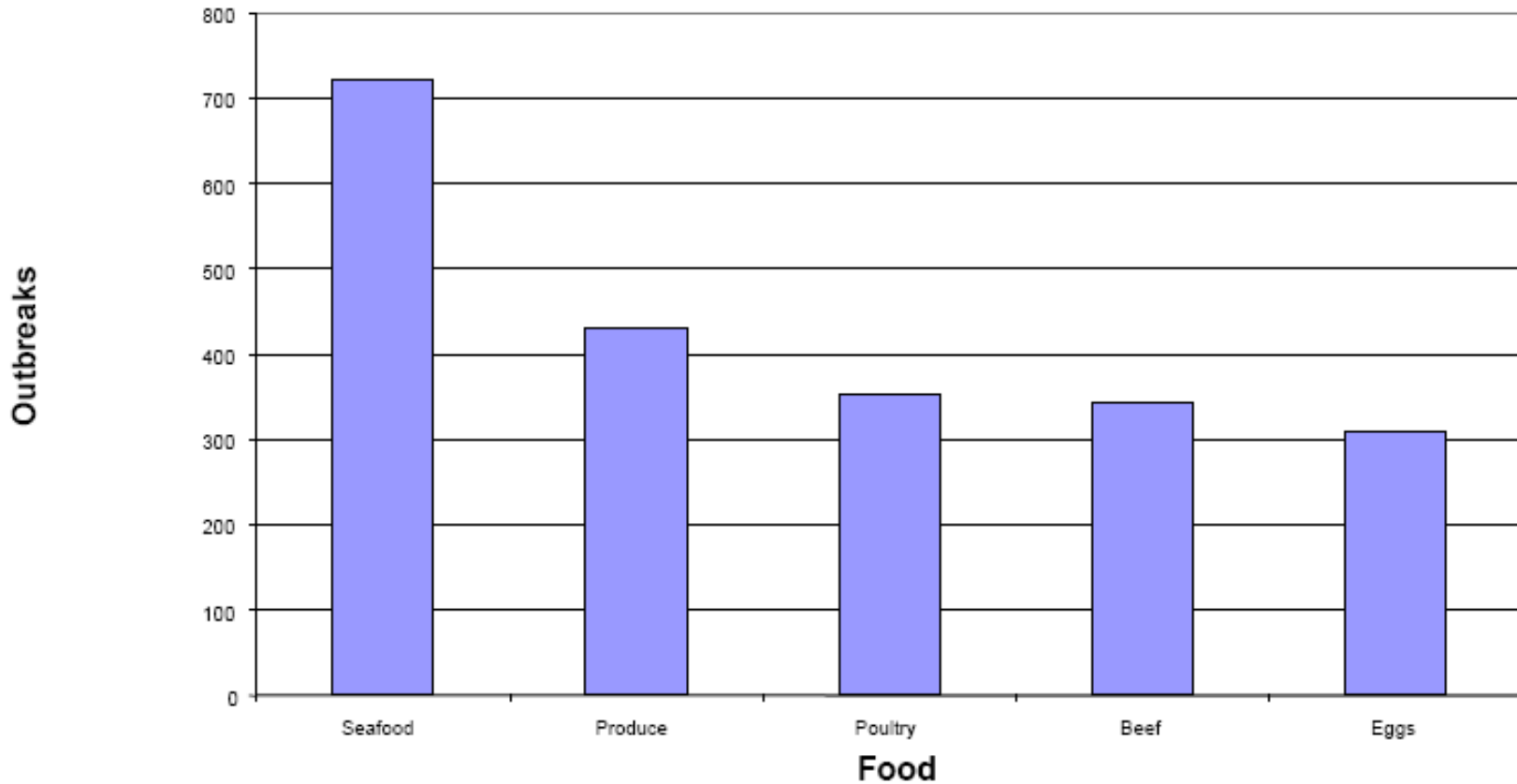
- BY [Mara Bovsun](#) NEW YORK DAILY NEWS Saturday, June 15, 2013, 7:20 PM



Center for Science in the Public Interest

Figure 4

Top Five Single-Food Vehicles of Outbreaks, 1990-2003

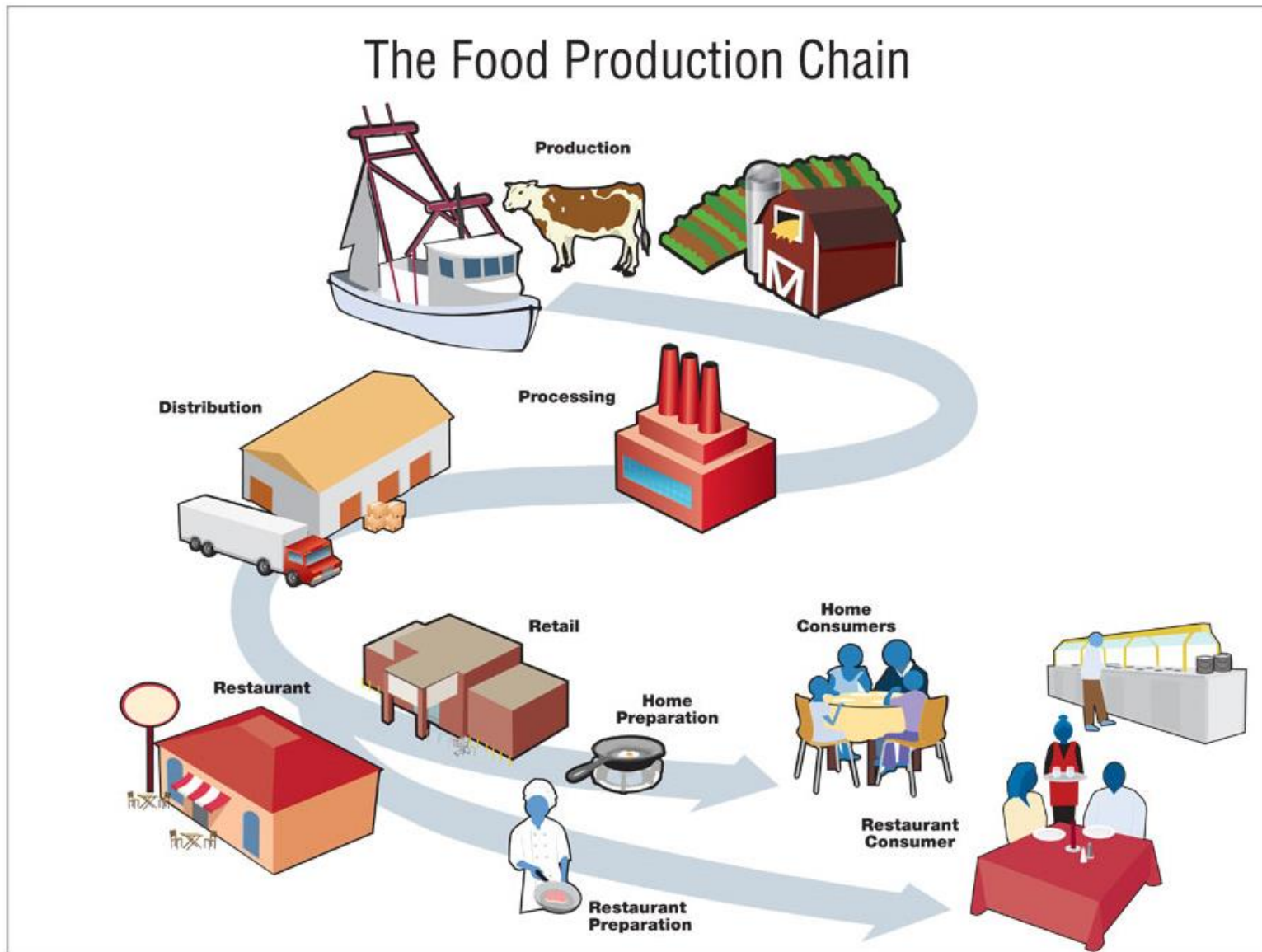


Copyright © 2004 by Center for Science in the Public Interest
Sixth Edition, March 2004

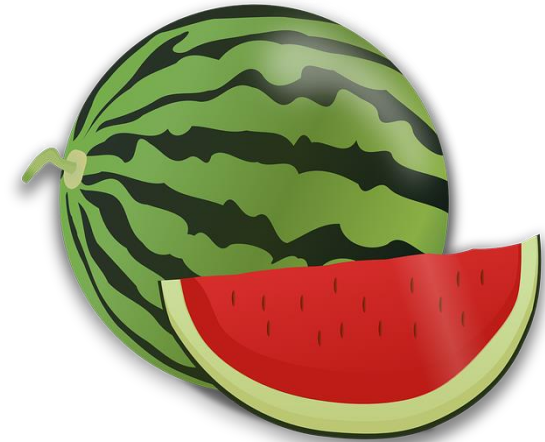
How Does Produce Get Contaminated?



From Farm to Fork



Contamination



- Grown outside
 - Animals, birds and insects
- Enter via the stomata in leaves
- Via cuts/bruises in the fruit
 - Fruit flies can transfer E. coli to damaged apples
- Surfaces of produce (melons)
 - Not washed, then prepared

- During production and harvest
 - Contaminated water
 - Feces and urine in the fields
 - 2 hours into the root system
- Retail, food service or at home

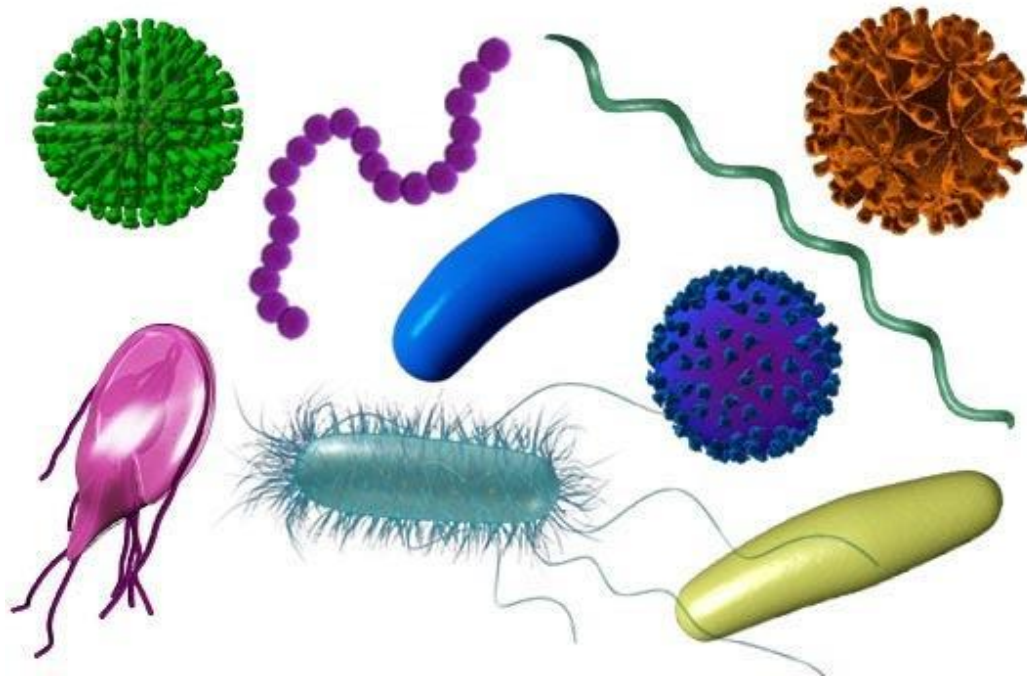


Who is Most Likely to get Sick?

- Small children under 5
- The elderly
- Immunocompromised individuals



Microorganisms



Microorganisms

- Bacteria, parasites, viruses or molds
- Natural part of the environment
- Can be a problem in organic and conventional operations
- Garden soil
 - Botulism
- Well water
 - Chemicals, cleaning solutions, fertilizers, pesticides and heavy metals (lead)



Microorganisms and Produce

- **Bacterial** pathogens such:

- *Shigella*
- *E. coli* O157:H7
- *Salmonella*
- *Clostridium botulinum*
- *Listeria monocytogenes*



- **Viruses:** Hepatitis A and Norovirus

- **Parasites** *Cyclospora* and *Cryptosporidium*

Commonalities



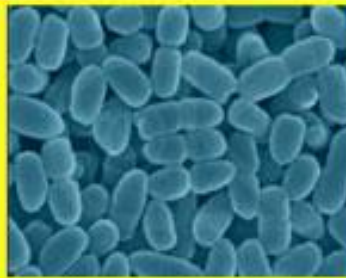
- They all originate from fecal material of humans or animals or:
 - Are spread by contamination (Viral)
- Humans and animals can shed pathogens without signs of illness.
- Illnesses can be severe especially in susceptible individuals (young children, elderly, and immunosuppressed).
- Infective doses (numbers of organisms causing illness) can be very low

BACTERIAL

Bacillus



Bordetella



Clostridium



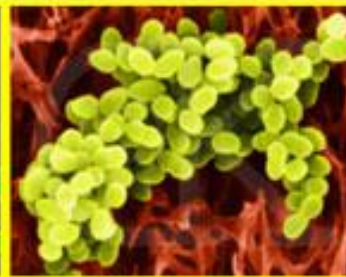
Escherichia



Spirulina



Staphylococcus



Streptococcus



Salmonella



Shigella

- **Food easily contaminated by hands, including:**
 - Salads containing TCS food (potato, tuna, shrimp, macaroni, chicken)
 - RTE
 - Food in contact with contaminated water, such as produce
- **Common Symptoms:**
 - Abdominal pain and cramps
 - Fever (occasionally)
 - Bloody diarrhea



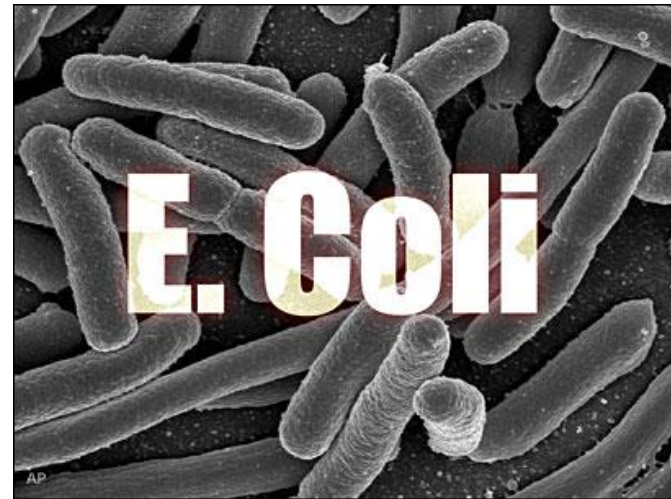
Prevention



- **Most important prevention measure:**
 - Practice personal hygiene
- **Other prevention measures:**
 - Exclude workers diagnosed with *Shigella* spp. from the operation
 - Exclude food handlers with diarrhea from the operation
 - Wash hands
 - Control flies inside and outside the operation

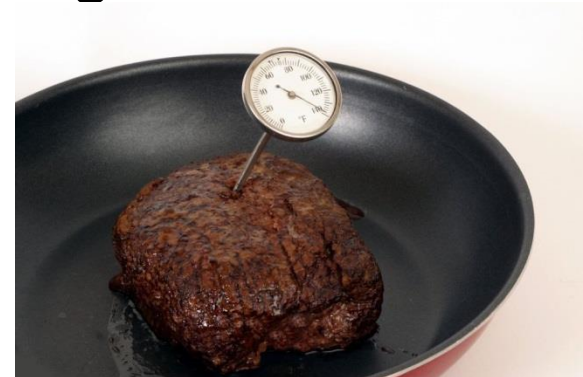
E. coli O157:H7

- **Commonly Linked Food**
 - Ground beef (raw and undercooked)
 - Contaminated produce
- **Most Common Symptoms**
 - Diarrhea (becomes bloody)
 - Abdominal cramps
 - Kidney failure (in severe cases)



Prevention

- **Control time and temperature**
- Cook food, especially ground beef, to minimum internal temperatures (160° F)
- Purchase produce from approved, reputable suppliers
- Prevent cross-contamination between raw meat and ready-to-eat food
- **Keep staff with diarrhea out of the operation**
- Keep staff diagnosed with hemorrhagic colitis out of the operation
- Use a thermometer!



Salmonella

Commonly Linked Food

Most Common Symptoms

Poultry and eggs

Diarrhea

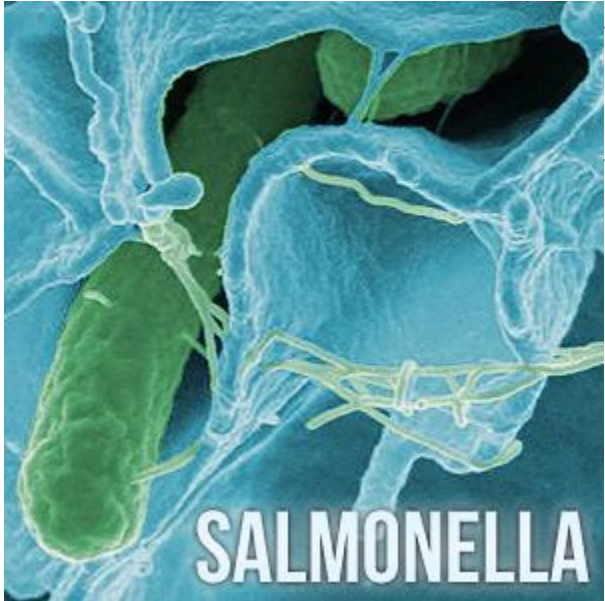
Dairy products

Abdominal cramps

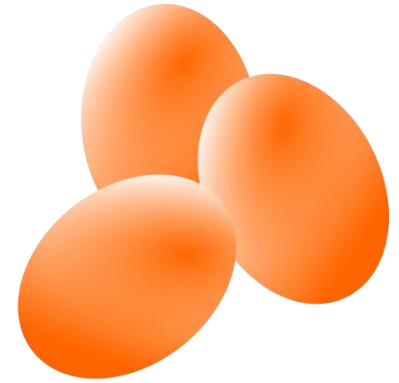
Produce

Vomiting

Fever



Prevention



- Prevent cross-contamination
- Other prevention measures:
- Cook poultry and eggs to minimum internal temperatures (165° F and 145° F)
- Prevent cross-contamination between poultry and ready-to-eat food
- Keep workers diagnosed with salmonellosis out of the operation
- Carried by animals



Clostridium botulinum

- **Foods:**

- Reduced-oxygen packaged (ROP) food
- Temperature-abused vegetables, such as baked potatoes
- Untreated garlic-and-oil mixtures
- Incorrectly canned food

- **Symptoms:**

- Double vision
- Difficulty speaking and swallowing
- Nausea and vomiting
- Weakness



Prevention

- **Control time and temperature**
- Hold, cool, and reheat food correctly
- Inspect canned food for damage



Listeria monocytogenes

- Found in cool, moist places, soil, carried by animals
- **Commonly Linked Food**
 - Raw meat
 - **Ready-to-eat food such as:**
 - Deli-meat
 - Hot dogs
 - Soft cheese
 - Unpasteurized dairy products
 - Ice cream



Who is Affected?

- **Pregnant women:**
 - Miscarriage and sterility
- **Newborns:**
 - Sepsis
 - Pneumonia
 - Meningitis



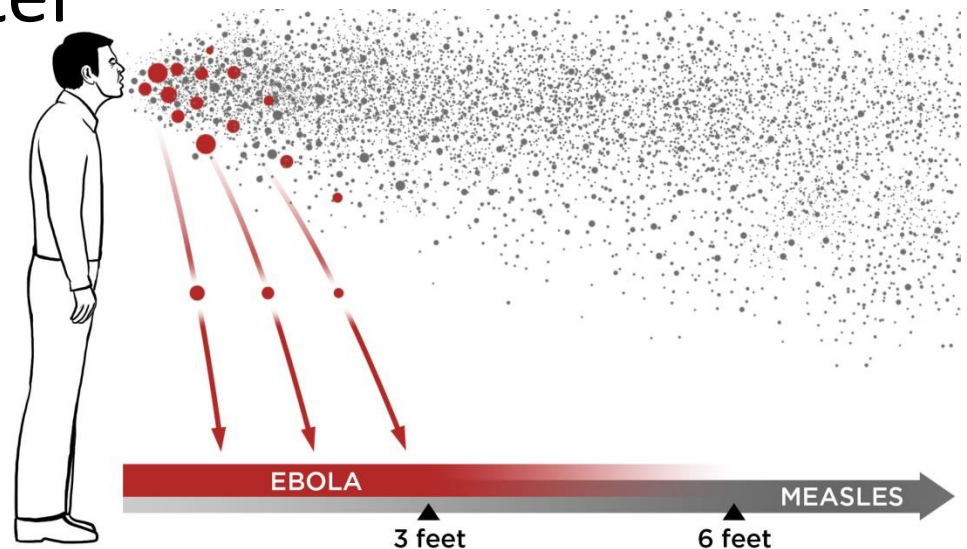
Prevention



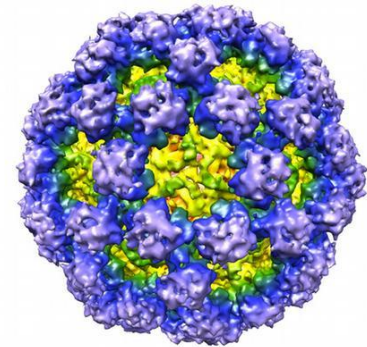
- **Control time and temperature**
- Throw out any product that has passed its use-by or expiration date (7 day rule)
- Cook raw meat to minimum internal temperatures
- Prevent **cross-contamination** between raw or undercooked food and ready-to-eat food
- Avoid using unpasteurized dairy products
- Wash produce

Viruses

- 60% of US illnesses associated with leafy greens from 1973-2006 involved Norovirus
- Huge Hepatitis A outbreak linked to contaminated green onions
- Hydroponics and water



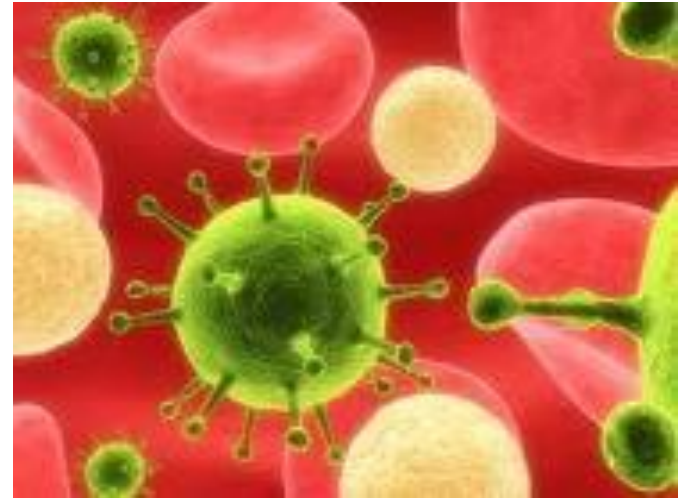
Viruses



- Carried by human beings and animals
 - Require a living host to grow
 - Do not grow in food
 - Can be transferred through food and remain infectious in food
- Sources:
 - Food, water, or any contaminated surface
 - Typically occur through fecal-oral routes

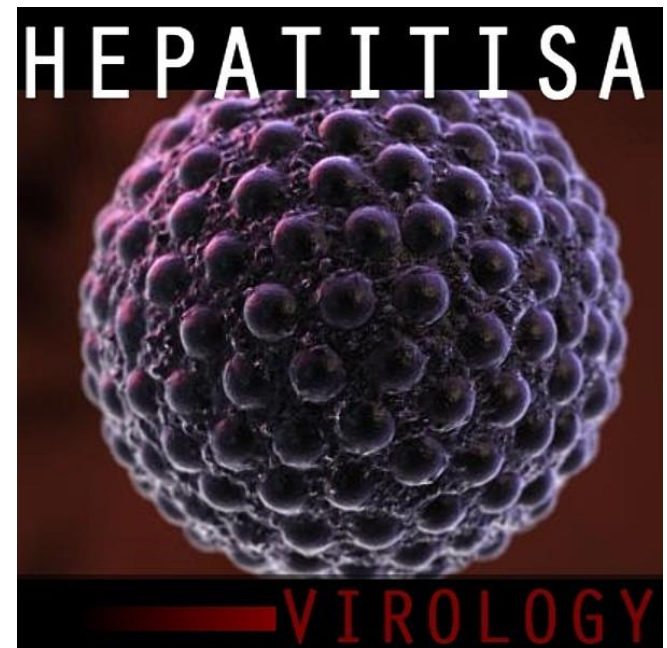
Viruses

- Viruses can be transferred from
 - Person to person
 - People to food
 - People to food-contact surfaces
- People
 - Carry viruses in their feces
 - Can transfer them to their hands after using the restroom

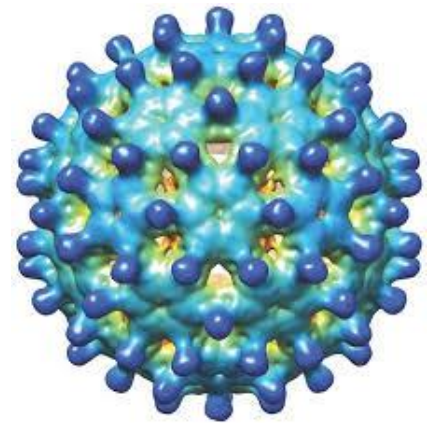


Hepatitis A

- **Commonly Linked Food**
 - Ready-to-eat food
 - Shellfish from contaminated water
 - Person to person
- **Most Common Symptoms**
 - Fever (mild)
 - General Weakness
 - Nausea
 - Abdominal pain
 - Jaundice (appears later)



Prevention



- Practicing personal hygiene
- Exclude staff who have been diagnosed with hepatitis A from the operation
- Exclude staff who have jaundice from the operation
- **Wash hands**
- **Avoid bare-hand contact with ready-to-eat food**
- Purchase shellfish from approved, reputable suppliers

Norovirus

- **Commonly Linked Food**
 - Ready-to-eat food
 - Shellfish from contaminated water
 - Leafy greens (such as lettuce),
 - Fresh fruits
- **Most Common Symptoms**
 - Vomiting
 - Diarrhea
 - Nausea
 - Abdominal cramps

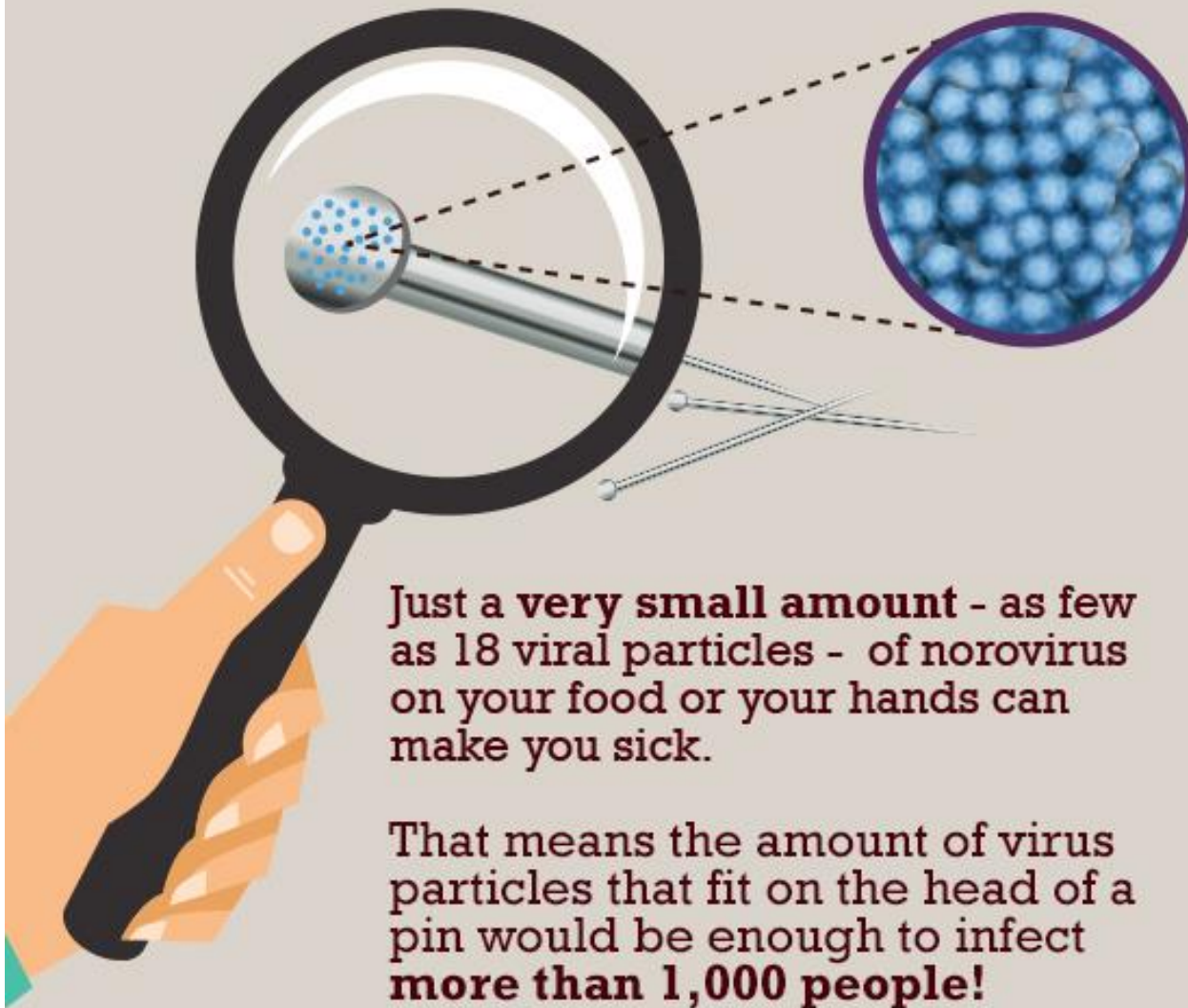


Norovirus Statistics

- **Leading cause of illness and outbreaks from contaminated food in the United States**
- 50% of all outbreaks of food-related illness are caused by Norovirus
- Causes 19–21 million cases of acute gastroenteritis
- Leads to 1.7–1.9 million outpatient visits
- 400,000 emergency department visits, primarily in young children
- Contributes to about 56,000–71,000 hospitalizations
- 570-800 deaths, mostly among young children and the elderly



How contagious is norovirus?



Just a **very small amount** - as few as 18 viral particles - of norovirus on your food or your hands can make you sick.

That means the amount of virus particles that fit on the head of a pin would be enough to infect **more than 1,000 people!**

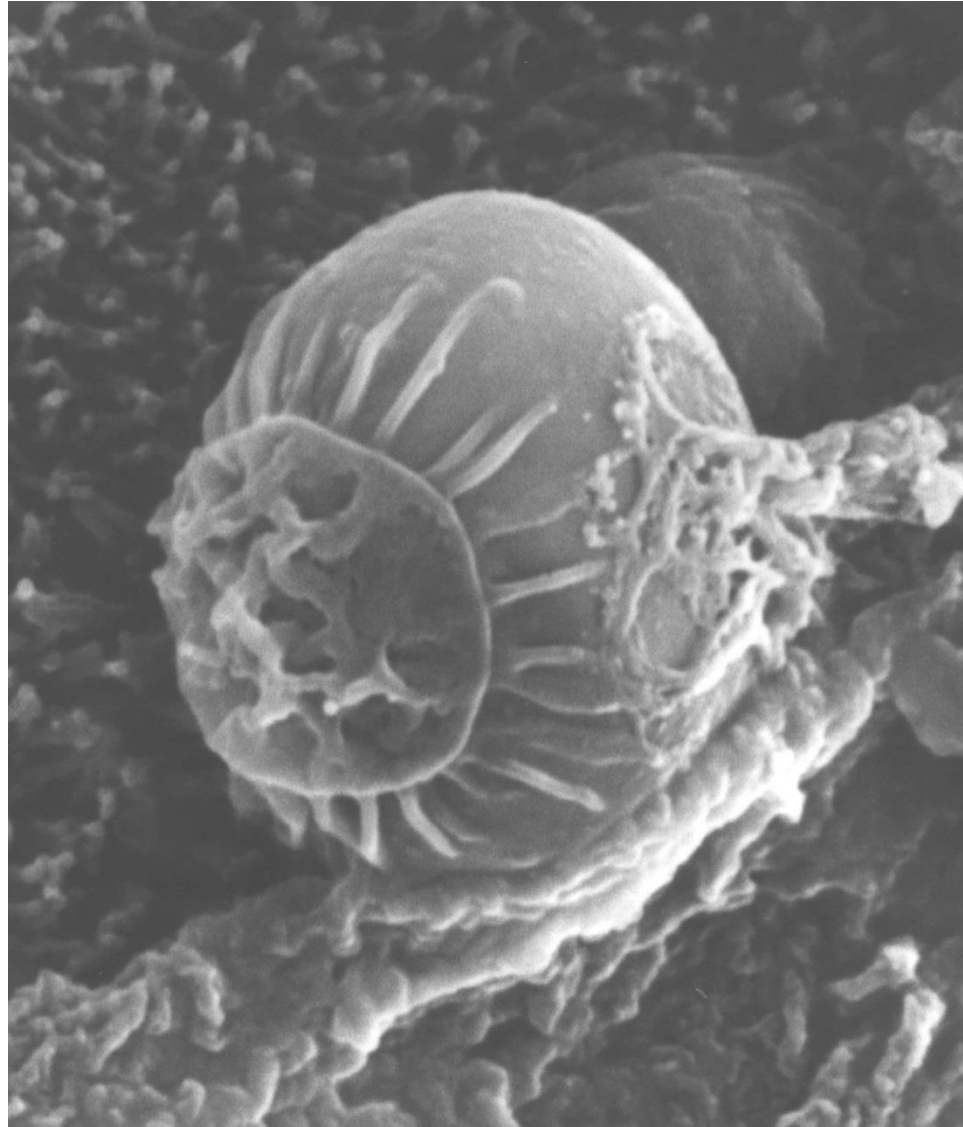
SOURCE: Journal of Medical Virology, August, 2008

Prevention

- Practicing personal hygiene
- Exclude staff diagnosed with Norovirus from the operation
- Exclude staff with diarrhea and vomiting from the operation
- Wash hands
- **NO** bare-hand contact with ready-to-eat food
- Purchase shellfish from approved, reputable suppliers



PARASITES



Parasites

- An organism that lives on or in a host
- Gets its food from or at the expense of its host
- Parasites can cause disease in humans
- Some parasitic diseases are easily treated and some are not



Parasite Sources

- Seafood
- Wild game
- Food processed with contaminated water, such as produce



Prevention

- Purchase food from approved, reputable suppliers
- Cook food to required minimum internal temperatures
- Fish that will be served raw or undercooked must be frozen correctly by the manufacturer
 - Sushi grade fish



Cyclospora

- **Commonly Linked Food**
 - Incorrectly treated water
 - Produce such as berries, lettuce, or basil
- **Most Common Symptoms**
 - Nausea
 - Abdominal cramps
 - Mild fever
 - Diarrhea alternating with constipation
 - Loss of weight
 - Loss of appetite



Prevention

- Purchase food from approved, reputable suppliers
- Purchase produce from approved, reputable suppliers
- Keep food handlers with diarrhea out of the operation
- **Wash produce with cold running water**
- **Wash hands**



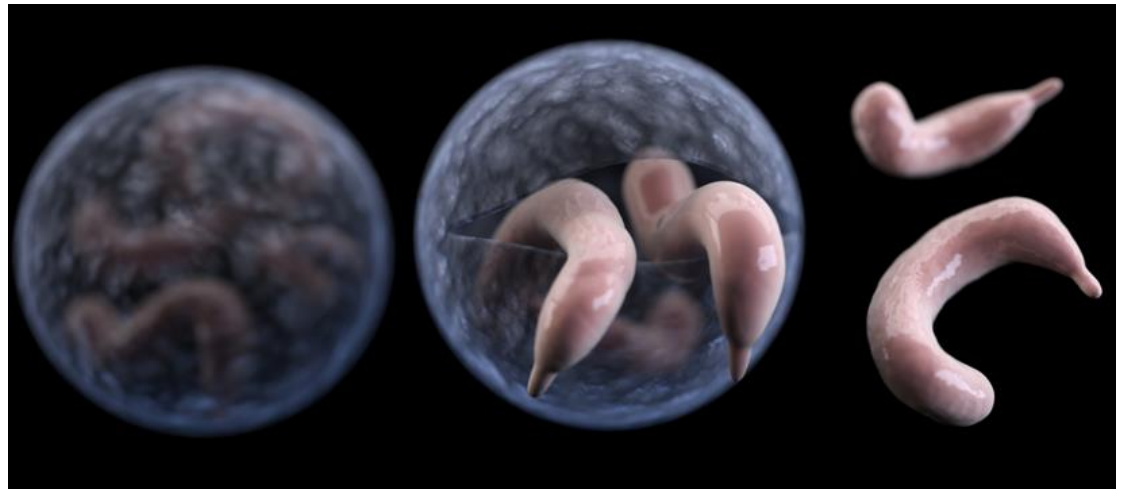
Cryptosporidium

- **Commonly Linked Food**
 - Contaminated water
 - Produce
- **Most Common Symptoms**
 - Watery diarrhea
 - Abdominal cramps
 - Nausea
 - Weight loss



Prevention

- Purchase from approved, reputable suppliers
- Use correctly treated water
- Keep food handlers with diarrhea out of the operation
- **Wash produce with cold running water**
- **Wash hands**



Preventing Contamination



How to Prevent Contamination

- Locate gardens away from manure, wells, septic systems and garbage
- Locate away from wild life
- Use compost safely
- Don't use animal waste, meat or dairy scraps in compost for the garden
- Test your well yearly

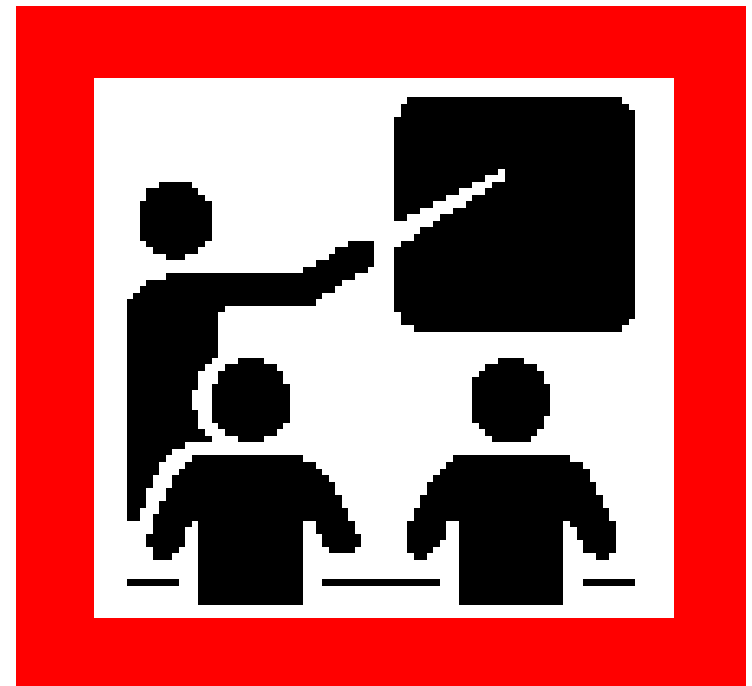


- Keep pets out
- Watch for nesting animals
- Don't feed wildlife near your garden



Training

- Train all staff/workers and visitors to prevent contamination
- Training at the nursery level for safe plant handling and growth
- Training for
 - Farmers
 - Harvesters
 - Producers
 - Shippers
 - Grocery staff
 - Farmers market staff



The FDA Food Safety Modernization Act (FSMA) Produce Safety

- Now final
- Compliance dates for some farms begin in two-four years
- Based on science-based minimum standards for the:
 - Safe growing
 - Harvesting
 - Packing
 - Holding of fruits and vegetables grown for human consumption.



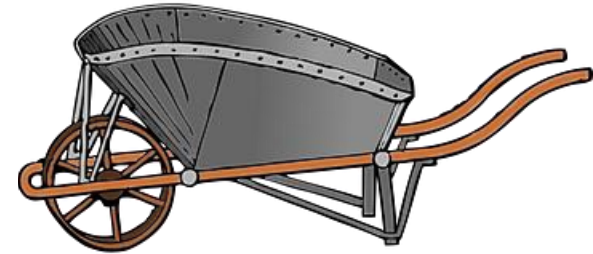
Synopsis

- Water—quality and testing
- Soil Amendments
- Sprouts
- Domesticated and wild animals
- Worker training and health and hygiene
- Equipment, tools and buildings
- Variances



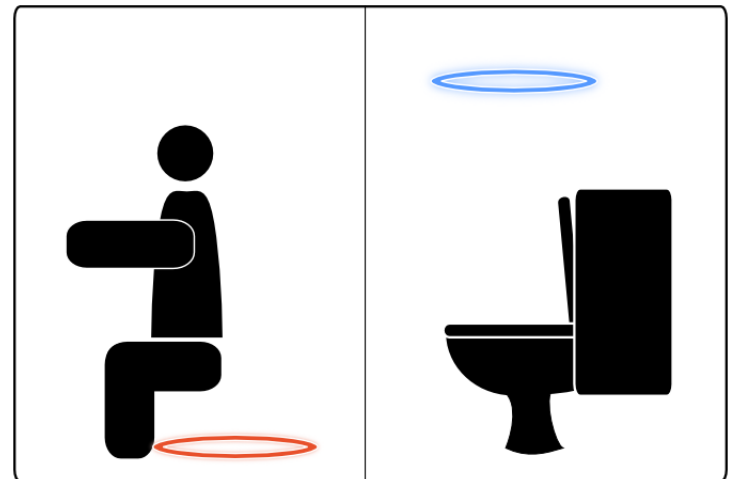
Working in Your Garden

- Clean tools in between use
- Watch your shoes
- Use clean gloves
- Sanitize everything
 - Tools
 - Shoes
 - Harvesting containers



Farm

- Irrigation and wash water are pathogen free
- Farm and processing equipment pathogen free
- Place for handwashing for workers
- Bathroom facilities
- Composted manure
- Animals
- Visitors
- Pesticides



Napa





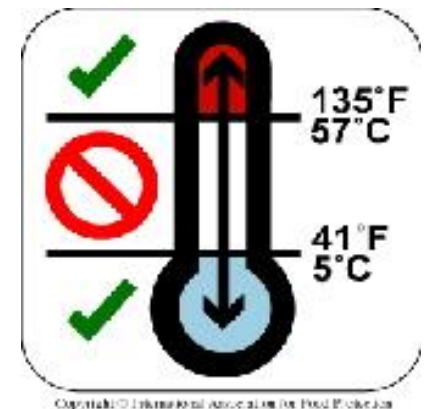
Harvesting

- Use clean hands
- Shake off excess dirt when harvesting
- Use food grade containers
 - No 5 gallon chemical buckets
 - Garbage bags
 - Trash cans
 - Dirty boxes



Storage

- Store refrigerated produce at 41° F or lower
- Store room temp produce at 70° F or lower
 - Well ventilated
 - Away from chemicals
 - Dirt brushed off or washed
 - Consider what produce is stored together





Microorganisms found on the bottom of this lettuce box



Microorganisms from fingers that have touched the lettuce box

IOWA STATE UNIVERSITY
University Extension

This research project was funded by the USDA Cooperative States Research, Education, and Extension Service, Project No. 2005-S1110-03282. The mention of trade or company names does not mean endorsement. The contents are solely the responsibility of the authors and do not necessarily represent the views of USDA.

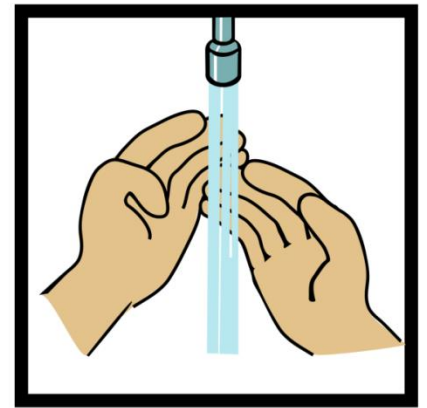


Distribution

- Handwashing and bathroom facilities
- Sanitary packing facilities
- Sanitary packaging
- Sanitary trucks
- Ice and cooling water
- Insect control
- GAP training (good agricultural practices)
- Cross contamination



Preparation



- Wash hands
- Use sanitized equipment and sinks
- Avoid cross contamination
- Wash produce under cold water with a produce brush
- **DO NOT USE:**
 - Soap
 - Bleach
 - Detergent



- Wash, rinse and sanitize cutting boards, knives and surfaces in between each item or batch
- Wash your hands
- Store leftovers in the fridge
- Store cut melons, tomatoes and leafy greens at 41° F or lower







THE DIRTY DOZEN



Are There Really More Outbreaks

- Underreported
 - 1 in 4
- More produce from all over the world all the time



Where Has Your Produce Been?





- Pathogens are evolving
 - Causing illnesses at lower levels
 - Surviving longer periods in hostile environments
- Increase in the population of susceptible individuals
- We have better tests
- We are looking harder



Take Home

- We have one of the safest food systems in the world
- Handle produce carefully from seed to trash can
- Wash your produce and your hands!



