MICROBIAL HAZARDS

Microorganisms are everywhere. They can be found in the air, in water, in soil, on animals, and even on humans. Some are beneficial, such as those used to make fermented dairy and meat products. Others cause spoilage. And, a small number are pathogenic (or harmful) and so can cause disease, such as foodborne illness.

Three types of microorganisms can contaminate food and cause foodborne illness – bacteria, viruses, and parasites. Another group of microorganisms that one also needs to be concerned about are fungi, which are yeast and molds. Yeast and mold cause food to spoil but do not cause foodborne illness.

When harmful microorganisms get into food and your customers then eat the food, foodborne illness could result. The most common symptoms of foodborne illness are: diarrhea, vomiting, fever, sore throat with fever, and jaundice.

Three types of foodborne illness and their definition	
Infection	Eating food contaminated with harmful microorganisms
Intoxication	Eating food contaminated with the toxins (poisons) formed by some types of bacteria or mold; eating food contaminated with other biological or chemical toxins (poisons)
Toxin-mediated infection	Eating food contaminated with harmful microorganisms. These microorganisms grow in the body and then form toxins (poisons).

Bacteria Basics

Bacteria are not visible to the naked eye. Therefore, you cannot look at a food to determine if bacteria are there. Harmful bacteria are those that cause foodborne illness. They can only grow in potentially hazardous food. Potentially hazardous foods are moist, low-acid, and have protein. Some examples of potentially hazardous food are meat, milk, cooked vegetables, cooked rice, baked potatoes, poultry, and seafood.

Types of Bacteria

Unlike animals and plants that are made up of many cells, bacteria are single-celled microorganisms. Bacteria come in a variety of shapes and are impossible to see without a microscope. Because they are about 1/25,000th of an inch long, they must be magnified about

1,000 times to be seen. For example, about 400 million bacteria clumped together would be about the size of a grain of sugar.

Only when bacteria are in the form of a vegetative cell are they able to grow in food. However, some types of bacteria are able to change into a different form, called a spore. When bacteria are in the form of a spore, they cannot grow in food. One key concern with spores is that proper cooking does not destroy them. Cooking will heat shock the spore so that it can turn back into a vegetative cell. If potentially hazardous food is cooked and then allowed to sit at room temperature, the heat shocked spores become vegetative cells, the vegetative cells then grow, and if they grow to large enough numbers, they could cause foodborne illness. Therefore, it is very important that potentially hazardous foods be maintained at proper temperatures after cooking. If they are not at proper temperatures, they must be thrown out after four hours.

Some bacteria form toxins (or poisons). Not all toxins are destroyed by proper cooking. Therefore, if potentially hazardous food is kept in the temperature danger zone for more than four hours, toxins might form. Cooking or reheating potentially hazardous food that has been temperature abused will not always make it safe to eat.

How Do Bacteria Grow?

When bacteria grow, they increase in numbers not in size. This process is called doubling. Under ideal conditions, the number of bacteria can double every 30 minutes. For example, if cooked rice is left out at room temperature, after five hours there could be more than 10,000 bacteria in the rice. This is more than enough bacteria to cause foodborne illness.

Many factors affect bacterial growth but the most important ones are food, water, pH, oxygen, and temperature.

Factors that Affect Bacterial Growth	
Food	Bacteria grow best in potentially hazardous food, which are moist, low acid, and have some protein.
Water	Bacteria need water to grow. Foods that have a water activity of 0.85 or higher can support the growth of bacteria. Water activity is a measure of how much water is available to the bacteria.
pH	Bacteria cannot grow well in high-acid foods. Most bacteria grow in food that has a pH of 4.6 or higher. pH is a measure of how much acid or alkali is in a product. It is indicated on a scale from 0 to 14, with 7 being neutral. If the pH value is below 7, the food is acid; if it is above 7, the food is alkaline.
Oxygen	Some bacteria require oxygen to grow (aerobes) while others can grow only in the absence of oxygen (anaerobes). However, many bacteria grow under either condition and these bacteria are called facultative anaerobes.
Temperature	Bacteria grow over a wide range of temperatures. Temperature is the most widely used method to control bacterial growth. Bacteria grow slowly at temperatures below 41°F (5°C). They begin to die at 135°F (57°C) or hotter.

Controlling Bacteria

The best way to prevent foodborne illness caused by bacteria is to implement food safety policies that:

- *Promote good personal hygiene* -- Only allow healthy workers to handle food and make sure all workers wash their hands properly and frequently while in the operation.
- *Prevent cross-contamination* -- Store foods properly and only use cleaned and sanitized utensils and surfaces to store, prepare, and serve food.
- *Keep food out of the temperature danger zone* -- Cook foods to proper temperatures and hold potentially hazardous foods at 41°F (5°C) or colder or 135°F (57°C) or hotter.

Virus Basics

Viruses are the smallest of the microorganisms that can cause foodborne illness. One cannot look at a food to determine if viruses are present. Viruses are different than bacteria in that they do not grow in food. Viruses simply use food as a vehicle to get from one person to another. Therefore, viruses can contaminate any food. Water, salads, shellfish, iced drinks, and other ready-to-eat foods are the most sources of viral foodborne illnesses.

Controlling Viruses

The best way to control viruses is to prevent them from getting into food in the first place. If viruses get into food, cooking might not destroy them. Therefore, as a foodservice manager you must:

- *Promote good personal hygiene* -- Only allowing healthy workers to handle food. Have all workers frequently and properly wash their hands.
- *Buy all food from an approved and safe source* – Approved sources are regulated by the government are so are more likely to be safe.
- *Use safe water for food preparation and cleaning* -- Safe water is drinking quality.

Parasite Basics

Like bacteria and viruses, most parasites cannot be seen. Like viruses, parasites do not grow in food. There are two ways that parasites are commonly transmitted to humans through food. (1) Some parasites are in human feces and so may contaminate drinking water, foods handled by infected persons, or vegetables and fruits grown on soils fertilized with feces. (2) Parasites are naturally present in many animals, such as pigs, cats, rodents, and fish. If these foods are not cooked to proper endpoint temperatures, foodborne illness could result.

Controlling Parasites

Cooking foods to proper endpoint temperatures is the most common way to eliminate parasites from food. Freezing will also kill some parasites in food. To kill parasites in fish that is to be served raw, the fish can be:

- frozen and stored at a temperature of –4°F (-20°C) or colder for seven days *or*
- frozen and stored at –31°F (-35°C) for 15 hours.

Mold Basics

Molds are microscopic fungi that can live on plants and animals. Most molds spoil foods. Some form toxins that can cause illness. Molds can grow in a wide range of foods. Unlike bacteria, mold can grow in foods that are high acid and low moisture. Freezing does not destroy molds. Molds also need air to grow.

Most molds produce spores. These spores can be transported by air, water, or insects. Molds forms spores which, when dry, float through the air and find suitable conditions where they can start growing again. While most molds like warm temperatures, they can grow at refrigerator temperatures -- 41^{o}F (5^{o}C) or colder. Molds also tolerate salt and sugar so they can grow in opened jars of jams and jelly and on cured, salty meats, such as ham, bacon, salami, and bologna. Molds also have branches and roots that are like very thin threads. The roots may be difficult to see when the mold is growing on food and may also be very deep in the food. Therefore, if you see mold on a food, you must throw out all of the food and not just the moldy portion.

Some molds cause allergic reactions and respiratory problems. And a few molds, in the right conditions, produce mycotoxins (or poisons) that can make you sick. Mycotoxins are produced by certain molds found primarily in grain and nut crops, but are also known to be on celery, grape juice, apples, and other produce. However, not all molds are harmful. Some are used to make certain kinds of cheeses, such as Roquefort, blue, Gorgonzola, and Stilton.

Yeast Basics

Yeast are another type of fungi. Yeast are commonly found on plants, grains, fruits, and other foods containing sugar. They are present in soil, in the air, on the skin and in the intestines of animals and in some insects. They are transferred from place to place by people, equipment, or food and air currents. Yeast cause food to spoil and do not cause foodborne illness.

Common Foodborne Microorganisms that Cause Foodborne Illness

FOODBORNE BACTERIA		
Bacteria	**Foodborne Illness**	**Common Foods**
Bacillus cereus	Intoxication	Temperature-abused cooked rice, sauces, puddings, soups, casseroles
Campylobacter	Infection	Unpasteurized milk and dairy products
Clostridium botulinum	Intoxication	Improperly home canned food; garlic-and-oil mixtures that are not acidified; temperature-abused baked potatoes, stews, sautéed onions, modified atmosphere packaged (MAP) foods

FOODBORNE BACTERIA (continued)		
Bacteria	**Foodborne Illness**	**Common Foods**
Clostridium perfringens	Intoxication	Temperature abused cooked meat, meat dishes, cooked beans
Escherichia coli 0157:H7 and 0157:NM	Toxin-mediated infection	Improperly cooked ground beef, lettuce; unpasteurized apple cider
Listeria monocytogenes	Infection	Deli meats, soft cheese, seafood/seafood products, hot dogs, unpasteurized milk
Salmonella	Infection	Improperly cooked poultry, shell eggs; temperature abused sliced melons, sliced tomatoes; improperly processed raw sprouts
Shigella	Intoxication	Salads, lettuce, raw vegetables, milk and dairy products, poultry
Staphylococcus aureus	Intoxication	Temperature-abused meat and meat products, poultry and egg products, mayonnaise-based salads, cream-filled pastries
Vibrio	Infection	Raw or partially cooked oysters
Yersinia	Infection	Unpasteurized milk; tofu; nonchlorinated water; improperly cooked meat, oysters, fish

FOODBORNE VIRUSES		
Virus	**Foodborne Illness**	**Common Foods**
Hepatitis A	Infection	Ready-to-eat foods that will not receive a further heat treatment; unsafe water; and improperly handled ice
Norovirus	Infection	Ready-to-eat foods that will not receive a further heat treatment; unsafe water
Rotavirus	Infection	Ready-to-eat foods that will not receive a further heat treatment; unsafe water
FOODBORNE PARASITES		
Parasites	**Foodborne Illness**	**Common Foods**
Cryptosporidium parvum	Infection	Water, salads and raw vegetables, milk, unpasteurized apple cider, ready-to-eat food
Cyclospora cayetanensis	Infection	Water, raw produce, fish, raw milk
Giardia duodenalis	Infection	Contaminated water, salads, and raw vegetables washed with contaminated water
Toxoplasma gondii	Infection	Contaminated water, raw or undercooked meat
Trichinella spiralis	Infection	Raw and undercooked pork and pork products (particularly sausage), raw and undercooked wild game

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