Chapter 12: Food Safety and Food Technology

PowerPoint Lectures for
Nutrition: Concepts and Controversies, eleventh edition
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Lectures by Judy Kaufman, Ph.D.

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The Food and Drug Administration (FDA) is the major agency charged with monitoring the U.S. food supply.
Introduction

The following list indicates the FDA’s ongoing areas of concern regarding the safety of our food supply.

1. Microbial food borne illness

2. Natural toxins in foods

3. Residues in foods
   a. environmental & other contaminants
   b. pesticide residues
   c. animal drugs

4. Nutrients in foods

5. Intentional approved food additives

6. Genetic modification of foods
Table 12-1

Agencies That Monitor the U.S. Food Supply

- **CDC (Centers for Disease Control and Prevention)** a branch of the Department of Health and Human Services that is responsible for monitoring foodborne diseases.
  - Together with the USDA and FDA, CDC operates *FoodNet*, an organization that tracks the prevalence, trends, causes, and interventions of U.S. foodborne illnesses.
  - These groups also conduct molecular DNA tracking of foodborne illness-causing microorganisms through *PulseNet*, a network of scientists in every state who react quickly to identify illness outbreaks.

- **EPA (Environmental Protection Agency)** the federal agency that is responsible for regulating pesticides and establishing water quality standards.

- **FDA (Food and Drug Administration)** the part of the Department of Health and Human Services’ Public Health Service that is responsible for ensuring the safety and wholesomeness of all foods sold in interstate commerce except meat, poultry, and eggs (which are under the jurisdiction of the USDA); inspecting food plants and imported foods; and setting standards for food consumption. The FDA also regulates food additives.

- **CORE (Coordinated Outbreak Response and Evaluation Network)** FDA specialist teams that work to prevent and minimize outbreaks of foodborne illness by:
  - continuously monitoring trends and data for signs of outbreak emergence.
  - responding rapidly to stop outbreaks.
  - preventing future outbreaks by improving FDA policies, processes, and guidelines for food industries.
  - informing the media and consumers about outbreaks.

- **USDA (U.S. Department of Agriculture)** the federal agency that is responsible for enforcing standards for the wholesomeness and quality of meat, poultry, and eggs produced in the United States; conducting nutrition research; and educating the public about nutrition.

- **WHO (World Health Organization)** an international agency that develops standards to regulate pesticide use. A related organization is the FAO (Food and Agricultural Organization).
Microbial food borne illness (a.k.a. food poisoning) is first on the list because the number of deaths from this far outweigh other kinds of food-related deaths.
• With the privilege of abundance comes the responsibility to choose and handle foods wisely.
Microbes and Food Safety

- Food borne illness caused by microbes can be life threatening and difficult to treat sometimes.

- Especially vulnerable:
  - Pregnant women
  - Newborns and young
  - Older adults
  - People with weak immune systems
How Do Microbes in Food Cause Illness in the Body?

- Microorganisms can cause food borne illness by *infection* or by *intoxication*.
  - Infection
    - When the microorganism infects the tissues of the human body and multiplies there.
    - Ex: Salmonella bacteria or hepatitis bacteria
  - Intoxication
    - When the microorganism in the food produces *enterotoxins* (poisons that act on mucus membranes) or *neurotoxins* (poisons that act upon the cells of the nervous system), poisonous substances that cause harm ranging from stomach pain to death.
### Table 12-2

#### Major Microbes of Foodborne Illnesses

<table>
<thead>
<tr>
<th>Organism Name</th>
<th>Most Frequent Food Sources</th>
<th>Onset and General Symptoms</th>
<th>Prevention Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Foodborne Infections</strong></td>
<td></td>
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</tr>
<tr>
<td>Campylobacter (KAM-per-loh-BAK-ter) bacterium</td>
<td>Raw and undercooked poultry, unpasteurized milk, contaminated water</td>
<td>Onset: 2 to 5 days. Diarrhea, vomiting, abdominal cramps, fever; sometimes bloody stools; lasts 2 to 10 days.</td>
<td>Cook foods thoroughly; use pasteurized milk; use sanitary food-handling methods.</td>
</tr>
<tr>
<td>Clostridium (claw-STRID-ie-em) perfringens (per-FRING-e-em) bacterium</td>
<td>Meats and meat products stored at between 120°F and 130°F</td>
<td>Onset: 8 to 16 hours. Abdominal pain, diarrhea, nausea; lasts 1 to 2 days.</td>
<td>Use sanitary food-handling methods; use pasteurized milk; cook foods thoroughly; refrigerate foods promptly and properly.</td>
</tr>
<tr>
<td>Escherichia coli; E. coli (esh-eh-REEK-eu-uh-KOH-ee) bacterium (including Shiga toxin-producing strains)</td>
<td>Undercooked ground beef, unpasteurized milk and juices, raw fruits and vegetables, contaminated water, and person-to-person contact</td>
<td>Onset: 1 to 8 days. Severe bloody diarrhea, abdominal cramps, vomiting; lasts 5 to 10 days.</td>
<td>Cook ground beef thoroughly; use pasteurized milk; use sanitary food-handling methods; use treated, boiled, or bottled water.</td>
</tr>
<tr>
<td>Norovirus</td>
<td>Person-to-person contact; raw foods, salads, sandwiches</td>
<td>Onset: 1 to 2 days. Vomiting; lasts 1 to 2 days.</td>
<td>Use sanitary food-handling methods.</td>
</tr>
<tr>
<td>Listeria (lis-TER-e-AH) bacterium</td>
<td>Unpasteurized milk; fresh soft cheeses; luncheon meats, hot dogs</td>
<td>Onset: 1 to 21 days. Fever, muscle aches; nausea, vomiting, blood poisoning, complications in pregnancy, and meningitis (stiff neck, severe headache, and fever).</td>
<td>Use sanitary food-handling methods; cook foods thoroughly; use pasteurized milk.</td>
</tr>
<tr>
<td>Salmonella (sal-moh-NAH-lah) bacteria (&gt;2,300 types)</td>
<td>Raw or undercooked eggs, meats, poultry, raw milk and other dairy products, shrimp, frog legs, yeast, coconut, pasta, and chocolate</td>
<td>Onset: 1 to 3 days. Fever, vomiting, abdominal cramps, diarrhea; lasts 4 to 7 days; can be fatal.</td>
<td>Use sanitary food-handling methods; use pasteurized milk; cook foods thoroughly; refrigerate foods promptly and properly.</td>
</tr>
<tr>
<td>Toxoplasma (TOK-so-PLAZ-ma) gondii parasite</td>
<td>Raw or undercooked meat, contaminated water; raw goat’s milk; ingestion after contact with infected cat feces.</td>
<td>Onset: 7 to 21 days. Swollen glands, fever, headache, muscle pain, stiff neck.</td>
<td>Use sanitary food-handling methods; cook foods thoroughly.</td>
</tr>
<tr>
<td><strong>Foodborne Intoxications</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Clostridium (claw-STRID-ie-em) botulinum (bot-Chew-LINE-um) bacterium produces botulin toxin, responsible for causing botulism</td>
<td>Anaerobic environment of low acidity (canned corn, peppers, green beans, soups, beets, asparagus, mushrooms, ripe olives, spinach, tuna, chicken, chicken liver, liver pate, luncheon meats, ham, sausage, stuffed eggplant, lobster, and smoked and salted fish)</td>
<td>Onset: 4 to 36 hours. Nervous system symptoms, including double vision, inability to swallow, speech difficulty, and progressive paralysis of the respiratory system; often fatal; leaves prolonged symptoms in survivors.</td>
<td>Use proper canning methods for low-acid foods; refrigerate homemade garlic and herb oils; avoid commercially prepared foods with leaky seals or with bent, bulging, or broken cans. Do not give infants honey because it may contain spores of Clostridium botulinum, which is a common source of infection for infants.</td>
</tr>
<tr>
<td>Staphylococcus (STAF-ih-loh-KOK-us) aureus bacterium produces staphylococcal toxin</td>
<td>Toxin produced in improperly refrigerated meats; egg, tuna, potato, and macaroni salads; cream-filled pastries</td>
<td>Onset: 1 to 6 hours. Diarrhea, nausea, vomiting, abdominal cramps, fever; lasts 1 to 2 days.</td>
<td>Use sanitary food-handling methods; cook foods thoroughly; refrigerate foods promptly and properly.</td>
</tr>
</tbody>
</table>

*NOTE: Travelers’ diarrhea is most commonly caused by E. coli, Campylobacter jejuni, Shigella, and Salmonella.*

*The “How to” on pp. 629-629 provides more details on the proper handling, cooking, and refrigeration of foods.*

*Q157, Q145, and other Shiga toxin-producing strains.*
How Do Microbes in Food Cause Illness in the Body?

- *Staphylococcus aureus* – the most common cause of food intoxication
  - Toxin is heat-stable and cannot be destroyed by heating
  - Improperly refrigerated: meats, egg, tuna, potato & macaroni salad, cream filled pastries.
How Do Microbes in Food Cause Illness in the Body?

- Clostridium botulinum, the most deadly intoxication
  - C. botulinum requires anaerobic conditions to grow and produce the neurotoxin.
  - Can grow in improperly canned (especially home-canned) foods, home-fermented foods such as tofu, and homemade garlic or herb-flavored oils stored at room temperature.
  - Botulism quickly paralyzes and can lead to death in 24 hours without treatment.
  - Toxin is heat-sensitive and so boiling the food for 10 minutes inactivates the toxin.
Food Safety from Farm to Table

**FARMS**
Farmers and workers must use safe methods of growing, harvesting, sorting, packing, and storing food to minimize contamination hazards.

**PROCESSING**
Processors must follow USDA and FDA guidelines concerning contamination, cleanliness, and education and training of workers. Industries must monitor for safety at critical control points (use HACCP, see text).

**TRANSPORTATION**
Containers and vehicles transporting food must be clean. Cold food must be kept cold at all times.

**RETAIL: GROCERY AND RESTAURANTS**
Owners and employees must follow the FDA’s Food Code on how to prevent foodborne illnesses. Establishments must pass local health inspections and people in charge must demonstrate food-safety knowledge.

**CONSUMER RESPONSIBILITY**
Consumers must learn and use sound principles of food safety as taught in this chapter and stay mindful that foodborne illness is a real possibility.
Commercially prepared food is usually safe, but an outbreak of illness from this source often makes the news because outbreaks can affect many people at once.

Dairy farmers rely on pasteurization to make milk safe to consume but it still needs refrigeration because not all bacteria are killed.
Attention on E. coli

- *E. coli* 0157:H7 is the dangerous type of *E. coli*.
  - Causes bloody diarrhea, severe cramps, dehydration and sometimes **hemolytic-uremic syndrome**

**hemolytic-uremic syndrome**: abnormal blood clotting, kidney failure, damage to central nervous system & other organs and death.

- Associated with eating tainted meat, raw milk, or contaminated produce
Table 12–3

Dangerous Symptoms of Foodborne Illnesses

Get medical help for these symptoms:
- Bloody stools.
- Dehydration.
- Diarrhea of more than 3 days’ duration.
- Fever of longer than 24 hours’ duration.
- Headache with muscle stiffness and fever.
- Numbness, muscle weakness, tingling sensations in the skin.
- Rapid heart rate, fainting, dizziness.
- Severe intestinal cramps.

Warning signs of botulism—a medical emergency:
- Difficulty breathing.
- Difficulty swallowing.
- Double vision.
- Weak muscles.
**Table 12-4**

Are Your Foods Expiring?

Food manufacturers voluntarily print the following kinds of dates on labels to inform both sellers and consumers of the products’ freshness.

- **Sell by**: Specifies the shelf life of the food. After this date, the food may still be safe for consumption if it has been handled and stored properly. Also called *pull date*.
- **Best if used by**: Specifies the last date the food will be of the highest quality. After this date, quality is expected to diminish, although the food may still be safe for consumption if it has been handled and stored properly. Also called *freshness date* or *quality assurance date*.
- **Expiration date**: The last day the food should be consumed. All foods except eggs should be discarded after this date. For eggs, the expiration date refers to the last day the eggs may be sold as “fresh eggs.” For safety, purchase eggs before the expiration date, keep them in their original carton in the refrigerator, and use them within 30 days.\(^a\)
- **Open dating**: A general term referring to label dates that are stated in ordinary language that consumers can understand, as opposed to *closed dating*, which refers to dates printed in codes decipherable only by manufacturers. Open dating is used primarily on perishable foods, and closed dating on shelf-stable products such as some canned goods.
- **Pack date**: The day the food was packaged or processed. When used on packages of fresh meats, pack dates can provide a general guide to freshness.

\(^a\)For best quality, use eggs within 3 weeks of purchase.
Three requirements of disease causing bacteria:

1. Warmth (40F-140F) unhealthy range
2. Moisture
3. Nutrients
Safe Food Handling

FIGHT BAC!

CLEAN
Wash hands and surfaces often.

SEPARATE
Don’t cross-contaminate.

CHILL
Refrigerate promptly.

COOK
Cook to proper temperatures.

Keep Food Safe From Bacteria
Keep Your Hands and Surfaces Clean

This person’s clean-looking but unwashed hand is touching a sterile nutrient rich gel. After 24 hours, these large colonies provide visible evidence of the microorganisms that were transferred from the hand to the gel.
Keep Hot Foods Hot

Step 1:
Wet hands and apply liquid or clean bar soap. Place bar soap on a rack to drain between uses.

Step 2:
Dislodge germs by scrubbing hands together for about 15 seconds—about the time it takes to recite the alphabet. Scrub fingers, tops of hands, and palms, use a nailbrush to clean under fingernails.

Step 3:
Rinse hands in clean water and dry with a freshly laundered towel or paper towel.
Keep Your Hands and Surfaces Clean

- To eliminate microbes on surfaces, utensils and cleaning items, you can:
  - Use 1 tsp bleach per quart of water for washing sponges and surfaces
  - Wash with soapy hot water
  - Use an automatic dishwasher*
  - For sponges, place a wet sponge in a microwave oven

Determined to be the best ways to sanitize sponges in an experiment by the USDA microbiologists.
Keep Raw Foods Separate

- Keeping raw foods separate means preventing cross-contamination of foods.
  - Use separate cutting boards
  - Put cooked burgers on a different plate than the one they were on initially
Keep Hot Foods Hot

• Use a food thermometer to test the temperature of cooked foods.

• Hot food must be held at 140 F or above
<table>
<thead>
<tr>
<th>Table 12-7</th>
<th>Safe Food Storage Times: Refrigerator (≤40°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>For products with longer shelf lives, rotate them like restaurants do. “First-In-First-Out” means to check dates and use up older products first.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>1 to 2 Days</strong></td>
<td></td>
</tr>
<tr>
<td>Raw ground meats, breakfast or other raw sausages; raw fish or poultry; gravies</td>
<td></td>
</tr>
<tr>
<td><strong>3 to 5 Days</strong></td>
<td></td>
</tr>
<tr>
<td>Raw steaks, roasts, or chops; cooked meats, poultry, vegetables, and mixed dishes; lunchmeats (packages opened); mayonnaise salads (chicken, egg, pasta, tuna); fresh vegetables (spinach, green beans, tomatoes)</td>
<td></td>
</tr>
<tr>
<td><strong>1 Week</strong></td>
<td></td>
</tr>
<tr>
<td>Hard-cooked eggs, bacon, or hot dogs (opened packages); smoked sausages or seafood; milk, cottage cheese</td>
<td></td>
</tr>
<tr>
<td><strong>1 to 2 Weeks</strong></td>
<td></td>
</tr>
<tr>
<td>Yogurt; carrots, celery, lettuce</td>
<td></td>
</tr>
<tr>
<td><strong>2 to 4 Weeks</strong></td>
<td></td>
</tr>
<tr>
<td>Fresh eggs (in shells); lunchmeats, bacon, or hot dogs (packages unopened); dry sausages (pepperoni, hard salami); most aged and processed cheeses (Swiss, brick)</td>
<td></td>
</tr>
<tr>
<td><strong>2 Months</strong></td>
<td></td>
</tr>
<tr>
<td>Mayonnaise (opened jar); most dry cheeses (Parmesan, Romano)</td>
<td></td>
</tr>
</tbody>
</table>
• Always chill prepared or cooked foods in shallow containers, not deep ones.

• Food needs to be kept at 40 F or below
Which Foods Are Most Likely to Make People Sick?
Which Foods Are Most Likely to Make People Sick?

- Foods that are high in moisture & nutrients
- chopped
- ground
  - Contrary to popular belief, foods with mayonnaise are less likely to spoil due to the acidity of mayo.
Meats and Poultry

• A safe hamburger is cooked well-done (internal temperature of 160°F) and has juices that run clear. Place it on a clean plate when it’s done.
Animal Diseases

• Not related to sanitation, but animal diseases like “mad cow disease” or, more properly, bovine spongiform encephalopathy (BSE), can pose a worry for meat eaters.

  • **Prion (pree-on)** – an infectious protein.

  • More than 10 years ago, almost 150 people died of the disease, most in Great Britain.

  • Precautions are now taken which have greatly reduced the risk and cases of human diseases are rare.
Avian flu (or bird flu) is an infection of wild birds and domestic poultry (primarily in Asia)

- Properly handled and cooked domestic poultry and eggs pose virtually no bird flu threat to the eater
- No infected birds have been found in the U.S.
• *Salmonella* or other bacteria may contaminate raw, unpasteurized eggs, or other foods such as fresh juices, salsas, meats, sprouts, fruit and salads.
  - Raw cookie dough is hazardous but the slice-and-bake dough is pasteurized and so safe to eat raw.
• Properly cooked fish and other seafood sold in the U.S. and Canada are safe from microbial threats.
  – Not recommended for anyone to eat raw or lightly cooked seafood
  – Raw seafood can cause illness from
    • Viruses, worms, flukes, bacteria
<table>
<thead>
<tr>
<th>Myths</th>
<th>Truths</th>
</tr>
</thead>
<tbody>
<tr>
<td>If a seafood was consumed raw in the past with no ill effect, it is</td>
<td>Each harvest bears separate risks, and seafood is increasingly</td>
</tr>
<tr>
<td>safe to do so today.</td>
<td>contaminated.</td>
</tr>
<tr>
<td>Drinking alcohol with raw seafood will “kill the germs.”</td>
<td>Alcoholic beverages cannot make contaminated raw seafood safe.</td>
</tr>
<tr>
<td>Putting hot sauce on raw oysters and other raw seafood will “kill</td>
<td>Hot sauce has no effect on microbes in seafood.</td>
</tr>
<tr>
<td>the germs.”</td>
<td></td>
</tr>
</tbody>
</table>
Foodborne Illness from Various Sources

- Seafood: 33%
- Produce: 20%
- Beef: 16%
- Poultry: 17%
- Eggs: 14%
Why do you think food borne illness from produce is increasing?

*Answer on next slide*
Raw Produce

- Foods consumed raw, such as lettuce, spinach, tomatoes, and scallions, that grow close to the ground are susceptible to contamination from animal waste runoff.
- Produce may be imported from countries that do not adhere to safe growing practices.
• Honey can contain dormant spores of *Clostridium botulinum* that can germinate and grow in the human body to produce the deadly botulinum toxin.
  
  – Adults are usually protected by stomach acid but infants under 1 year of age should never be fed honey.
Table 12-9  

**Produce Safety**

**Cleaning Fresh Fruits and Vegetables**

1. Remove and discard the outer leaves from vegetables such as lettuce and cabbage before washing.
2. Wash all fruits and vegetables (including organically grown and homegrown, regardless of place of purchase) just before cooking or eating.
3. Wash fruits and vegetables under clean running water and scrub with clean vegetable brush, or with your hands. Commercial vegetable washing products are safe to use; do not use soap, detergents, or bleach solutions.
4. Dry fruits and vegetables before cutting or eating.
5. Cut away damaged or bruised areas that may contain microbes. Toss out moldy fruit or vegetables.
6. Refrigerate washed or prewashed cut fruits, vegetables, and salads.

**Juice Safety**

1. Choose chilled pasteurized juices or shelf-stable juices (canned or boxed) that have been treated with high temperature to kill microbes and check their seals to be sure no microbes have entered after processing.
2. Especially infants, children, the elderly, and people with weakened immune systems should never be given raw or unpasteurized juice products.
Picnics and Lunch Bags

• Keep foods cold until eaten.
• Use thermal lunch bags; freeze beverages to pack with the foods.
• Store leftovers promptly and properly.

• Follow the 2, 2 and 4 rules of leftover safety:
  – Within 2 hours of cooking, refrigerate food in shallow containers about 2 inches deep, and use it up within 4 days or toss it out.
How Can I Avoid Illness When Traveling?

- Chance of getting sick is 50-50 when traveling to a place where cleanliness standards are lacking.
  - Boil it
  - Cook it
  - Peel it
  - Forget it!
These advances may offer benefits, but some also often raise concerns among consumers.
Irradiation

- Food irradiation has been extensively evaluated over the past 50 years
- approved in over 40 countries
- approved by numerous health agencies, including the World Health Organization (WHO) and the American Medical Association.
Irradiation

• Low doses protect consumers from food borne illnesses by:
  • Controlling mold in grains like aflatoxin
  • Sterilizing spices and teas
  • Controlling insects and extending shelf life in fresh fruits and vegetables
  • Destroying disease-causing bacteria in fresh and frozen meats
Irradiation

- Food approved for irradiation by the FDA
  - Citrus fruits
  - Fresh and frozen red meats, such as lamb, pork, beef
  - Mushrooms
  - Onions
  - Potatoes
  - Poultry
  - Spices
  - Strawberries
  - Tomatoes
  - Eggs
  - Wheat
How Irradiation Works

- Irradiation exposes foods to gamma rays from a radioactive compound cobalt 60.
- As radiation passes through living cells, it disrupts and kills or deactivates the cells.
- Some vitamins are destroyed
  - Kills growth cells in the eyes of potatoes and ends of onions to prevent sprouting
  - It delays ripening in fresh fruits and vegetables
  - Does not change the taste
Consumer Concerns about Radiation

• Concerns include:
  
  • Fear that food will be radioactive and cause harm (which is false).
  
  • Requires transporting radioactive materials, training workers to handle them safely and dispose of spent wastes.
  
  • Unscrupulous food manufacturers might use the technology to make old or tainted food seem wholesome.
This “radura” logo is the international symbol for foods treated with irradiation.
Other Technologies

• Several other technologies have potential to resolve some of the threat from contamination of food products:
  
  • Improved automated testing on site
  
  • **Modified atmosphere packaging (MAP)/vacum packaging**
  
  • High pressure processing (HPP) - using high pressure H2O to kill disease causing microbes
  
  • **Ultrasound** - high energy shockwaves through water to remove pathogens from crevices of leafy greens
Toxins, Residues, and Contaminants in Foods

• The FDA, along with the Environmental Protection Agency (EPA), regulates many chemicals in foods that occur as a result of human activities.

• Some toxins occur naturally too.
Nature has provided many plants with natural poisons to fend off diseases, insects, and other predators.

Examples:

- The herb sassafras contains a *carcinogen* and liver toxin
- Cabbage, turnips, mustard greens, and radishes contain small amounts of *goitrogens* that can enlarge the thyroid gland causing goiter. Cooking eliminates the problem.
- Raw lima beans, cassava, apricot pits contain *cyanogens* which are precursors to cyanide (deadly poison)
- Potatoes contain solanine, a powerful, bitter, narcotic-like substance
- Red tide toxin occurs during algae blooms

To avoid poisoning, eat all foods in moderation and choose a variety.
Pesticides help ensure the survival of food crops, but the damage pesticides do to the environment is considerable and increasing.

- Accumulate in food chain
- Kill pests’ natural predators
- Pollute the water, soil, and air
Do Pesticides on Foods Pose a Hazard to Consumers?
Do Pesticides on Foods Pose a Hazard to Consumers?

- **Pesticide residues** on agricultural products can survive processing and are often present in and on foods served to people.
Table 12–11

Ways to Reduce Pesticide Residue Intakes

In addition to these steps, remember to eat a variety of foods to minimize exposure to any one pesticide.

- Trim the fat from meat, and remove the skin from poultry and fish; discard fats and oils in broths and pan drippings. (Pesticide residues concentrate in the animal’s fat.)
- Select fruits and vegetables with intact skins.
- Wash fresh produce in warm running water. Use a scrub brush, and rinse thoroughly.
- Use a knife to peel an orange or grapefruit; do not bite into the peel.
- Discard the outer leaves of leafy vegetables such as cabbage and lettuce.
- Peel waxed fruits and vegetables; waxes don’t wash off and can seal in pesticide residues.
- Peel vegetables such as carrots and fruits such as apples when appropriate. (Peeling removes pesticides that remain in or on the peel, but also removes fibers, vitamins, and minerals.)
- Choose organically grown foods, which generally contain fewer pesticides.
Alternatives to pesticides include:

- Natural pesticides found in some plants leave less persistent residues in the environment than most man-made ones.
- Advances in biotechnology have reduced the need for pesticides sprayed on many crops.
- Choose organic foods.
Consumer Corner: Organic Foods

- Sales of **certified organic foods** are skyrocketing.
- Consumers pay 10 to 40 percent more.
# Organic Foods

<table>
<thead>
<tr>
<th>A Food Meeting This Description...</th>
<th>Can Bear This On Its Label.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Made with exclusively 100% organic ingredients</td>
<td><img src="image" alt="USDA Organic" /> “100% Organic”</td>
</tr>
<tr>
<td>Made with at least 95% organic ingredients</td>
<td><img src="image" alt="USDA Organic" /> “Organic”</td>
</tr>
<tr>
<td>Made with at least 70% organic ingredients</td>
<td>Made with organic ingredients” (May not use seal; may list up to three organic ingredients on front of package)</td>
</tr>
<tr>
<td>Made with less than 70% organic ingredients</td>
<td>(May not use seal and must make no claims on the front of the package; may list organic ingredient on side panel.)</td>
</tr>
</tbody>
</table>
A diet of organic foods measurably reduces pesticide exposure.

- Not known if the tolerance limit set for a pesticide is of any risk to a sensitive individual.
Pesticide Residues

- Foods imported from other countries may contain residues of pesticides that are banned from use here.
• There are no differences in nutrient composition between organic and conventional foods.

• Organic candy bars and fried snack chips are no more nutritious (or less fattening) than ordinary treats.
Environmental Benefits

- Organic foods are grown by using the techniques of sustainable agriculture that produce food without environmental harm.
Potential Health Risks

• For microbial safety, certified organic foods test about the same as conventionally produced foods.

• Consumers may still be exposed to dangerous microorganisms.
• Organic foods cost more than conventionally grown foods.
Animal Drugs

• Consumer groups express concern about drugs given to livestock that produce food.

• Of particular concern:
  – Hormones
  – Antibiotics
  – Drugs that contain arsenic compounds
Bovine somatotropin (bST) causes cattle to produce more meat and milk on less feed than untreated cattle.

The FDA has deemed products from treated cattle to be safe.
Antibiotics in Livestock

- Antibiotics are given to livestock to ward off infection in crowded living conditions and promote rapid growth.

- Animals have to be in a drug free period during which the drugs break down is required before slaughter.

- Antibiotic overuse fosters antibiotic resistance in bacteria, threatening human health.
• Arsenic drugs are used to promote growth in chickens and other livestock.

• An adult would still have to eat more than 21 ounces of chicken each day to receive less than half of the maximum daily arsenic level deemed safe.
• Persistent environmental contaminants pose a significant, but generally small, threat to the safety of food.
Level 1: Several tons of producer organisms (plant and animal plankton)

Level 2: A few tons of plankton-eating fish such as bluegill, perch, stream trout, and smelt

Level 3: 100 pounds of fish-eating fish such as lake trout, walleye, and bass

Level 4: A 150-pound person

Key:
- Toxic chemicals

1. Plants and plankton at the bottom of the food chain become contaminated with toxic chemicals, such as methylmercury (shown as red dots).

2. Contaminants become more concentrated in small fish that eat the plants and plankton.

3. Contaminants become further concentrated in larger fish that eat the small fish from the lower part of the food chain.

4. If none of the chemicals are lost along the way, people ultimately receive all of the toxic chemicals that were present in the original plants and plankton.
Environmental Contaminants

Minimalist disease. The effects of mercury contamination can be severe.
• Food contaminant is anything that does not belong there.

• Some contaminants can be broken down by microorganisms, sunlight or oxygen.

• The body can also excrete or metabolize contaminants to harmless substances.
Mercury

- A heavy metal that is poisonous
- Seafood (mackerel, swordfish, shark, tilefish)
- Poisons the nervous system, loss of coordination, irreversible blindness, impaired mental function
Are Food Additives Safe?

• The 3,000 or so food additives approved for use in the U.S. are strictly controlled and well-studied for safety.

• Without additives, bread would quickly mold and salad dressing would go rancid.
<table>
<thead>
<tr>
<th>Agent Type</th>
<th>Function in Foods</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimicrobial agents (preservatives)</td>
<td>Prevent food spoilage by mold or bacterial growth.</td>
<td>Acetic acid (vinegar), benzoic acid, nitrates and nitrites, prpionic acid, salt, sugar, sorbic acid.</td>
</tr>
<tr>
<td>Antioxidants (preservatives)</td>
<td>Prevent oxidative changes and delay rancidity of fats; prevent browning of fruit and vegetable products.</td>
<td>BHA, BHT, propyl gallate, sulfites, vitamin C, vitamin E.</td>
</tr>
<tr>
<td>Artificial colors</td>
<td>Add color to foods.</td>
<td>Certified food colors such as dyes from vegetables (beet juice or beta-carotene) or synthetic dyes (tartrazine and others).</td>
</tr>
<tr>
<td>Artificial flavors, flavor enhancers</td>
<td>Add flavors; boost natural flavors of foods.</td>
<td>Amyl acetate (artificial banana flavor), artificial sweeteners, MSG (monosodium glutamate), salt, spices, sugars.</td>
</tr>
<tr>
<td>Bleaching agents</td>
<td>Whiten foods such as flour or cheese.</td>
<td>Peroxides.</td>
</tr>
<tr>
<td>Chelating (KEE-late-ing) agents (preservatives)</td>
<td>Prevent discoloration, off flavors, and rancidity.</td>
<td>Citric acid, malic acid, tartaric acid (cream of tartar).</td>
</tr>
<tr>
<td>Nutrient additives</td>
<td>Improve nutritional value.</td>
<td>Vitamins and minerals.</td>
</tr>
<tr>
<td>Stabilizing and thickening agents</td>
<td>Maintain emulsion, foams, or suspensions or lend a desirable thick consistency to foods.</td>
<td>Dextrins (short glucose chains), pectin, starch, or gums such as agar, carrageenan, guar, locust bean, and other gums.</td>
</tr>
</tbody>
</table>
Regulations Governing Additives

• The FDA has the responsibility for deciding which additives shall be in foods.

• Manufacturers must comply with many regulations that ensure safety.
The GRAS List

• Many additives were exempted from complying with rules set by the FDA because they had been in use for a long time and their use entailed no known hazards.

• Some 700 substances are on the GRAS List (generally recognized as safe).

• No additives are permanently approved; all are periodically reviewed.
### The Margin of Safety

- A food additive is supposed to have a wide **margin of safety**.

- Most additives that involve risk are allowed in foods only at levels 100 times below those at which the risk is still known to be zero.
A few food additives receive the most publicity because people ask questions about them most often.
Salt and Sugar

- Salt and sugar are widely used as preservatives. They remove water from the food and microbes need water to grow.

*Two long-used preservatives*
Nitrites

Nitrites are added to:

- Preserve the pink color of hot dogs and other cured meats
- Inhibit rancidity
- Prevent bacterial growth, especially the deadly botulinum bacterium

In the stomach, nitrites can be converted to nitrosamines, chemicals linked to colon cancer.

Other sources of nitrosamines exist.
Sulfites

• Sulfites prevent oxidation in many processed foods, in alcoholic beverages, and in drugs

• For most people, sulfites are harmless, but some people are allergic

• FDA prohibits sulfites on food meant to be eaten raw (except grapes)
Monosodium Glutamate (MSG)

- MSG is a flavor enhancer widely used in restaurants, especially Asian restaurants.
- MSG also has a basic taste (termed *umami*).
- In sensitive people, MSG produces adverse reactions known as the **MSG symptom complex**.
Incidental Food Additives

- **Incidental food additives** are contaminants that are unintentionally added to foods.

- They end up in food during production, processing, storage, packaging, or consumer preparation.
  - Include:
    - Tiny bits of paper, plastic, glass, tin and the solvent used to decaffeinate some coffee.
Incidental Food Additives

- Adverse effects are rare.
- Well regulated and their safety confirmed by strict procedures like those governing intentional additives.
In general, the more heavily processed a food is, the less nutritious it becomes.
### Food Feature: Processing and the Nutrients in Foods

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>METHOD AND PURPOSE</th>
<th>TYPICAL FOODS</th>
<th>EFFECTS ON NUTRIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canning</td>
<td>Boil food to sterilize it and seal it in an impervious can or jar to preserve it.</td>
<td>Fruit, fruit preserves, prepared foods such as soups or pasta dishes, vegetables, and meats.</td>
<td>Causes substantial losses of water-soluble vitamins, particularly thiamin and riboflavin; other water-soluble vitamins are dissolved in cooking liquid.</td>
</tr>
<tr>
<td>Drying</td>
<td>Dehydrate foods to eliminate the water that microbes require for growth.</td>
<td>Fruit, vegetables, meats.</td>
<td>Commercial drying (especially freeze-drying performed at low temperatures) leaves most nutrients intact; home drying may destroy substantial vitamin content, particularly thiamin in foods treated with sulfur dioxide.</td>
</tr>
<tr>
<td>Extruding</td>
<td>Grind, heat, and blend foods with certified colors and flavors and push the resulting paste through screens to form various shapes.</td>
<td>Grains or soybeans, particularly as cereals, baconlike salad toppings, or snack foods in the form of puffs, crisps, or bits.</td>
<td>Considerable nutrient losses occur, notably vitamin E, fiber, magnesium, and the water soluble vitamins.</td>
</tr>
<tr>
<td>Freezing</td>
<td>Cool a food to its frozen state to stop bacterial reproduction and slow enzymatic reactions.</td>
<td>Fruit, vegetables, ready-to-bake doughs, prepared grain products, meats, soy meat replacers, and mixed dishes.</td>
<td>Negligible effects on nutrients.</td>
</tr>
<tr>
<td>Method</td>
<td>Example Uses</td>
<td>Nutritional Impact</td>
<td></td>
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<tr>
<td>Modified atmospheric packaging</td>
<td>Package food in a gas-impermeable container from which air is removed or replaced with other gases to preserve food freshness.</td>
<td>Ready-to-eat salads, cut fruits, soft fresh pasta noodles, baked goods, prepared foods, fresh and preserved meats.</td>
<td>Preserves vitamins by slowing enzymatic breakdown.</td>
</tr>
<tr>
<td>Pasteurizing</td>
<td>Expose food to elevated temperature for long enough to reduce bacterial contamination.</td>
<td>Refrigerated foods such as milk, fruit juice, and eggs.</td>
<td>Causes trivial losses of some vitamins.</td>
</tr>
<tr>
<td>Ultrahigh temperature processing</td>
<td>Expose food to high temperatures for a short time to eliminate microbial contamination.</td>
<td>Shelf-stable foods such as boxed milk, boxed fruit juice, shelf-stable entrée dishes for microwaving.</td>
<td>Causes trivial losses of some vitamins.</td>
</tr>
</tbody>
</table>
The nutrient density of processed foods exists on a continuum:

- Whole-grain bread > refined white bread > doughnuts
- Milk > fruit-flavored yogurt > canned pudding
- Corn on the cob > canned cream corn > caramel corn
- Oranges > orange juice > orange-flavored drink
- Baked ham > deviled ham > fried bacon
Food Feature: Processing and the Nutrients in Foods

Purchase mostly whole foods or those that processing has benefited nutritionally.
• Although **genetic engineering (GE)** technologies are relatively new to farming, their roots lie in naturally-occurring genetic events and centuries-old breeding techniques.
Controversy: Genetically Modified Foods: What Are the Pros and Cons?

<table>
<thead>
<tr>
<th>TABLE C12-1 Genetic Engineering Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>clone an individual created asexually from a single ancestor, such as a plant grown from a single stem cell; a group of genetically identical individuals descended from a single common ancestor, such as a colony of bacteria arising from a single bacterial cell; in genetics, a replica of a segment of DNA, such as a gene, produced by genetic engineering.</td>
</tr>
<tr>
<td>GE foods genetically engineered foods; food plants and animals altered by way of rDNA technology.</td>
</tr>
<tr>
<td>genetic engineering (GE) the direct, intentional manipulation of the genetic material of living things in order to obtain some desirable trait not present in the original organism. Also called recombinant DNA technology and biotechnology.</td>
</tr>
<tr>
<td>genetic modification intentional changes to the genetic material of living things brought about through a range of methods, including rDNA technology, natural cross-breeding, and agricultural selective breeding.</td>
</tr>
<tr>
<td>outcrossing the unintended breeding of a domestic crop with a related wild species.</td>
</tr>
<tr>
<td>plant pesticides substances produced within plant tissues that kill or repel attacking organisms.</td>
</tr>
<tr>
<td>recombinant DNA (rDNA) technology a technique of genetic modification whereby scientists directly manipulate the genes of living things; includes methods of removing genes, doubling genes, introducing foreign genes, and changing gene positions to influence the growth and development of organisms.</td>
</tr>
<tr>
<td>selective breeding a technique of genetic modification whereby organisms are chosen for reproduction based on their desirability for human purposes, such as high growth rate, high food yield, or disease resistance, with the intention of retaining or enhancing these characteristics in their offspring.</td>
</tr>
<tr>
<td>stem cell an undifferentiated cell that can mature into any of a number of specialized cell types. A stem cell of bone marrow may mature into one of many kinds of blood cells, for example.</td>
</tr>
<tr>
<td>transgenic organism an organism resulting from the growth of an embryonic, stem, or germ cell into which a new gene has been inserted.</td>
</tr>
</tbody>
</table>
- Wild plants cross-pollinate randomly.
- Farmers change the genetic makeup of crops and farm animals through selective breeding.
Natural Cross-Pollinating and Selective Breeding

native corn  colorful carrots
Genetic Engineering Basics

Selective Breeding—DNA is a strand of genes, much like a strand of pearls. Traditional selective breeding combines many genes from two individuals of the same species.

rDNA Technology—Through rDNA technology, a single gene or several may be transferred to the receiving DNA from the same species or others.
Research in genetic engineering is currently directed at creating:

- GE crops and animals with added desired traits, such as altered nutrient composition, extended shelf life, freedom from allergy-causing constituents, or resistance to diseases or insect pests.
- GE crops that survive harsh conditions, such as applications of herbicides, heavily polluted or salty soils, or drought conditions.
- GE microorganisms that produce needed substances, such as pharmaceuticals or other products that do not occur in nature or occur only in small amounts.
• These salmon are all of the same age and type. The largest one received a growth-enhancing gene, greatly accelerating its growth rate.
• The American Dietetic Association takes the position that agricultural and food biotechnology can enhance the quality, safety, nutritional value, and variety of the food supply, while helping to solve problems of production, processing, distribution, and environmental and waste management.
### Ethical Arguments about Genetic Engineering

<table>
<thead>
<tr>
<th>Arguments in Opposition to Genetic Engineering</th>
<th>Arguments in Support of Genetic Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>Ethical and moral issues.</strong> It’s immoral to “play God” by mixing genes from organisms unable to do so naturally. Religious and vegetarian groups object to genes from prohibited species occurring in their allowable foods.</td>
<td>1. <strong>Ethical and moral issues.</strong> Scientists throughout history have been persecuted and even put to death by fearful people who accuse them of playing God. Yet today, many of the world’s citizens enjoy a long and healthy life of comfort and convenience due to once-feared scientific advances put to practical use.</td>
</tr>
<tr>
<td>2. <strong>Imperfect technology.</strong> The technology is young and imperfect; genes rarely function in just one way, their placement is often imprecise, and potential effects are impossible to predict. Toxins are as likely to be produced as the desired trait.</td>
<td>2. <strong>Advanced technology.</strong> Recombinant DNA technology is precise and reliable. Many of the most exciting recent advances in medicine, agriculture, and technology were made possible by the application of this technology.</td>
</tr>
<tr>
<td>3. <strong>Environmental concerns.</strong> Environmental side effects are unknown. The power of a genetically modified organism to change the world’s environments is unknown until such changes actually occur—then the “genie is out of the bottle.” Once out, the genie cannot be put back in the bottle because insects, birds, and the wind distribute genetically altered seed and pollen to points unknown.</td>
<td>3. <strong>Environmental protection.</strong> Genetic engineering may be the only hope of saving rain forest and other habitats from destruction by impoverished people desperate for arable land. Through genetic engineering, farmers can make use of previously unproductive lands such as salt-rich soils and arid areas.</td>
</tr>
<tr>
<td>4. <strong>“Genetic pollution.”</strong> Other kinds of pollution can often be cleaned up with money, time, and effort. Once genes are spliced into living things, those genes forever bear the imprint of human tampering.</td>
<td>4. <strong>Genetic improvements.</strong> Genetic side effects are more likely to benefit the environment than to harm it.</td>
</tr>
<tr>
<td>5. <strong>Crop vulnerability.</strong> Pests and disease can quickly adapt to overtake genetically identical plants or animals around the world. Diversity is key to defense.</td>
<td>5. <strong>Improved crop resistance.</strong> Pests and diseases can specifically fought on a case-by-case basis. Biotechnology is the key to defense.</td>
</tr>
<tr>
<td>6. <strong>Loss of gene pool.</strong> Loss of genetic diversity threatens to deplete valuable gene banks from which scientists can develop new agricultural crops.</td>
<td>6. <strong>Gene pool preserved.</strong> Thanks to advances in genetics, laboratories around the world are able to stockpile the genetic material of millions of species that, without such advances, would have been lost forever.</td>
</tr>
<tr>
<td>ARGUMENTS IN OPPOSITION TO GENETIC ENGINEERING</td>
<td>ARGUMENTS IN SUPPORT OF GENETIC ENGINEERING</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>7. <strong>Profit motive.</strong> Genetic engineering will profit industry more than the world’s poor and hungry.</td>
<td></td>
</tr>
<tr>
<td>8. <strong>Unproven safety for people.</strong> Human safety testing of genetically altered products is generally lacking. The population is an unwitting experimental group in a nationwide laboratory study for the benefit of industry.</td>
<td></td>
</tr>
<tr>
<td>9. <strong>Increased allergens.</strong> Allergens can unwittingly be transferred into foods.</td>
<td></td>
</tr>
<tr>
<td>10. <strong>Decreased nutrients.</strong> A fresh-looking tomato or other produce held for several weeks may have lost substantial nutrients.</td>
<td></td>
</tr>
<tr>
<td>11. <strong>No product tracking.</strong> Without labeling, the food industry cannot track problems to the source.</td>
<td></td>
</tr>
<tr>
<td>12. <strong>Overuse of herbicides.</strong> Farmers, knowing that their crops resist herbicide effects, will use them liberally.</td>
<td></td>
</tr>
<tr>
<td>13. <strong>Increased consumption of pesticides.</strong> When a pesticide is produced by the flesh of produce, consumers cannot wash it off the skin of the produce with running water as they can with most ordinary sprays.</td>
<td></td>
</tr>
<tr>
<td>14. <strong>Lack of oversight.</strong> Government oversight is run by industry people for the benefit of industry—no one is watching out for the consumer.</td>
<td></td>
</tr>
<tr>
<td>7. <strong>Everyone profits.</strong> Industries benefit from genetic engineering, and a thriving food industry benefits the nation and its people, as witnessed by countries lacking such industries. Genetic engineering promises to provide adequate nutritious food for millions who lack such food today. Developed nations gain cheaper, more attractive, more delicious foods with greater variety and availability year round.</td>
<td></td>
</tr>
<tr>
<td>8. <strong>Safe for people.</strong> Human safety testing of genetically altered products is unnecessary because the products are essentially the same as the original foodstuffs.</td>
<td></td>
</tr>
<tr>
<td>9. <strong>Control of allergens.</strong> Allergens can be transferred into foods, but these are known, and thus can be avoided. Allergen-free peanuts and other foods are under development.</td>
<td></td>
</tr>
<tr>
<td>10. <strong>Increased nutrients.</strong> Genetic modifications can easily enhance the nutrients in foods.</td>
<td></td>
</tr>
<tr>
<td>11. <strong>Excellent product tracking.</strong> The identity and location of genetically altered foodstuffs are known, and they can be tracked should problems arise.</td>
<td></td>
</tr>
<tr>
<td>12. <strong>Conservative use of herbicides.</strong> Farmers will not waste expensive herbicides in second or third applications when the prescribed amount gets the job done the first time.</td>
<td></td>
</tr>
<tr>
<td>13. <strong>Reduced pesticides on foods.</strong> Pesticides produced by produce in tiny amounts known to be safe for consumption are more predictable than applications by agricultural workers who make mistakes. Because other genetic manipulations will eliminate the need for postharvest spraying, fewer pesticides will reach the dinner table.</td>
<td></td>
</tr>
<tr>
<td>14. <strong>Sufficient regulation, oversight, and rapid response.</strong> The National Academy of Sciences has established protocol for safety testing of GE foods. Government agencies are efficient in identifying and correcting problems as they occur in the industry.</td>
<td></td>
</tr>
</tbody>
</table>
Ethical Arguments about Genetic Engineering

• Some consumers believe that food biotechnology will cause more harm than good
**Table C12-4: Food Production Methods Compared: Organic, Conventional, and rDNA Technology**

**SOIL CONDITION AND ENVIRONMENT**

- **Organic**: Improves soil condition through crop rotation and the addition of complex fertilizers such as manure; controls erosion; highly protective of waterways and wildlife. Uses sustainable agriculture techniques.
- **Conventional**: Depletes soil; adds synthetic chemical fertilizers containing only a few key elements; can create soil erosion problems. Runoff pollutes waterways, and sprays poison wildlife such as birds and beneficial insect predators.
- **Genetic engineering**: No direct effect on soil or erosion; may require fewer pesticide sprays, thus protecting waterways and wildlife, but may harm wildlife by exposing wild species to altered genes or plant pesticides; may soon make use of salty, dry, or other currently unusable lands. May produce “genetic pollution.”

**NUTRIENTS IN FOODS**

- **Organic**: Suggestive evidence of slightly increased content of trace minerals, vitamin C, and improved amino acid balance in produce over conventionally farmed produce.
- **Conventional**: Standards for nutrient composition of foods are set by analysis of conventionally produced foods.
- **Genetic engineering**: Potential for increasing nutrient and phytochemical content, at the will of the producer.
Benefits to Consumers

- **Organic**: Reduced exposure to pesticides and other sprays and animal medications and hormones. New standards define organic techniques, with regulatory oversight. Long history of safety for human consumption of food varieties. Ethical comfort of knowing that food-producing animals are well treated.

- **Conventional**: General safety and pesticide residues monitored regularly; many varieties of foods available at low cost.

- **Genetic engineering**: Greater food production at low cost, keeping consumer prices low and availability high. Particular products may meet particular consumer demands, such as better flavor, increased vitamin or phytochemical content, or improved freshness of foods. Potential exists for helping to ease world hunger. Crops may produce medicines needed in impoverished areas of the world.

Consumer Safety Issues

- **Organic**: Consumer must wash produce well to remove possible dangerous microbial contamination and pesticides that may have “drifted” onto produce.

- **Conventional**: Consumer must wash produce well to remove possible dangerous microbial contamination and pesticides that are applied to produce.

- **Genetic engineering**: Consumer must wash produce well to remove possible dangerous microbial contamination and pesticides (especially herbicides) that are applied to produce. Internally produced plant pesticides do not wash off. Other dangers include introduction of allergens from other species and unproven safety of consuming rDNA products over a lifetime. Unknown dangers may also exist.