FE 305- FOOD MICROBIOLOGY
Introduction

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Introduction

- The substances consumed in order to obtain the energy to be used in the growth and development of living things, their reproduction, the construction and repair of their tissues and the realization of metabolic events in the cell are called "food".
- **Food is everything that people eat and drink, except medicine, in order to survive and meet their physiological needs**.
- Healthier food is defined as “physically, chemically and microbiologically safe food containing nutrients in sufficient and balanced amounts”.
- Microorganisms have beneficial and harmful effects in the food industry.
- The development of taste and aroma in foods and the production of various foods using microorganisms are beneficial effects.
- Harmful microorganisms in foods can lead to deterioration of human health, poisoning, and even death in some cases.
- In addition, it can cause serious damage to the country's economy by causing loss of product and time.

Introduction

- Antonie van Leeuwenhoek described “living animalcules,” many of the conditions that controlled microbiological spoilage had been identified empirically.
- However, it was the emergence of the science of microbiology that moved food preservation from an art to a science, allowing foods to be processed, distributed, and marketed with a high degree of confidence in terms of both the product’s quality and safety.
- The scope of food microbiology is highly inclusive, interfacing with virtually all microbiology subdisciplines (e.g., public health microbiology, microbial genetics, fermentation technologies, microbial physiology).
    - the development of biofilms and
    - the ability to detect low numbers of metabolically stressed microbes from highly complex matrices are two areas where food microbiologists are providing critical insights into the behavior of microbiological systems.
    - predictive microbiology,
    - probiotics,
    - microbial risk assessments, and
    - naturally occurring antimicrobials.

Food and Microorganism

- There is a constant relationship between microorganisms, plants and animals in nature.
- They play an important role in many geochemical events (N, CO_2, O_2 cycle).
- As a result of enzymatic activities, they cause the deterioration of various foodstuffs.
- A large number of pathogenic microorganisms are the cause of infection in humans, animals and plants.
- The main function of microorganisms is to carry out various activities to maintain their own generation and life. For this, they carry out the following basic reaction;

Organic compounds  Cell structures + Energy + Inorganic compounds

- Substances formed as a result of this reaction provide nutrition to plants, and plants provide nutrition to animals.

Food and Microorganism

- It is deteriorated by the enzymatic activity of microorganisms found in the natural flora of foods and subsequently contaminated.
- This has led to thinking about how to store foods without spoiling.
- Fermentation and drying are the oldest methods of food preservation.
  - For example: acid-producing bacteria in pickles, vinegar, dairy products;
  - Alcoholic beverages such as beer and wine are the fermentation products of alcohol-producing yeasts.
- Mankind in the first ages consumed raw foods, then from BC. 6000 - 8000 years, cooking, salting, drying, oiling, soaking in the snow went to the way of storing.

Food and Microorganism

- In these periods, trial and error empirical methods were used in storage methods, and it was not known that various diseases were transmitted to humans by food.
  - For example: In 1943, when 40,000 people died in ergot poisoning caused by *Claviceps purpurea*, it was not known that the cause was a toxin produced by mold.
- Saprophytic microorganisms, spoilage in food,
- Pathogenic microorganisms cause food poisoning and infection,
- Some microorganisms also play a beneficial role in the production of alcoholic beverages such as fermented meat, yoghurt, beer-wine.
- The relationship between food and microorganism associated with factors,
  - internal (intrinsic) factors such as pH of food, water activity, and nutrient elements in food (protein, fat, CH, mineral, vitamin etc.),
  - extrinsic (external) factors such as humidity, temperature, gases, etc. in the environment where the food is stored.

Nutrition and Food Assurance

- It is known that the world population reached 7.6 billion in 2020, and about 98% of this increase occurred in underdeveloped and developing countries, and the urbanization in developing countries doubled from 1995 to 2020, reaching 3.4 billion.
- Such population growth and urbanization necessitate new approaches to food security and food systems.
- On the other hand, ongoing innovations such as the development of plant and animal production and the extension and cultivation techniques for this, the control and prevention of pre-harvest and post-harvest losses, the implementation of effective food processing and distribution systems, the development of new technologies are aimed strengthens the delivery of food for consumption at meeting the nutritional needs of this ever-increasing population.
- With the increase in urbanization, radical changes in food production and consumption processes and changes in food sources may lead to the extension of the food chain, the emergence of new hazards or the increase in the severity of existing hazards.
  - For this reason, the food safety approach is one of the systems that should be applied in every country in order to ensure the welfare of the society in terms of both health and economy.

Food Safety

- Nutrition and a healthy life, which are among the most basic needs of human beings, are possible on the basis of food safety.
- The emergence of many new diseases in the world has shown the importance of food safety.
- Foodborne diseases have negative consequences on human health in both developed and developing countries.
- Food-related problems do not only affect human health, but also affect the economic and social structures of individuals, families, societies, sectors and finally countries.
- On a global scale, food trade, besides providing foreign exchange to food exporting countries, brings added value to the sector and makes significant contributions to national income.
- Despite all this, food-borne risks can cause serious health problems in all layers of the society, as well as a decrease in work efficiency and economic losses in the society.
- Food safety systems highlight the "**farm to table food safety**" approach, which is an effective method for reducing food-borne hazards.
  - The basic approach to the prevention of food-borne hazards requires careful examination of each step in the food chain, from raw materials to food consumption, and the implementation of control measures.

Food Safety

- In recent year, the development of the food industry and the globalization of food trade have changed the food production and distribution methods.
- Different from previous years, food and feed materials are produced using different methods in very different ways and can be delivered to very different distances in a very short time frame.
- Likewise, it is possible for food-related negativities to be carried to many consumption points rapidly in the same way.
  - In the last "dioxin" crisis that occurred in Europe on the brink of the 2000s, more than 1500 farms "dioxin" contaminated feeds were sent within two weeks from a single source. Food obtained from animals fed with these feeds was also delivered to other regions, countries and even continents within a few weeks. Both the health and economic repercussions of the dioxin crisis are still relevant.
- There is always the possibility that new risks may arise in the future.
- In developed countries, approximately 50% of the expenditures on food are made outside the home.
  - Considering that even a single contamination risk can spread socially, locally, nationally, regionally or intercontinentally, the importance of the issue is understood much more clearly.
- Considering the increase in urbanization, it is necessary to impose strict sanctions on food establishments that produce and distribute food, storage and food service, and to implement food safety systems effectively.

Food Safety

- Today, the globalization of the food trade has increased the variety of foods while offering safe, high quality, affordable foodstuffs that meet consumer expectations and needs while offering various benefits to consumers.
- While progress has been made in many countries to make foodstuffs safer, millions of people are frequently exposed to foodborne illnesses every year due to the consumption of contaminated food.
- Consumers are now aware of the various pathogenic microorganisms and various chemicals in the food supply and the risks they cause.
- The emergence of innovations such as genetic engineering, heating and packaging technology, applications of food additives, pesticides and veterinary drugs and various issues such as their residues and mycotoxins make the issue even more important in the context of food safety risks.
- The development of some new technologies increases food production and diversity; however, it also brings some question marks in making the products safer and gaining consumer appreciation.
- In order to reach a healthy conclusion, these issues should be evaluated in a participatory and transparent way using internationally valid methods.

Food Safety

- Food safety refers to the whole of the measures taken to eliminate physical, chemical, biological and all kinds of damages that may occur in food. Looking at the concept of safe food from a narrow perspective;
  - when prepared as intended; It is a food that is suitable for consumption due to its physical, chemical and microbiological properties and has not lost its nutritional value.
- If a food item is harmful to human health; When it is eaten, abnormal changes occur in human health, such as causing disease symptoms in the human body, increasing existing disorders.
- All the hazards that affect food safety are caused by biological, chemical, physical contamination and some malpractices during production.
- For this reason, “food safety” can be ensured if everyone involved in the food chain fulfills their responsibilities.
- Food safety and quality can be regulated by implementing food safety and quality programs in the food industry.

Food Safety

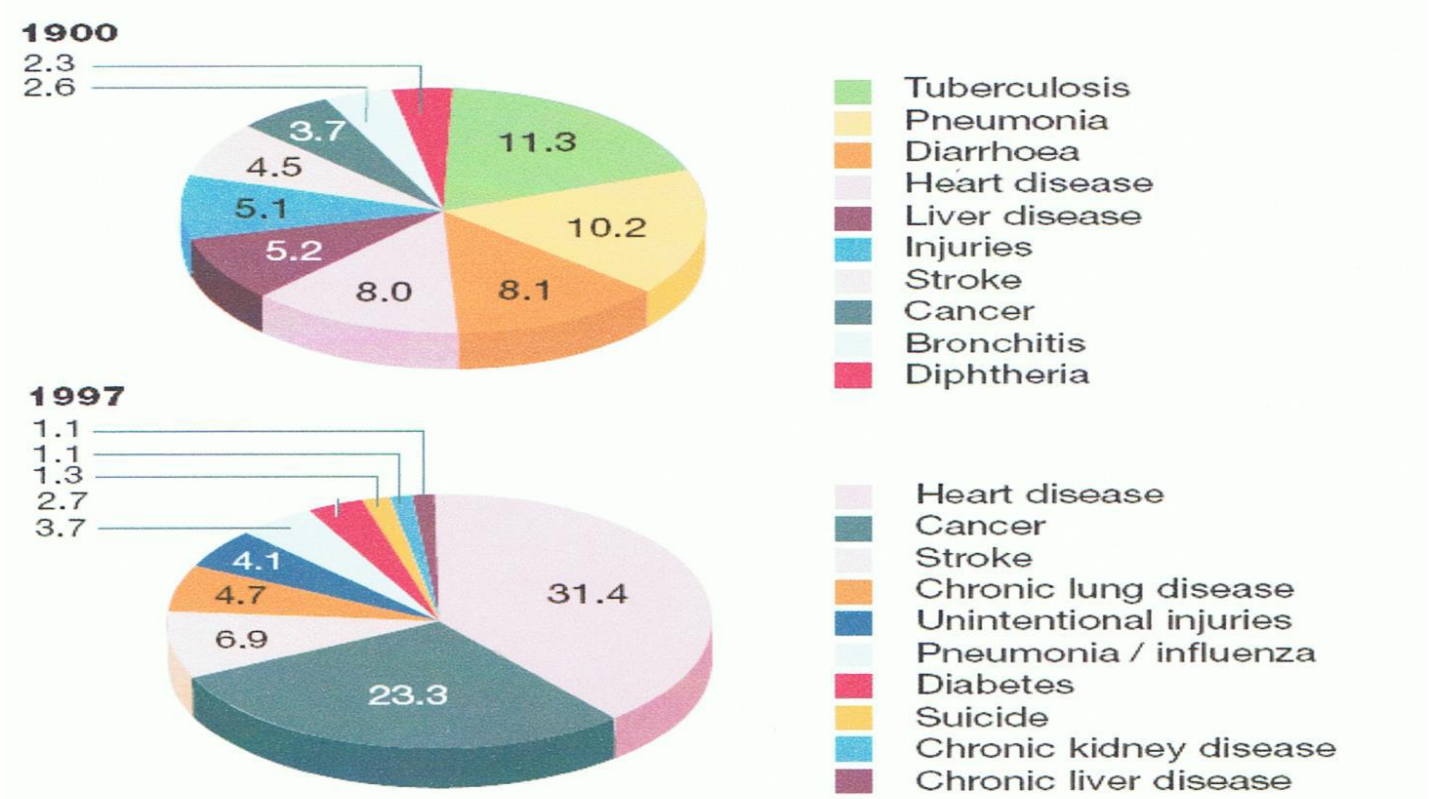


Figure 2 – The ten leading causes of death in the United States in 1900 and 1997. From "Changing Patterns of Infectious Disease", Mitchell L. Cohen, Nature, Volume 406, 17 August, 2002, pp 762-767.

Hazards From Foods

- The prerequisite for obtaining food safety is the provision of safe raw materials. In this context, in order to produce food safety, they must first be produced and prepared in enterprises with a minimum healthy and hygienic environment and technical conditions.
- Food-related hazards are divided into three classes: physical, biological and chemical.
  - **Physical Hazards** are all kinds of foreign substances (stone, soil, metal, glass, bone, wood, etc.) that are undesirable in foodstuffs, which affect consumer preference and may cause health problems.
  - **Biological Hazards** - bacteria, molds, natural occurring toxins
  - **Chemical Hazards** – chemicals like petroleum, herbicides, pesticides, heavy metals.

Hazards From Foods

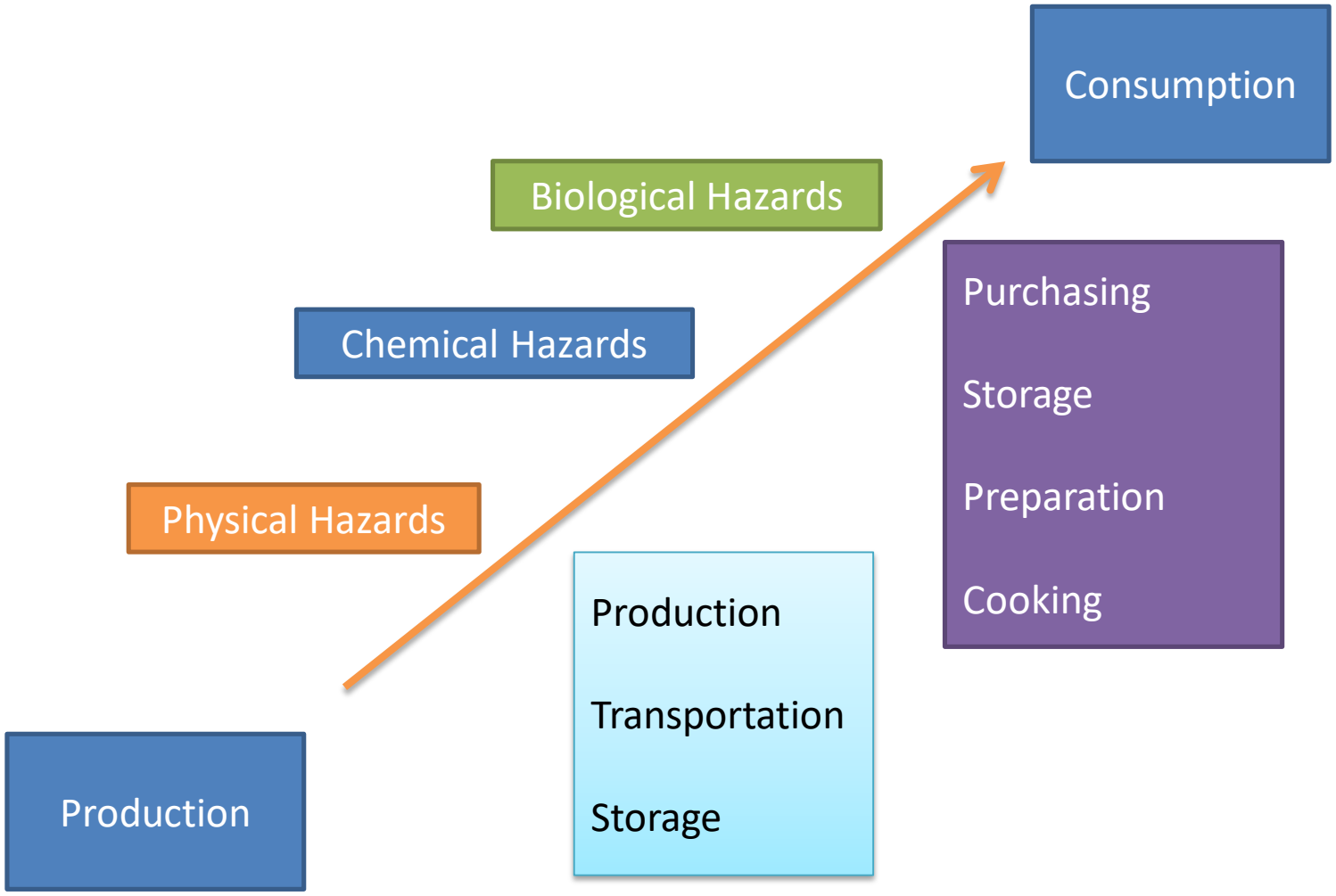
- **MICROBIAL HAZARDS** take the first place among food-borne risks and vary depending on various factors. Foodborne risks are important in many stages of production.
  - Unless sterilized, foodstuffs naturally contain many microorganisms. When this number exceeds a certain limit, it becomes unusable due to the negative changes that occur and poses a risk to human health.
- Within the scope of the main **CHEMICAL HAZARDS**, veterinary and agricultural pesticide residues that are used incorrectly and unconsciously in order to increase the efficiency in animal husbandry and plant production, various chemicals transmitted from environmental sources or some dangerous substances formed during food processing can be counted.
  - Natural toxic components and allergens in the structure of foods are important elements to be considered within the scope of food safety. In addition, it is of great importance to control the food additives being food grade, using them in accordance with the technique and applying them at the prescribed doses.

Hazards From Foods

- In foods, there are hazards that may arise from raw materials, production methods and techniques, and employee hygiene practices, as well as dangers that may arise from contamination of various foreign substances (paint, machine oils, etc.).
- All these potential hazards must be under management's control during production, purchase, processing, distribution and sale.

Chemical Hazards	Source
Pesticides contamination	Raw material pesticide application
Detergents and Disinfectants	Poor rinsing after cleaning
Packaging Chemicals	Chemical used in package film production
Contamination of product with oil	Machine oils used in equipment
Heavy metal contamination	Water, soil, environment
Residual pesticides	Application of pesticides
Nitrate, nitrite, Urea	Water

Hazards from Foods



Important Microorganisms in Food

- As it is known, it is a common practice to classify microorganisms according to their technical use, as well as some morphological features.
- In the classification of microorganisms, which are important in food microbiology, a mixed application is observed that includes all three of these three methods from time to time.
  - For example, bacteria, fungi, etc.
    - In addition to technical classification such as; gram-positive bacteria, gram-positive cocci, etc.
  - Classification based on features such as, as well as scientific binomial classification, order, family, genus and species are specified.
- Microorganisms, which gain importance in foods with their different aspects and need to be sought or reproduced and used, are primarily divided into three important groups according to their importance and effects in terms of foods and consumers. These;
  - Microorganisms cause spoilage or used as technically,
  - Indicator microorganisms,
  - Toxic microorganisms (pathogen or produce toxin).

Microorganisms cause spoilage or used as technically

They are divided into the following groups according to some important features:

1. **Microorganisms Growing in the Cold (Psychrotrophic)**
   - In fact, these are mesophyll microorganisms with the best growth temperatures between 20-30 °C. However, since the generation time at low temperatures is also very short, they are capable of growing rapidly at temperatures around 7 °C, thus clouding liquid media within a week, at the latest 10 days, or forming distinct colonies on solid media in the same time. Bacteria constitute an important part of microorganisms in this group. However, yeast and molds are also included in the group. For example,
     - Bacteria: *Acinetobacter, Aeromonas, Alcaligenes, Bacillus, Chorombacterium, Clostridium, Flavobacterium, Lactobacillus, Pseudomonas, Psychrobacterium, Vibrio, Yersinia* etc.
     - Yeasts: *Candida, Hansenula, Kloeckera, Kluyveromyces and Saccharomyces*
     - Molds: *Botrytis, Cladosporium, Geotricum, Sporotrichum* etc.
   - Regardless of the technical group, microorganisms that develop at low temperatures cause deterioration in protein-rich foods such as fish, meat and poultry meat, milk and products.

Microorganisms cause spoilage or used as technically

2. **Fat Oxidizing (lipolytic) microorganisms**

- Microorganisms capable of forming lipase enzyme and thus breaking down fats were included in this group.
- These are also technically representative species of bacteria, yeasts and molds. For example,
  - Bacteria: *Alcaligenes, Brevibacterium, Brochtrix, Micrococcus, Pseudomonas, Serratia, Staphylococcus etc.*
  - Yeasts: *Candida, Hansenula, Rhodotorula, Saccharomycopsis, etc.*
  - Molds: *Alternaria, Aspergillus, Cladosporium, Fusarium, Penicillium, Rhizopus etc.*
- Microorganisms in this group are agents of spoilage in foods such as fat-containing or fat-rich foods, dairy products, margarine and butter.

Microorganisms cause spoilage or used as technically

3. Protein-destroying (proteolytic) microorganisms

- As the name suggests, it is a group of food spoilage microorganisms that are capable of breaking down proteins.
- A large number of bacterial genera and species are included in this group. These include *Acinetobacter, Aeromonas, Bacillus, Clostridium, Corynobacterium, Lactobacillus, Lactococcus, Micrococcus, Morexella,* etc. found in genera.
- Species that are representative of this group, on the one hand, cause deterioration by changing the taste and smell of protein-containing foods, on the other hand, they have a beneficial effect on the ripening of some cheese varieties and meat products.
- In addition, there are species that are among the desired microorganisms with their use in the production of protease enzymes used in the food industry.

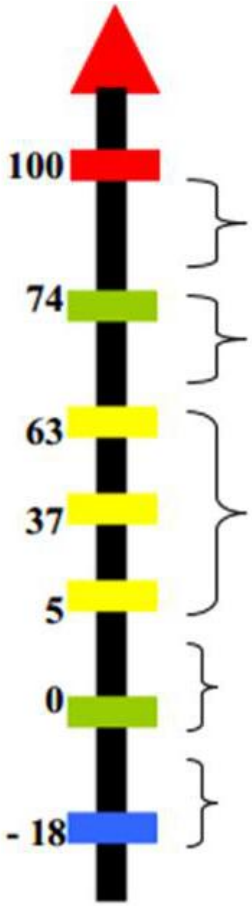
Microorganisms cause spoilage or used as technically

4. Salt-loving (halophilic) microorganisms

- Microorganisms in this group are living things that need salt for their growth or can thrive in high salt concentrations. For this reason, they are a spoilage factor in foodstuffs that are tried to be preserved by salting. This group includes bacteria, yeast and molds.
  - Bacteria are divided into three groups according to the salt concentration in which they are able to grow: growing in low salt (2-5%) and growing in medium salt (5-20%) and growing in too much salt (20-30%).
  - In yeasts, some *Candida, Pichia* and *Brettanomyces* species are found growing in environments containing up to 20% salt.
  - Among the molds, there are those that grow in environments containing up to 20% salt. For example, *Aspergillus halophilicus*.
- Among the microorganisms in this group, the ones mentioned among the bacteria are *Halococcus* and *Halobacterium* (*Archaebacter*) species. They develop in salty foods and cause color changes as well as deterioration of taste and odor.

Microorganism-temperature relationship

- Animal foods that are not cooked at the appropriate temperature and time pose a danger.
- Bacteria like foods with protein (milk, eggs, meat, etc.).



safe zone (many microorganisms die)

moderately safe zone (some microorganisms survive)

danger zone (microorganisms grow rapidly)

growth of microorganisms slows down

growth of microorganisms stop but do not die

FOOD POISONING

INFOGRAPHIC ELEMENTS

SPOILED FOOD

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SYMPTOMS

ABDOMINAL CRAMPS

NAUSEA

DIZZINESS

FIVER

HEADACHE

DIARRHEA

TREATMENT

LOREM IPSUM

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HOW TO PREVENT

WASH HANDS

WASH FRUITS AND VEGETABLES

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FRESH FOOD

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AVOID OUTDATED FOOD

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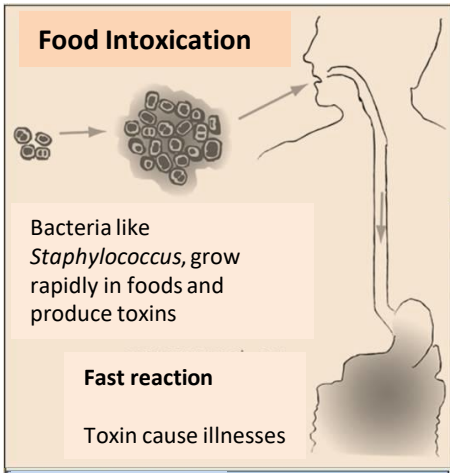
FOOD POISONING

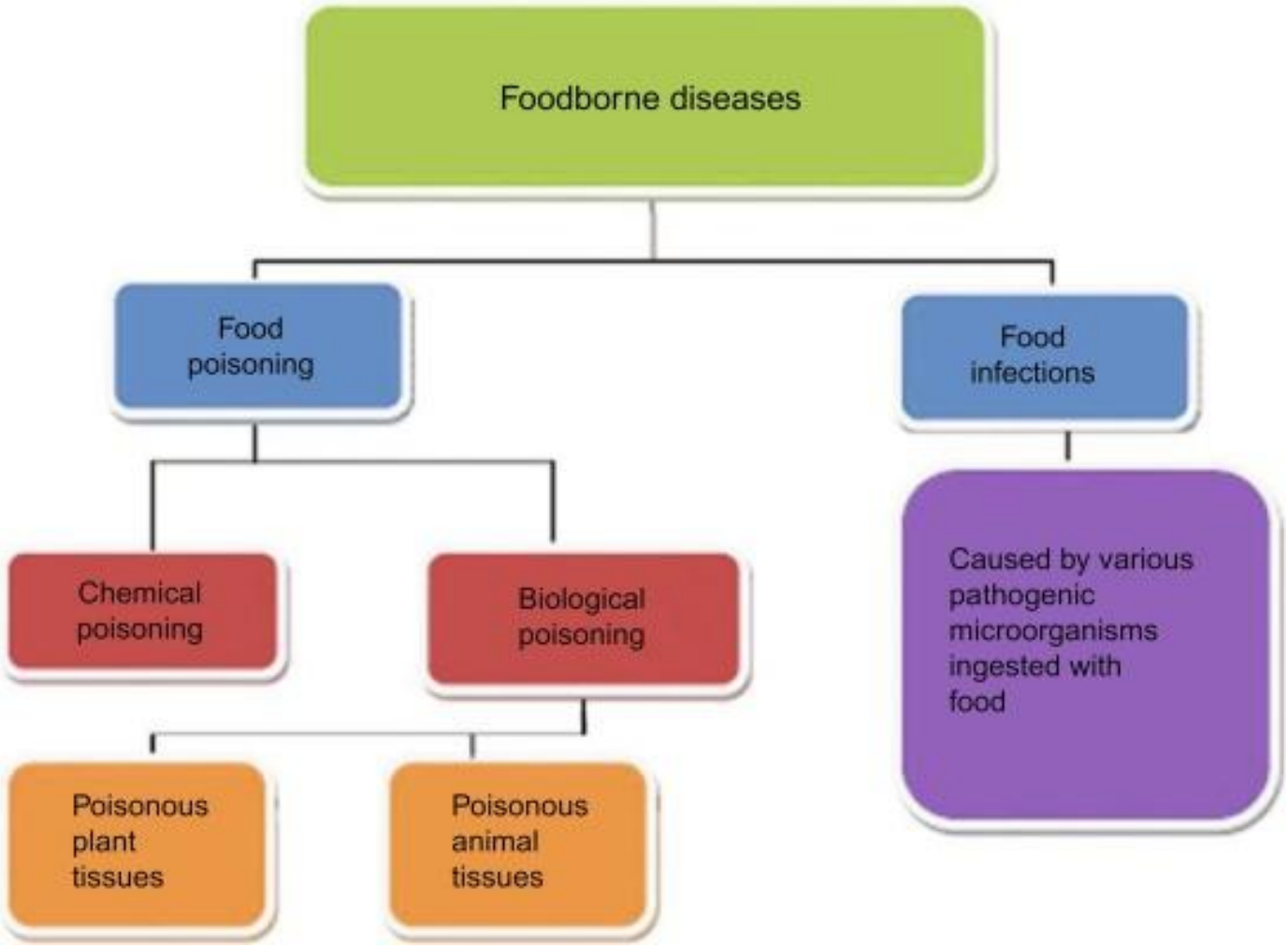
- Food poisoning is a disease caused by eating foods containing certain microbes or their toxins, poisonous animals, plants or chemicals.
- Food poisoning and infections occur with the onset of severe pain in the stomach and intestines after eating food. The time between eating the food and the appearance of symptoms is called the incubation period of the disease.
- Both the incubation and the severity of the symptoms differ from person to person. In general, symptoms include nausea, vomiting, cramps in the stomach and intestines, and diarrhea with severe pain. It is possible to divide these diseases into the following groups according to their causes:
  - Overeating; too much eating cause some metabolic disorders
  - Inadequate eating; taking lesser amounts of nutrients than the required amount.
  - Food sensitivity: some compounds causing allergy or sensitivity in some people
  - Food bacterial infection: Pathogens, comes from either raw material or contamination, cause illnesses
  - Food parasitic invasions: tenya, etc
  - Food Poisoning: Illness comes from taking microorganisms or their toxins by the foods.

FOOD POISONING

- The differences between the duration and severity of food poisoning are due to the following reasons:
  - The type of microorganisms that cause the disease.
  - The number of bacteria and toxin density in the food consumed (As the number of bacteria increases, the infection power of the bacteria or the amount of toxin increases, so the disease becomes more severe.)
  - The degree of sensitivity of individuals (very young, very old, sick and weak people are more sensitive.)
- Food poisonings are examined in groups according to their origin and causes, as explained below:
  1. Bacterial Food Poisoning
     - a - Intoxication type poisoning
     - b - Infection type poisoning
     - c. Toxico-Infection
  2. Poisoning from animal and plant foods
  3. Poisoning with chemical substances

Food Poisining





Food Poising

- In microbial poisings, chemical hazards that pose a danger to foods can be divided into three categories:
  - Chemicals present in the natural structure of food, such as Hemagglutinins in kidney beans, poisonous mushrooms, Japanese Fu-gu fish.
  - Additives that may pose hazards to the consumer due to overdose or reaction with other materials, such as Sodium nitrite (therapeutic agent > nitrosamines), coloring additives, preservatives, pesticides and fungicides.
  - Technical errors during sowing, harvesting, transportation and/or processing can contaminate food with chemicals. For example, packaging materials containing toxic substances in contact with food, cleaning agents, metals dissolved in the product and care materials.

FOODBORNE ILLNESES

Salmonellosis

Identification - The most common food borne illness caused by many species of bacterisa. It causes acute onset of head ache, fever, abdominal pain, diarrhea, nausea with occasional vomiting. Incubation period is 6-72 hours usually between 12-36 hours.
Reservoir - Exists in domestic and wild animals incudind poultry, pigs, cattle, rodents and pets such as baby chicksa and ducklings, trutles, igunas, dogs and cats.
Transmission - Ingestion of the organism in food obtained from infected animals or contaminated by feces from infected animals or peoples. Epidemics are traced to contaminated vegetables and fruit, eggs, processed meat, undercooked poultry products, raw milk and dairy products and foods prepared by infected food personnel.

Campylobacter Enteritis

Identification – An enteric disease caused by Campylobacter jejuni or C. coli accompained by malaise, diarrhea, bloody stools, abdominal pain, fever, nausea, and vomiting. Symptoms may occur 2-5 days after exposure and per sist for a week.
Reservior – Poultry, cattle and other animals such as puppies, kitten, other pets, swine, sheep, rodents and birds. Most raw poultry is contaminated with Campylobacter. **Transmission** – Ingestion of the organisms in under-cooked meat, contaminated water and food, raw milk, farm animals, pets. Infective dose is low. Person to person transmission is possible but not common.

Listeriosis

Identification – A disease which causes meningoencephalitis and/or septicemia in new-borns and adults that is caused by L. monocytogenes. In pregnant women it causes fever and miscarriage or stillbriths. An asymptomatic woman can transmit the disease to the fetus. High risk populations include neonates, elder ly, immunocompromised, pregnant women, alcoholics, diabetics.
Resrvior – Soil, silage, forage, and water. Animal reserviors include infected wild and domestic ani-mals. Up to 10% of the healthy people have L. monocytogenes in their feces but do not have symptoms.
Transmission – Ingestion of contaminated foods such as soft cheeses, raw milk, vegetables, ready to eat meats and pates. In neonatal infections, the bacteria is transmitted by the mother in utero or from passage through the birth canal.

Staphylococcal Food Intoxication

Identification – It is not an infection but is caused by the enterotoxins produced by Stapylococcusaureus. The disease is charachterized by abrupt (30 minutes to 4hours) and violent onset of vomiting, severe nausea, cramps, and prostration. Illness lasts a day or two. These entero toxins are resistant to boiling or thermal processing.
Reservoir – Humans. About 25% of the population carries this bacteria. Occa-sionally cows with infected udders, dogs and fowl.
Transmission – Ingestion of food containing the enterotoxin. The food becomes contaminated first with the bacteria via the food han-dlers' hands. At room temperatue, the bacteria multiply and produce the enterotoxin. Can be found in improperly handled or stored salad dressings, custards, sliced meat, meat products, meat sandwiches, unprocessed cheese.

E Coli O157:H7

Identification – Causes acute diarrhea with no fever. Incubation period is 2 to 10 days, most commonly 3-4 days. Diarrhea may be mild to severe with no blood or almost entirely blood. About 8% of people having diarrhea caused by this organism progress to hemolytic uraemic syndrome (HUS). Infectious dose is very low. Children under 5 are at greatest risk for developing HUS.
Reservior – Cattle are the primary res ervoir although it is also found in deer. Humans can serve as the reservoir for person to person transmission. **Transmission** – Fecal/oral and the ingestion of food contaminated with ruminant feces. Seious out-breaks have been associated with petting zoos, beef, hamburger, melons, spinach, lettuce, sallions, apple cider, alfalfa sprouts, and unpasteurized milk. Person to person transmission ocurs in families, custodial care facilities, and day care centers. Water borne transmis-sion comes from drinking and recreational water

Giardiasis

Identification – A protozoan infection that may be either asymptomatic, cause acute self-limiting diarrhea, or chronic, frequent diarrhea with camps, bloating and incomplete absortipon of fats and vitamins evertually leading to fatigue and weight loss. In severe giar diasis there may be reactive arthritis and damage to the duodenal and jeju nal mucosal cells. Median incubation is 7-10 days.
Reservior – Humans and possibly beavers and other wild and do-mesticated animals.
Transmission – Localized outbreaks occur from the ingestion of food and water contaminatd with protozoans cysts. Typical chlorine treated of drinking water is not enough to destroy the cysts. Unfil-tered, contaminated recreational water can be a source. Person to person transmission occurs from transfer of cysts from infected people particularly in day care centers and institutions.

Norovirus

Identification – A viral infection that causes mild to moderate gastrointes tinal illness with nausea, vomiting, diarrhea, abdominal pain, headache, malaise, and low grade fever. Usually lasts for 1-3 days.
Reservior – Humans are the only known reservior.
Transmission – Fecal/oral through ingestion of contaminated food, water or shell fish. Also contact with i nfected fomites.

Aflatoxin Intoxication

Identification – Liver cancer caused by food contaminated with certain species of Aspergillus fungi. As the fungi grow, they produce aflatoxins and other my cotoxins that contaminate the food. Incubation period for funal growth may be 2 days to 3 months
Reservoir – As pergullus funal species are ubiquitous and exist worldwide partucularly in decaying plant material, compost piles, mulch, and leaf piles. Aflatoxin and mycotoxin production is variable and depends upon the type of Aspergillus species and enviromental conditions.
Transmission – Airborne transmission of spores. Ingestion and posii-bly inhalation of mycotoxins.

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Microbial Hazards

- The hazards of foodborne pathogenic microorganisms have been known for many years.
  - Milk-borne tuberculosis and salmonellosis risks were identified at the beginning of the twentieth century and risky products were controlled by pasteurization;
  - Botulism, control of hermetically sealed cans (low acid foods) was achieved by applying a heat treatment above 100 °C.
- Despite the developments in food science and technology, foodborne diseases are seen with increasing serious diseases and death events in all countries and the increasing trend of microbial pathogens still continues.
- Food safety problems cause heavy economic losses as well as food-borne diseases and preventable deaths.
- In recent years, food contamination and foodborne diseases have been systematically evaluated.
  - Studies in the USA, Australia, Germany and India confirm the conclusion that millions of people are affected by various food-related adverse events (illness, death or economic damage).
  - It is reported that 30% of the population in industrialized countries is affected by such negativities every year.

Microbial Hazards

- The economic cost of food-borne adverse events caused by microorganisms;
  - In the United States, only seven pathogens cost $34 billion to human health.
  - In England and Wales in 1996, the medical cost was estimated to be between $300-700 million in addition to the loss of life due to five foodborne infections.
  - Based on the fact that there is an average of 11,500 food poisonings per day in Australia, a cost of approximately $2.6 billion per year has been calculated.
  - The cost of food poisoning caused by *Staphyloccus aureus* in India appears to be higher than in a similar outbreak situation in the USA.
- Disease outbreaks such as *Escherichia coli* and *Salmonella*, as well as others, cause serious food safety problems and consumer concern.
- Although the ecology of the organisms that cause food poisoning is known, their control cannot be fully achieved from time to time.
  - Inadequate and wrong production techniques, the inability to control the hazards in agricultural production, food production and processing can also be explained by reasons such as the fact that foodstuffs constitute a good medium for microorganisms.
  - The negativities caused by the microorganism show an increasing trend and the resistance to many antibiotics is also increasing.

Microbial Hazards

- Over the past two decades, many microorganisms have been recognized as potential causes of foodborne illness.
  - For example, microorganisms such as *Listeria monocytogenes*, *Clostridium perfringens, Campylobacter jejuni, Vibrio parahaemolyticus, Yersinia enterocolitica* have been identified as disease agents.
- Food production, processing, preparation, storage and packaging procedures have led to the fact that the danger factors for food safety are different, as well as their emergence in different ways.
  - For example, *Listeria monocytogenes* and *Clostridium botulinum* appear due to changes in processed and packaged foods.
- Effective prevention and control of such microorganisms requires the application of GAP principles in the primary production stage, as well as the placement of systems such as HACCP and GMP in the food processing process.

Microbial Hazards

- Mycotoxins are toxic, carcinogenic, mutagenic and teratogenic chemicals of biological origin produced by certain molds.
- Important mycotoxins include aflatoxins, ochratoxins, fumonisins, patulin, zeralenone and trichothecenes.
- Dry fruits such as hazelnuts, pistachios, peanuts, walnuts, almonds and corn are sensitive to mycotoxin contamination.
- Aflatoxins are the most studied mycotoxins, and the relationship between their intake into the body and causing liver cancer has been clearly demonstrated.
- Almost all plant origin products work as a good substrate for fungal growth, followed by mycotoxin contamination of the raw material to be used for food and feed purposes.
- It is now well known that feed material contaminated with mycotoxins even passes into the milk of animals.

Food Microbiology

Food microbiology mainly deals with microbiological quality and control of microorganisms in food.

- New technological purposes (in food production, processing, distribution, storage and food consumption) introduce new problems.
- They can not be solved by just using known microbiological knowledge.
  - Food microbiology deals with these problems and effectively solves them.

Food Microbiology

- The microbiological knowledge should include:
  - food spoilage,
  - foodbome diseases,
  - effective control of microorganisms,
  - bioprocessing of foods,
  - basic information of microbial physiology,
  - metabolism and genetics,
  - developing methods for rapid and effective detection of spoilage and pathogenic microorganisms,
  - developing desirable microbial strains to produce foods,
  - produce fermented foods of better quality,
  - producing enzymes and food additives,
  - developing methods to remove bacteria from food and equipment surfaces, and
  - developing methods for effective control of spoilage and pathogenic microorganisms in food.

Food Microbiology

An individual who has complete courses in **food microbiology** (both lecture and laboratory) should gain some basic knowledge in the following areas:

- Determination of microbiological quality of foods.
- Uses of ingredients in food production.
- Knowing sources of microorganisms contaminating with foods.
- Determination of microbial types involved in spoilage, and foodborne disease.
- Design correct procedures to control the spoilage and pathogenic microorganisms in food.
- Apply new techniques in food processing
- Apply knowledge to overcome the new problems.
- Design effective sanitation procedures to control spoilage and pathogen problems in food processing area.
- Use desirable microorganisms to produce fermented foods.
- Design methods to produce better starter cultures in the production of fermented foods and probiotic.
- Apply food regulation standards.