Microbial spoilage of foods.

Cause of spoilage:

Spoilage may be due to one or more of the following:

1. Growth and activity of microorganisms
2. Insects
3. Action of the enzymes of the plant or animal food.
4. Purely chemical reactions i.e., those not catalysed by enzymes of the tissues or of microorganisms
5. Physical changes such as those caused by freezing, burning, drying, pressure etc.

Classification of foods by ease of spoilage:

1. Non perishable foods:

These foods which do not spoil unless handled carelessly include such products as sugar,flour and dry beans.

2. Semi perishable foods:

If these foods are properly handled and stored, they will remain unspoiled for a long period. Ex: Potatoes, apples etc.

3. Perishable foods:

It includes most important daily foods that spoil quickly . Ex: Meats, fish, poultry, milk, eggs, fruits and vegetables.

<u>Food Preservation</u>

Food preservation is the name for a number of processes that help to preserve food, involves preventing the growth of microorganisms, as well as preventing the oxidation of fats that cause rancidity. Food preservation may also include processes that inhibit enzymatic browning reaction in apples after they are cut during food preparation.

*Principles of food preservation

1) Prevention or delay of microbial decomposition

a. By keeping out microorganisms (asepsis)

b. By removal of microorganisms, e.g., by filtration, etc.

c. By hindering the growth and activity of microorganisms, e.g., by low temperature, drying, anaerobic conditions, or chemicals.

d. By killing the microorganisms, e.g., by heat or radiation

2) Prevention or delay of self-decomposition of the food.

a. By destruction or inactivation of food enzymes, e.g., by blanching

b. By prevention or delay of purely chemical reactions, e.g., prevention of oxidation by means of an antioxidant

3. Prevention of damage because of insects, animals, mechanical caused, etc.

<u>Asepsis:</u>

It is the keeping out microorganisms as a preservative factor. The inner tissues of healthy plants and animals usually are free from microorganisms. If there is a protective covering about the food, microbial decomposition is delayed or prevented. Ex: Shells of nuts, skins of fruits & vegetables, shells of egg and fat on meat or fish. Packaging of foods is a widely used application of asepsis.

<u>Removal of Microorganisms:</u>

Removal of microorganisms is not very effective in food preservation but under special conditions it may be helpful. Removal may be accomplished by means of filtration, centrifugation, washing, trimming.

a) Filtration:

It is the only successful method for the complete removal of organisms and its use is limited to clear liquids. This method has been used successfully with fruit juices, beer, soft drinks, wine and water.

b) Centrifugation :

It is not very effective. All microorganisms are not removed.

Ex: 1) Used in the treatment of drinking water but it is insufficient to remove micro organisms

2) In the milk, main purpose of centrifugation is not to remove bacteria but to take out other suspended materials, but bactofugation is to remove bacteria from milk.

c) Washing:

Washing raw foods remove spoilage microorganisms.

Ex: Cabbage heads or cucumbers before their fermentation into sauerkraut and pickles, removes most of the soil microorganisms on the surface.

Washing fresh fruits and vegetables removes soil organisms that may be resistant to the heat process during canning.

Washing foods is dangerous if water adds spoilage microorganisms and increases the moisture so that growth of spoilage organisms is encouraged.

d) Trimming:

Spoiled portions of a food removed by trimming. Large no. of spoilage organisms are removed by this way.

Ex: Trimming the outer leaves of cabbage heads for the manufacture of sauerkraut.

Maintenance of Anaerobic conditions:

Packaged foods may have the anaerobic conditions in the container.
A complete fill, the head space in a can or replacement of the air by CO_2 or by an inert gas such as nitrogen will bring about anaerobic conditions.
Spores of aerobic bacteria may resistant to heat and survive in canned foods but unable to grow in the absence of O_2.

*<u>Preservation of food by low temperature:</u>

The main microbiological objective in low-temperature preservation of food is to prevent or reduce growth of microorganisms. Low temperature also reduces or prevents catalytic activity of microbial enzymes, especially heat-stable proteinases and lipases. Germination of spores is also reduced, but spores are not killed at low temperature . Low-temperature storage, especially freezing, is also lethal to microbial cells, and under specific conditions, 90% or more of the population can die during low-temperature preservation.

The metabolic activities, enzymatic reactions, and growth rates of microorganisms are maximum at the optimum growth temperature. As the temperature is lowered, microbial activities associated with growth slow down.

Normally, the generation time, is doubled for every 10C reduction in temperature. Thus, a species dividing every 60 min in a food at 22 C will take 120 min to divide if the temperature is reduced to 12C.

The lag and exponential(Log) phases and the germination time (of spores) for some psychrotrophs (mesophilic types) become longer as the temperature is reduced to 0C or even to –1C.

The term ***psychrophile*** is applied to organisms that grow over the range of subzero to 20°C, with an optimum range of 10-15°C.

The term ***psychrotroph*** is an organism that can grow at temperatures between 0°C and 7°C and produce visible colonies (or turbidity) within 7-10 days. Some psychrotrophs in fact, *mesophiles*. The microorganisms that cause the spoilage of meats, poultry, and vegetables in the 0-5°C range would be expected to be psychrotrophs.

Table 1: Bacterial Genera That Contain Species/Strains Known To Grow at or below 7°C

Gram Negatives	***Gram Positives***
Acinetobacter	
Aeromonas	*Bacillus*
Alcaligenes	*Brevibacterium*
Alteromonas	*Brochothrix*
Cedecea	*Carnobacterium*
Chromobacterium	*Clostridium*
Citrobacter	*Corynebacterium*
Enterobacter	*Deinococcus*
Erwinia	*Enterococcus*
Escherichia	*Kurthia*
Flavobacterium	*Lactobacillus*
Halobacterium	*Lactococcus*
Hafnia	*Leuconostoc*
Klebsiella	*Listeria*
Moraxella	*Micrococcus*
Morganella	*Pediococcus*
Photobacterium	*Propionibacterium*
Pantoea	*Vagococcus*
Proteus	
Providencia	
Pseudomonas	
Psychrobacter	
Salmonella	
Serratia	
Shewanella	
Vibrio	
Yersinia	

Methods:

A. Common or cellar storage:

The temperature in common or cellar storage usually lower than 15°C. Root crops, potatoes, cabbage, celery, apples stored for limited periods.

Fruits and vegetables by their own enzymes and by microorganisms is not prevented but is slower than at atmospheric temperatures.

B. Ice Chilling

This is used in retail stores where the foods are kept over ice; the surface in contact with the ice can reach between 0 and 1°C. Fresh fish, seafood, meats, cut fruits, vegetable salads (in bags), are stored by this method. Temperature fluctuation (due to the size of the container or melting of ice), duration of storage (fresh or several days), and cross-contamination can cause microbiological problems, especially from foodborne pathogens.

C. Refrigeration

Refrigeration temperature at 4 to 5°C. For perishable products, 4.4 °C is considered a desirable refrigeration temperature. Commercial food processors may use as low as 1°C for refrigeration of perishable foods (such as fresh meat and fish). For optimum refrigeration in commercial facilities along with low temperature the relative humidity and proper spacing of the products are also controlled. Raw and processed foods of plant and animal origin, as well as many prepared and ready-to-eat foods, are preserved by refrigeration.

For refrigerated products , the products are nonsterile, even a very low initial microbial population (e.g., £10 cells or spores per 10 g), capable of growing (or germinating) under the storage condition, can multiply to reach hazard (for pathogen) or spoilage levels, thereby reducing the safety and stability of the product. Any fluctuation in temperature or other abuse (e.g., a leak in a vacuum or modified atmosphere package, or oxygen permeation through the packaging materials) can greatly accelerate their growth.

D. Freezing

Freezer temperatures are those at or below -18°C., a temperature at which most of the free water in a food remains in a frozen state. Dry ice (–78°C) and liquid nitrogen (–196 °C) can also be used for freezing . Raw produce (vegetables, fruits), meat, fish, processed products, and cooked products (ready-to-eat after thawing and warming) are preserved by freezing.

The two basic ways to achieve the freezing of foods are quick and slow freezing. **Quick or fast freezing** is the process by which the temperature of foods is lowered to about -20°C within 30 minutes.

Slow freezing refers to the process whereby the desired temperature is achieved within 3-72 hours. This is essentially the type of freezing utilized in the home freezer.

Quick freezing possesses more advantages than slow freezing, from the standpoint of overall product quality. Quick freezing possesses more advantages than slow freezing, from the standpoint of overall product quality. The two methods are compared below:

Table 2: Comparison of Freezing Methods

Quick Freezing	**Slow Freezing**
• small ice crystals formed, there is less mechanical damage of food. • blocks or suppresses metabolism • Time required is 30 min • no adaptation to low temperatures • thermal shock • no protective effect • microorganisms frozen into crystals	• large ice crystals formed, more mechanical damage of food is observed. • breakdown of metabolic rapport • Time required is 3-72 hrs. • gradual adaptation • no shock effect • accumulation of concentrated solutes with beneficial effects

Effect of Freezing on Microorganisms

• There is a sudden mortality immediately on freezing, varying with species.
• The proportion of cells surviving immediately after freezing die gradually when stored in the frozen state.
• Freezing, the free water forms ice crystals.
• Freezing results in an increase in the viscosity of cellular matter, a direct consequence of water being concentrated in the form of ice crystals.
• Freezing results in a loss of cytoplasmic gases such as O_2 and CO_2. A loss of O_2 to aerobic cells suppresses respiratory reactions.
• Freezing causes changes in pH of cellular matter.
• Freezing effects concentration of cellular electrolytes.
• Freezing causes a general alteration of the colloidal state of cellular protoplasm such as proteins.
• Freezing causes some denaturation of cellular proteins.
• Freezing induces temperature shock in some microorganisms. This is true more for thermophiles and mesophiles than for psychrophiles.
• Freezing causes metabolic injury to some microbial cells.