FE 305 FOOD MICROBIOLOGY
Source of Microbial Contamination of Foods

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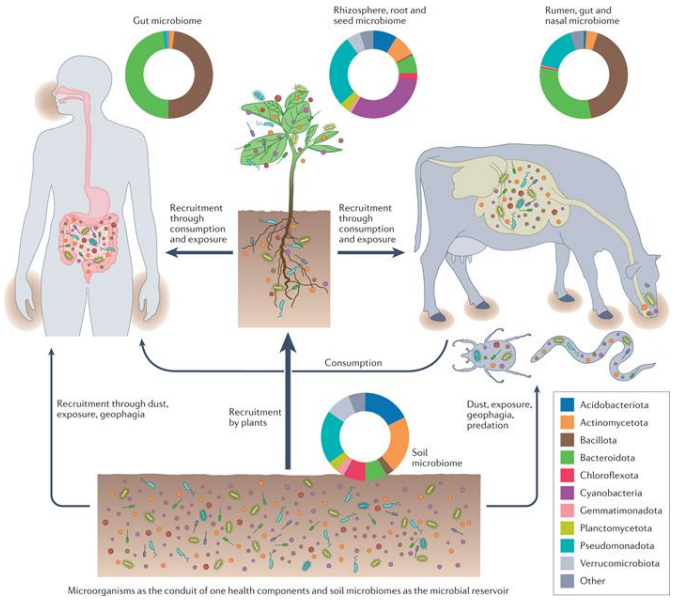
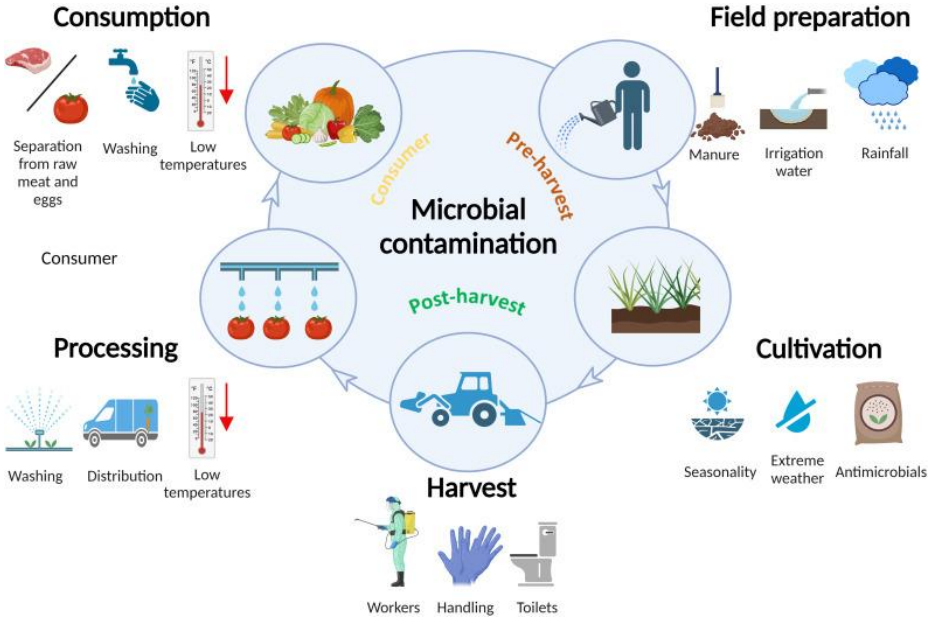
Introduction

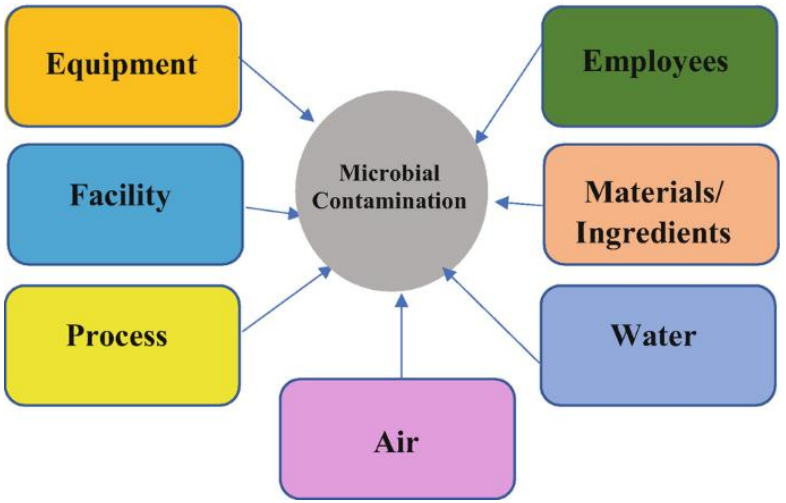
- The microorganisms in the food are from;
  - The natural microflora of the foods and
  - Contamination from air, dust, water, animals, people, birds, etc.
    - During the harvesting, processing, storage, distribution and food preparation.





Sources of Microbial Contamination

- Microbial flora of foods with microorganisms naturally found on food; creates microorganisms contaminated from outside/environment during storage, transportation and processing activities.
- In order to prevent food-borne intoxications or infections, and to extend the storage period of foods, contaminations must be prevented / kept at a minimum.
- Sources of contamination of food by microorganisms:
  - Soil
  - Water- sewage
  - Air
  - People
  - Animal-Herb
  - Equipment
  - Raw materials and additives

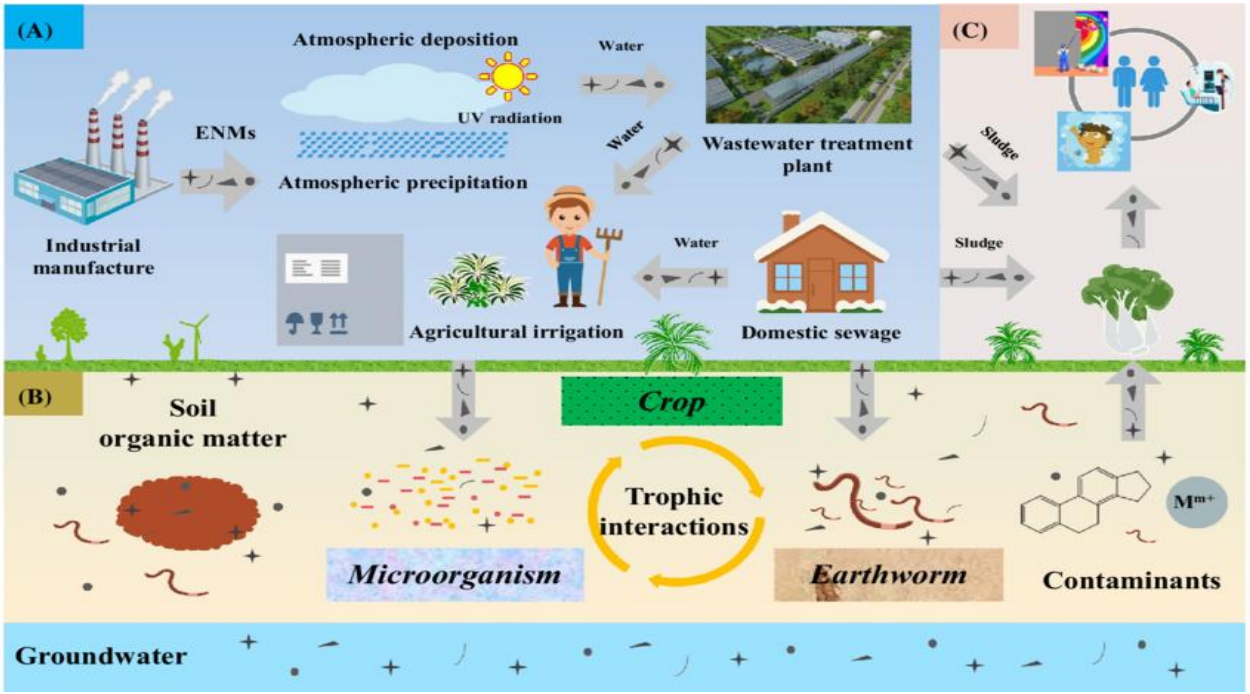


Soil

- Soil acts as a natural environment for many microorganisms. Microbial density is greater at the surface of the soil than at the depths. Most microorganisms are found in the first 50 cm of soil surface depth.
- The number of microorganisms in the soil; It varies according to the moisture content of the soil, acidity, temperature and whether it contains fertilizer or not.
- Microorganisms in the soil can be transmitted to fruits and vegetables by direct contact or by their tubers and roots in the soil. Contamination may occur when the wind blows dust from the soil surface or the food that grows close to the soil surface by splashing mud during heavy rains.
  - Cereals are most susceptible to contamination during harvest.

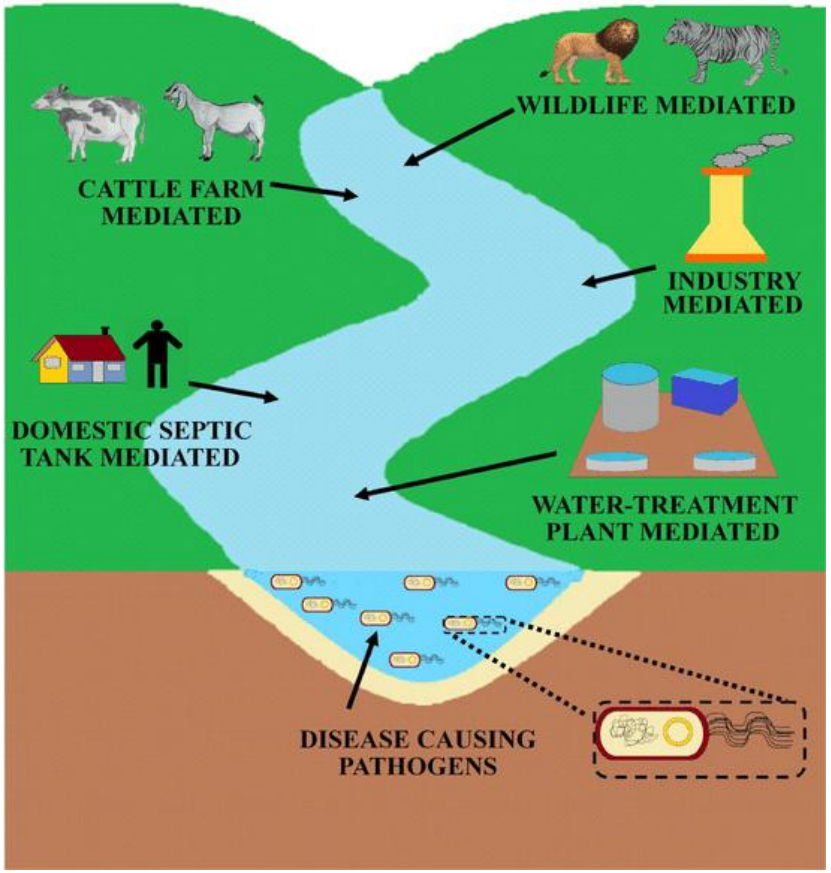
Soil

- Microorganisms in the dust formed as a result of the drying of the soil surface are dispersed to other soils, rivers and oceans as a result of the dispersion of the dust by the wind.
  - Bacteria of the genus *Alcaligenes, Bacillus, Clostridium, Corynebacterium, Micrococcus, Pseudomonas and Serratia*, as well as molds, *Actinomycetes* and many yeast species are microorganisms found in the soil.
  - Yeasts are common in the soil of orchards and vineyards.
  - Molds are found in various soil types, usually in the form of mold spores.



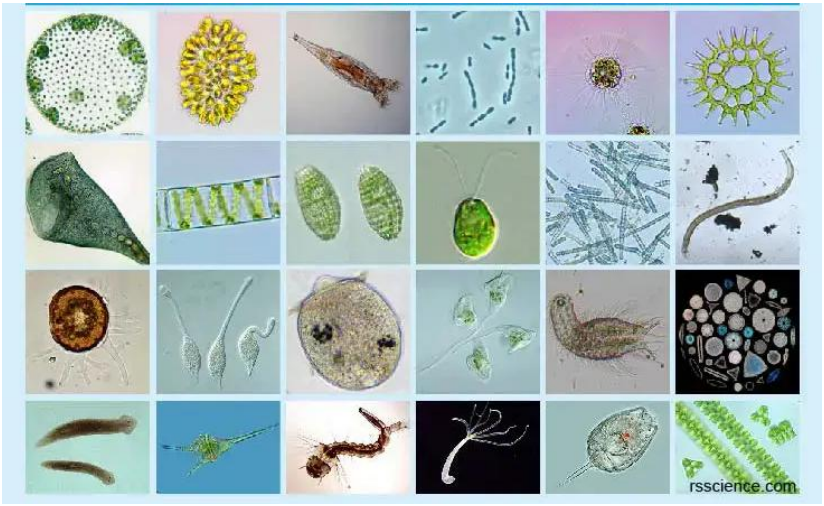
Water

- Water interacts with food in many areas, from growing and processing food to cleaning food contact surfaces. Water can also host many microorganisms in its natural flora.
- Water is used for;
  - Irrigation of crops,
  - Drinking by animals,
  - Fishery and marine products,
  - Washing of foods
  - Processing and storage of foods (e.g. Fish on ice),
  - Processing and transportation facilities and
  - Ingredients in many processed foods.
- Thus water quality can greatly influence the microbial quality of foods.



Water

- Microorganisms are also spread by the movement of the clouds formed over large water bodies by the wind and the water falling back to the soil surface in the form of rain. Therefore, it should not come as a surprise that the microorganisms found in water and soil are the same.
- It is accepted that the bacteria listed below and specified as foodborne are mostly transmitted from water and soil.
  - *Alcaligenes, Bacillus, Citrobacter, Clostridium, Corynebacter, Enterobacter, Micrococcus, Proteus, Pseudomonas and Serratia*,
  - Almost all molds are found in water and soil.
  - Molds are microorganisms that play a very important role in the breakdown of plant and animal substances and cause diseases in plants, and they are very common in nature.
    - For example: *Aspergillus, Rhizopus, Penicillium, Trichotechium, Botrytis and Fusarium*
  - Since most of the yeasts are mostly related to plants, their number in water is quite low.



Water

We can examine the microorganisms found in water in three groups:

1. Microorganisms Naturally Found in Water

- *Vibrio, Pseudomonas, Sarcina, Micrococcus, Aeromonas* etc. with optimum growth temperature of 25°C or less. There are certain types of bacteria.

2. Microorganisms Living in Soil

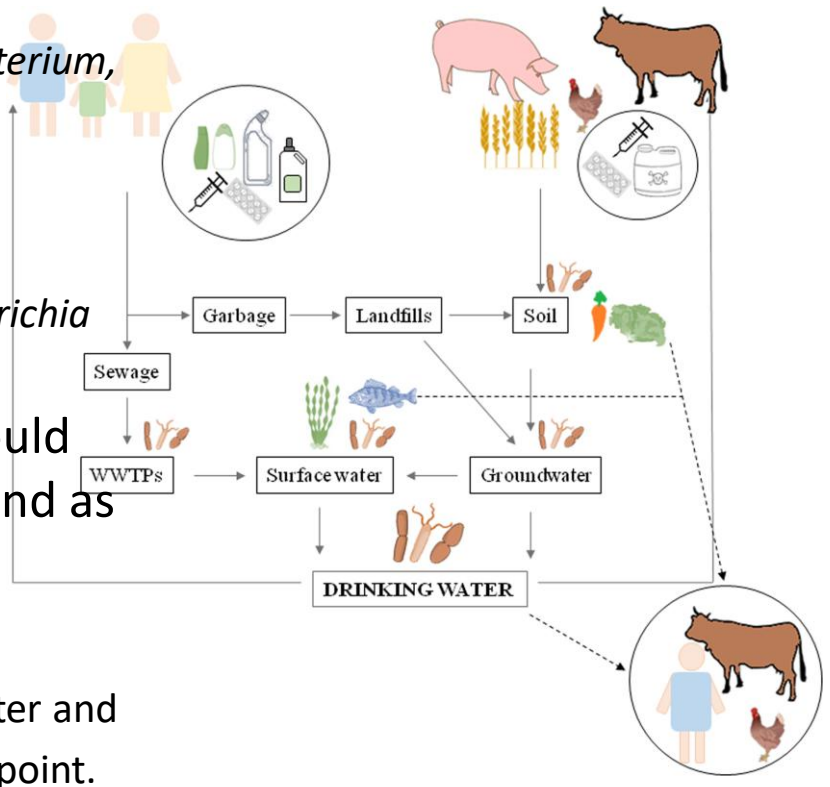
- This group includes the saprophytic members of the *Bacillus*, *Streptomyces* and *Enterobacteriaceae* family, which mix with the water as a result of washing the soil and have an optimum growth temperature of 25°C or lower.

3. Natural Microflora in the Intestines of Humans and Animals

- *E. coli, Streptococcus faecalis, C. perfringens, Klebsiella* etc., which cause hygienic deterioration of waters. It is contaminated to the waters from the feces and urine of humans and animals. Such contaminated water is not drinkable or used.

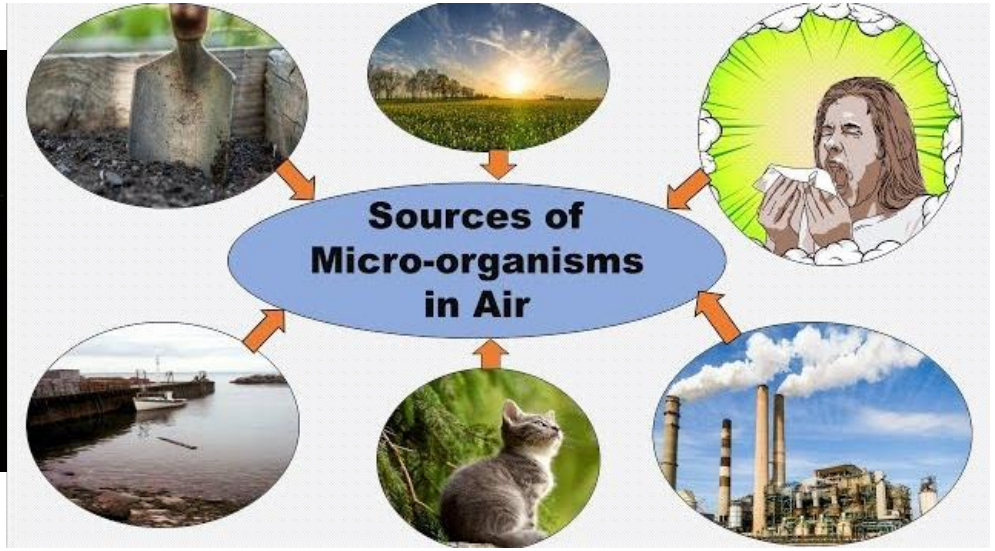
Water

- Water will contaminate microorganisms with foods
  - Directly or indirectly by hands, equipment, utensils and the like.
- Water can contain spoilage microorganisms;
  - Such as *Alcaligenes, Bacillus, Chromobacterium, Enterobacter, Enterococcus, Escherichia, Flavobacterium, Micrococcus, Proteus*, and *Pseudomonas*.
- Improperly treated water may also contain pathogen;
  - Such as *Salmonella, Staphylococcus aureus, Escherichia coli*, etc.
- Treated water, such as chlorine-treated, should be used in processing, washing, sanitation and as ingredients.
- Water used for foods should
  - meet the bacteriological standards of drinking water and
  - be acceptable from sanitary and economical viewpoint.



Air

- Air has no microflora of its own. Microorganisms in the air are generally of dust, soil and plant origin, and they rise with the effect of the wind and form the microflora of the air as a result of mixing into the air. Humans also affect the microflora of the air. Millions of microorganisms enter the air when coughing, sneezing and talking. Especially in closed areas;
  - Air flow rate,
  - The number of people in the area and
  - The mobility of people is decisive on the microbial load of the air.
- Microorganisms commonly found in the air are *Streptococcus* species in dairy factories; in breweries they are yeasts.
- Microorganism load in the section where raw foods or live animals are present in food establishments is much higher than in clean areas.



Air

- When the air to be taken into operation from outside is filtered, the air is directed to move from inside to outside, air circulation is provided from clean areas to polluted areas, airborne contaminations are prevented.
- Microorganisms in air and dust include all types of microorganisms except some pathogens. Apart from these, *Staphylococcus* and *Salmonella* species are also found in the air and dust, although they are not the main source of contamination to foods.
- Among the microorganisms found in air and dust, *Bacillus* and *Micrococcus* species, which are resistant to varying degrees of dryness, are particularly noteworthy. From time to time, various types of molds and yeasts are also encountered.

People

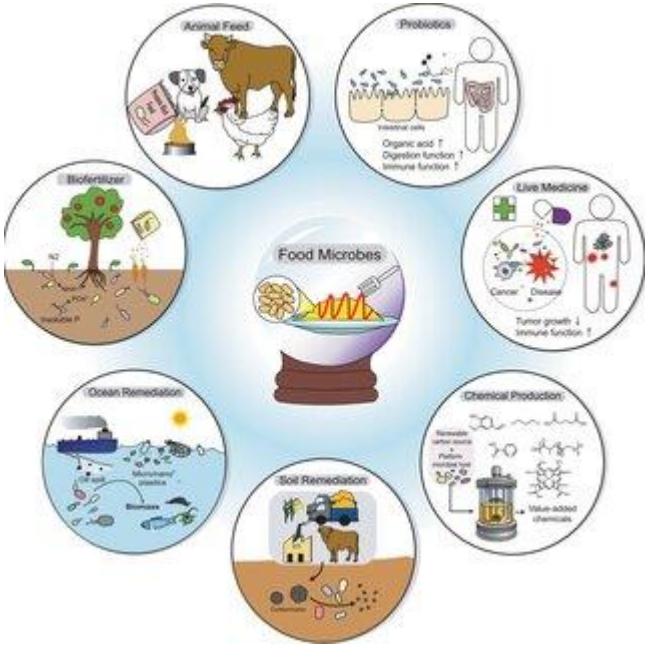
- The microflora of the human body begins to form from the moment of birth. People become contaminated with microorganisms from every environment they come into contact with.
- They can also transmit microorganisms on their clothes, things, other people and food.
- The human body microflora can vary from person to person and depending on external factors. Washing the body and personal cleaning agents are especially effective on the skin microflora. The drugs used and the foods consumed affect the microflora of the digestive system.
- Food is in contact with humans at many stages (preparation, processing, packaging, storage, transportation) from harvest to final consumer.

People

- This makes humans the most important source of contamination. Especially hands, clothes, mustache, accessories, breath, saliva are important points that affect the microbial load of food.
- *Staphylococcus* species in the nasal and throat mucosa of humans and *E. coli* in the intestine are the main microorganisms.
- For this reason, the hygiene and training of the personnel is important in terms of preventing contamination.
- The microbiota found on the hands of food workers and on the outer surface of their clothes gives important clues about the habits and environment of the worker.
  - The microbiota can normally be composed of organisms found on any item that people come into contact with, or it can originate from dust, water, soil and similar environments.
  - There are various types of microorganisms that are transmitted from the hands, nasal cavity and mouth.
  - Among these genera, *Micrococcus* and *Staphylococcus* are the most notable ones, and *Staphylococcus* are commonly found on the hands, arms, nasal cavity, mouth and other parts of the body.
  - *Salmonella* and *Shigella* genera are mainly of intestinal origin, and if people do not comply with sanitation rules, they are transmitted to food.

Animals

- A healthy muscle tissue is considered sterile.
- After slaughter, it begins to be contaminated with dust, soil and intestinal microorganisms.
  - Among these microorganisms, pathogenic *Brucella, Coxiella, Listeria, E. coli, Salmonella* etc. In addition to bacterial species, there are non-pathogenic soil-borne bacteria and some parasites.
- Farm animals become infected by feeding on contaminated feed or by coming into contact with the droppings of animals and birds.
- While the pre-milking milk of a healthy animal is sterile, there may be contamination from the udder, hands, milking tools and containers after milking.
  - There may be *Staphylococcus* and *Micrococcus* species in raw milk flora.
  - *S. aureus* bacteria are found in the milk of animals infected with mastitis disease.
- While healthy animal eggs are considered sterile immediately after laying, they can be infected with fecal *Salmonella* bacteria.
- Insects, flies, pests and rodents play an important role in the transport of microorganisms and their contamination with food.



Animals

Animal Feeds

- One or all of the bacteria, molds and yeasts mentioned so far can be found in animal feed.
- The type of microorganisms found in feeds depends, first of all, on the source and type of feed, whether a process is carried out to kill microorganisms, the type of packaging material in which it is stored, and similar factors.
- Feeds play an important role in the spread of the *Salmonella* genus, which causes food infection. Once these organisms are seen in one part of the enterprise, their distribution is very rapid.

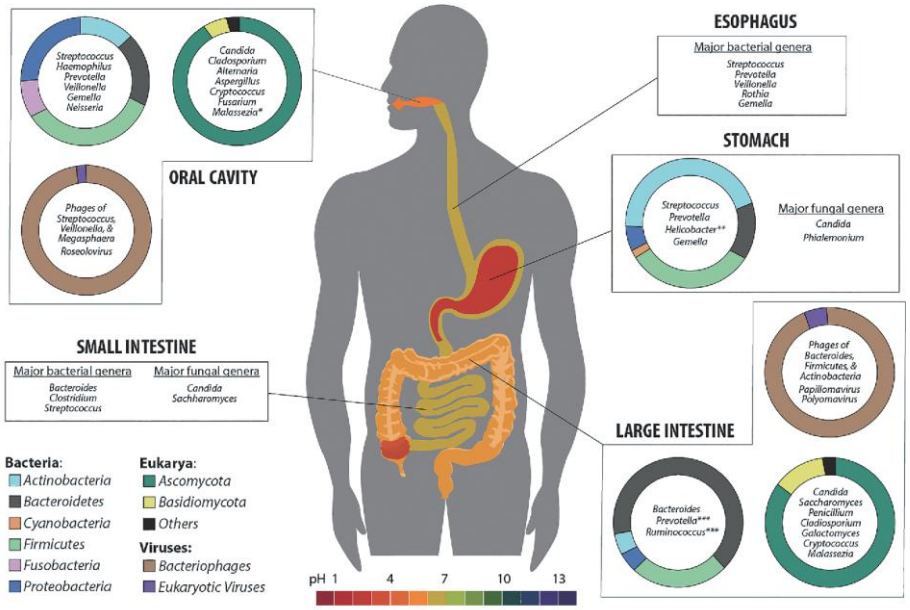
Animal Skins and Hides

- Microorganisms found in soil, water, animal feed, dust and fecal sources can all be found in animal skins and hides.
- These microorganisms can also be transmitted from animal hides to the hands of workers or directly to food.
- Some organisms in the skin and post microbiota can settle in the lymph system of butchery animals and pass to the muscle tissue after slaughter.

Intestinal Track of Animals and Humans

- This environment contains bacteria that are more often found in the intestinal tracts of animals and humans than in soil, water, or other places.
  - The most common among them are; *Bacteroides, Escherichia, Lactobacillus, Proteus, Salmonella, Shigella, Staphylococcus* and *Streptococcus*.
  - The most notable among these is the genus *Escherichia*, whose natural habitat is the intestinal system of humans and other mammals.

- Apart from these, *Clostridium, Citrobacter, Enterobacter* and *Pseudomonas* can be counted among the genera frequently seen in the intestinal system.
- Intestinal bacteria can directly enter the soil and water from the intestinal systems of animals. They can also infect plants, dust and food containers from soil and water.
- Although the presence of molds in intestinal systems is not thought much, yeast species belonging to the genus *Candida* are frequently encountered, especially in the human intestinal tract.



Intestinal Track of Animals and Humans

- When foods are touched with contaminated hands,
  - Pathogens of intestinal origin have a good chance to contaminate food.
- Bacterial pathogens from intestinal tract can cause cholera, bacillary dysentery, typhoid fever and infectious hepatitis.
- Genera of bacteria most commonly present in intestinal tract of man and animals are:

Bacteroides
Bifidobacterium
Citrobacter
Clostridium
Enterobacter
Escherichia
Fusobacterium
Klebsiella
Lactobacillus
Paracolobacterium
Pseudomonas
Salmonella
Shigella
Staphylococcus
Streptococcus

- Sanitation of foods and drink, and sanitary sewage disposal are important in the prevention of microbial spread to environment.
- Patients with the disease or carriers should not work in the food production.

Plants and Plant Products

- Plants; soil, water, fertilizer and animal etc. contaminated by microorganisms from different sources. The natural flora of different fruits also differs from each other.
  - Yeasts such as *Saccharomyces, Hansenula, Torulopsis, Candida* in the natural flora of fruits and vegetables,
  - Bacteria such as *Pseudomonas, Alcaligenes, Micrococcus, Flavobacterium*, and faecal coliform group bacteria and lactic acid bacteria are frequently encountered in the flora of plants.
- *Salmonella, Shigella, Vibrio cholera* etc. in vegetables that come into contact with sewage mixed waters. Bacteria and protozoa such as *Entamoeba hystolytica* can be encountered.
- Ground maize, wheat and rice contain spore-forming bacteria such as *B. cereus* and *C. perfringens*.
- However, some bacteria are more associated with plants than with soil.
  - Among these genera, especially *Acetobacter, Erwinia, Flavobacterium, Kurthia, Lactobacillus, Leuconostoc, Pediococcus and Streptococcus* genera are important. From time to time, some genera not listed above can also be found on plants and herbal products.
  - Among the molds, the most important plant-derived strains are those that cause spoilage during the marketing of fruits and vegetables.
  - The yeast genus *Saccharomyces* found in many plant products and especially fruits. *Rhodotorula* is also a common yeast.

Plants and Plant Products

- Plants may contain human pathogens,
  - from contaminated soil, water, human hand, animal, air, harvesting equipment, raw sewage and the others.
- Fruits and vegetables carry a natural flora
- Fruits and vegetables contain microorganisms on surface;
  - Their type and level vary with soil condition, type of fertilizers and water used, and air quality.
- Natural surface flora of plants usually includes species in the following genera:

Acetobacter
Alcaligenes
Bacillus
Clostridium
Enterobacter
Erwinia
Flavobacterium
Lactobacillus
Leuconostoc
Listeria
Micrococcus
Pediococcus
Pseudomonas
Streptococcus
Xanthomonas

Plants and Plant Products

- Some species from *Saccharomyces*, *Rhodotorula* and *Torula* are important plantborne yeast;
  - cause spoilage on vegetables and fruits (so called market disease).
- Mold genera commonly present on plant foods are *Aspergillus*, *Alternaria, Botrytis, Fusarium, Penicillium* and *Cladosporium*.
- Enteric pathogens can associate with plant foods;
  - If the soil is contaminated with untreated sewage.
- Followings increase the microbial numbers and types on planty foods:
  - Disease of plants;
  - Damage of surface before, during and after harvesting;
  - Long delays between harvesting and washing; and
  - Unfavorable storage and transport conditions after harvesting.

Plants and Plant Products

- Microbial loads can be reduced in planty foods
  - By proper methods, used during handling (such as use of treated sewage or other types of fertilizers),
  - Reducing damage during harvesting,
  - Quick washing with good quality water to remove soil and dirt, and
  - Storage at low temperature until processing.

Equipment

- In order for the cleaning to be carried out effectively in food establishments, there must be gaps between the equipment, between the equipment and the ceiling and the wall to allow cleaning.
- All tools and equipment used in production and come into contact with food, containers and containers used repeatedly; It should be made of materials that are health-friendly, easy to clean, smooth and not causing contamination. This material should also be resistant to substances such as alkali, acidic and salt used in cleaning and to factors such as heat and steam.
- Workplaces should be established in such a way as to prevent the entry of living creatures and environmental pollutants that may be a source of contamination.
- Wood materials that are open to microbial growth and difficult to clean and disinfect should not be used, except in mandatory areas.
- Equipment used for raw and cooked food should be separate to avoid cross-contamination.
- The type of microorganisms present on food containers depends on the type of food being processed, the treatment of these containers, their storage conditions and other factors.

Equipment

- If vegetables are constantly processed in the same containers, naturally there will be microorganisms related to the vegetable in question in these containers.
- If the containers are washed with hot or boiling water, the remaining microbiota consists of microorganisms that are resistant to this process.
- On the other hand, if the containers are stored in an open dusty place, they also contain airborne bacteria, yeast and molds.
- When processing equipment is used continuously for a long period of time, microorganisms can multiply.
  - Therefore, they can act as a continuous source of microorganisms for product.
- Improper sanitation of equipment such as utensils, cutting boards, knives, spoons and others can be the source of cross-contamination.
- *Bacillus, Clostridium, Enterobacter, Escherichia, Lactobacillus, Listeria, Leuconostoc, Micrococcus, Pseudomonas, Salmonella*, yeasts and molds can contaminate the food from equipment.
- Packaging materials used in food production should be in the proper microbiological standards.
- Prevention;
  - Adequate equipment,
  - Hygienic design,
  - Sanitation
  - Effective cleaning
  - can reduce microbial contamination from utensils.

Raw Materials and Additives

- In addition to the natural flora of the food, air, water, soil, tools, equipment, personnel, etc. Contamination with microorganisms from sources makes food risky for health. Consumption of infected foods can cause various diseases in living things.
- Various additives added to food can contaminate foods with a high number of microorganisms, even if they are added in small amounts. Additives, especially in processed foods, are important sources of contamination.
  - Since spices are of vegetable origin, they are carriers of many microorganisms of soil, water and animal origin.
  - Heat-resistant *Bacillus* and *Clostridium* spores can be found in canned foods preserved by commercial sterilization.
  - Fish containing halophilic bacteria and salted with sun-dried salts may deteriorate.
  - *Osmophilic* yeasts and *Xerophilic* molds found in concentrated syrups added to foods to reduce water activity can cause food spoilage.
  - Starch, sugar and flour can contain spores of thermophilic bacteria.
  - Pathogens may present in the dried egg and chocolate, such as *Salmonella*.

Primary Source of Food Poising Microorganisms

- The most important food poisoning bacteria and their common sources:
- *Staphylococcus aureus* associates with nasal cavity of man and animals as well as with other parts of body.
- *Salmonella enterica* ser. *Typhimurium* and *S. enteritidis* are indigenous to the intestinal tract of man and animals, poultry and eggs.
- *Streptococcus pyogens* can associate with nasal cavity of man and animals.
- *Bacillus cereus* can associate with starchy foods, such as rice and pasta dishes and small meat dishes,
- *Campylobacter jejuni* can associate with water, poultry and milk.
- *Listeria monocytogenes* can associate with vegetables, milk and soft cheeses.
- Brucella can associate with meat from an infected animals, raw milk, cream and cheese prepared from raw milk.
- Clostridium perfringens associate with soil.
- Pathogenic *Escherichia coli* mainly present in intestinal tract of man and animals.