First Annual Food Science/Safety Workshop for High School Teachers

2011

Koury Covention Center Greensboro, NC
Date: 25th July, 2011
Time: 9:00 AM-4:00 PM

Agenda

Time	Presentation Title	Presenter
9:00-10:00 AM	Introduction to Food Science and Technology	Salam Ibrahim
10:00-11:00 AM	Introduction to Food Microbiology and Food safety	Rabin Gyawali
11:00-12:00 PM	Food Contamination	Saeed Hayek
12:00-1:00 PM	Lunch Break	
1:00-2:00 PM	Chemical Contaminants in Food	Madhavi Hathurusinghe
2:00-3:00 PM	Food quality control-HACCP	Sangeetha Viswanathan
3:00-4:00 PM	Food labeling: an important challenge food safety	Mehrdad Tajkarimi

Dr. Salam A. Ibrahim, PhD
Research Professor of Food Science
Food Microbiology and Biotechnology laboratory
North Carolina A & T State University
171 Carver Hall, Greensboro, NC
Tel: 336-334-7328 (Office), 336-314-2252 (Cell)
Email: ibrah001@ncat.edu

Dr. Salam A. Ibrahim is a food scientist and currently a research professor at the North Carolina A&T State University, conducting research in the area of dairy food processing and food safety. He has won several accolades during his career and is also a member of various professional organizations and honor societies. His professional expertise focuses on developing functional foods with emphasis on probiotic properties and plant extracts, using lactic acid bacteria as biological control agents to inhibit a wide range of spoilage and interaction between carbohydrates and milk protein for stabilization. In particular, Dr. Ibrahim has developed new courses in food safety/sanitation (FCS 651), food microbiology and biotechnology (FCS 653), and food analysis (FCS 633), which have enhanced the food science teaching program. Dr. Ibrahim also has several food protection and defense projects with the NCFPD at the University of Minnesota. He has conducted several projects with USDA CSREES and the US Agency for International Development (USAID).

Summary of the presentation:

Introduction to Food Science and Technology

The presentation deals with basic understanding of food science and technology and possible career and opportunity in the food industry. The presentation also covers major food compounds as related to food chemistry (water, proteins, carbohydrates, and lipids). This includes the chemical structure, functions and properties and examples in food products. It includes basic understanding of food products and nutritional values.

Introduction to Food Science and Technology

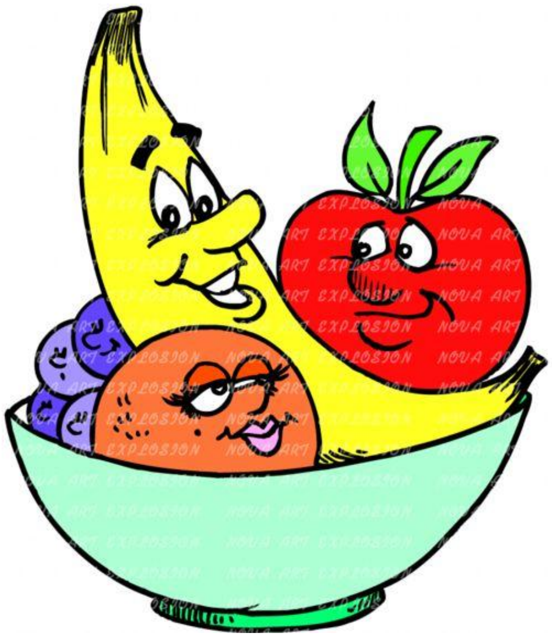
Dr.Salam A.Ibrahim
Research Professor
North Carolina A&T State University

Outline

- Food Science and Food Technology
- Food Industry and Career Opportunities
- Food Chemistry
- Water
- Proteins
- Carbohydrates
- Lipids
- References

Did you know….

- You use more calories eating celery than there are in the celery itself
- Apples are more effective at keeping people awake in the morning than caffeine
- Avocados have more protein and good lipids than any other fruit
- Strawberries have more vitamin C than oranges
- McDonald’s salads contain up to 60% more fat than their burgers



Have you ever wondered…

- How easy it is to grab a meal from the store
- How there is a wide variety of flavors in your favorite drink
- How you can still enjoy those delicious cookies with lower fat
- Or why packaged ready-to-eat cut fruit stays crisp and does not turn brown?

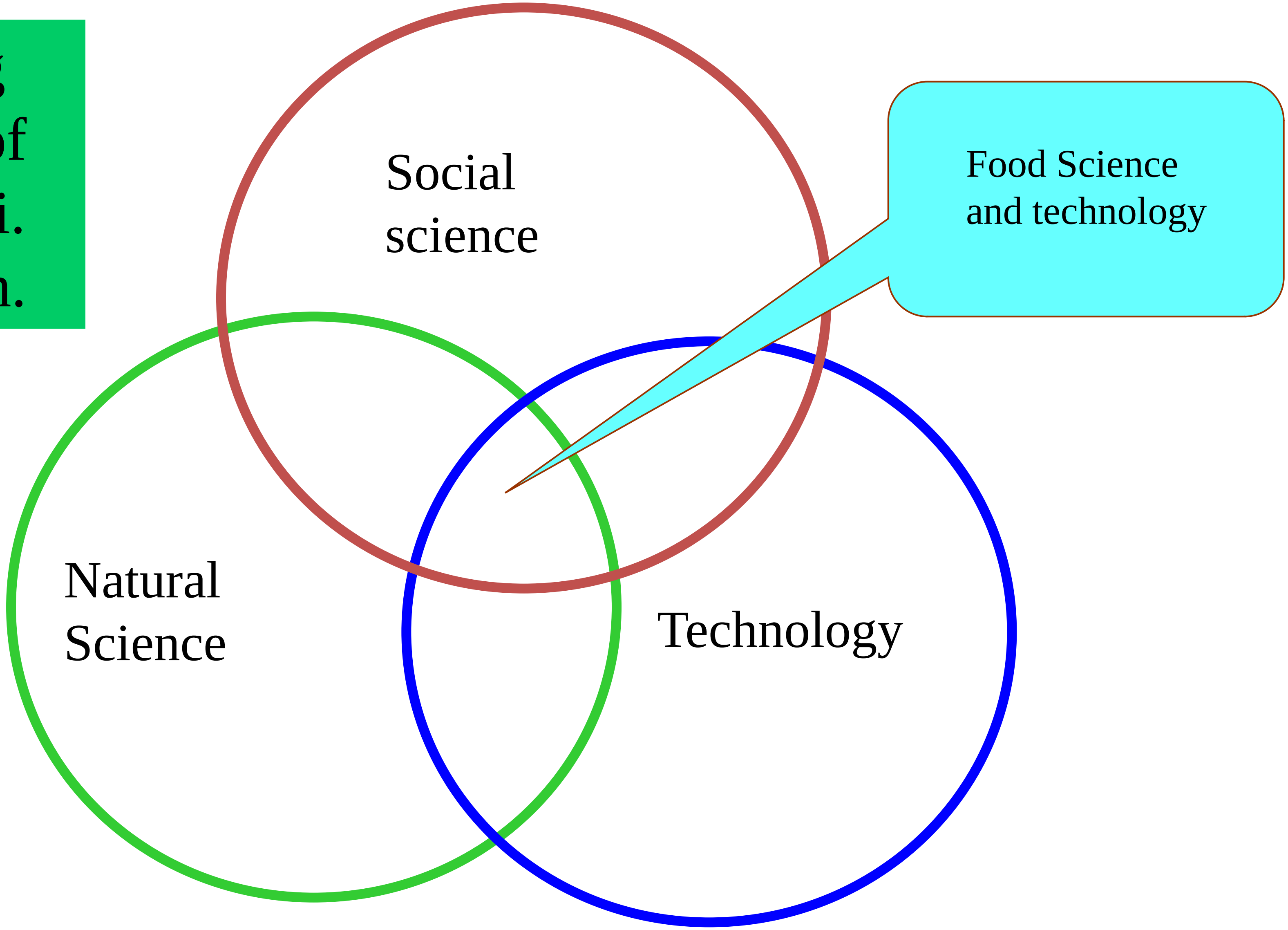
Then food science may be a career for you!!

What is Food Science and Technology?

<u>Food Science</u> is the discipline in which the engineering, biological, and physical sciences are used to study the nature of foods, the causes of deterioration, the principles underlying food processing, and the improvement of foods for the consuming public

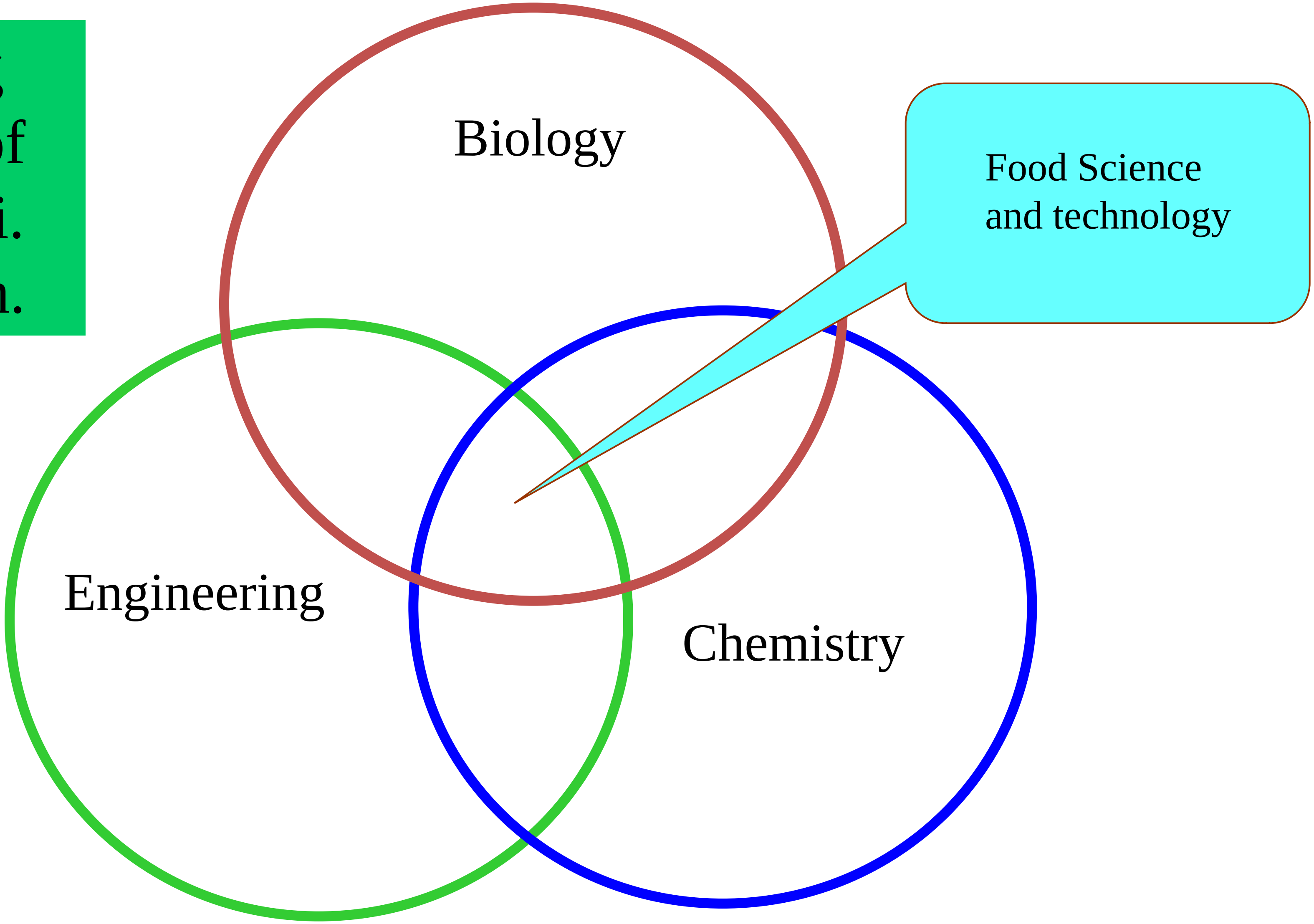
<u>Food Technology</u> is the application of food science to the selection, preservation, processing, packaging, distribution, and use of safe, nutritious, and wholesome food

Building Blocks of Food Sci. and Tech.



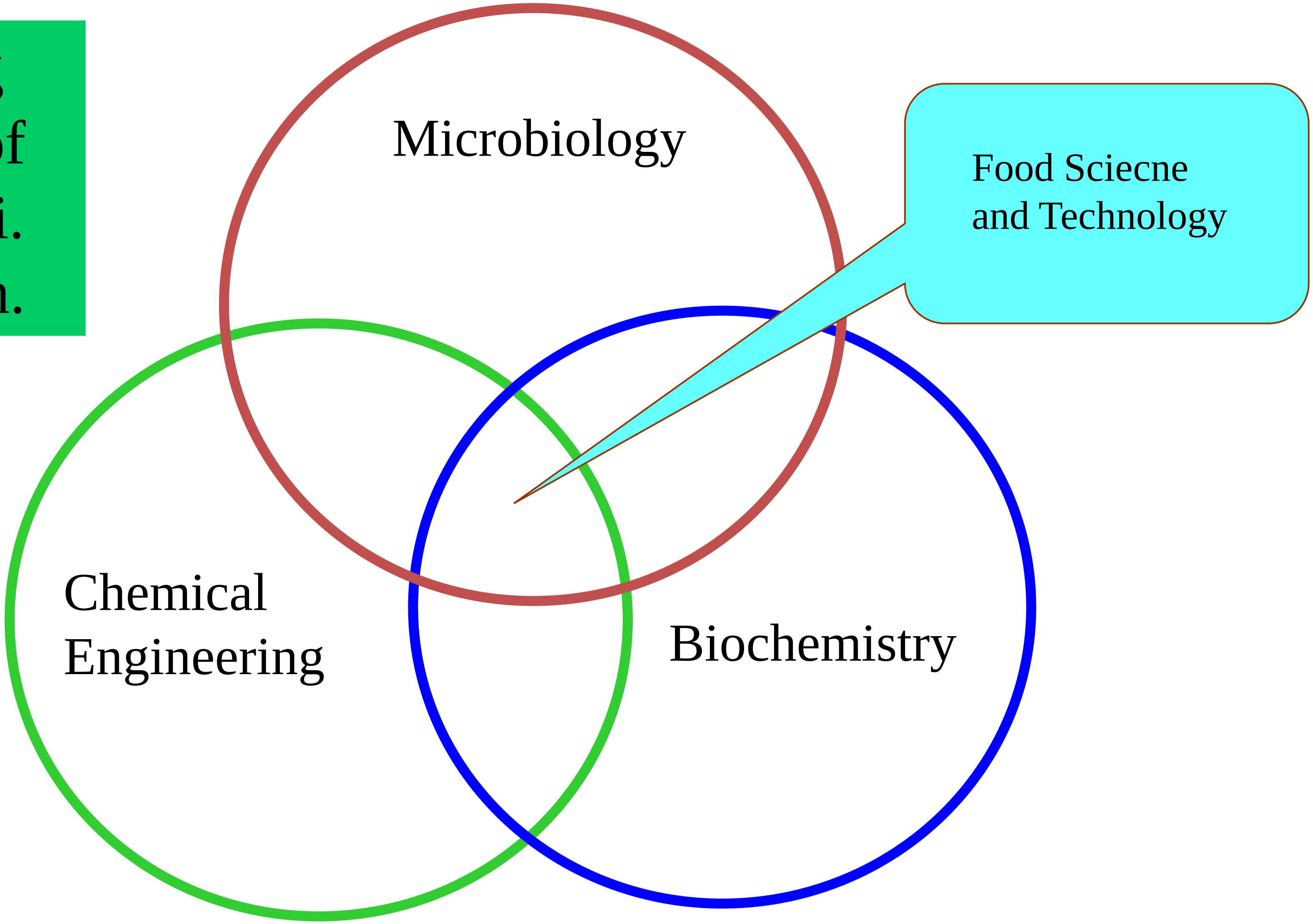
Food Industry as a Whole

Building Blocks of Food Sci. and Tech.



Food Science & Technology as a Academic Subject

Building
Blocks of
Food Sci.
and Tech.



Food Science and Technology Discipline

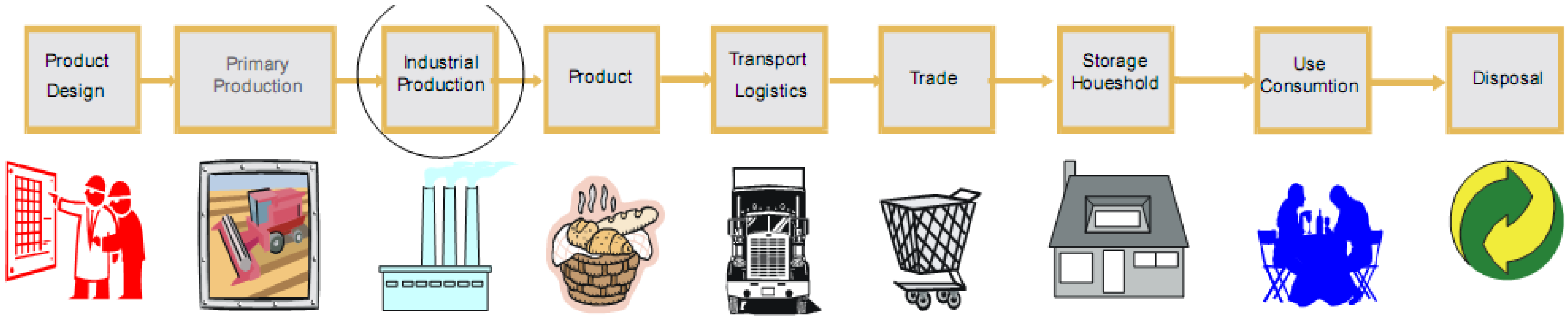
Why food science?

- The food industry is the 2nd largest manufacturing sector
- Generally more positions available than graduating students to fill them
- It is an applied science: You could see the product you worked on in the grocery store
- It's fun! Food scientists get to play with their food!
- It's exciting! Food scientists never get bored. They work in the lab, in the pilot plant, and travel to different plants sometimes all around the world

What is the role of a food scientist?

A Food Scientist studies the physical, microbiological, and chemical makeup of food. Depending on their area of specialization, Food Scientists may develop ways to process, preserve, package, or store food, according to industry and government specifications and regulations

Food Industry Career opportunities



Food Industry is a huge circle, includes: agriculture production, processing and manufacturing, marketing, logistics, research, education, supervision, equipments, ingredients and additives, etc

Professional opportunities include: engineer, technician, quality controller, product developer, market manager, teacher, researcher, government officer, etc.

Where can you work?

- Food processors
- Ingredient manufacturer/suppliers
- Academia
- Self-employed/Consultant
- Government
- Non-government organizations
- Foodservice
- Testing laboratory

Food Chemistry

Food Chemistry is the study of:

- The composition of raw materials in foods
- The composition of the end-products of food production
- The changes which occur in food during its production, processing, storage and cooking

Food Chemistry

Basic food chemistry deals with the primary components in food:

- Water (moisture)
- Proteins
- Carbohydrates
- Lipids
- Others

Water

- Major Component of most foods
- Water has several effects on food stability and overall quality
- Affects texture, appearance and taste –interacts w/ proteins, CHO and lipids: grapes vs raisins; milk vs yogurt and cheese
- Good cooking medium – hard to burn foods by boiling & steaming compared to broiling or frying
- Chemical reactions, enzymatic changes, and microbial growth may occur readily in foods with high water content

Water activity

- Water activity (Aw) is a measure of the availability of water for biological functions and relates to water present in a food in “free” form
- In a food system total water is present in a food in “Free” and “Bound” form
- Bound Water – held tightly to other molecules, exhibit no flow properties, not a solvent, high density, inability to freeze, cannot be expressed from tissues
- Water Activity in all foods is always <1.0
- Water Activity of pure water is 1.0

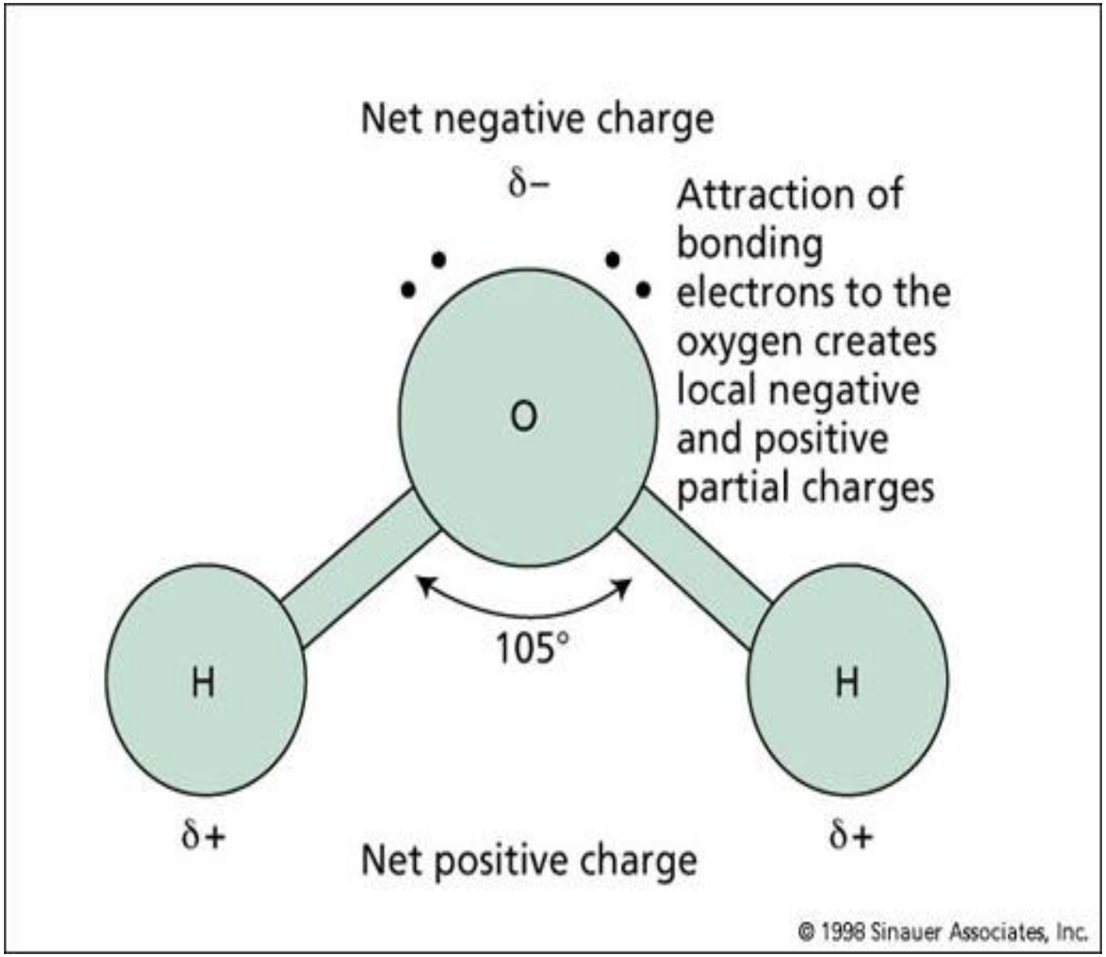
Water activity and microbial growth

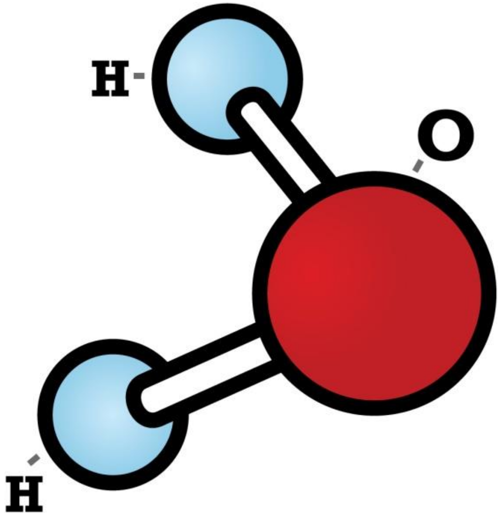
- Water in food is necessary for microbial growth
- Aw of foods can be reduced by removing water and increased by the adsorption of water
- Microorganisms can be controlled by reducing the Aw of food
- Aw can be reduced by adding solutes, ions, hydrophilic colloids, freezing and drying

Water content of food products

Food	water content (%)
Tomato	95
Lettuce	92
Orange	82
Broccoli	78
Milk	87
Meat	65
Chicken	62
Fish	60
Jam	25
Honey	20
Rice	12
Coffee	5
Milk powder	4
Shortening	0

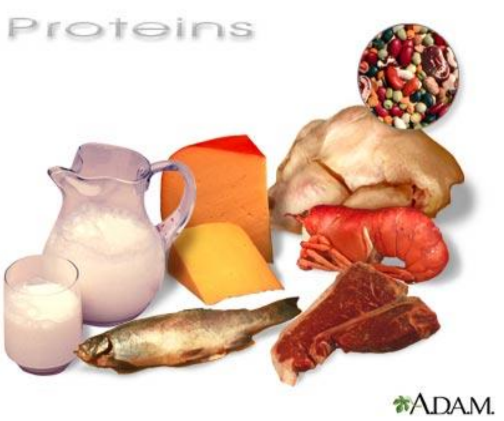
Structure of water





Proteins

- Proteins are made up of small units called amino acids
- 20 amino acids found in plant and animal proteins
- A protein may contain 500 or more amino acids



Functions of Protein

- Proteins play functional key roles in structuring and maintaining living cells
- Most foods contain protein. Eg: Collagen in meat, gluten in wheat, albumin in egg
- Some type of proteins help with reactions (enzymes) while others are part of the cell structure
- Our genes code for proteins

Denaturation

- Change in structure of protein molecules, results in unfolding. pH, temperature, mechanical action contribute to denaturation

- Eg. When egg white is whisked, it incorporates air to form a foam. If the foam is left to stand, it will collapse back to liquid

Coagulation

- Follows denaturation, proteins unfold and forma solid stable network
- When egg white is heated, it becomes firmer and sets
- Another form of coagulation occurs in the production of cheese. Rennin causes milk proteins to clot, producing curd and whey. Other application: yogurt, thickening of sauces

Gelation

- Gel is a mixture of fluids locked in a mass of denatured and coagulated proteins
- Gels are often formed by the proteins of eggs or flour in such products as puddings, batters, and doughs. Gelatin, a type of protein found in the bone and skin tissue of animals, also forms gels
- Some types of carbohydrates such as alginate, starch, and pectin, also form gels

Types of Proteins

- Storage proteins
- Transport proteins
- Structural proteins
- Protective proteins
- Toxic proteins

Carbohydrates

- ***Simple carbohydrates***
  - Natural sugars
  - Added (Refined) sugars

- ***Complex carbohydrates*** (polysaccharides)
  - Starch
  - Fiber

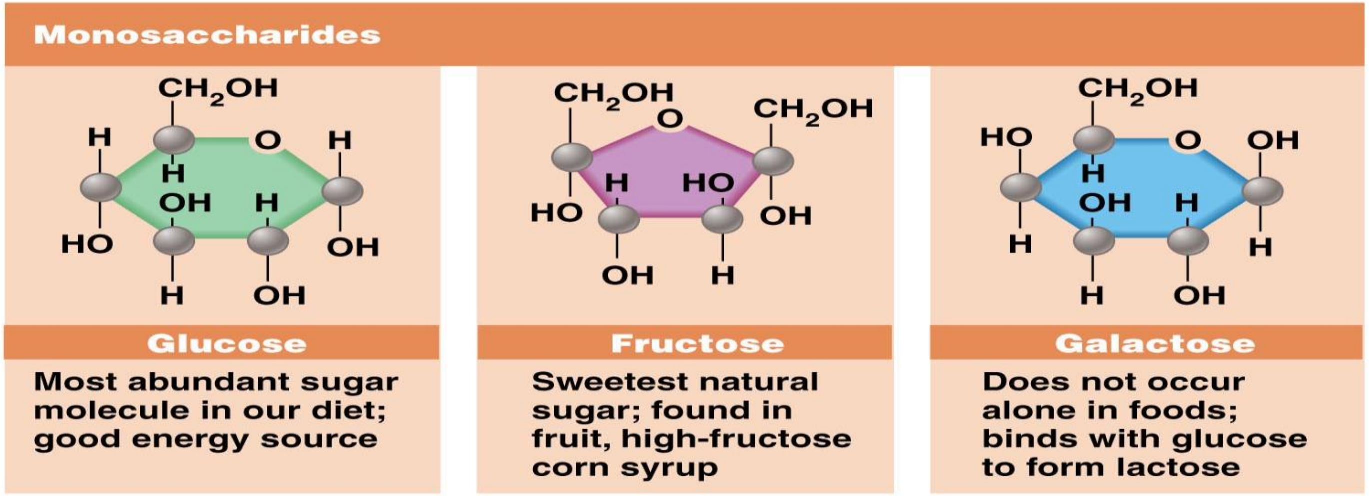
Functions of carbohydrates

- Functions as primary source of body's energy
  - Central nervous system and red blood cells rely almost exclusively on glucose
  - Glucose is stored in liver and muscles as glycogen
- Spares protein from being burned for energy
- Breakdown of fatty acids and preventing ketosis
- Biological recognition processes
- Flavor and Sweeteners
- Dietary fiber

Simple sugars
Monosaccharides

- A 6 Carbon ring with a water attached
- Monosaccharides = One Sugar

3 Types : glucose, fructose and galactose



Simple sugars
Monosaccharides

Glucose

- Blood sugar
- Basic source of energy in the body
- Storage = glycogen

Fructose

- Major sugar found in fruit and honey
- Sweetest monosaccharide

Galactose

- Rarely found by itself in food…complex with glucose
- Found in milk sugar “Lactose”

Lactose = galactose + glucose

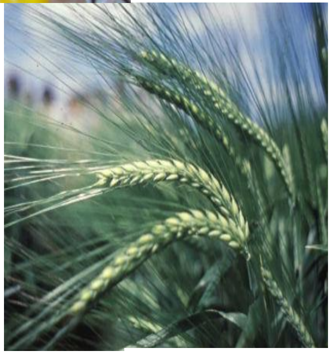
Simple sugars
Disaccharides

Sucrose

- Glucose + Fructose
- Each contain a 6-Carbon ring and water
- Candies, cake, cookies, table sugar

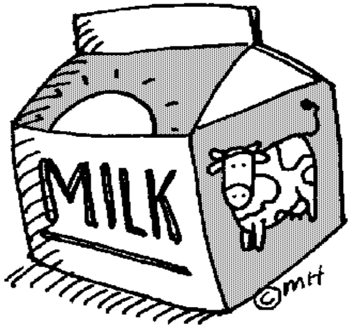
Maltose

- Glucose + Glucose
- Uncommon in food sources, except barley
- Breakdown product of Starch
- Product of fermentation ➡ Alcohol



Lactose

- Glucose + Galactose
- Milk Sugar



Complex sugar
Polysaccharides

Glycogen

- Made and found in our bodies
- Not found in plants
- Storage form of Carbohydrate in the body
- Saved for later use
- Stored in liver and muscle

Starch

- Most common food polysaccharide
- Long branched or unbranched chain of glucose molecules
- Yams, corn, potatoes, peas, beans, wheat, rice, oats, breads, pasta, barley, rye

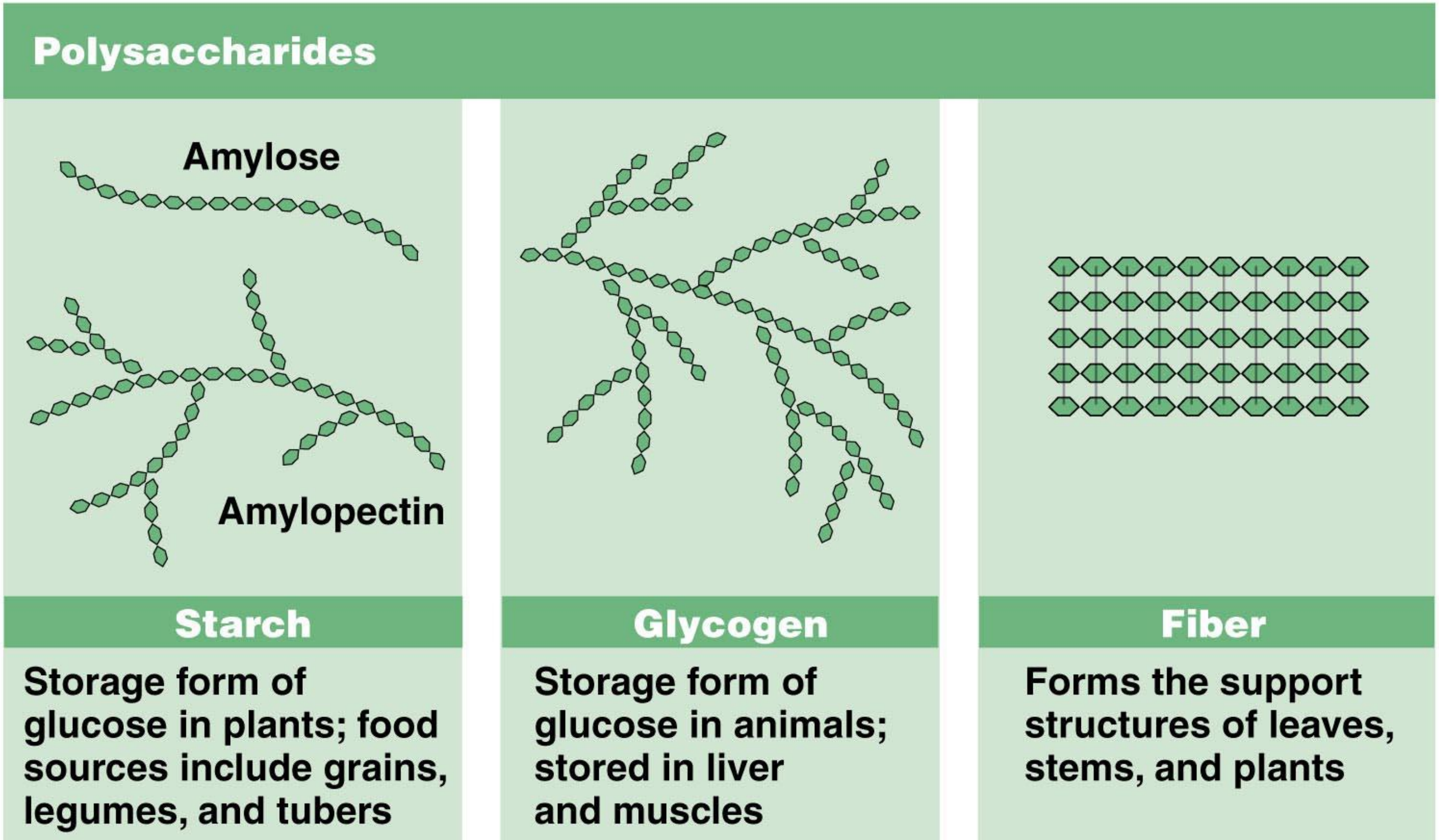
Complex sugar Polysaccharides

Fiber

- Found in plant foods that the body can't digest or absorb
- Some fiber is digested by bacteria in the large intestine
- Two types: soluble or viscous fiber and insoluble or non viscous fiber

Soluble fiber: Fruits, legumes, oats, barley, rye, seeds and vegetables

Insoluble fiber: Wheat bran, brown rice, whole grains, vegetables, fruits, legumes


Polysaccharides
Amylose
Amylopectin
Starch
Storage form of glucose in plants; food sources include grains, legumes, and tubers
Glycogen
Storage form of glucose in animals; stored in liver and muscles
Fiber
Forms the support structures of leaves, stems, and plants

Lipids

- Fat and Oils are lipids **Fat + Oils= lipid**
- "Lipids consist of a board group of compounds that are generally soluble in organic solvents but sparingly soluble in water…."
- Types of lipids include: triglyceride, phospholipid and sterol
- Most of the fat we eat is in the form of triglycerides (consists of 3 fatty acids)

Fatty acids

Saturated fat

- Only single bonds between carbon atoms
- Usually solids at room temperature
- Shortening, butter, lard, coconut oil

Unsaturated fat

- More liquid at room temperature

Monounsaturated: One double bond. Eg: olive oil, canola oil, nuts, seeds

Polyunsaturated: 2 or more double bonds. Unstable. Eg: sunflower, sesame seed, safflower oils.

Hydrogenation

- Mono and poly unsaturated fatty acids can have hydrogen atoms added
- Adding hydrogen alters the oils and makes it more solid
- Prevents rancidity and increases shelf life and stability
- Useful in margarine, peanut butter
- Most fried and processed foods, baked goods, snack food

WOULD YOU LIKE SOME CARBONATED LIQUID SUGAR WITH YOUR DEEP FRIED FAT?

Trans fats

- Trans fats refers to triglycerides containing unsaturated fatty acids in the trans conformation
- Found in partially hydrogenated fats or oils
- Help to solidify food
- FDA adopted new food labeling

  labels give weight of trans fat

  restrict low fat definitions by trans fat content

- Some margarines are sold as ”trans free”

  No hydrogenation

  Mix saturated and unsaturated fats

  Tend to be soft spreads

Butter

Nutrition Facts

Serving size 1 Tbsp (14g)
Servings Per Container 32

Amount per serving	
Calories 100	Calories from Fat 100
	%Daily Value*
Total Fat 11g	17%
Saturated Fat 7g	36%
Cholesterol 30mg	10%
Sodium 90mg	4%
Total Carbohydrate 0g	0%
Protein 0g	
Vitamin A 8%	

Not a significant source of dietary fiber, sugars, vitamin C, calcium, and iron.

*Percent Daily Values are based on a 2,000 calorie diet.

INGREDIENTS: Cream, salt.

Margarine (stick)

Nutrition Facts

Serving size 1 Tbsp (14g)
Servings Per Container 32

Amount per serving	
Calories 90	Calories from Fat 90
	%Daily Value*
Total Fat 10g	15%
Saturated Fat 2g	10%
Polyunsaturated Fat 2g	
Monounsaturated Fat 3g	
Cholesterol 0mg	0%
Sodium 95mg	4%
Total Carbohydrate 0g	0%
Protein 0g	
Vitamin A 10%	

Not a significant source of dietary fiber, sugars, vitamin C, calcium, and iron.

*Percent Daily Values are based on a 2,000 calorie diet.

INGREDIENTS: Vegetable oil blend (partially hydrogenated and liquid soybean oils), water, sweet cream buttermilk, salt, vegetable mono- and diglycerides, soy lecithin, citric acid, artificial flavor, vitamin A, colored with beta carotene.

Margarine (tub)

Nutrition Facts

Serving size 1 Tbsp (14g)
Servings Per Container 32

Amount per serving	
Calories 90	Calories from Fat 90
	%Daily Value*
Total Fat 10g	15%
Saturated Fat 2g	10%
Polyunsaturated Fat 4.5g	
Monounsaturated Fat 2.5g	
Cholesterol 0mg	0%
Sodium 95mg	4%
Total Carbohydrate 0g	0%
Protein 0g	
Vitamin A 10%	

Not a significant source of dietary fiber, sugars, vitamin C, calcium, and iron.

*Percent Daily Values are based on a 2,000 calorie diet.

INGREDIENTS: Water, liquid soybean oil, partially hydrogenated soybean oil, sweet cream, buttermilk, gelatin, salt, vegetable mono- and diglycerides, soy lecithin, lactic acid, artificial flavor, vitamin A, colored with beta carotene.

Margarine (liquid)

Nutrition Facts

Serving size 1 Tbsp (14g)
Servings Per Container 32

Amount per serving	
Calories 60	Calories from Fat 60
	%Daily Value*
Total Fat 7g	10%
Saturated Fat 1g	6%
Polyunsaturated Fat 4g	
Monounsaturated Fat 1.5g	
Cholesterol 0mg	0%
Sodium 85mg	3%
Total Carbohydrate 0g	0%
Protein 0g	
Vitamin A 10%	

Not a significant source of dietary fiber, sugars, vitamin C, calcium, and iron.

*Percent Daily Values are based on a 2,000 calorie diet.

INGREDIENTS: Liquid soybean oil, water, sweet cream buttermilk, salt, partially hydrogenated cottonseed oil, vegetable mono- and diglycerides, soy lecithin, citric acid, artificial flavor, vitamin A, colored with beta carotene.

Essential fatty acids

- Necessary for the production of body’s cells-skin, brain cells, hormones, cholesterol
- Omega-3 and omega-6 fatty acids
- Cannot be synthesized by the body and must be obtained in the diet
- Lower blood triglyceride level and bad cholesterol

TABLE 5-2 Sources of Omega Fatty Acids

Omega-6	
Linoleic acid	Vegetable oils (corn, sunflower, safflower, soybean, cottonseed), poultry fat, nuts, seeds
Arachidonic acid	Meats, poultry, eggs (or can be made from linoleic acid)
Omega-3	
Linolenic acid	Oils (flaxseed, canola, walnut, wheat germ, soybean) Nuts and seeds (butternuts, flaxseeds, walnuts, soybean kernels) Vegetables (soybeans)
EPA and DHA	Human milk Pacific oysters and fish[a] (mackerel, salmon, bluefish, mullet, sablefish, menhaden, anchovy, herring, lake trout, sardines, tuna) (or can be made from linolenic acid)

[a] All fish contain some EPA and DHA; the amounts vary among species and within a species depending on such factors as diet, season, and environment. The fish listed here except tuna provide at least 1 gram of omega-3 fatty acids in 100 grams of fish (3.5 ounces). Tuna provides fewer omega-3 fatty acids, but because it is commonly consumed, its contribution can be significant.

Role of lipids

- Energy source
- Carrier of fat soluble vitamins
- Major component of membranes
- Flavor and texture source of foods
- Emulsifying agents

References

- *Essentials of Food Science* *http://rapidshare.com/files/119471859/efsaasdaDASD0387699392.rar.html*
- *Fundamental of Food Reaction Technology* *http://www.nzifst.org.nz/foodreactiontechnology/*
- *Handbook of Food Products Manufacturing* *http://depositfiles.com/en/files/4468639*
- *Physical Principles of Food Preservation* *http://depositfiles.com/en/files/0ouaccs85*
- *Encyclopedia of Foods* *http://rapidshare.com/files/107905681/Encyclopedia_of_Foods.pdf*
- *Food Composition Data： Production, Management and Use* *http://222.173.194.17/foodziliao/file2/200712191440.rar*
- *Find Information and materials in course website and BBS*

Experiments in Food Science Laboratory Manual

Contents

Introduction: What Is Food Science?

This laboratory manual has two purposes. The first purpose is to describe what food science is and what food scientists do. The second purpose is to describe fun laboratory experiments that demonstrate practical applications of food science. Food science is all of the science involved in taking agricultural food products from the farmer's gate to the grocery store, restaurant, or dinner table. Food scientists generally work with all sectors of agriculture. Food science includes both basic and applied biology, microbiology, chemistry, math, business, engineering, physics, and other disciplines. A food scientist's goal is to make safe, high quality food products that are profitable to all segments of agriculture.

Those who earn a bachelor of science in the food science discipline have starting salaries of $45,000 to $55,000 per year and work for some of the largest food manufacturing companies in the country. Food science students also have opportunities to compete in national competitions dealing with food, such as Dairy Judging, Meats Judging, New Product Development, and the Research Chef's Association. These events offer participants networking and learning opportunities for future career growth.

It is also possible to pursue a career as a veterinarian through an option in the food science curriculum. This is an excellent opportunity for students interested in veterinary school to work towards an undergraduate degree while completing the pre-veterinary (pre-vet) required curriculum. The veterinary school acceptance rate for food science majors is very competitive compared to the acceptance rate for all pre-vet disciplines. But students with food science backgrounds and degrees who do not get accepted in veterinary school still have great job opportunities making $45,000 to $55,000 a year to start, with room for rapid advancement. Such an annual income and opportunities may not be available to students who graduate from other programs with pre-vet curriculums.

Laboratory exercises in this manual demonstrate principles behind butter making (density, lipid chemistry), cheese production (acid precipitation, protein chemistry), processed meat production (use of salt in meats, protein chemistry), meat marination (use of vacuum in meat processing), sensory evaluation (principles of sensory science; appearance, taste, and smell), candy production (candy chemistry, carbohydrate crystallization), and bread production (bread texture, gluten proteins). These laboratory experiments demonstrate some simple scientific principles that apply to food and explain why and how it is possible to make certain food products.

Mississippi State University Extension Service

Experiment 1: Butter

Purpose

This experiment demonstrates the principles of butter making.

Materials

- 1/3 cup heavy cream
- measuring cups
- clean jar with secure, tight-fitting lid
- salt (1/3 teaspoon or to taste)
- crackers

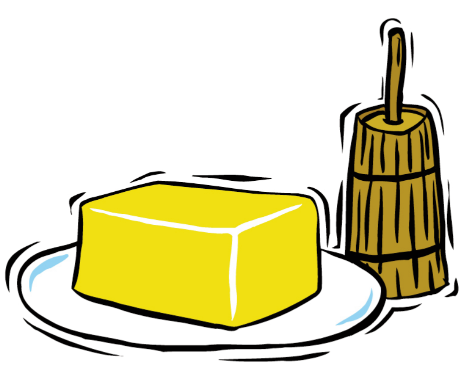
Procedure

1. Pour 1/3 cup of heavy cream into a clean jar. Cap the jar.
2. Shake the jar. Take turns shaking; you may need to shake for 15 to 20 minutes. The cream will start looking like cottage cheese (whipped cream). Continue shaking.
3. You will note a separation of solids and liquids.
4. The solid is butter, and the liquid is buttermilk.
5. Pour off the buttermilk. Add salt to the butter for more flavor. Try the butter on crackers.

Notes

Dairy milk is composed of 87 percent water, 3.2 percent protein, 3.9 percent fat, 4.8 percent carbohydrate, and roughly 1 percent minerals and vitamins. The fat in milk is a mixture of lipids. Triglycerides are the main type of lipid. Lipids have a lower density than water, so when raw milk sits for several hours, the cream (butter) will rise to the top.

The density of cream is the basis for butter making. The cream is churned to separate the butter (solids) from the buttermilk (liquid). Butter contains at least 80 percent milk fat by weight. The butter can be salted and poured into molds for further processing. Butter remains solid when refrigerated but softens to a spreadable consistency at room temperature and melts to a thin liquid consistency at 32 to 35 ˚C (90 to 95 ˚F). Butter is generally pale yellow but can vary from deep yellow to nearly white. The yellow color is the result of the b-carotene in the grass that dairy cows eat.



Homogenizing milk prevents the cream (butterfat) layer from separating from the milk. Homogenizing breaks down the fat globules into smaller globules and disperses them evenly in the milk. The smaller globules will not rise to form cream during normal storage conditions.

Experiment 2: Casein (Milk Protein)

Purpose

This experiment demonstrates (1) the precipitation of protein (casein) from milk with an acid (vinegar) and (2) the effectiveness of casein as a bonding agent to make casein glue.

Materials

- measuring cups and spoons
- 1/4 cup milk
- 400 milliliter beaker
- stir bar
- pH meter
- thermometer
- hot plate
- stir plate
- 1 teaspoon vinegar
- cheesecloth
- weigh boats
- 1/2 teaspoon household ammonia
- glass rod
- wooden craft sticks

Procedure

1. Pour 1/4 cup of milk into a 400 mL beaker. Place stir bar into beaker.
2. Measure the pH of the milk. Place a thermometer in the beaker.
3. Heat the milk to 70 ˚C on a hot plate. Remove the beaker from the heat. Remove the thermometer.
4. Place the beaker with the warm milk on a stir plate and add 1 teaspoon vinegar. Stir for 2 minutes. Allow the milk to sit for a few minutes. The casein will precipitate into heavy white curds. The remaining liquid is the whey.
5. Measure the pH of the liquid portion again.
6. Cover the top of the beaker with a piece of cheesecloth. Drain off the vinegar and whey over a sink. Carefully remove the cheesecloth and collect the curds (casein) in the cheesecloth. Rinse the cheesecloth containing the casein in cool water and squeeze the cheesecloth until the casein is almost dry. Spread out the cheesecloth to let the casein dry for a few minutes.
7. After drying them, place the curds into a weigh boat.
8. Very carefully add 1/2 teaspoon ammonia solution to the curds. (**CAUTION: ammonia is an irritant.)**

Slowly stir with a glass rod until the mixture becomes thick and creamy in texture.

9. Rub the casein glue onto two wooden craft sticks and join them together. Allow the glue to dry for a few minutes.

Notes

Milk is composed of many proteins. The main groups are casein and whey proteins. Caseins are very digestible when compared to other food proteins, making it a very important human food. Casein is negatively charged in its natural state. This negative charge permits the casein to disperse in milk. When you add an acid, the H+ concentration neutralizes the negatively charged casein. When you acidify milk, its pH is allowed to reach 4.6, which brings casein to its isoelectric point. The isoelectric point is the point at which all charges are neutral. When casein loses its negative charge, it precipitates as curds. This acid casein is the basis for the manufacture of cottage cheese and cream cheese. Acid casein is also used in the chemical industry; in the production of adhesive products, textiles, and cosmetics; and as a binding agent in food products.

Casein can also be precipitated with rennin, an enzyme found in calves' stomachs. This rennin coagulum is made of casein, whey protein, fat, lactose, and minerals. It has a fluffier and spongier texture than the acid precipitate. This is the basis for the manufacture of cheese.

Reference

http://members.ift.org/IFT/Education/TeacherResources/

Experiment 3: Role of Salt In Meat Processing

Purpose

This experiment demonstrates the importance of salt in meat processing.

Materials

- food preparation gloves
- food scale that measures in metric units
- 100 grams raw ground beef, divided equally
- small food processor
- 20 milliliters water, divided equally
- 2 grams salt
- spoons
- large white paper such as butcher paper
- paper towels
- newspapers

Procedure

Wear gloves when working with raw meat. Keep meat away from other food products. Wash hands and workplace after completing the experiment.

1. Place 50 g ground beef into a small food processor.
2. Add 10 mL water. Chop the meat for 15 seconds.
3. Remove the meat from food processor. Form it into a ball. Flatten it like you are making a hamburger patty.
4. Now, put the slightly flattened meat in the palm of your gloved hand (palm up). Turn your hand over (palm down). What happens? Does the meat stick to your hand, or does it fall down?
5. Repeat step 1 in this procedure with the other half of the meat. In step 2, dissolve 2 g salt into the 10 mL of water before adding the water to the meat. Follow steps 3 and 4 with the new mixture.
6. Tape a piece of white (butcher) paper to the wall. Place plenty of newspaper on the floor below. Throw the two meat patties at the paper. Does either one stick to the paper?

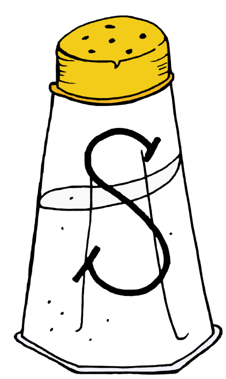
Notes

In this experiment, ground meat without salt probably did not stick to your hand or to the target. When you added salt to the ground meat, it made the salt-soluble proteins come to the surface of the meat. In scientific terms, it extracted the salt-soluble proteins from the cellular structure. The proteins then acted like glue.

Salt serves many purposes. It brings out natural flavors, slows growth of spoilage microorganisms, and enhances a food's color, odor, and appearance. This experiment shows that salt also creates the protein structure necessary to make processed meats like hot dogs and deli meats. Salt helps bind meat by extracting its proteins, which "glue" together adjacent pieces of meat. Salt also increases water-binding properties, which reduce cook losses and contribute to enhanced texture. It also helps give a smooth, firm texture to processed meats. In addition, it helps with the color development of ham, bacon, hotdogs, and other processed muscle food products.

Did You Know?

Without salt, it would be impossible to make hot dogs, deli meats, and other processed meats. Can you explain why?



Experiment 4: Exploding Marshmallows

Purpose
This experiment demonstrates (1) the principles of air pressure, (2) how changes in air pressure can affect food products, and (3) the principle behind applying a vacuum in meat processing.

Materials
- vacuum pump
- glass jar suitable to be attached to the vacuum pump (The jar should have a rubber stopper with a hole in it to insert a tube. The tube connects to the vacuum pump. You could also use a capped Erlenmeyer flask with a side arm to attach a tube that will connect to the vacuum pump.)
- marshmallows (different sizes)

Procedure
1. Place a marshmallow inside the glass jar.
2. Cap the jar. Connect the tube from the rubber stopper to the vacuum pump.
3. Turn on the vacuum pump. What happens?
4. Turn off the vacuum pump. What happens now?
5. Discuss your results.

Variations: You can place several marshmallows inside the glass jar or make a marshmallow man. You can also try expanding chicken meat.

Notes
Marshmallows are a mixture of sugar, air, and gelatin. The sugar makes them sweet, the air makes them fluffy, and the gelatin is a protein that holds everything together. By volume, marshmallows are mostly air. When subjected to vacuum, the air from around the marshmallow is removed. This decrease in pressure causes the air trapped inside the marshmallow to push outward, expanding it. Eventually the vacuum is strong enough to pull air from inside the marshmallow, causing it to shrink. When the air in the jar returns to normal atmospheric pressure, you end up with a "mallow grape" because the air has been removed from inside the marshmallow.

This same principle is used in the meat and poultry industry to marinate chicken and other pre-marinated meats. Vacuum meat tumblers marinate meat in a very short time. Under vacuum, the foods' fibers stretch, becoming more porous. This allows the marinade to penetrate evenly throughout the product. Vacuum tumbling allows meat to absorb up to about 20 percent of its starting weight in marinade without extended preparation. There is an increased yield in the raw product, which means increased yield after cooking and a product that is juicy and tasty.

Reference:
www.spacegrant.hawaii.edu/ScienceDemos/vacuumDemos.html

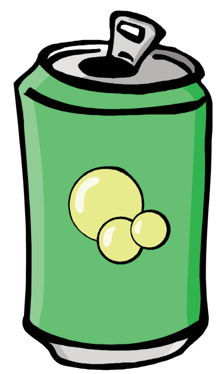
Experiment 5: Food Flavors

Purpose
This experiment demonstrates how appearance influences our perception of how foods taste.

Gatorade
Materials
- small sampling cups with lids (2 oz size is ideal)
- Gatorade (lemon-lime flavor and orange flavor)
- red food color

Procedure
1. Add a few drops of red food coloring to lemon-lime flavored Gatorade. Mix until the color resembles the orange of orange flavored Gatorade.
2. Pour the two orange-colored Gatorades, lemon-lime and orange, into sampling cups. Label each cup using a code to identify each type of drink.
3. Give students both samples.
4. Ask the student to pinch his or her nose and taste each Gatorade sample. Record the response.
5. Ask the student to release his or her nose and taste each Gatorade sample. Record the response.

Soft Drink
Materials
- small sampling cups with lids (2 oz size is ideal)
- Sprite or other clear soda
- Coca-Cola or other brown cola
- caramel color



Procedure
1. Add a few drops of caramel color to Sprite until the color is similar to that of Coke.
2. Pour both drinks (Coke and colored Sprite) into labeled sampling cups. Each cup should have a code to identify its drink.
3. Provide students with both samples.
4. Ask the student to pinch his or her nose and taste each soda sample. Record the response.
5. Ask the student to release his or her nose and taste each soda sample. Record the response.

Variation: If you cannot find caramel color, you can try a red-colored soda like cherry and an unflavored clear soda like club soda or seltzer water. Add a few drops of red color to the clear soda until it looks like the red soda, pour the sodas into the sampling cups, and ask the students to taste both drinks.

Did You Know?
Most of the time we assume things about a food's flavor based on its color. Changing the color of lemon-lime Gatorade can make it look like orange-fla-

vored Gatorade, but it still tastes like lemon lime. However, your mind can play tricks on you and convince you that it is orange flavored. Similarly, the color of Sprite is changed so it looks like Coke, but it does not taste like Coke.

Experiment 6: Determining Flavor With Your Nose?

Purpose

This experiment demonstrates how your mouth and nose work together to perceive different flavors.

Materials

- jelly beans of different colors
- small sampling cups

Procedure

1. Place two jellybeans of the same color in the sampling cup.
2. Ask the student to pinch his/her nose and taste a jellybean from the cup. Record the response.
3. Ask the student to release his/her nose and taste another jellybean from the same cup. Record the response.

Notes

You cannot determine flavor without your nose. Without the sense of smell, foods would not be tasty. You would not be able to tell the difference between foods with the same texture. A food's odors allow us to determine its flavors. About 80 to 90 percent of what we perceive as "taste" is actually due to the sense of smell. This is why foods taste bland when you have a cold or a stuffy nose.

There are four different types of true tastes: sour, sweet, salty and bitter. The salty/sweet taste buds are near the front of the tongue, the sour taste buds line the sides of the tongue, and the bitter taste buds are at the very back of the tongue. Children are very sensitive to the flavors in foods. As people age, their taste buds become less sensitive.

Experiment 7: Candy Making (Hard-Crack Stage, 300 ˚F)

Purpose

This experiment demonstrates (1) the chemistry of candy making and (2) the effect of temperature on the texture of candies.

Materials

- shallow baking pan (8x8x2 inch)
- heavy duty aluminum foil
- oil spray
- 435 grams (about 2 1/8 cups) sugar
- 1/2 cup light corn syrup
- 1/2 cup water
- 2-quart saucepan or 1000 mL beaker
- candy thermometer
- stove (for saucepan) or hot plate (for beaker)
- food color
- 1/2 teaspoon oil flavoring
- spatula

Procedure

1. Line an 8x8x2 inch pan with heavy duty aluminum foil, extending foil over the edges of the pan. Oil the pan lightly.
2. Combine sugar, corn syrup, and water in a 2-quart saucepan or a 1000 mL beaker. Place a candy thermometer in the pan. The thermometer should not touch the bottom of the pan or beaker. Stir the mixture over high heat until it boils.
3. Reduce heat to medium. Continue cooking over medium heat. Do not stir the mixture while it is cooking. When the syrup reaches 260 ˚F, add food color. Do not stir; boiling action will incorporate color into the syrup. Remove from heat precisely at 300 ˚F. Remove thermometer.
4. Once boiling has stopped, add flavoring. Pour syrup quickly but carefully into prepared pan. (**CAUTION: mixture is very hot.**) Let it stand for 5 minutes.
5. Using a broad spatula, mark candy surface in 1/2 inch squares. Retrace previous lines and press the spatula deeper each time until you can press the spatula to the bottom of the pan.
6. Cool completely. Use foil to lift candy out of the pan. Break candy into squares and store in plastic bags.

Variation: You can use plastic molds for hard candy or lollipops. Lightly oil the molds before pouring the hot mixture. Twist the lollipop stick to make sure it is covered with the syrup. Let lollipops cool until hardened before removing from molds.

Notes

Sucrose, or table sugar, and other sugars are the main ingredients in candy. Sucrose is made of two simple sugars, glucose and fructose, that are bound together. Sugar crystals are solid at room temperature. When sugar crystals are dissolved in water, the sugar goes into solution. At a particular temperature, water can dissolve only a certain amount of a particular sugar. The solution reaches the point where no more sugar can be dissolved, and extra sugar will just sink to the bottom. This point is called the saturation point.

Heating the sugar/water solution increases the amount of sugar that can be dissolved. The heat causes the crystals to break into smaller molecules. The sugar molecules move faster and farther apart, enabling the solution to dissolve more and more sugar molecules. The solution turns into a clear sugar syrup. As you add more sugar, the solution becomes supersaturated. This means that the solution has reached a delicate balance of just enough sugar molecules and enough heat to keep the sugar molecules dissolved, but in an unstable state. The sugar molecules begin to crystallize back into a solid at the least disruption of heat or action. In other words, the sugar comes back together as sugar crystals when the syrup cools.

To make candy, you boil a mixture of sugar and water to create sugar syrup. The water evaporates, and the sugar concentrates. The higher the temperature, the more concentrated the sugar becomes. The texture of a candy (hard, soft, or chewy) depends on its cooking temperature and ingredients.

References

http://www.exploratorium.edu/cooking/candy/index.html
http://en.wikipedia.org/wiki/Candy

Temperature (˚F)	Use	Description
Soft-Ball Stage (235-240 ˚F) Sugar concentration: 85%	Fudge, fondant, pralines, peppermint creams, and buttercreams	Soft ball: a small amount of syrup dropped into ice water forms a soft, flexible ball but flattens like a pancake after a few moments.
Firm-Ball Stage (245-250 ˚F) Sugar concentration: 87%	Caramels	Firm ball: syrup forms a firm ball that will not flatten when removed from water but remains malleable and will flatten when squeezed.
Hard-Ball Stage (250-265˚F) Sugar concentration: 92%	Nougat, marshmallows, gummies, divinity, and rock candy	Hard ball: syrup dropped into ice water forms a hard ball, which holds its shape on removal. Can change shape when pressed.
Soft-Crack Stage (270-290 ˚F) Sugar concentration: 95%	Taffy and butterscotch	Soft crack: syrup dropped into ice water separates into hard but pliable threads, which bend slightly before breaking.
Hard-Crack Stage (300-310 ˚F) Sugar concentration: 99%	Toffee, nut brittles, hard candy, and lollipops	Hard crack: syrup dropped into ice water separates into hard, brittle threads that break when bent.
Caramelized sugar		Temperatures are higher than any of the candy stages, creating caramelized sugar.

Experiment 8: Gluten

Purpose
This experiment demonstrates (1) what gluten is, (2) its importance in bread making, and (3) its presence in all-purpose flour.

Materials
Mixing bowls
Measuring cups and spoons
1/2 cup + 2 teaspoons all-purpose flour
1/2 cup soy flour
1/2 cup water, divided

Procedure
1. Measure 1/2 cup of soy flour into a bowl. Measure 1/2 cup of all-purpose flour into a different bowl.
2. Add 1/4 cup of water to each bowl of flour and mix.
3. If the all-purpose flour mixture is sticky, add up to 2 teaspoons of additional flour, 1 teaspoon at a time. Mix and knead after each flour addition. Do not add flour to the soy flour mixture.
4. Knead dough mixtures for about 5 minutes each. Note texture, appearance, color, elasticity, and flexibility of each dough ball. The soy flour dough looks clumpy, yellowish, and has no elasticity. Why? The all-purpose flour is opaque, elastic, and flexible.
5. Place the all-purpose dough ball under the faucet and run cool water over it. Squeeze the dough ball to drain white, starchy water. Continue doing this under running water for about 5 minutes. What happened? Note how the dough shrinks in size, changes color, and becomes thread-like. These are the gluten threads. The water that drains from the dough ball is white as the starch is washed out of the dough ball.

Notes
Gluten is a protein found in wheat, rye, and barley. All breads made with wheat flour have a certain amount of gluten, depending on the type of flour. For example, cake flour has the lowest amount of gluten (5 to 8 percent), while high-gluten flour has greater than 14 percent. All-purpose flour is 11 to 12 percent gluten.

Gluten is the substance that gives bread its structure, texture, and elasticity. Gluten is made up of two main groups of proteins: gliadins and glutenins. Without these proteins, it would not be possible to make bread with an acceptable texture. Gluten is developed in the dough when gliadins and glutenins absorb water and are pulled and stretched in the kneading process. As the proteins are worked, they become long, flexible strands. The yeast produces gases in the dough, mostly carbon dioxide. These strands trap the gas bubbles, and the dough rises before it is baked.

Without gluten, bread would be very dense or flat. Rice, potato, and oat flours do not have gluten, and bread made from these flours does not turn out well.

Did you Know?
Some people are unable to eat gluten because of either a wheat allergy or celiac disease. Gluten causes damage to the intestines and stomach of a person with celiac disease.

Reference
VanDyke, E.M. 2007. *Chemistry Supplement to High School Food Technology*. Pittsburgh Teaching Institute. http:\\www.chatham.edu/pti/Kitchen_Chem/VanDyke_01.htm

The information given here is for educational purposes only. References to commercial products or trade names are made with the understanding that no discrimination is intended against other products that may also be suitable.

By **Dr. M. W. Schilling**, Assistant Professor, Food Science, Nutrition, and Health Promotion; **Viodelda Jackson**, Research Associate II, Food Science, Nutrition, and Health Promotion; and **Dr. J.B. Williams**, Assistant Extension/Research Professor, Food Science, Nutrition, and Health Promotion.

Publication 2469

Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. Published in furtherance of Acts of Congress, May 8 and June 30, 1914. VANCE H. WATSON, Director (POD 02-08)

Rabin Gyawali, M.S.
Research Assistant
Food Microbiology and Biotechnology Laboratory
North Carolina A & T State University
Greensboro, NC
Email: rabingyawali@hotmail.com

Rabin Gyawali received his Bachelor of Science in Zoology from Tribhuvan University, Nepal and came to North Carolina A&T State University to pursue higher education. During his study, he served as a Research Assistant in the Family and Consumer Sciences Department and his research was focused on studying various natural antimicrobial compounds against foodborne pathogens, under the supervision of Dr. Salam A. Ibrahim. He was recognized for his academic excellence at North Carolina A&T State University and his research findings were presented at various national conferences and meetings. He graduated with his Masters degree in Dec. 2010 and is currently a Research Assistant under Dr. Salam A. Ibrahim, with key responsibilities of designing and conducting scientific research studies in food microbiology. Though, he finds most aspects of food science fascinating, he is particularly interested in the study of foodborne pathogens and controlling the survival and growth of microorganisms in foods. He further plans to pursue a doctoral degree in food science.

Summary of the presentation:

Introduction to food microbiology and food safety

Frequent foodborne illness resulting from the consumption of food contaminated with pathogenic bacteria has been of vital concern to public health. Therefore, understanding the basic concept of microbiology regarding the types of microorganisms, how they grow and multiply, and the methods used to control pathogens is important. This presentation briefly covers the concept and tools for studying microorganisms in food and the use of natural antimicrobials in controlling the growth of pathogens.

Introduction to Food microbiology and Food safety

Rabin Gyawali
Food Microbiology Laboratory
North Carolina A&T State University
July 25th, 2011

Microbiology is the branch of science dealing with microorganisms: Bacteria, Viruses and Fungi.

Outline

- Harmful microorganisms
- Growth media
- Bacterial growth
- Beneficial microorganisms
- Natural antimicrobial compounds and their effect on harmful bacteria

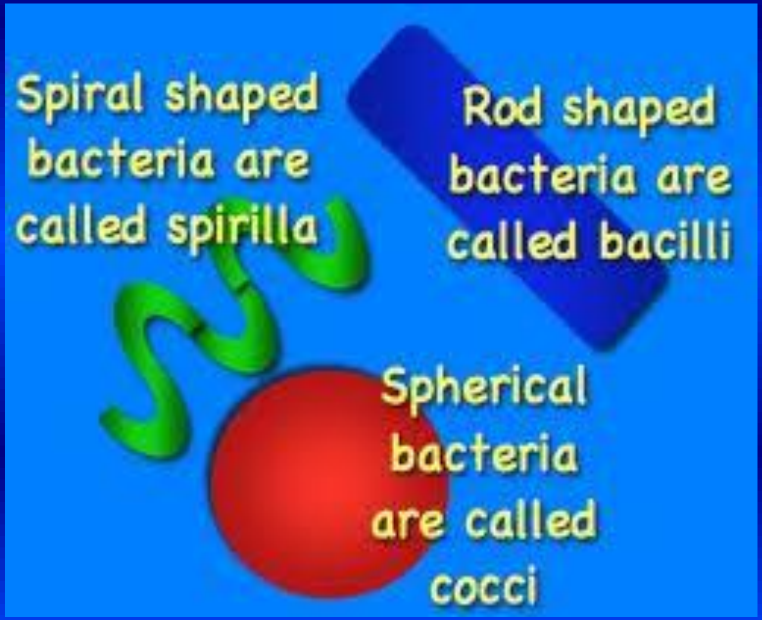
Harmful microorganisms

- *Salmonella*
- *Escherichia coli (E. Coli)* O157:H7
- *Campylobacter*
- *Listeria monocytogenes*
- *Clostridium botulinum*
- *Shigella* spp.

Bacteria

- Microscopic single cells
- Cause most food illness
- Shapes

  -Rod, Cocci (spheres), Spiral
- Spore formers



(Centers for Disease Control and prevention, 2003).

Bacterial classification

- Based on their oxygen requirements
- Aerobes- use oxygen

  (Eg.) *Bacillus*, *Staphylococcus* spp.

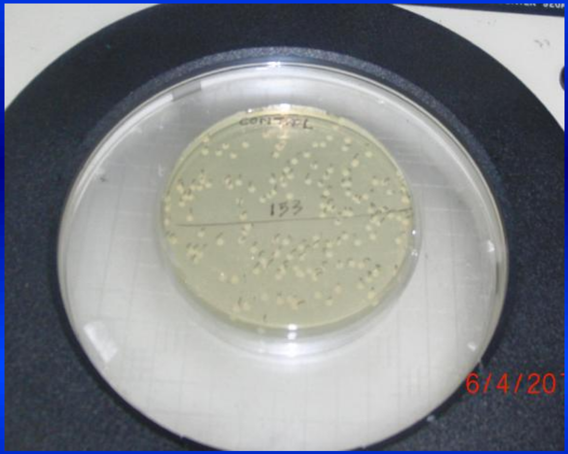
- Anaerobes- do not require oxygen

  (Eg.) *E. coli*, *Clostridium botulinum*

Nonselective media

- Brain Heart Infusion (BHI) Agar
- Isolation and cultivation of most anaerobic bacteria/ fastidious microorganisms

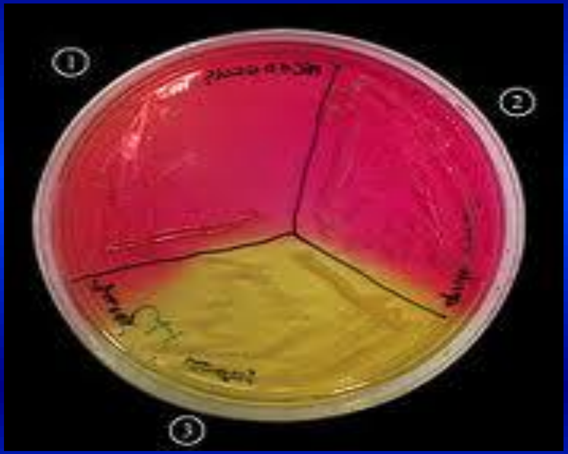
- BHI Agar
- Brain heart infusion
- Yeast extract
- Hemin
- Vit K
- Agar
- L- Cysteine



Selective and differential media

❖ Mannitol Salt Agar:

- used to identify *Staphylococcus aureus*



➢ Mannitol Salt Agar

- High salt conc. (7.5%) inhibits most bacteria
- Sugar mannitol
- Indicator (Turns Yellow when acidic)

Selective and differential media

A. *Staphylococcus aureus*

B. *Staphylococcus epidermidis*

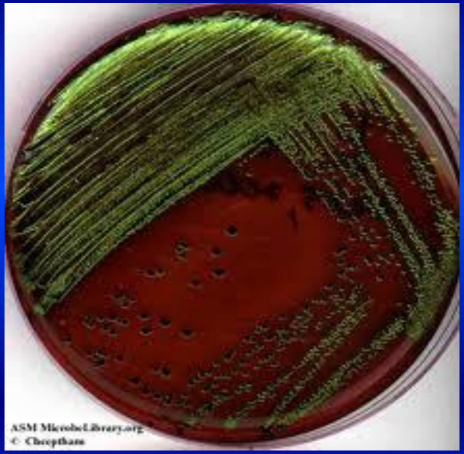
C. *Escherichia coli*

Source: Patricia shields and Anny Y Tsang, ASM microbe library

- Because *E. coli* is gram negative and cannot grow in high salt

Selective media

- Inhibits the growth of some bacteria



Example:

- EMB (Eosin Methylene Blue)
- dyes inhibit gram (+) bacteria
- Selects for gram (-) bacteria

Selective and differential media

- MacConkey's Agar: used to identify *Salmonella*

- MacConkey's Agar
  - Bile salts and crystal violet inhibits inhibits gram +ve bacteria
  - Lactose

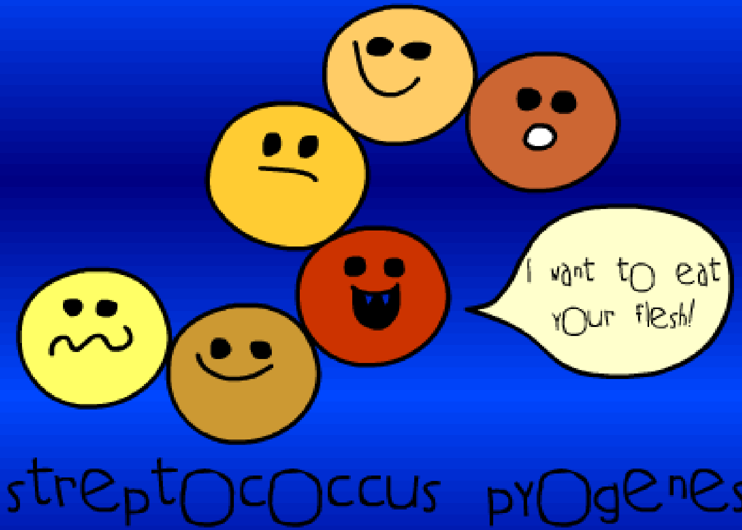
lactose fermenting colonies

non lactose fermenting colonies

Most of the gram (-) bacteria can ferment lactose but Salmonella cannot

Differential media

- Differentiate between different organisms growing on the same plate



Example:

- Blood Agar Plate (TSA with 5% sheep blood)
- To differentiate different types of *Streptococci*

Bacterial reproduction

Image source: www.DennisKunkel.com

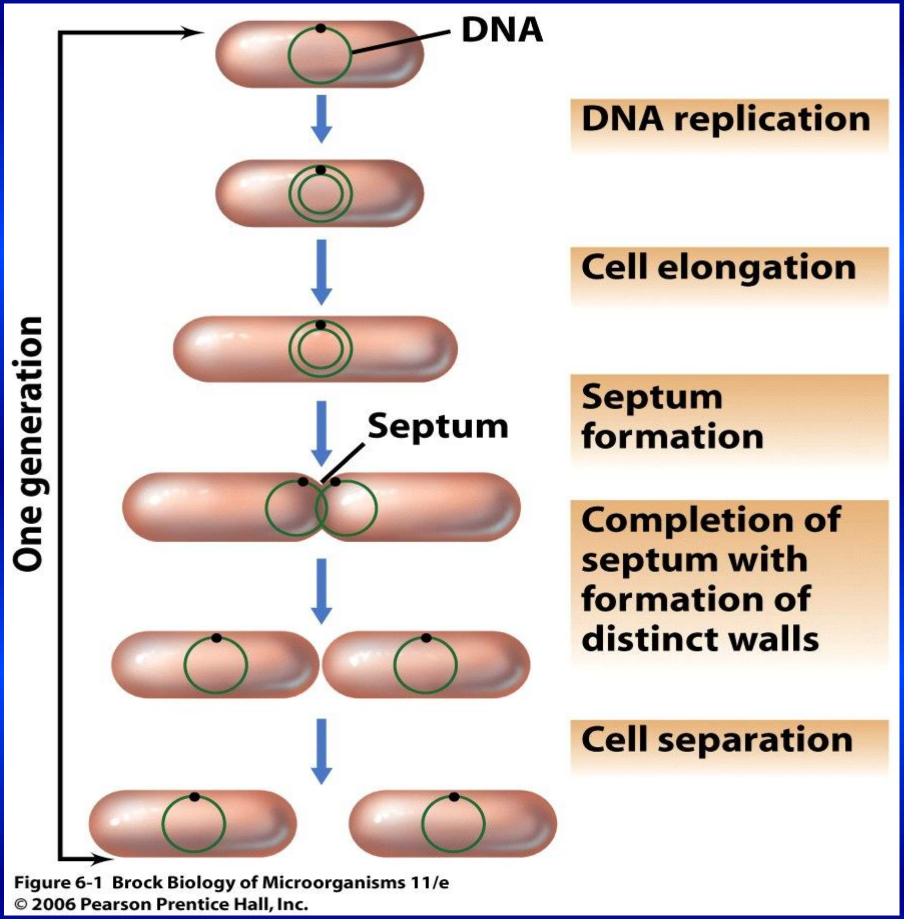
Generation time

Generation	Cell numbers
1	100
2	200
3	400
4	800
5	1, 600
6	32, 000
7	64, 000
………	…………

- Bacteria will grow and multiply by dividing into 2 in every 20 minutes

Cell division

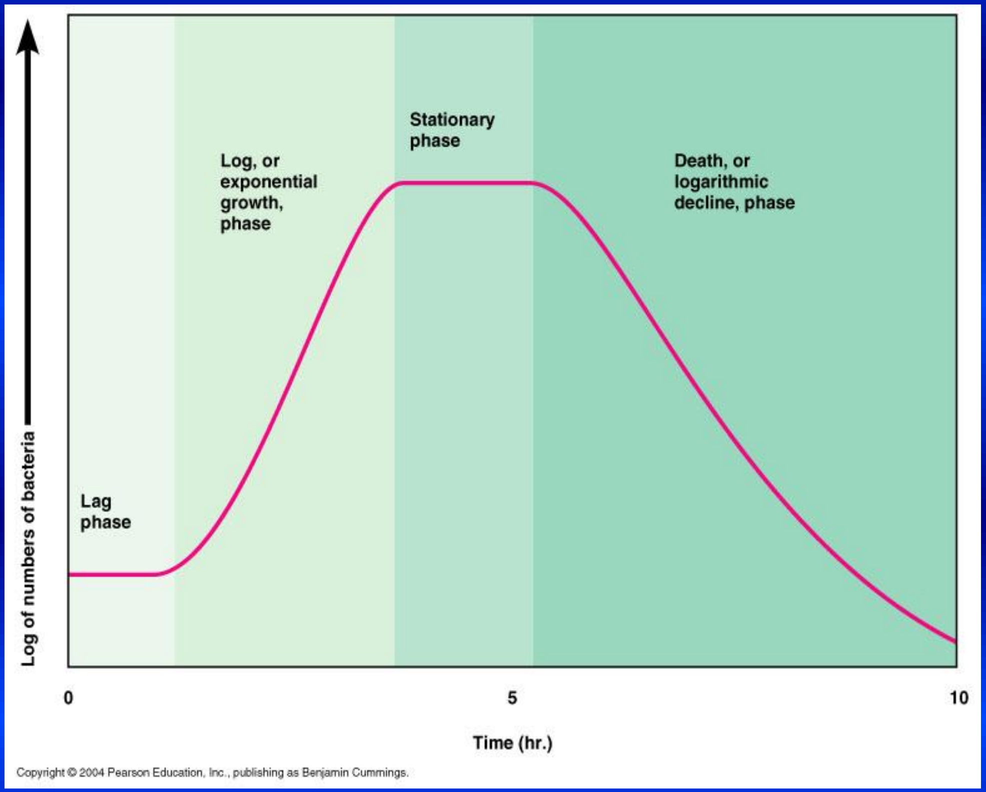
- Increase in number of bacterial cells
- Cells replication by binary fission
- For example: E. coli cell
  - Cell elongate
  - Partition formation
  - Two daughter cells



source: *Brock Biology of microorganisms*, 11th ed.

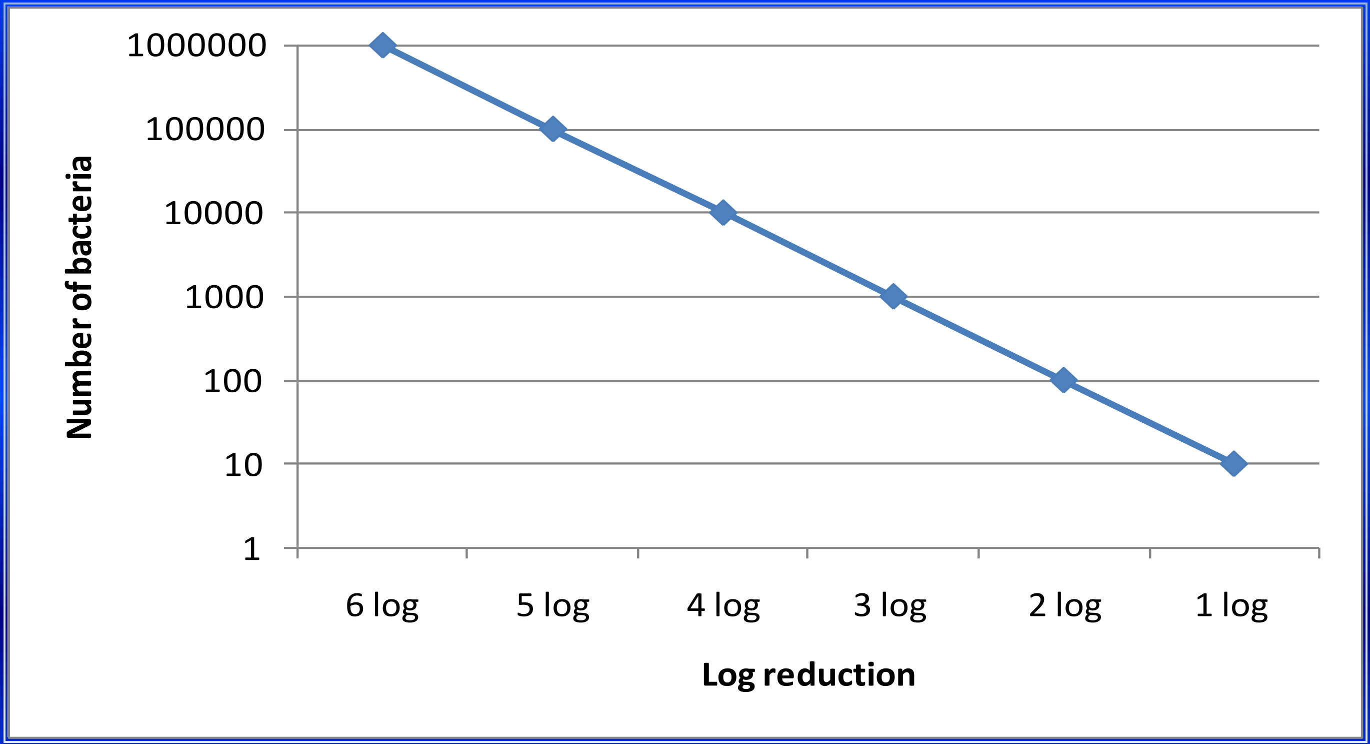
Bacterial growth curve

- Lag phase
- Exponential growth
- Stationary phase
- Death phase



Source: 2007 *Pearson Education*, inc.

Log concept



- 1 log reduction= 10 times smaller
- 2 log reduction= 100 times smaller
- 3 log reduction= 1000 times smaller
- 4 log reduction= 10,000 times smaller
- 5 log reduction= 100,000 times smaller
- 6 log reduction= 1,000, 000 times smaller

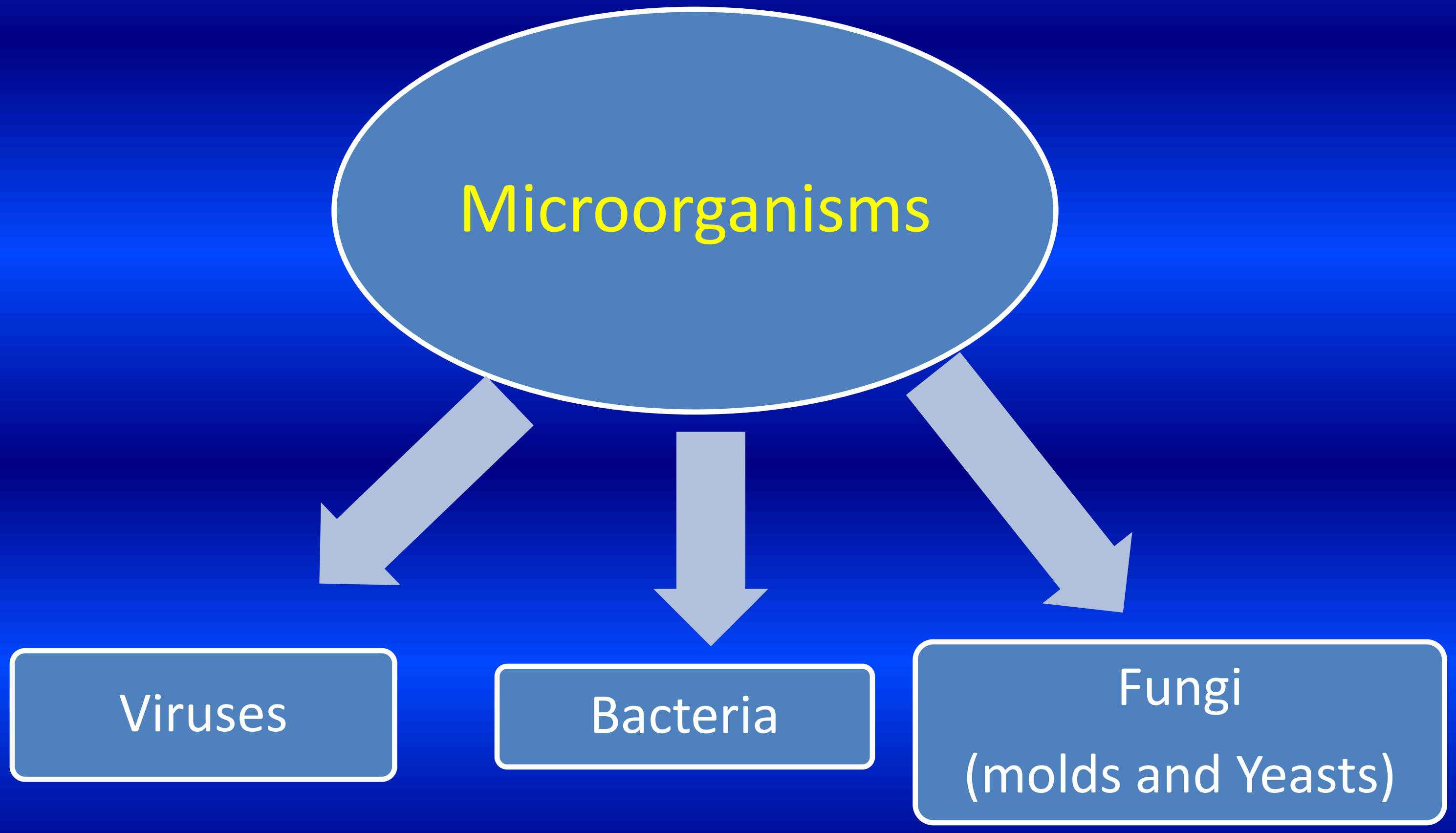
What bacteria need for growth?

- Food
- Moisture
- Warmth/temperature
- Time

Other factors affecting growth

- pH level
- oxygen
- competition

Germs



Beneficial microorganism

- Fermentation
  - Cheese, Beer, Wine, Bread, Yogurt
- Enzymes
- Human metabolism
- Decay
  - Decomposition, Waste treatment

Beneficial microorganism

- Helpful bacteria or fungi added or naturally present in foods
- Improve digestion and fight disease
- Important: family Lactobacillaceae
- Produce lactic acid, changes milk to yogurt

Beneficial microorganisms

- Probiotics are living microorganisms

- Commercially used Probiotic species.

***Lactobacillus* species**	***Bifidobacterim* species**	***Strptococcus* species**
L. acidophilus	*B. bifidum*	*S. thermophilus*
L. reuteri	*B. breve*	
L. rhamnosus	*B. lactis*	

Yeast

- Genus *Saccharomyces*
- Produce chemical reactions
- Produce alcohol and $CO2$ from sugar
- Leavening of bread and alcohol

Molds

- Genus *Penicillium*
- to ripen and flavor cheeses
- used in the synthesis of antibiotics and hormones

Harmful bacteria

- Pathogens (Food Safety)

  - Illness, diseases, and death

- Spoilage (Food Quality)

  - Short Shelf Life, Off Flavors, Poor Quality

Natural antimicrobial products

Onion

Mushroom

Dried lily flower

Xoconostle

Aloe Vera

Chives

Guava

Pomegranate

Bell peppers

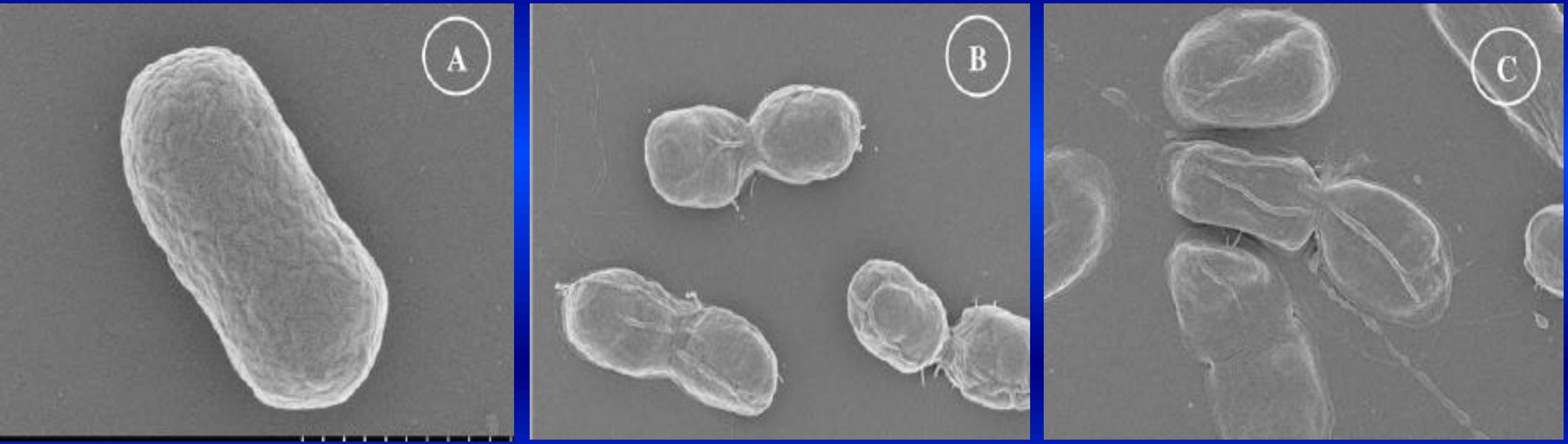
Why natural products?

- Antimicrobial, antifugal
- Sulfur containing compounds
- Phytochemcials
- Flavonoids
- Vitamins and polyphenols
- Antioxidant activity

Targets of antimicrobial compounds

- Cell membrane
- Enzymes and Proteins
- DNA & RNA

- A. untreated cells
- B/C. treated cells



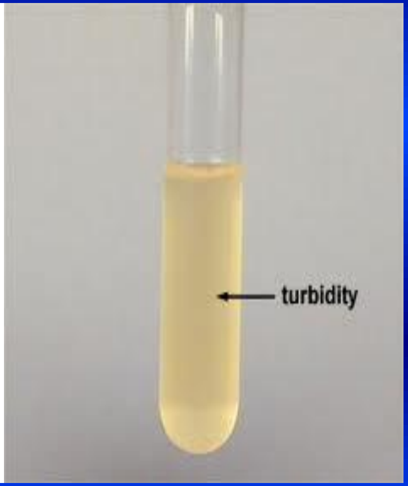
Source: Turgis et al. (2009). Antimicrobial activity of mustard essential oil against *Escherichia coli* O157:H7 and *Salmonella* typhi . *Food Control.*

Food sources and pathogens

Pathogens	Sources
E. Coli O157:H7	beef, poultry, apple cidar, raw milk, vegetables
Salmonella	poultry, meat, eggs, milk, vegetables, fruits, peanuts, shellfish
Listeria monocytogenes	cheese, ground meat, poultry, dairy products, seafood, vegetables
Campylobacter jejuni	poultry, milk, mushrooms, clams, water, cheese, pork, eggs
Clostridium	meat, beef, turkey, chicken gravies, beans, seafood
Staphylococcus aureus	workers, meat (sliced) poultry, fish, canned mushrooms, dairy products bakery items
Vibrio sp.	Oysters, other seafood.

Source: *CDC, Surveillance for foodborne disease outbreaks*

Effect of onion on *E. coli* O157:H7

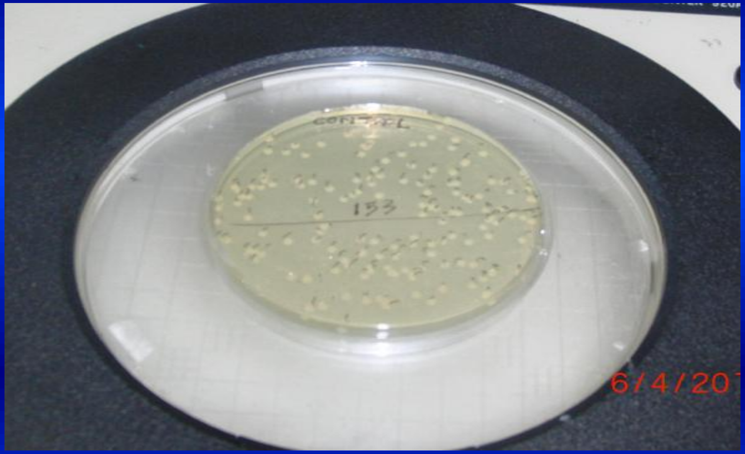


Enumeration of bacterial population

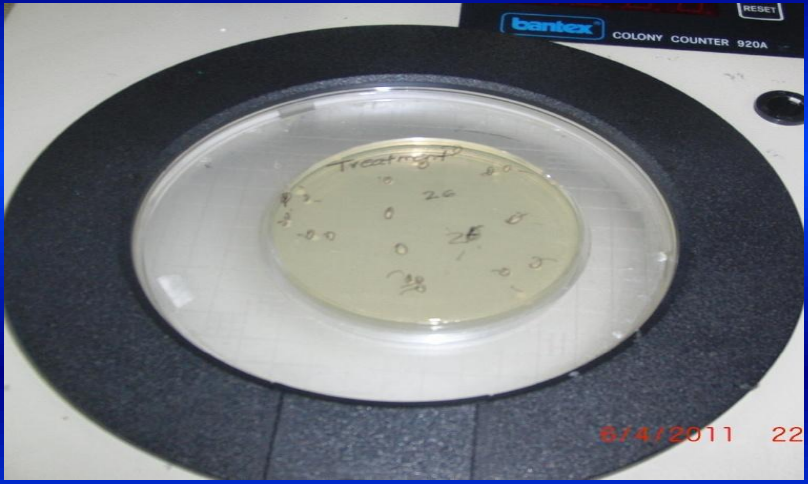
Turbidity reading

Incubation @ 37 ° C

# of bacteria without onion



# of bacteria with onion



Foodborne illness

- 76 million cases each year
- 350, 000 Hospitalizations
- 5000 deaths
- costs nation $ 152 billion annually
- Nearly $ 39 billion loss attributed to produce

Source: Centers for Disease Control and Prevention (CDC); U.S. Department of Agriculture (USDA)

Higher risk

- Infants
- Pregnant women
- Young children/older adults
- People with weak immune systems
- Individuals with certain chronic disease

Simple prevention measures

- Hand washing
- Drink pasteurized milk/juices
- Wash raw fruits and vegetables
- Cook beef/beef products, poultry and eggs thoroughly (internal 160 - 170 ° F)

Additional resources

- Centers for Disease Control and Prevention
- http://www.cdc.gov/foodsafety
- U.S. Department of Agriculture
- www.centerforfoodsafety.org
- www.foodhaccp.com
- www.foodsafety.gov

Thank You !

Five keys to safer food

Keep clean

- Wash your hands before handling food and often during food preparation
- Wash your hands after going to the toilet
- Wash and sanitize all surfaces and equipment used for food preparation
- Protect kitchen areas and food from insects, pests and other animals

Separate raw and cooked

- Separate raw meat, poultry and seafood from other foods
- Use separate equipment and utensils such as knives and cutting boards for handling raw foods
- Store food in containers to avoid contact between raw and prepared foods

Cook thoroughly

- Cook food thoroughly, especially meat, poultry, eggs and seafood
- Bring foods like soups and stews to boiling to make sure that they have reached 70°C. For meat and poultry, make sure that juices are clear, not pink. Ideally, use a thermometer
- Reheat cooked food thoroughly

Keep food at safe temperatures

- Do not leave cooked food at room temperature for more than 2 hours
- Refrigerate promptly all cooked and perishable food (preferably below 5°C)
- Keep cooked food piping hot (more than 60°C) prior to serving
- Do not store food too long even in the refrigerator
- Do not thaw frozen food at room temperature

Use safe water and raw materials

- Use safe water or treat it to make it safe
- Select fresh and wholesome foods
- Choose foods processed for safety, such as pasteurized milk
- Wash fruits and vegetables, especially if eaten raw
- Do not use food beyond its expiry date

There is a growing demand for food safety information at the international, national and local level. Working with WHO's network of regional and national offices and partner organizations, the Five Keys messages can be successfully disseminated all over the world. WHO encourages governments, industry and consumer organizations to disseminate this important food hygiene message.

To learn more about the Five Keys and
potential collaborations, contact:
Françoise Fontannaz
Department of Food Safety, Zoonoses and Foodborne Diseases
E.mail: fontannazf@who.int

World Health Organization
Avenue Appia 20 - 1211 Geneva 27 - Switzerland

Prevention of Foodborne Disease: The Five Keys to Safer Food

World Health Organization

Each day thousands of people die from preventable foodborne disease

Foodborne disease

- **Is a problem in both developing and developed countries**
- **Is a strain on health care systems**
- **Severely affects infants, young children, elderly and the sick**
- **Creates a vicious cycle of diarrhoea and malnutrition**
- **Hurts the national economy and development, and international trade**

Food can become contaminated with dangerous microorganisms at any point before consumption.

Following simple food hygiene steps can prevent most foodborne diseases.

Following the Five Keys not only prevents illness from eating contaminated food but also contributes to the prevention of diseases caused by handling infected animals, such as avian flu.

Knowledge is the key to health

WHO actively promotes the adaptation of global health messages to the local level. Educational projects are being implemented at the community level thanks to a contribution from the United Kingdom (DFID).

The Five Keys poster has been translated into more than 30 languages. WHO has also developed a Five Keys training manual with tips on how to adapt the training program for different target groups (food handlers, consumers, school children, women).

Proper food handling is key to foodborne disease prevention

WHO in action

WHO has developed a global food hygiene message with five key steps that promote health. The message explains safe food handling and preparation practices.

The poster is available in a variety of foreign languages in electronic format at: http://www.who.int/foodsafety/consumer/en

Saeed Hayek, MS.
Graduate research assistant
Energy and environmental Science, PhD program
Food Microbiology and Biotechnology Laboratory
North Carolina A & T State University
Greensboro, NC
336 334 7328 (O) 336-965-0632 (M)
safesaeed@yahoo.com

Saeed Hayek is a Doctoral student at the North Carolina Agricultural and Technical State University in the Department of Energy and Environmental Science, with focus in Environmental Food Science, and a graduate research assistant at the Food Microbiology and Biotechnology laboratory. He completed his Bachelor's degree in Nutrition and Food Science from the University of Jordan in 1995 and his Masters degree from the Northeastern Illinois University in 2004. His current research focuses on developing a laboratory medium for lactic acid bacteria using sweet potato as the basic component, under the direction of Dr. Salam Ibrahim. He is also participating in the Kannapolis Scholars Program to study the impact of gut microbiota on the cancer preventive effect of black tea polyphenols. In addition to that, his research interest also includes finding natural antimicrobial products to control *E. coli O157:H7* and *Salmonella* in food. He is keen on building more knowledge and skills through his active participation in professional meetings, conferences, workshops, and short courses.

Summary of the presentation:

Food Contamination

Food Contamination refers to the presence of harmful chemicals and microorganisms which can cause consumer illness. It can be caused by biological, physical, or chemical conditions and/or during harvesting, processing, distribution, and preparation. Food is also contaminated through soil, air, and waterborne microorganisms. Contamination can be reduced through effective sanitation, protected storage, proper disposal of garbage, and protection against toxins. This presentation helps in the identification of contamination sources and steps to prevent and control contamination in food.

Food Contamination

Saeed Hayek. MS.
Graduate research assistant
Food Microbiology and Biotechnology Laboratory
North Carolina A & T State University

Food contamination:

What?

Why?

Where?

How?

Eat Like a Peasant and Enjoy

What is food contamination?

Contamination: the presence of a condition in food that can be harmful to humans

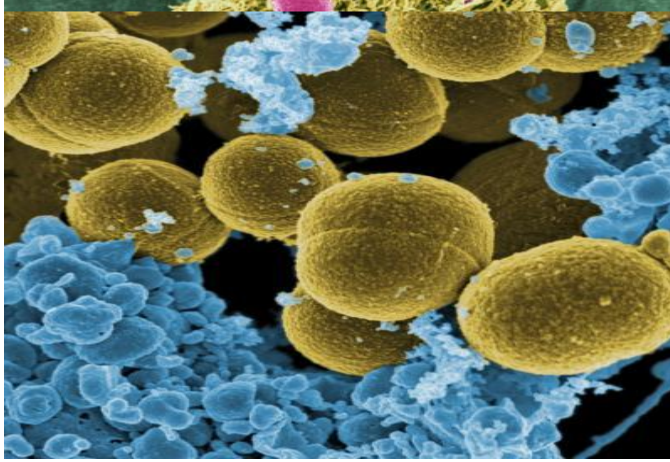
Harmful conditions:

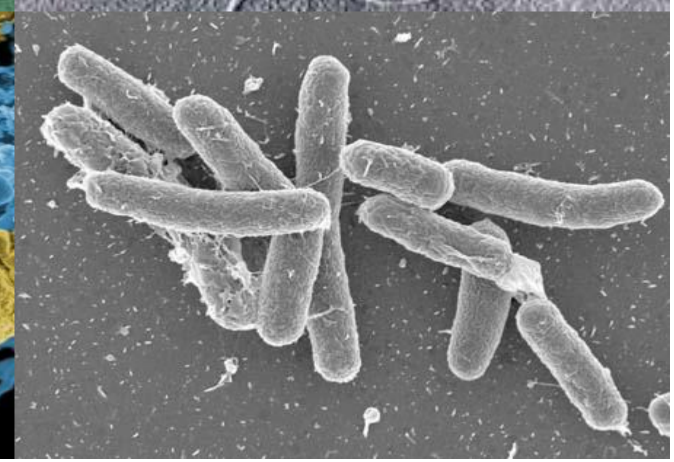
- ❑ **Biological** …. *Salmonella, E. coli*
- ❑ **Chemical** …. *Pesticides, Lead, mercury*
- ❑ **Physical** …. *Glass, Metal*

➢ ***Most important is biological***

E coli O157:H7

Listeria monocytogenes





Staphylococcus aureus

Salmonella enteritids

Why food contamination?

- Health
- Illnesses
- Deaths

✓ **Better Safe Than Sorry**

✓ **Eat Like a Peasant and Enjoy**

WARNING!!!!!!!!!!!!

Deaths and Illnesses Caused by Food Contamination

Foodborne illness causes an estimated
48 million illnesses
and **3,000** deaths each year in the United States by eating contaminated food. **(USDA report May 24, 2011)**

Symptoms food contamination:

✓flu-like symptoms

✓ nausea

✓vomiting

✓ diarrhea

✓fever

Within minutes to weeks

Why not reported?

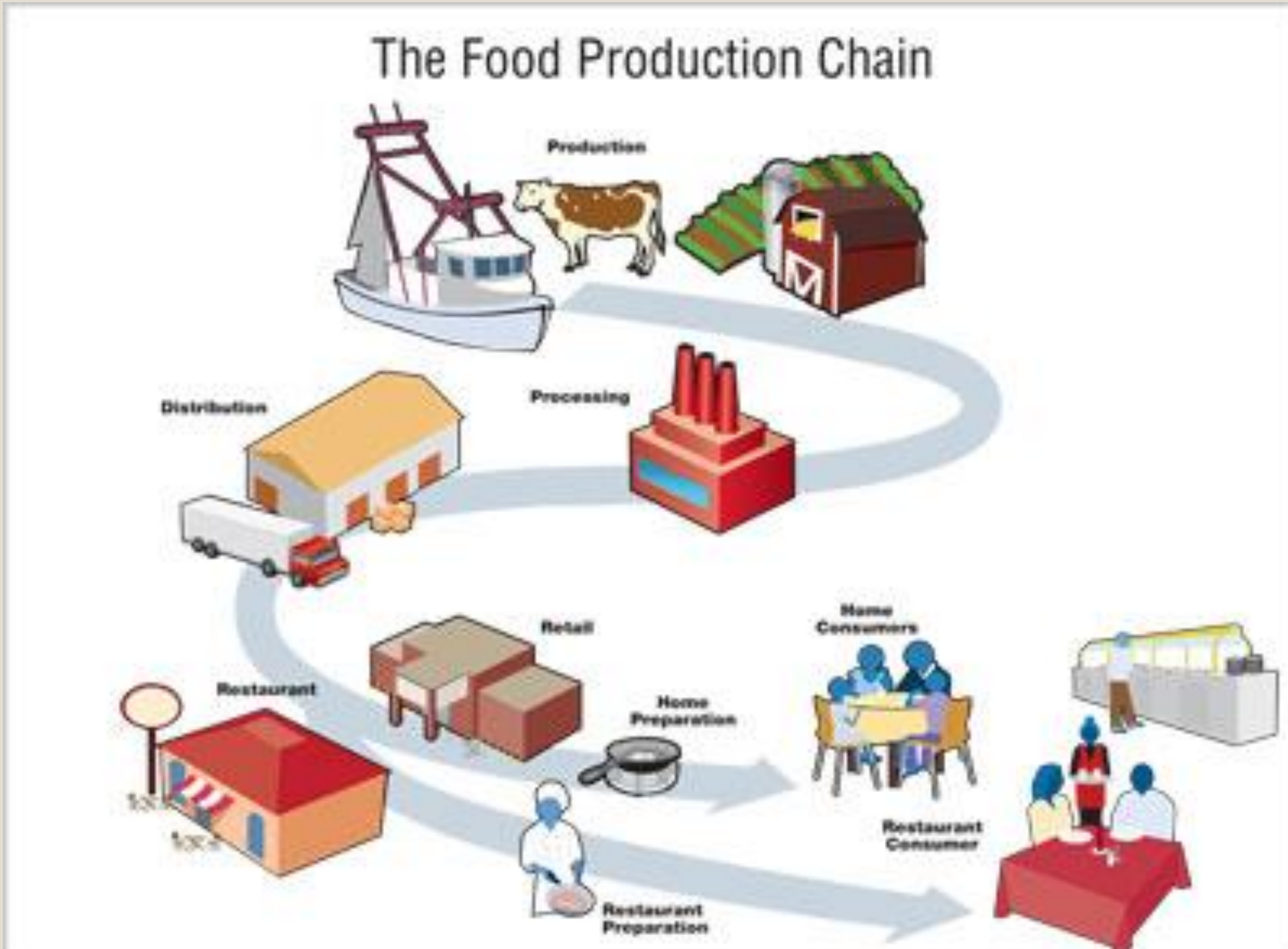
✓Symptoms are often flu-like

✓Many people may not recognize that the illness is caused by harmful bacteria or other pathogens in food

Where food contamination:

FARM TO TABLE

A CELEBRATION OF THE 100 MILE MENU


The Food Production Chain
Production
Distribution
Processing
Retail
Home Consumers
Restaurant
Home Preparation
Restaurant Consumer
Restaurant Preparation

Production:

- ✓ Growing plants
- ✓ Raising animals
- ✓ From the wild

➢ *Examples:*

- Infected hens
- Contaminated water
- Toxin in Fish

Processing

- ✓Simple processing: cleaning and sorting
- ✓Complicated processing: Slicing, shredding, pasteurization, or slaughtering

➢*Examples:*

- Contaminated water or ice
- Unclean storage
- During meat slaughtering, from intestines

Distribution:

- ✓Farm to processing plant
- ✓Processing plant to consumer
- ✓Food serving ex. Restaurant

➢*Examples:*

- Refrigerated food left for long time in warm weather
- Unclean truck
- Glass jar breaking in transport

Preparation:

✓Most contamination

✓In kitchen of restaurant or home

Examples:

- Not washing hands
- Same knife for chicken & salad
- Meat juices to other items

Mishandling at Multiple Points:

✓ Further mishandling of food, can lead to outbreaks

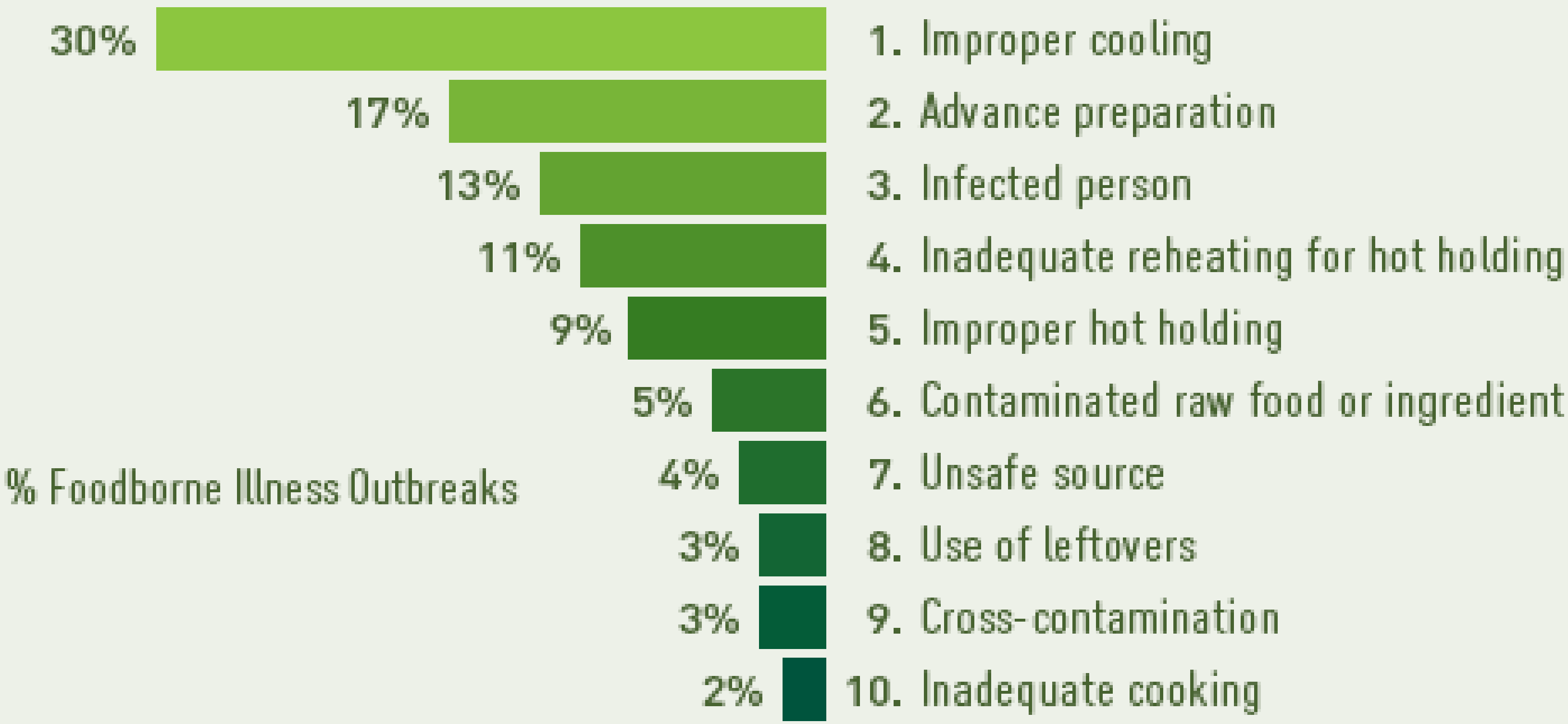
✓ Many pathogens grow quickly in food held at room temperature

Solution!!!!

Reheating or boiling food

TOP TEN IMPROPER FOOD HANDLING PRACTICES THAT CAUSE FOODBORNE ILLNESS

The Top Ten chart illustrates the improper food handling practices that cause over 95% of all foodborne illness outbreaks in foodservice establishments.

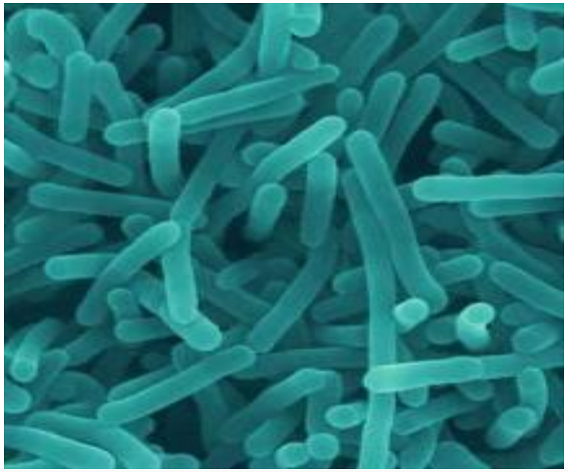


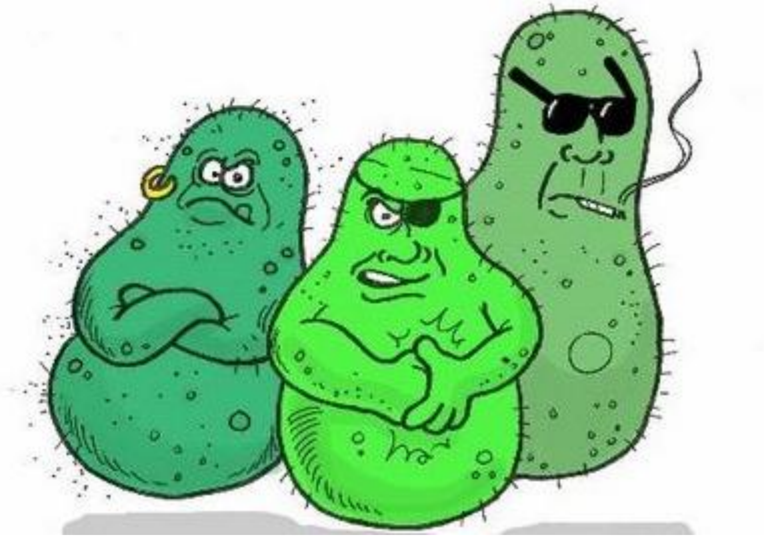
SOURCE: WILCOTT, LYNN (2001) BC RESTAURANT NEWS, VANCOUVER, BC

How?

Direct and indirect food-contact

- ❑Personnel: primary contamination source
- ❑Contaminated Food products may cause ***foodborne illness*** through infections or intoxications





Transfer of contamination:

Three links:

1. *Agent;* Transmission of agent to the environment of food
2. *Source;* A source for each agent
3. *Mode;* Transmission of agent from source to food
4. *Host:* Growth support (food or host)

Required conditions:

1) Nutrients
2) Moisture
3) pH (acidity)
4) Oxidation-reduction potential
5) Lack of competitive microorganisms
6) Lack of inhibitors

Who is the source?

- *Healthy individual*
- *Healthy animals*
- *Clean hands*
- *Clean equipments*
- *Chicken*
- *Meat and fish*

Every thing around us can be a source of contamination


SOURCES OF FOOD CONTAMINATION
RAW MATERIALS / INGREDIENTS
FOOD HANDLERS / MAN
WATER
FOOD
PACKAGING MATERIAL
AIR / DUST
ANIMALS & BIRDS
SOIL
GARBAGE & SEWAGE
RODENTS
INSECTS

In food establishment:

Zonal approach (advanced by Kraft Foods):

Direct to food

Zone 1

Indirect to food

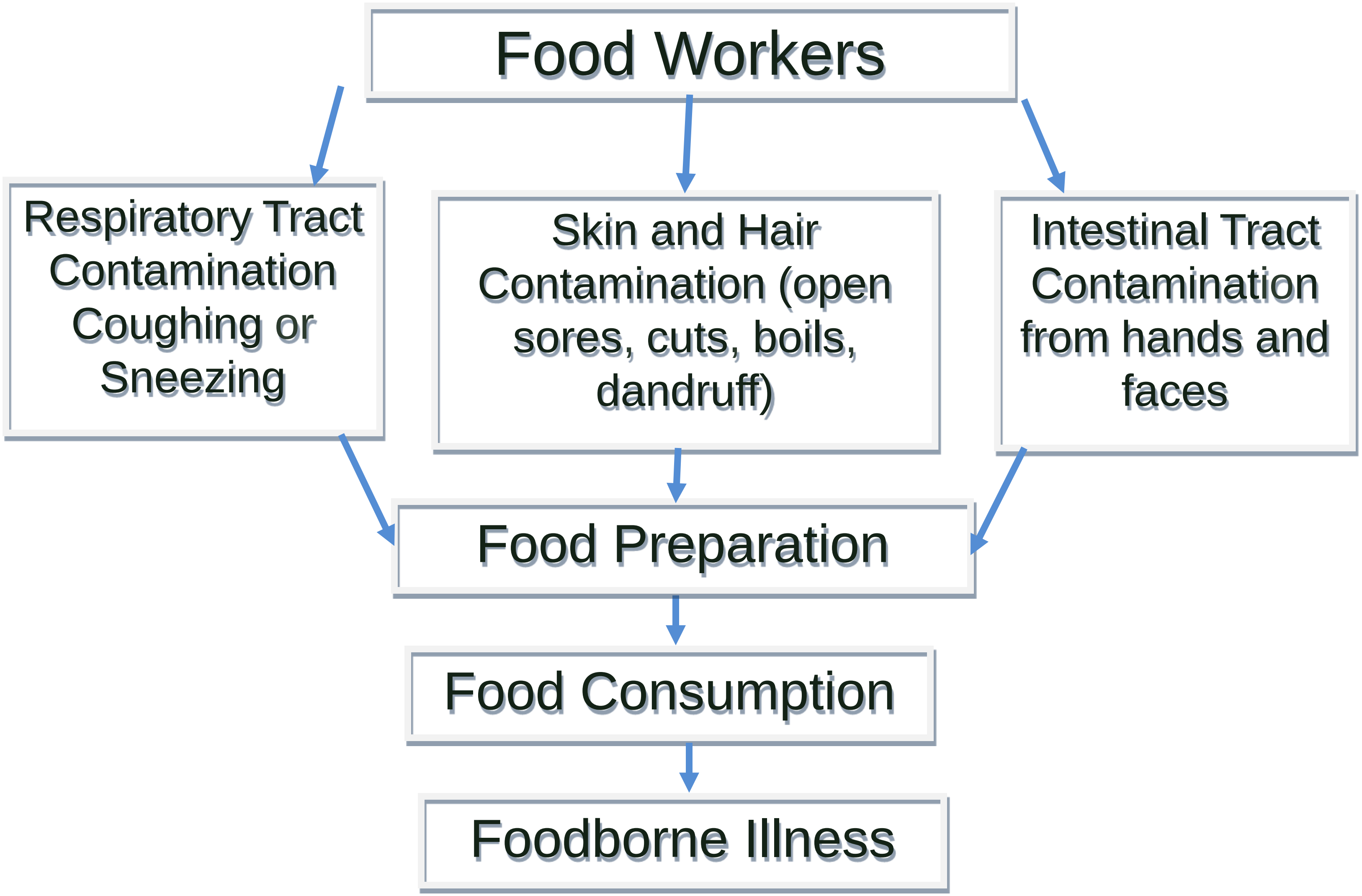
Zone 2

Zone 3

Zone 4

Hallway &
entrances

Potential contamination of food by humans:



Food products as a source of contamination:

Dairy Products:

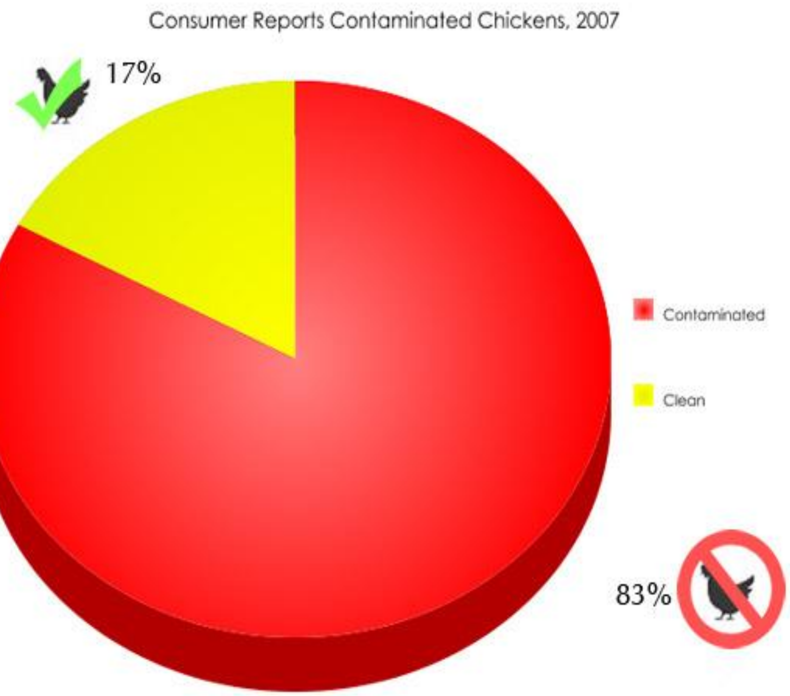
(*Listeria monocytogenes*)

Red Meat Products :

Slaughtering

Cutting, processing, storage, and distribution

Poultry Products:
Defeathering and evisceration
Salmonella and Campylobacter

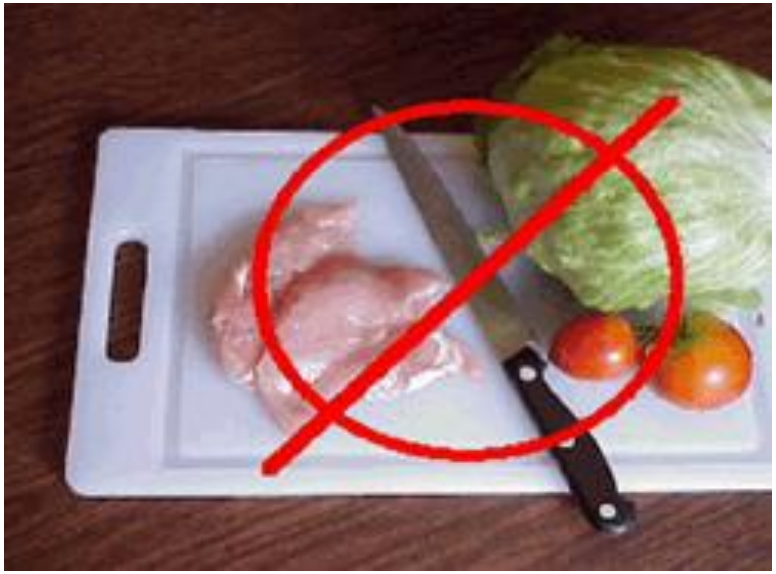


Seafood Products:

Harvesting, processing, distribution, and marketing

Adjuncts: Ingredients

Cross contamination:



Other contamination sources

Equipment

Improved hygienic design and more effective cleaning.

Employees

The largest contamination source

Microorganisms: hands, hair, nose, mouth

Transferred: processing, packaging, serving, touching, breathing, coughing, or sneezing

Air and Water

Water: Cleaning and ingredients

Sewage

Faulty plumbing

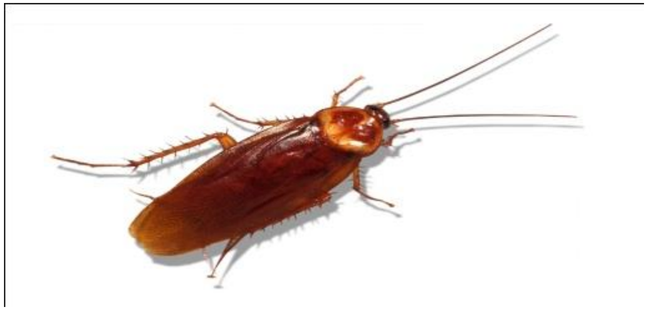
All bodies of water free of raw sewage

Not applied to fruit and vegetable fields

Insects and Rodents

Flies and cockroaches transmit disease by their waste, mouth, and feet

Rats and mice: feet, fur, and intestinal tract



Protection against contamination

The Environment

Ready to eat food should:

- Not be touched by human hands unless washed & handled with gloves
- Covered with a close-fitting cover or placed in closed cabinet
- Stored and/or held at appropriate temperature

Storage

•Controlled and protected against dust, insects, and rodents

• Organized with appropriate stock rotation

•Floors, walls, & shelves cleaned by appropriate cleaning compounds

Litter and Garbage

- Clean and seamless, with close-fitting lids, receptacles in work areas to accommodate food waste
- Receptacles to be washed and disinfected regularly, usually daily

Toxic Substances

•Poisons and chemicals should not be stored near foods

•Cleaning compounds should be clearly labeled

Hygiene to the human body:

Skin: staphylococci

Fingers: hand-dip sanitizer

Fingernails: under fingernails, jewelry

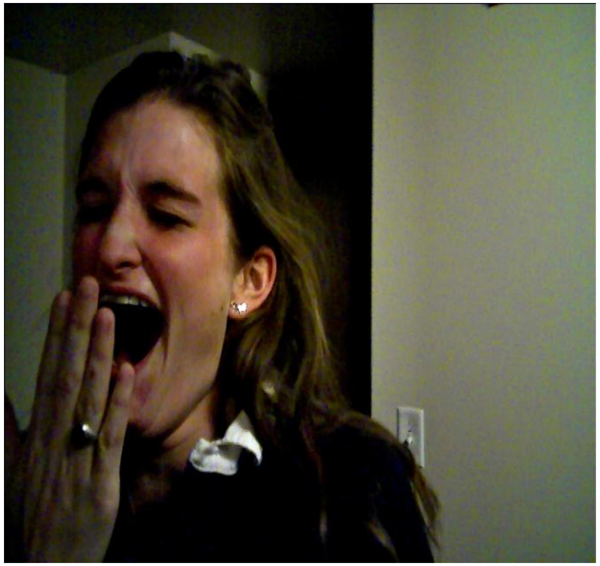
Hair: staphylococci

Eyes:

rubbing the eyes; contaminate hands

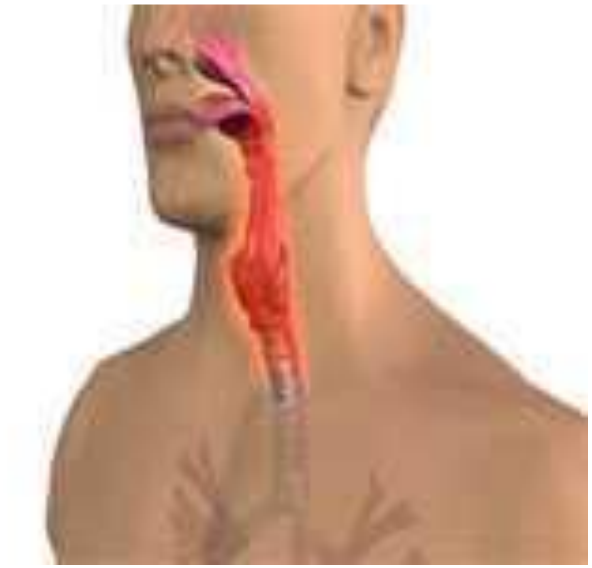
Mouth:

Sneezing transfers bacteria to the air and may land on food



Excretory Organs:
Particles of feces collect on hairs in anal region and spread to clothing

Nose
Nasopharynx
Respiratory Tract



Hand Washing

- The first line of defense against disease
- 38% food contamination from improper hand washing
- Supervisors and managers should practice appropriate hand washing

Why hand washing?

- Hand washing efficacy against resident flora ranges from 35 to 60%
- Alcohol-based instant hand sanitizers used after hand washing


SAFE HAND WASHING
HAZARDS:
Cross-contamination from human body bacterial pools, dirty containers, utensils, packages, and raw food.
1. Wet Hands and Brush
2. Soap Brush
3. Brush & Lather
4. Rinse
5. Soap Hands
6. Lather
7. Rinse
8. Towel Dry

In case of contamination:

- Preserve the evidence
- Seek treatment as necessary
- Call the local health department
- Call the USDA Meat and Poultry Hotline at 1-888-MPHotline (1-888-674-6854) if the suspect food is a USDA-inspected product and you have all the packaging

SUMMARY

- Major contamination sources are water, air, dust, equipment, sewage, insects, rodents, and employees
- Contamination of raw materials can also occur from soil, sewage, live animals, external surface, and the internal organs of meat animals
- Contamination from chemical sources can occur through accidental mixing of chemicals with foods

SUMMARY

- Ingredients can contribute to additional microbial or chemical contamination
- Contamination can be reduced through effective sanitation, protected storage, proper disposal of garbage, and protection against toxins
- Food handlers are potential sources of microorganisms that cause illness and food spoilage
- Personal hygiene is the cleanliness of a person's body

REFERENCES

- United States Department of Agriculture, http://www.ers.usda.gov/publications
- Norman G. Marriott and Robert B. Gravani. Principles of food sanitation. Fifth edition, 2010.
- Centers for Disease Control and Prevention, http://www.cdc.gov/outbreaknet/investigations
- Chao, T.S. 2003. Workers' personal hygiene. In *Food plant sanitation*, eds. Y.H. Hui, et al. New York: Marcel Dekker. Inc.
- Charles l. Wilson. Microbial Food Contamination. Second Edition, 2007 by Taylor & Francis Group, LLC.

Thank you

Eat safe

Questions

Madhavi Hathurusinghe, MS.
Graduate Research Assistant
Energy and Environmental Science, PhD program
Food Microbiology and Biotechnology Laboratory
North Carolina A & T State University
Greensboro, NC
Email: madhavih2006@yahoo.com

Madhavi Hathurusinghe is a doctoral student at the North Carolina Agricultural and Technical State University in the Department of Energy and Environmental Systems and also a graduate research assistant at the Food Microbiology and Biotechnology laboratory. She received her Bachelor's degree in Veterinary Science from University of Peradeniya, Sri Lanka in 2000 and completed her Masters degree in food safety in 2004 from the same university. In 2005, she joined the University of Peradeniya as a faculty member and was involved in teaching and research on the chemical residues in food. She was also involved in projects conducted by the International Atomic Energy Agency (IAEA) on chemical residues in food of animal origin with the collaboration of several European Laboratories. In 2007, she participated in a fellowship training program awarded by IAEA, to join the research conducted at Agrifood Bio-Sciences Institute, Belfast, United Kingdom. She started her doctoral studies in 2009 and her current research focuses on detecting whether lactic acid bacteria could be used as a biomarker for early detection of toxins in milk, under the direction of Dr. Salam A. Ibrahim. She has presented her findings in numerous conferences and meetings nationwide. She believes that the knowledge and skills she has gained along with the findings of her research, have motivated her to develop methods to detect and prevent harmful chemicals in food and thereby ensure consumer safety.

Summary of the presentation:

Chemical Contaminants in Food

Chemical contamination of food is a worldwide public health concern. Chemicals can enter into food at the farm, from the environment, during processing, transportation, storage or during cooking at home. The contamination of food can occur from air pollution, water, soil, pesticides, fertilizers, drugs used in food producing animals and food additives that are added during production. The chemical contamination of food can be prevented at farm level, by regulatory activities of the government authorities, and laboratory analysis with surveillance. This presentation focuses on educating consumers about the chemical safety of their food by sensible food practices during selecting, preparing, cooking and storage of food.

Chemical Contaminants in Food

Madhavi Hathurusinghe
North Carolina A & T State University
25th July 2011
Training Program for High School Teachers

Contents

Introduction

Chemical contaminants in food:

• Worldwide public health concern

• Leading cause of trade problems internationally

• Contamination may occur through air pollution, water and soil

Where do the chemicals in our food come from?

Pesticides & fertilizers

Livestock (Treatment / Prevent diseases)

Processing & preparation

Pesticides and fertilizers

Pesticides are used to protect food from pests such as insects, rodents, weeds, and mold

- Insecticides – To control insects
- Rodenticides – To control rodents
- Herbicides - To control weeds
- Fungicides – To control mold and fungi

Pesticides and fertilizers contd.

- Although there are benefits of pesticide use, there are draw backs, such as potential toxicity to humans
- One or more pesticides on 70.3 percent of samples tested (USDA)
- Centers for Disease Control and prevention has detected pesticides in blood and urine of 95.6% of more than 5000 Americans (CDC 2009)

Pesticides and fertilizers contd.

Benefits:

1. Control pests and plant disease vectors

2. Control of human/livestock disease vectors

3. Farm and agri-business revenues

Health risks of pesticides and fertilizers

- Birth defects
- Nerve damage
- Cancer
- Unique health risks to children

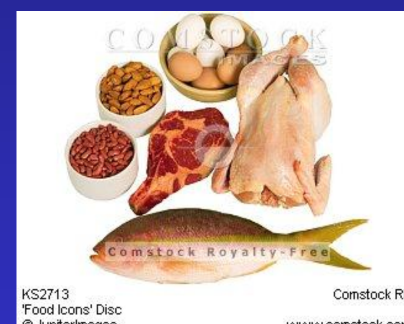
These effects depend on how toxic the pesticide is and how much of it is consumed..

How does antibiotics/hormone residues enter into the food chain?

Antibiotics/Hormones

Treatment / growth promotion

Food of animal origin



Trade

Implications

Allergies

Toxic effects

Carcinogenicity

mutagenicity

Antibiotic resistance

Chemicals used in production/processing of food

Food additives:

Any substance that become part of a food product

Intentional additives: To improve the quality of food product

Unintentional additives:

Insecticides, fungicides

herbicides

plant growth regulators

hormones

Chemicals used in production/processing of food contd.

Intentional additives:

Food industry uses about 3000 food additives

- Preservatives
  prevent growth of
  spoilage organisms

- Emulsifiers/Stabilizers
  prevent mixed food
  from separation

Chemicals used in production/processing of food contd.

Intentional additives:

- Antioxidants

  Prevent fat and oils from spoiling

- Colors

  Improve color of processed food
- Sweeteners/Flavor enhancers

  Bring out the taste of food
- Enrichment – restore lost nutrients to food
- Fortification – Increase nutritional value of food

Chemicals used in production/processing of food contd.

- Chemical cleaners, food sprays and fungicides
  used during shipping and storage

- Chemicals absorbed into our food from the way we cook
  Non stick pans, pots, bake-ware contains Teflon, which is made from perflurinated compounds
  (linked to cancer and reproductive problems)

Chemicals used in production/processing of food contd.

- Plastic containers, food wrappers
  Chemicals can be leached in to the food from the plastic containers and wrappers

BPA:

- Estrogenic compound- Interfere with body hormones
- More suscepptible groups are infants and pregnant women
- Linked with early puberty, cancer risk, nerve diseases

- In EU and Canada, BPA is banned in infant feeding bottles

Chemicals used in production/processing of food contd.

Understanding Plastic Recycling Codes

A handy guide to safe plastic use

Code	Name	Common Use	Recycle Rate	Recommendation
1	**PET** Polyethylene Terephthalate	Plastic bottles (soft drink, single-use water bottles, sport drinks), food jars, cosmetic containers.	23%	Be careful with producs labeled No. 1. Designed for single use only. Extended use increases risk of leaching and bacterial growth.
2	**HDPE** High density polyethylene	Grocery Bags, detergent bottles, milk and juice jugs.	27%	Appears to be Safe
3	**PVC** Polyvinyl chloride	Garden hose, cable sheathing, window frames, blister packs, blood bags, meat wrap.	< 1%	Avoid Nicknamed the Poison Plastic, contains many dangerous toxins.
4	**LDPE** Low density Polyethylene	Heavy duty bags, drycleaning bags, bread bags, squeezable bottles, plastic food wrap.	< 1%	Appears to be Safe
5	**PP** Polypropylene	Medicine bottles, cereal liners, packing tape, straws, potato chip bags.	3 %	Appears to be Safe
6	**PS** Polystyrene	CD and video cases, plastic cutlery, foam packaging, egg cartons.	< 1%	Avoid May leach styrene, a possible human carcinogen. May be a hormone disruptor.
7	**Other** **PC** Polycarbonate	Baby bottles, water cooler bottles, car parts	< 1%	Caution Concern with leaching of Bisphenol A which appears to cause chromosonal damage.

Useful Tips:

- Store food and water in glass or stainless steel containers whenever possible
- Minimize or eliminate exposure to plastics with code 1, 3, 6, or 7
- Do not use products (especially Baby Bottles) identified with No. 7

www.PlasticFreeBottles.com
Your source for alternatives to plastic bottles

Food additives contd.

Benefits

- Reduce food spoilage
- Maintain nutrient quality
- Prolong shelf life
- Reduce occurrence of disease
- Enhance flavor

Risks

- Cancer
- Birth defects
- Allergies
- Oil soluble in body fat

Chemical Contaminants in Food contd.

- Specific chemical issues:

Bisphenol A (BPA) → Widely used in plastics

Melamine →
- Infant formula in China (51900 infants & young children hospitalized)
- Pet feed in USA

Acrylamide →
- Used in treating drinking water to remove particles

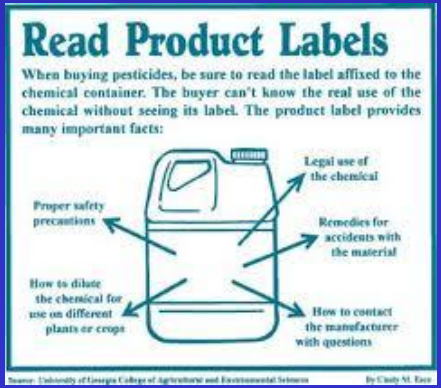
PCB and Dioxin →
- Industrial waste
  Found in salmon & milk

Prevention of chemical residues in food

- At farm level
- By regulatory activities
- By laboratory analysis with surveillance
- Educating the public and younger generation

At farm level

-Use antibiotics only when
 it is essential for treatment
- Not use antibiotics as feed additives
- Improve bio-security at all farms
- Good management practices
- Educate farmers
- Use chemicals according to
  manufacturers directions



At farm level

-Use natural methods to
prevent pests.

ie; Integrated pest management (IPM):

- Mechanical trapping devices
- natural predators (insects that eat other insects)
- Insect growth regulators

Regulatory Activities

- Standards for USA
  e.g. Acts and Regulations

- U.S. Department of Agriculture (USDA)
- U.S. Food and Drug Administration (FDA)
- U.S. Environmental Protection Agency (EPA)

- Standards for international trade
  e.g. EU directives

Laboratory analysis

- **Testing samples and surveillance**

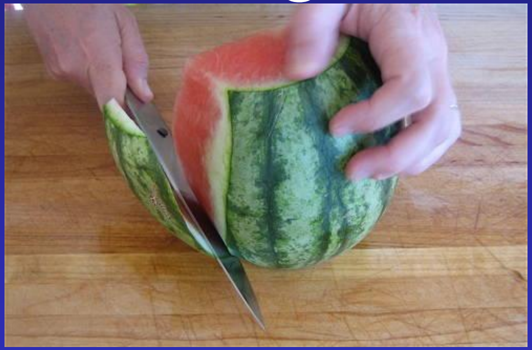
Educating the public and younger generation

How to minimize exposure to pesticides

Sensible food practices:

Washing

Peeling and trimming



Selecting a variety of foods

- Organically grown food

How to minimize exposure to chemicals from plastics

Sensible food practices:

- When possible it is best to avoid #7 plastics especially for children’s food
- Plastics with the #1, #2 and #4 on the bottom are safer and not contain BPA

- Find glass versions of baby bottles
- Avoid use of plastic containers to heat food in microwaves. Ceramic, glass, and other microwaveable dishware are good alternatives

Summary

- Chemicals enter the food chain through water, soil , air, during processing or treating farm animals
- Chemicals in food can cause health risks to human consumers, due to careless food practices and improper usage of chemicals in food industry
- These effects depend on how toxic the chemical is and how much of it is consumed and how long a person exposed to it

Summary

- We can prevent unnecessary contamination of food through sensible food practices

Remember

Food Safety is in our hands

Useful websites:

- http://www.who.int/foodsafety/chem/en/
- http://www.epa.gov/opp00001/food/
- http://www.epa.gov/opp00001/food/govt.htm
- http://www.epa.gov/opp00001/factsheets/securty.htm
- http://www.fsis.usda.gov/Science/Chemistry/index.asp
- http://www.fda.gov/food/foodsafety/foodcontaminantsadulteration/default.htm

Tasks

Task 1.

•Collect food labels and identify the additives. List the methods to minimize contamination of food from them.

Task 2.

•Collect plastic food containers and bottles. Identify the chemicals used in them and list the usage of each of them. Discuss sensible food practices to use them wisely to prevent chemicals in food.

NPTN fact sheets are designed to answer questions that are commonly asked by the general public about pesticides that are regulated by the U.S. Environmental Protection Agency (US EPA). This document is intended to be educational in nature and helpful to consumers for making decisions about pesticide use.

National
Pesticide
Telecommunications
Network

Pesticides in Drinking Water

What is a pesticide?

- A pesticide is a chemical that is used to control a pest. A pest can be an insect, weed, bacteria, fungus, rodent, fish or any other troublesome organism.
- Pesticide manufacturers develop most pesticides, although some occur naturally in the environment.
- Pesticides control one or more specific pests around homes, in agricultural areas and on public land.

Where does our drinking water come from?

- Drinking water comes from two main sources: surface water and ground water. See **Surface water and ground water** box. In urban areas, water from these sources is frequently pumped to water treatment plants and then to buildings.
- Drinking water in rural or agricultural areas often comes from individual wells drilled into aquifers. The water from these wells is usually not treated.
- Human activity depletes drinking water sources, which must be restored by rain and snow. See **Recharge** box.

Surface water and ground water. Lakes and rivers are bodies of fresh surface water that provide drinking water in certain areas of the country. Reservoirs are constructed (artificial) lakes that also hold water. Ground water is another source of fresh water. Aquifers are underground areas that can be tapped to provide fresh water. Water slowly flows through an aquifer like an underground river.

How can pesticides get into drinking water?

- Pesticides that are applied correctly may wash away from the application site. Rain falling on a treated area before the pesticide binds or degrades may carry the pesticide to surface water sources.
- Pesticides can seep into and through the soil during recharge of groundwater and get into aquifers.
- Pesticides are sometimes applied directly to lakes or wetlands for control of aquatic weeds, insects, or fish. However, these products are labeled to avoid use near drinking water systems.
- Some pesticides can move in air from the application site to surface waters used in a drinking water system.

Recharge. In a properly functioning drinking water system, natural sources replace the water removed by human activity. Rain and snow recharge most drinking water systems, but they sometimes fall far away from the drinking water collection site. For example, snow in the mountains can melt and run downstream to a valley reservoir. Rainwater also may travel large distances underground to get to a drinking water system.

- When a pesticide is spilled, dumped, or misused, the chance of it reaching drinking water is greater than with labeled uses.
- Pesticides can get into drinking water when homeowners illegally dump unused pesticides down the drain. For instructions on proper disposal of pesticides contact your County Cooperative Extension Office or State Environmental Department.
- In water treatment plants, disinfectant pesticides are intentionally put in drinking water to help protect humans from disease-causing organisms such as bacteria and viruses. See **Antimicrobials** box.

Antimicrobials. The Safe Drinking Water Act requires that public water supplies be disinfected. Antimicrobial pesticides are added during the process of drinking water treatment to prevent waterborne disease. Chlorine is the most common and cost effective antimicrobial used. However, this process can produce chemical by-products, some of which may have toxic effects. The EPA is responsible for setting drinking water treatment standards to ensure that human health is protected. They must balance the risks from microbial contaminants against risks from disinfectants and disinfection by-products.

Which pesticides are commonly found in drinking water?

- Pesticides used in the recharge zone might be found in drinking water. For example, drinking water in an agricultural area may contain pesticides that were sprayed on agricultural crops.
- Pesticides with certain chemical characteristics, such as high water solubility, are more likely to be found in drinking water.
- If pesticides are spilled or misused near a well, they can get into drinking water.
- Certain antimicrobial pesticides are common in drinking water that has come from a public source (municipal water).

How do I know if pesticides are in my drinking water?

- Officials regularly test the public water supplies (municipal water) for certain pesticides. Information on these tests is available from your local water company.
- If you get water from a well, you can contact your County Health Department or State Environmental Department to inquire if pesticides have been found in wells in your area.
- The only way to know if a pesticide is present in your drinking water is to have your water tested. Unfortunately, testing can be costly.

Can pesticides in drinking water cause health effects ?

- Pesticides found in drinking water may be harmful to your health. The toxicity of pesticides and the amount detected determine if any health effects are likely. See **Dose Response** box.
- Individual pesticides have different effects on humans. Variation exists in the toxicity of pesticides and the sensitivity of people to chemicals. In large amounts, some pesticides can cause long-term health effects, such as cancer or organ damage, in laboratory animals. Some pesticides at high doses can cause reproductive effects in laboratory animals.
- Most pesticides will have toxic effects on animals at high levels. Some pesticides are toxic at medium or low levels. Pesticides in drinking water are usually found at very low levels.

Dose-response. Pesticides can affect human health and the environment depending on how much chemical is present, the length and frequency of exposure, and the toxicity of the pesticide. Effects also depend on the health of a person and the condition of the environment when exposure occurs. Laboratories can detect extremely low levels of pesticides in drinking water that are unlikely to be harmful to humans.

- For many pesticides, scientists have determined levels that are not likely to pose health risks. See **Maximum Contaminant Level** box.
- When pesticides in drinking water are above acceptable levels, you should take measures to avoid drinking it.

Maximum Contaminant Level (MCL). The United States Environmental Protection Agency (EPA) has set specific maximum levels of certain pesticides that are allowed in drinking water. These levels are based on scientific data from long term animal studies and have an additional safety factor built in. By drinking water that contains pesticide at or less than the MCL, humans are not expected to be at a higher risk for health problems. The EPA has also established health advisory levels (HA's) for many pesticides. HA's are non-enforceable guideline levels for contaminants that are in place until it is determined that there is a need to establish an MCL.

What do I do if pesticides are found in my drinking water?

- If a pesticide is found in your drinking water above acceptable levels, you should report this to your State Department of Agriculture. If you are having health effects you suspect are linked to pesticide exposure, consult a physician or contact the **National Pesticide Telecommunications Network (NPTN)**.
- Drinking water contaminated with pesticides can be treated by a local water treatment facility to remove most of the pesticides. Activated carbon or reverse osmosis filters can be effective at removing pesticides from water. Consult your EPA Regional Office for the most effective treatment method for the pesticide(s) of concern.
- Contaminated wells can sometimes be dug deeper to avoid pesticides. *Note: This may not always solve the problem. Consult a professional engineer.*
- Using bottled water can be an alternative if your water is contaminated until you can take measures to correct the problem. *Note: Bottled water is not always regulated for pesticides*.

What is being done about pesticides in drinking water?

- Several government agencies including the U.S. EPA Office of Water, U.S. Geological Survey (USGS), and State Environmental Departments, and local city and county agencies monitor drinking water. *Note: Drinking water is not tested in all areas. Contact these agencies for further information.*
- Pesticide levels detected in water samples are compared to acceptable levels. If pesticides are found at higher than the acceptable levels, then agencies take action to correct the problem or notify affected citizens.
- The Safe Drinking Water Act is in place to reduce exposure to contaminants including pesticides in drinking water.
- Scientists are conducting research to better understand the long term effects of certain pesticides in drinking water.

Further reading:

1. *Drinking Water Regulations and Health Advisories.* U.S. Environmental Protection Agency, Office of Water, U.S. Government Printing Office: Washington, DC, 1996.
2. *Home Water Testing*. U.S. Environmental Protection Agency, Office of Water, U.S. Government Printing Office: Washington, DC, 1991.
3. *Is Your Drinking Water Safe?* U.S. Environmental Protection Agency, Office of Water, U.S. Government Printing Office: Washington, DC, 1994.
4. *National Primary Drinking Water Regulations Vols.1-3*. U.S. Environmental Protection Agency, Office of Water, U.S. Government Printing Office: Washington, DC, 1995.
5. *Pesticides in Drinking Water Wells.* U.S. Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances, U.S. Government Printing Office: Washington, DC, 1990.
6. *Pesticide Movement to Water: Proceedings of a symposium organized by the British Crop Protection Council, in conjunction with the Society of Chemical Industry.* Walker, A., Allen, R., Bailey, S. W., Blair, A. M., Brown, C. D., Gunther, P., Leake, C. R. & Nichols, P. H., Eds; British Crop Protection Council: Farnham, Surrey, UK, 1995.

Date reviewed: July, 2000

For more information contact: NPTN

Oregon State University, 333 Weniger Hall, Corvallis, Oregon 97331-6502.

Phone: 1-800-858-7378   Fax: 1-541-737-0761   Email: nptn@ace.orst.edu

NPTN at http://nptn.orst.edu/   EXTOXNET at http://ace.orst.edu/info/extoxnet/

Or:

U.S. EPA Safe Drinking Water Hotline

401 M Street, SW # 4604, Washington, DC 20460

Copies of this factsheet are not available at this hotline.

Phone: 1-800-426-4791   Fax: 1-703-285-1101   Email: hotline-sdwa@epamail.epa.gov

U.S. EPA Office of Ground Water and Drinking Water at http://www.epa.gov/safewater/

Sangeetha Viswanathan
Graduate student/Research Assistant
Food Microbiology and Biotechnology Laboratory
North Carolina A & T State University
Greensboro, NC
Email:sanvis20@gmail.com

In 2009, Sangeetha Viswanathan joined North Carolina A & T State University as a graduate student in Food Science. She received her Bachelor of Science in Nutrition and Dietetics from the University of Madras, India in 2002 and a Post Graduate Diploma in Food Science from the University of Auckland in 2004, New Zealand. She has also worked as a Quality Control Technician at a beverage manufacturing plant in Auckland, New Zealand. She comes with a wealth of knowledge in quality control process, quality management systems, auditing, writing Standard Operating Procedures (SOPs) and HACCP. She is currently a Research Assistant in the Family and Consumer Sciences Department and her research focus is on evaluating rice as a potential yogurt stabilizer, under the supervision of Dr. Salam A. Ibrahim. She plans to graduate with her Masters degree in Dec. 2011 and hopes utilize her knowledge in the industry.

Summary of the presentation:

Food quality control-HACCP

Hazard Analysis and Critical Control Point (HACCP) is a management system in which food safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product. HACCP is internationally recognized as the most effective way to produce safe food, providing a structure for objective assessment of what can go wrong and requiring controls to be put in place to prevent problems. Benefits, in addition to enhanced assurance of food safety, are better use of resources and timely response to problems. This presentation gives an overview of this most extremely important and most useful food safety system.

Food quality control-HACCP

Sangeetha Viswanathan

Graduate student

North Carolina A &T State University

Outline

- Introduction to food quality
- HACCP briefing
- Summary
- Pop quiz

What is quality?

- Generally, refers to an important character, a degree of excellence or a necessary attribute

- Scientifically, food quality, refers to technological, physical, chemical, microbiological, nutritional and sensory parameters necessary to produce wholesome food

What affects quality

- Improper agricultural practices
- Poor personal hygiene
- Inadequate or improper cooking and storage
- Contaminated raw materials
- Cross- contamination
- Inadequate cleaning and maintenance
- Addition of incorrect ingredients

Need for Quality control

- Curb food safety issues- a global concern affecting health, economy and international trade
- Safeguard public health
- Reduction in food complaints
- Required by many companies
- Increased market opportunities

When quality declines……

- Lack of quality as it relates to safety and wholesomeness, can result in sickness or death
- Food-borne illness is an example of sickness or even death when unsafe foods are produced and eaten

The solution....

- ✓Control at the source
- ✓Product design and process control
- ✓Good hygienic practices- farm to fork
- ✓Application of preventive approaches such as the Hazard Analysis Critical Control Point System (HACCP)

Origin of HACCP

- 1960's-Pioneered by the Pillsbury company and NASA, for the US space program
- Succeeding years has undergone refinement and widely accepted internationally

What is HACCP?

HACCP addresses three questions:

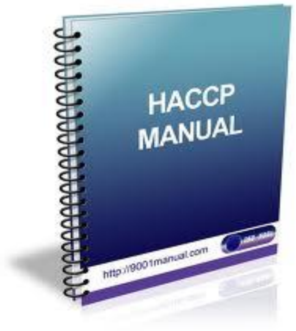
WHAT hazards can enter the product?

WHERE do these hazards occur?

HOW can we control or eliminate these hazards?

HACCP system

- Science based
- Step wise process:
  - Identifies potential food safety hazards
  - Evaluates risk
  - Installs preventative measures to eliminate or reduce hazards in foods
- Proactive rather than reactive
- 7 principles



With HACCP we can….

Action	Example
Identify foods and procedures more likely to cause food borne illness	Hamburger patty possibly contaminated with E.Coli
Develop procedures to reduce the risk of an outbreak	Cook patty to 155 F to kill bacteria
Monitor procedures that keep food safe	Hold patty above 140 F to minimize bacterial growth
Verify that the food served has been handled properly at each step	Document food cooking and holding temperatures

Preliminary stages of HACCP

Define terms of reference

↓

Assemble and train HACCP team

↓

Describe product/process

↓

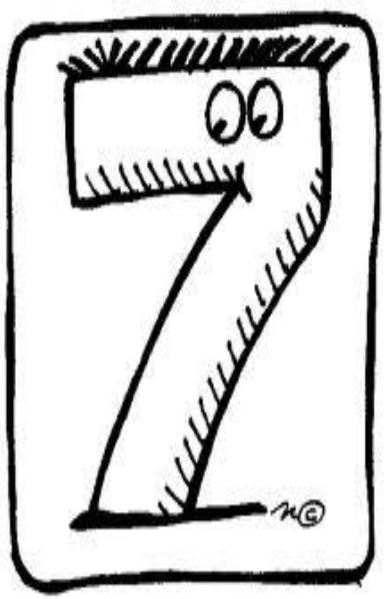
Identify intended use

↓

Construct and verify flow diagram

HACCP principles

- Perform a Hazard Assessment
- Identify Critical Control Points
- Establish Critical Limits
- Establish Monitoring Procedures
- Establish Corrective Actions
- Establish Verification procedures
- Determine Effective Record Keeping Systems



What is a hazard?

A biological, chemical or physical agent in a food which could cause an adverse health effect

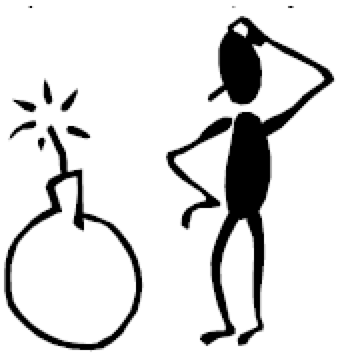
Biological	Chemical	Physical
Pathogens	Pesticides	Glass
Parasites	Cleaning fluids	Metal
Viruses	Allergens	Stones
Protozoa	Toxins	Wood
Mycotoxins	Banned substances	Parts of pests

What is risk?

Risk is an estimate of the likely occurrence of a hazard

HOW likely a problem can occur

WHAT would be the severity of the problem



Critical Control Points (CCPs)

- Any point in a specific food system at which a loss of control may result in an unacceptable health risk
- CCPs provide control over hazards
- A potential hazard can have more than one control point

What foods are potentially hazardous…

- meat
- poultry
- seafood

Other foods that have also been involved include:

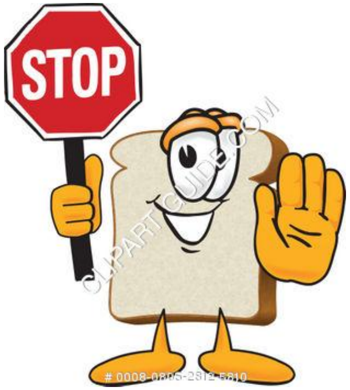
- eggs
- dairy products
- baked/boiled potatoes
- tofu & soy protein
- raw seeds & sprouts
- sliced melons
- garlic & oil mixtures
- cooked plant foods

#1-Performing hazard assessment

- Identify and assess hazard
  - Sources of potential hazard-raw materials like live animals, food ingredients, water
- Potential risk of each hazard
  - High risk/low risk, severity of sickness
- Develop preventive measures
  - Pasteurization, fermentation-time and temperature

#2-Identify CCPs

- Find places where food is more susceptible to contamination
- Food handling practices-Employee & environmental hygiene, preventing cross contamination, cooking, holding, & reheating



#3-Establish critical limits

- Standards and limits that must be achieved to eliminate food poisoning at each CCP
- Must be validated and measurable
- Most important- Time and temperature
- Eg: Cooking chicken to 165ºF,

  Chilling to 41ºF or less in 4 hours

#4-Establish monitoring procedures

Purposes:

- To determine when loss of control and deviations occur
- To help identify undesirable trends
- To provide written documentation
- Eg: Cook should be in charge of checking the temperature of cooking ground beef to assure the minimum internal temperature is being achieved

#5-Establish corrective action

Purposes:

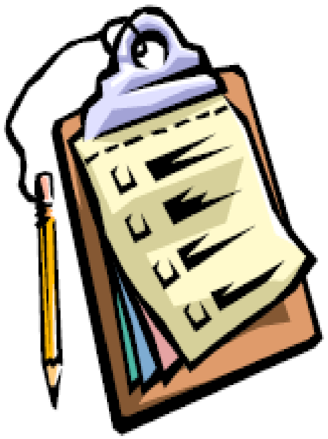
- To determine the disposition of any food that was produced when a deviation was occurring
- Correct the cause of the deviation
- Maintain records of corrective actions
- Eg: if ground beef has not reached 160˚F, the corrective actions can include letting it cook longer or increasing the cooking temperature.

#6-Establish verification procedures

- Frequently review the HACCP plan
- Determine that the plan is being correctly followed
- Ensure system controls hazards
- Eg: calibrating thermometers, equipment, review records and actions

#7-Establish record keeping procedures

- Preparation and maintenance of HACCP plan
- Includes flow charts, time and temperature logs, checklists
- Remember…if there is no record, it hasn't been done!!



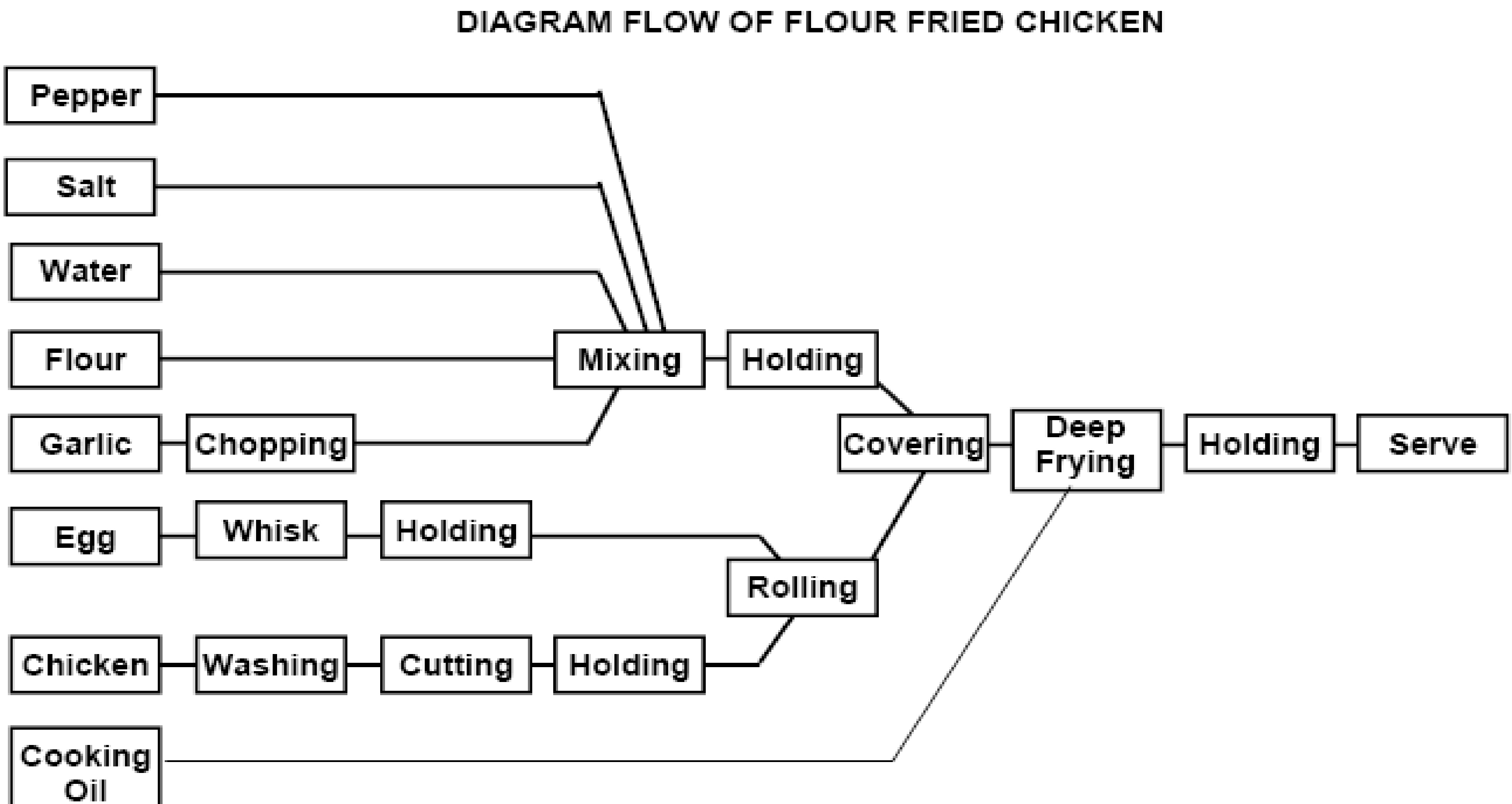
An example

Fried Chicken preparation:

- Take 3 lbs. of chicken meat, wash it, and cut into several pieces
- Pour ½ inch (1.25 cm) cooking oil in an electric skillet set at 350°F (175 °C). Beat two eggs in a flat dish
- Combine ½ cup (125 ml) flour with salt, pepper and two cloves of chopped garlic in a flat dish
- Dip chicken pieces in the egg mixture, then roll them in the flour mixture to coat all sides
- Drop the chicken into hot oil, and cook for

  about 15 minutes or until dark golden brown. Turn chicken pieces
- Reduce the temperature to 300°F (150°C) and continue cooking, uncovered, until golden on all sides and tender, about 15 minutes more. Serve immediately.

Process flow



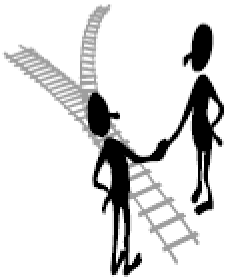
Point of control (raw material or process step)	Hazards	Control measures	CCP parameters	Critical limit	Target values	Monitoring procedures	Corrective action
Deep frying	Survival of or recontamination with microbial pathogen (*E. coli*, *C. jejuni*, *Salmonella* spp.)	Correct design and operation of deep frying	Temperature and time	70 ^{0}C all parts of chicken meat within 2 minutes	175 ^{0}C 15 minutes and 150 ^{0}C 15 minutes	Record the temperature and time at centre of meat	Adjust the temperature
Holding (or as GMP, can be avoided if it is consumed immediately)	Growth of and recontamination with microbial pathogen	Time of holding	Time of storage	less than 4 hours	Eat immediately while still hot/warm	Record the time	Reheating
		Storage condition	Storage condition of cooked chicken	No flies, cooked food should be covered	No flies, cooked food should be covered	Observe the flies and cover of cooked food	Reheating

Important points

- Hazard analysis is individual to the operation
- Critical points = areas which would result in greatest risk to customers
- Monitoring = physical measurement/observation
- Control = intervention is done to meet standards

Summary

- HACCP combined with good basic sanitation, a solid employee training program, and other prerequisite programs, can provide complete food safety management system



- Objective – provide safe, quality food
- Food safety is everyone's responsibility

Remember....

- HACCP is not a guarantee of food safety and is not a zero-risk system
- It is designed to minimize the risk of food safety hazards

An interesting comparison….

If you wear a seat belt, you may not prevent an accident—but you may reduce your risk of getting hurt….

Are you a HACCP pro?

1. Checking the internal temperature of pork fillet with a thermometer is an example of which HACCP principle?

a. Verification

b. Monitoring

c. Record keeping

d. Hazard analysis

2. Which of the following describes the proper way to dry hands after they have been washed?

a. Thoroughly with a hot-air hand dryer or a single service towel
b. Wipe them vigorously on an apron or a handkerchief
c. Use a cloth towel that is kept in the restroom
d. Wave hands briskly back and forth

3. Which of the following steps is likely to be a CCP for oysters that will be eaten raw?

a. Receiving
b. Storage
c. Preparation
d. All of the above

References

- www.fda.gov
- www.foodHACCP.com
- **HACCP.** Sara E. Mortimore, Carol Wallace, Christos Cassianos. December 2001, Wiley-Blackwell

Thank you for your attention!

Dr. Mehrdad Tajkarimi DVM MPVM PhD
Research Associate
Food Microbiology and Biotechnology laboratory
North Carolina A & T State University, Greensboro, NC
Tel: 336-334-7328 (Office), 530-601-6558(Cell) Fax: 336-334-7239
Email: Mtajkari@ncat.edu

Dr. Mehrdad Tajkarimi is a veterinarian who has a Ph.D. in food safety; he also has a Masters in Preventive Veterinary Medicine and continues his studies in nano science. He is working as a Research Associate in the Food microbiology and biotechnology laboratory at the North Carolina A&T State University. He has several years of teaching and training experience in the food industry and academia. His teaching is concentrated on the development of food safety/food protection and defense management systems at the national and international level.

Summary of the presentation

Food labeling: important challenge in food safety

Food labeling is very critical and an important part of food safety. Approximately, 2% of adults and about 5% of infants and young children in the United States suffer from food allergies; and each year, roughly 30,000 individuals require emergency room treatment and 150 individuals die because of allergic reactions to food. Domestic or imported packaged food is required to have a label that lists whether the product contains one of the top eight allergens including milk, egg, fish, shellfish, tree nuts, peanuts and soybeans. Some food items such as fresh produce, fresh meat and certain highly refined oils do not require listing on labels. It is necessary to have appropriate training and understanding about food labeling. This presentation will determine some perspectives in food labeling including allergens and other safety concerns associated with food labeling.

FOOD LABELING

Dr.Mehrdad Tajkarimi
North Carolina A&T State University

LABELING

- Since 2006, it has been much easier for people allergic to certain foods to avoid packaged products that contain them
- Rhonda Kane, a registered dietitian and consumer safety officer at the Food and Drug Administration.

ALLERGIES?!!

ALLERGIES

- Approximately 2 percent of adults and about 5 percent of infants and young children in the United States suffer from food allergies

- Each year, roughly 30,000 individuals require emergency room treatment and 150 individuals die because of allergic reactions to food

ALLERGIES

- Some food items such as fresh produce, fresh meat and certain highly refined oils don't require listing on labels.

FOOD ALLERGENS

These foods account for 90 percent of all food allergies:

- milk
- egg
- fish, such as bass, flounder, or cod
- crustacean shellfish, such as crab, lobster, or shrimp
- tree nuts, such as almonds, pecans, or walnuts
- wheat
- peanuts
- soybeans

"CONTAINS" AND "MAY CONTAIN“

- “Contains”: If “whey,” “egg yolks,” and a “natural flavor” that contained peanut proteins are listed as ingredients, the “Contains” statement must identify the words “milk,” “egg,” and “peanuts.”

"CONTAINS" AND "MAY CONTAIN"

- "may contain": A manufacturer might use the same equipment to make different products. Even after cleaning this equipment, a small amount of an allergen (such as peanuts) that was used to make one product (such as cookies) may become part of another product (such as crackers).

WHEN IN DOUBT, LEAVE IT OUT

- Manufacturers can change their products' ingredients at any time

- If you're unsure about whether a food contains any ingredient to which you are sensitive, don't buy the product

LABELING CONTENT

How to read the Nutrition Facts Label

Start here →

Nutrition Facts

Serving Size 1 cup (228g)
Serving Per Container 2

Amount Per Serving

Calories 250 — Calories from Fat 110

Limit these nutrients

Get enough of these nutrients

	% Daily Value*
Total Fat 12g	**18%**
Saturated Fat 3g	**15%**
Cholesterol 30mg	**10%**
Sodium 470mg	**20%**
Total Carbohydrate 31g	**10%**
Dietary Fiber 0g	**0%**
Sugars 5g	
Protein 5g	
Vitamin A	4%
Vitamin C	2%
Calcium	20%
Iron	4%

Quick guide to % daily value

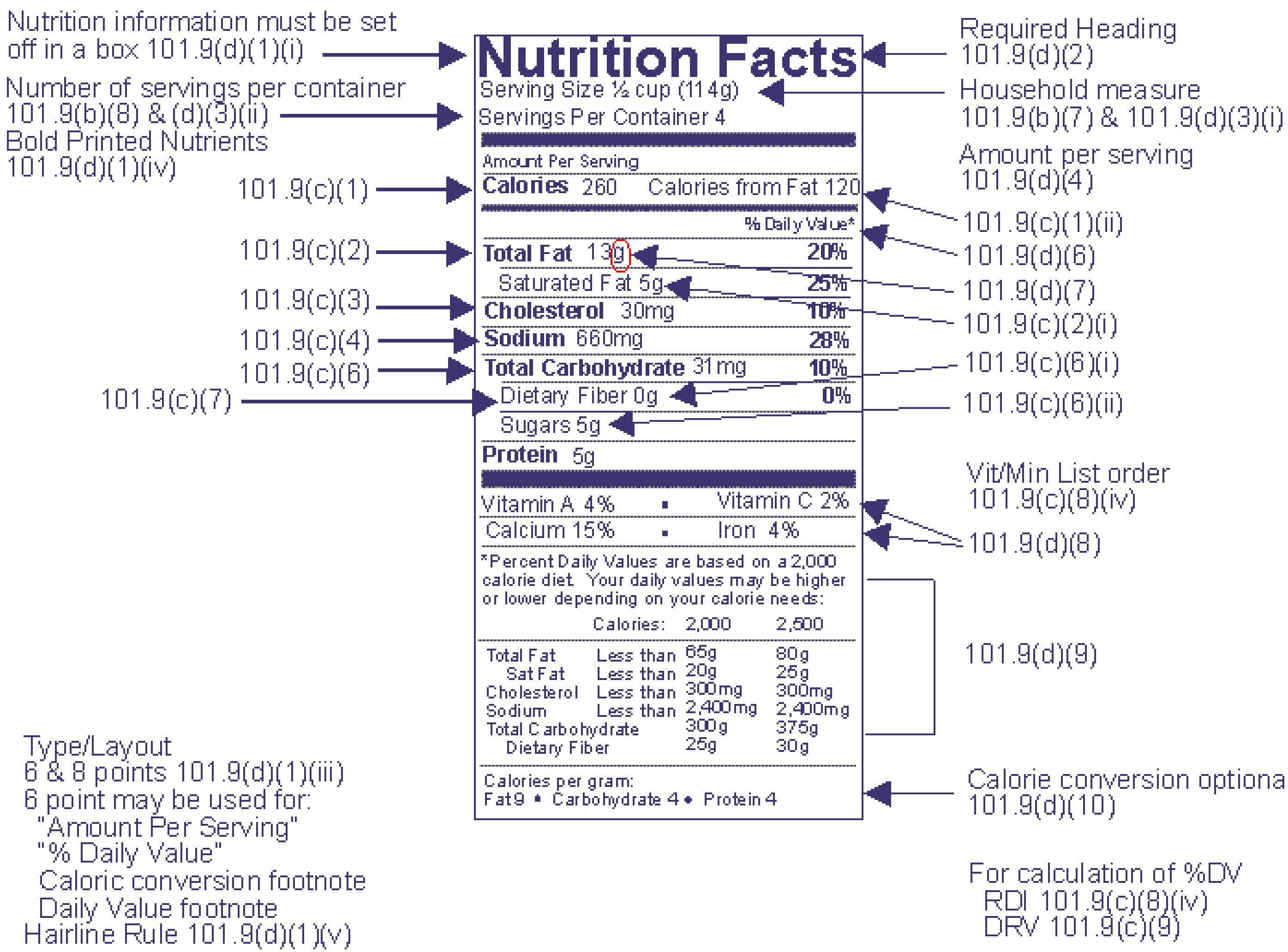
5% or less is low

20% or more is high

Footnote

*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs:

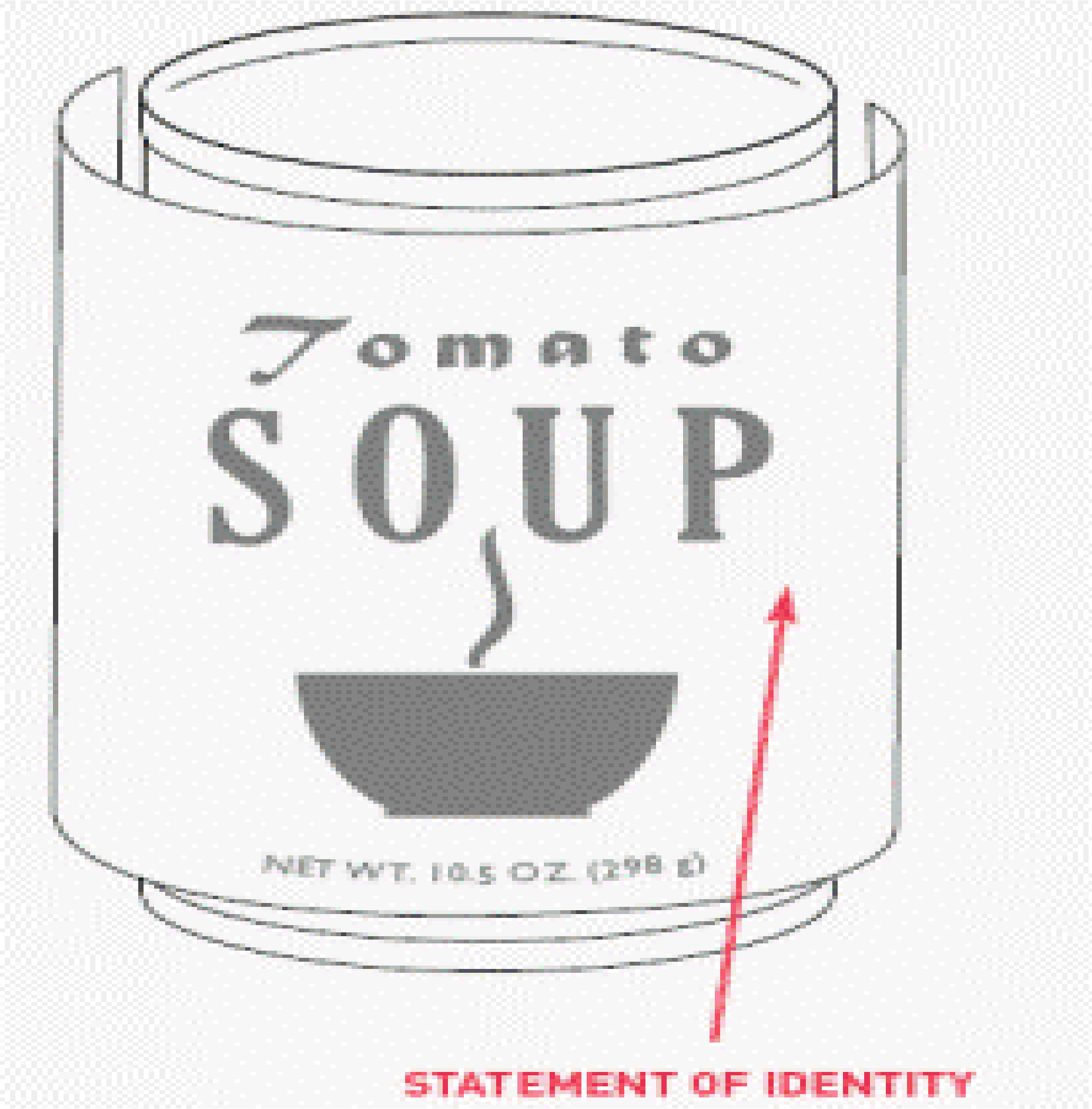
	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

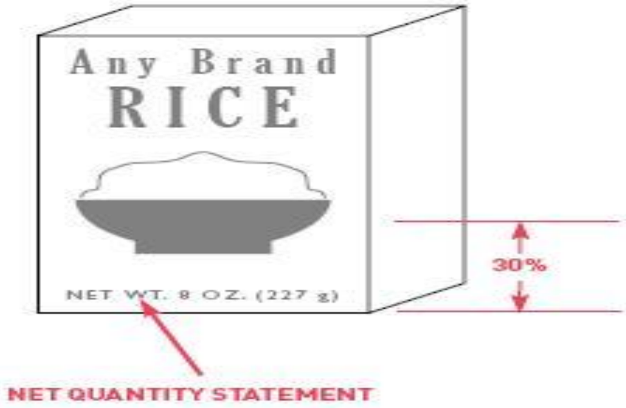


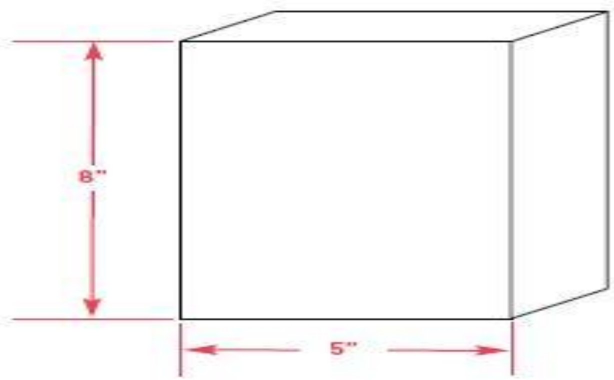
Nutrition information must be set off in a box 101.9(d)(1)(i)
Number of servings per container 101.9(b)(8) & (d)(3)(ii)
Bold Printed Nutrients 101.9(d)(1)(iv)
101.9(c)(1)
101.9(c)(2)
101.9(c)(3)
101.9(c)(4)
101.9(c)(6)
101.9(c)(7)
Nutrition Facts
Serving Size ½ cup (114g)
Servings Per Container 4
Amount Per Serving
Calories 260 Calories from Fat 120
% Daily Value*
Total Fat 13g 20%
Saturated Fat 5g 25%
Cholesterol 30mg 10%
Sodium 660mg 28%
Total Carbohydrate 31mg 10%
Dietary Fiber 0g 0%
Sugars 5g
Protein 5g
Vitamin A 4% • Vitamin C 2%
Calcium 15% • Iron 4%
*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:
Calories: 2,000 2,500
Total Fat Less than 65g 80g
Sat Fat Less than 20g 25g
Cholesterol Less than 300mg 300mg
Sodium Less than 2,400mg 2,400mg
Total Carbohydrate 300g 375g
Dietary Fiber 25g 30g
Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4
Required Heading 101.9(d)(2)
Household measure 101.9(b)(7) & 101.9(d)(3)(i)
Amount per serving 101.9(d)(4)
101.9(c)(1)(ii)
101.9(d)(6)
101.9(d)(7)
101.9(c)(2)(i)
101.9(c)(6)(i)
101.9(c)(6)(ii)
Vit/Min List order 101.9(c)(8)(iv)
101.9(d)(8)
101.9(d)(9)
Calorie conversion optional 101.9(d)(10)
For calculation of %DV
RDI 101.9(c)(8)(iv)
DRV 101.9(c)(9)
Type/Layout
6 & 8 points 101.9(d)(1)(iii)
6 point may be used for:
"Amount Per Serving"
"% Daily Value"
Caloric conversion footnote
Daily Value footnote
Hairline Rule 101.9(d)(1)(v)

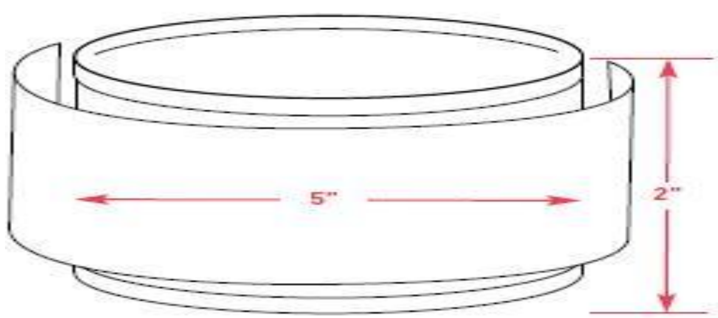
RECENT FDA REPORT

More than half of consumers in the United States often read the food label when buying a product for the first time. These consumers are also increasingly aware of the link between diet and heart disease.


Tomato
SOUP
NET WT. 10.5 OZ. (298 g)
STATEMENT OF IDENTITY



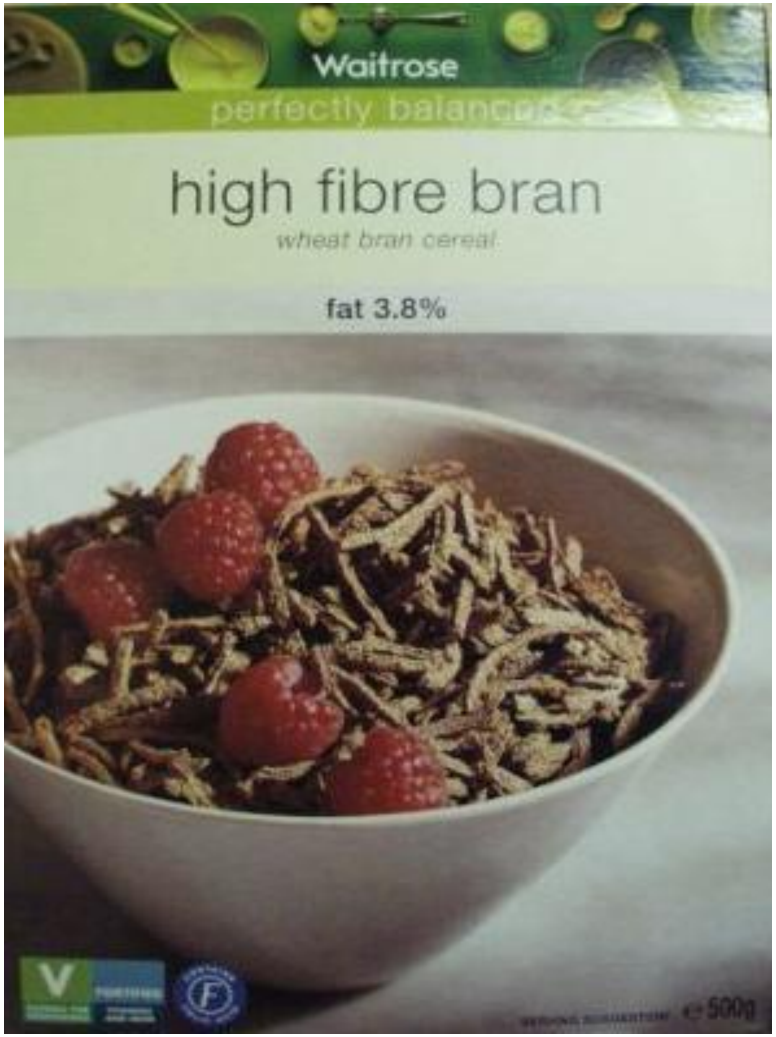




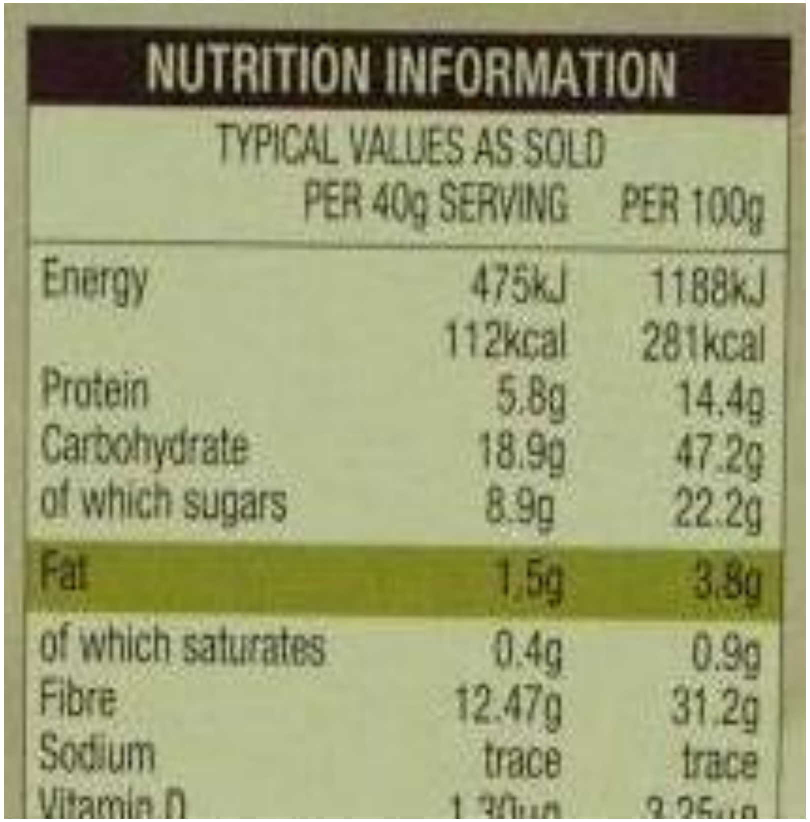
10" X 2" = 20 SQ. IN.
AREA OF PDP = 20 SQ. IN. X 40%
= 8 SQ. IN.

LETS DO SOME PRACTICE!

LETS DO SOME PRACTICE!

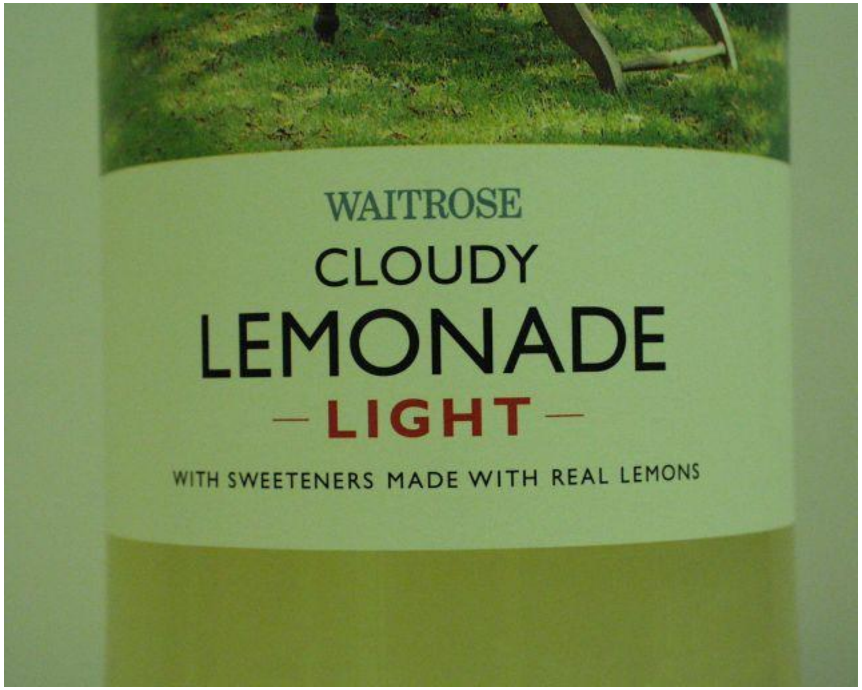


LETS DO SOME PRACTICE!



NUTRITION INFORMATION		
TYPICAL VALUES AS SOLD	PER 40g SERVING	PER 100g
Energy	475kJ	1188kJ
	112kcal	281kcal
Protein	5.8g	14.4g
Carbohydrate	18.9g	47.2g
of which sugars	8.9g	22.2g
Fat	1.5g	3.8g
of which saturates	0.4g	0.9g
Fibre	12.47g	31.2g
Sodium	trace	trace
Vitamin D	1.30µg	3.25µg

LETS DO SOME PRACTICE!



LETS DO SOME PRACTICE!

LETS DO SOME PRACTICE!

Ingredients: Sugar, water, maize flour (produced from genetically modified maize), egg, flavourings

MATERIAL AND RESOURCES

- **Food Labeling Guide FDA**
- **Consumer Nutrition and Health Information, FDA**
- **Food Allergen Labeling and Consumer Protection Act of 2004 , FDA**

"She read the ingredients listed on the label!"

THANK YOU

Your feedback is much appreciated

Presenter	Comments
Salam Ibrahim	
Rabin Gyawali	
Saeed Hayek	
Madhavi Hathurusinghe	
Sangeetha Viswanathan	
Mehrdad Tajkarimi	

Additional comments and suggestions: