FDE 447
Cold preservation Technology

Instructor:

Professor Ayla Soyer

Content

- Introduction
- Why food spoilage?
- Refrigeration and cold storage
- Freezing and frozen storage

Course learning outcomes

- why food spoils and explanes the principles of food refrigeration and freezing.
- refrigeration systems (mechanical and absoption)and parts of mechanical systems and refrigeration cycle.
- Cold storage of foods, refrigeration load
- freezing, freezing rate and time of foods
- freezing process of foods and freezing methods
- suitable freezing methods for foods
- Food quality during freezing and frozen storage

References

- Cemeroğlu, B., Soyer, A. 2010. Soğutma ve Dondurma. *Gıda Mühendisliğinde Temel İşlemler*. B. Cemeroğlu (Ed.), Bizim Grup Basımevi, Ankara. 1-259. sayfalar.
- Berk, Z. 2013. Refrigeration: Chilling and freezing. Chap.19,20. In: Food Process Engineering and Technology, 2nd Ed. 439-477, Elsevier Inc., USA.
- Evans, J.A. 2008. *Frozen Food Science and Technology*. P. 355, Blackwell Publishing Ltd., Oxford UK.
- Singh, R.P., Heldman, D.R. 2003. Introduction to Food Engineering. 3rd ed. Academic Press, Glasgow, Great Britain.

Content

- Why foods spoil? Basic concepts of refrigeration, cold storage
- Cooling systems: mechanical cooling and absorbtion cooling systems
- Cooling system items
- Refrigerants: primary and secondary refrigerants, their properties, refrigerant enthalpy- pressure chart cooling cycle
- Defrosting and insulation in cold storages
- Cold storage of foods, cooling load

- **Mid-term exam**

- Food freezing, principles of freezing, freezing phenomena, freezing in animal and plant materials
- Freezing systems:
  - Indirect contact freezing systems,
  - Direct contact freezing systems
- Estimation of freezing time
- Thawing of frozen foods
- Food freezing and product quality
- **Final exam**

COURSE ASSESSMENT AND EVALUATION		
method	number	Contribution margin (%)
Mid-term exam	1	30
Homework	1	20
Final exam	1	60
Total	3	100

Introduction

There are two groups of factors that cause food spoilage.

*Microorganisms (Bacteria, yeast, mold)

*Biochemical and chemical reactions

These two groups of factors are kept under control in the preservation of foods.

One of the control tools is temperature.

Microorganisms and biochemical and chemical reactions are controlled by using temperature

Preservation with temperature control

- High temperature
- Low temperature

Food preservation at low temperature comprises two distinct processes:

chilling and
freezing

History

- 1918: First household refrigerators
- 1920: W. Carrier. Start of commercial air conditioning
- 1938: C. Birdseye. Start of the frozen food industry
- 1974: S. Rowland and M. Molino. Refrigerant gases in the atmosphere suspected of destroying the ozone layer.

Low temperature storage

- Chilling is the application of temperatures in the range of 0°C to 8°C, i.e. above the freezing point of the food.

  NO FREEZING

- Freezing uses temperatures well below the freezing point, conventionally below -18°C.

Effect of temperature on food spoilage

Temperature and chemical activity

Effect of low temperature on enzymatic spoilage

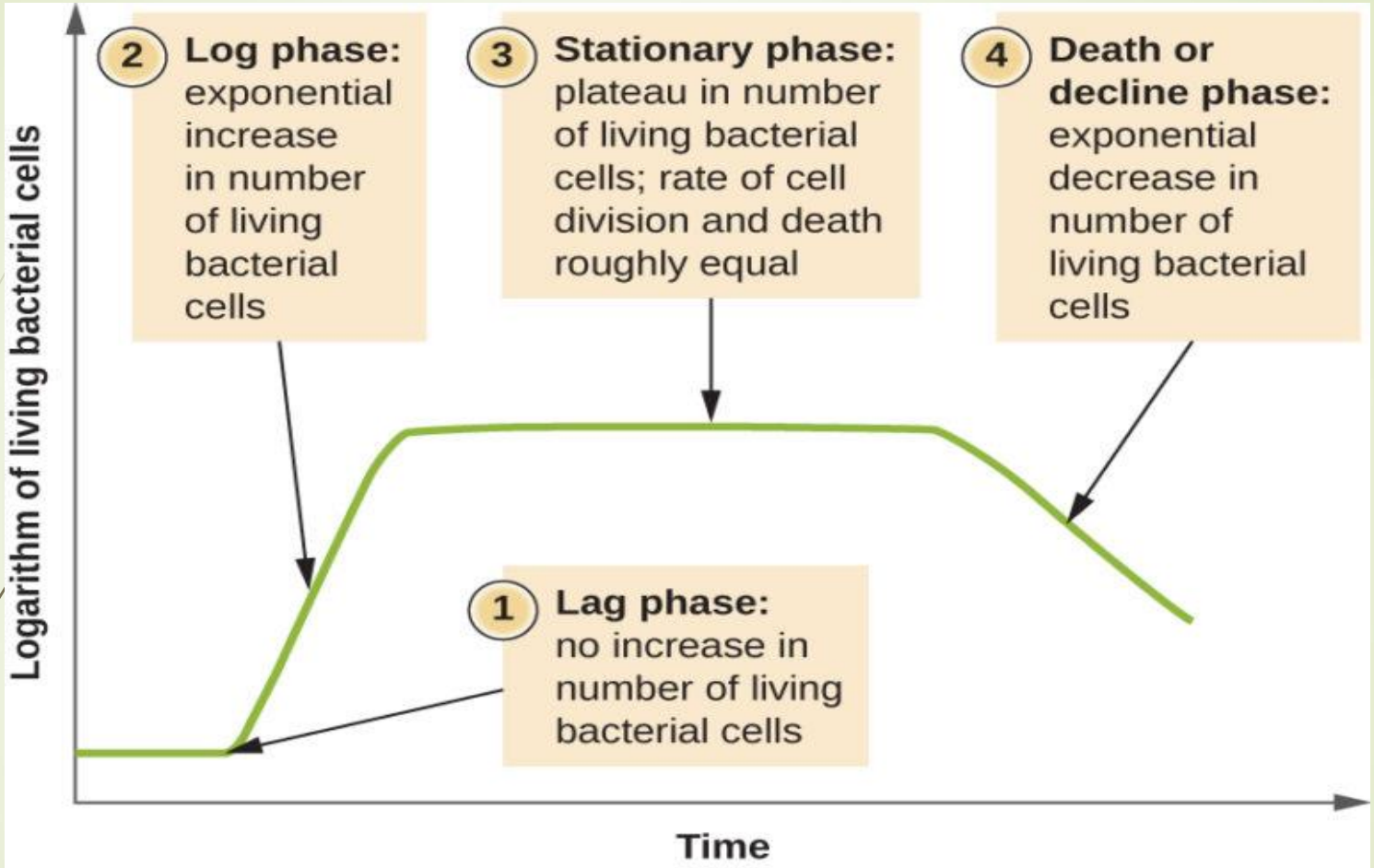
Effect of low temperature on microorganisms

With respect to the effect of temperature on their activity, microorganisms are grouped into four categories:

- thermophiles,
- mesophiles,
- psychrotropes
- psychrophiles

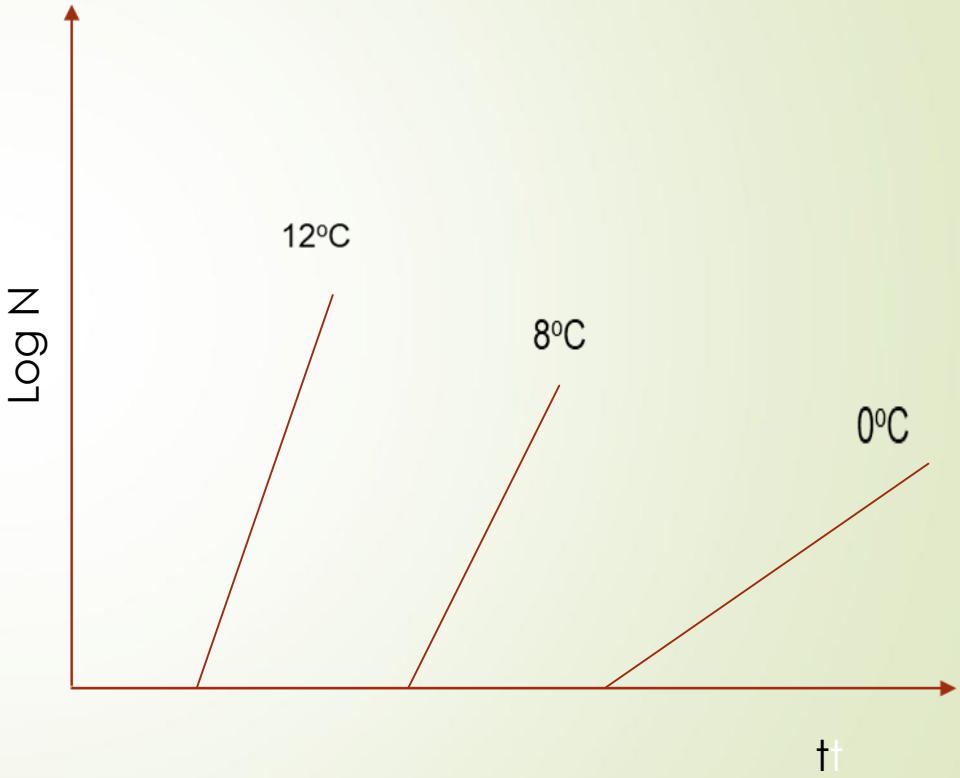
Bacteria, grouped by their growth temperature

Group	Growth temperature (°C)		
	Minimum	Optimum	Maximum
Thermophiles	34 to 45	55 to 75	60 to 90
Mesophiles	5 to 10	30 to 45	35 to 47
Psychrotropes	-5 to 5	20 to 30	30 to 35
Psychrophiles	-5 to 5	12 to 15	15 to 20



Typical growth curve of microorganisms.

- The induction period (lag phase) is longer
- Growth rate in the logarithmic phase is slower



Foods can be divided into 2 different groups in terms of cold storage.

- Active foods (Untouched fruit, vegetables, seeds)
- Processed foods (margarin, milk, fruit juice)

Effect of low temperature on biologically active (respiring) tissue

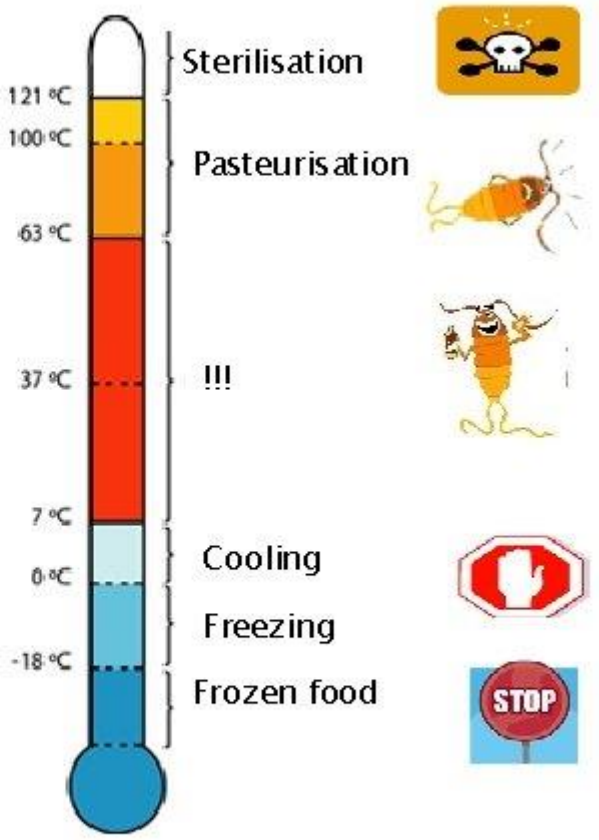
- «The principal biochemical post-harvest process that occurs in fruits and vegetables is respiration.

By Chilling of foods

- Microorganism activity is slowed down or stopped.
- Biochemical and chemical reactions are controlled.
- Two important physiological activities such as respiration and transpiration are slowed down in living foods.

Temperature

- The most important factor affecting microbial growth
- Optimum: 37°C
- lower temperatures retard microbial growth
- Higher temperatures eliminate microbes
  - refrigeration at 5°C retards but does not stop microbial growth
  - microorganisms can still cause spoilage with extended spoilage
  - growth at temperatures below -10°C has been observed



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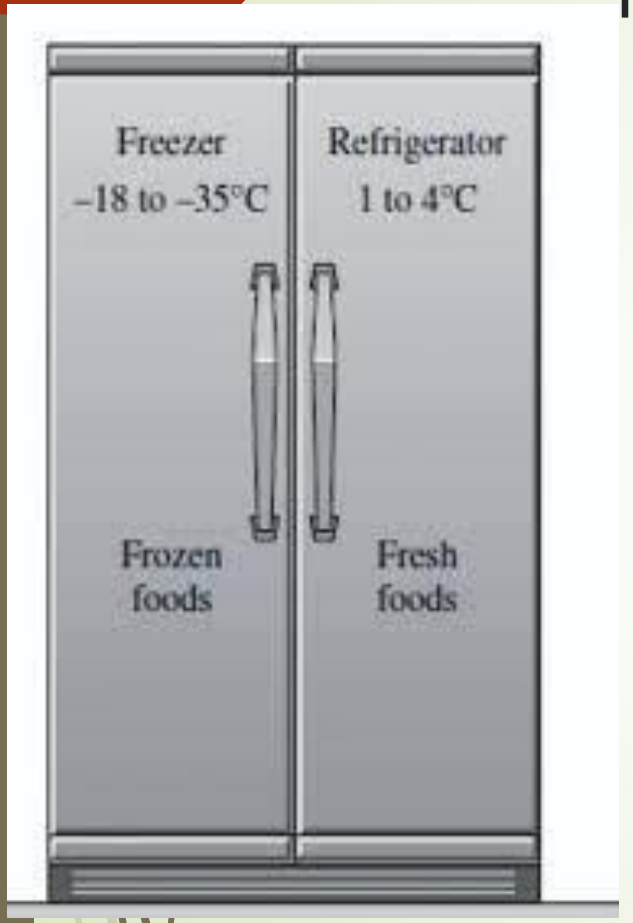
Storage life of chilled and frozen foods



The storage life of fresh perishable foods such as meats, fish, vegetables, and fruits at temperatures just above freezing:

→ Several days at temperatures just above freezing, usually between 1 and 4°C.

The storage life of frozen foods:

→ several months by freezing and storing them at subfreezing temperatures, usually between -18 and -35°C, depending on the particular food

- ✓ Shelf life in cold storage depends on the food. But it is definitely limited.

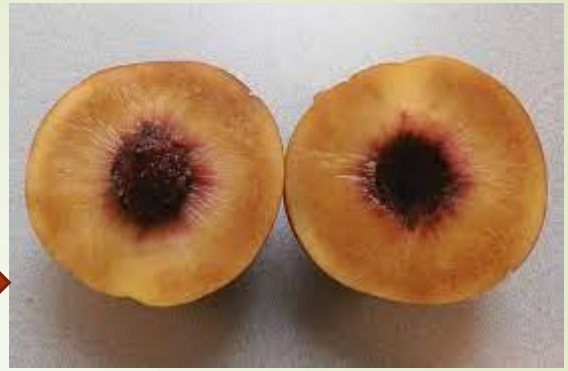
- ✓ e.g : Mushrooms, strawberries – A few days
- ✓ Apples, onions – for months
- ✓ Meats – a few days
- ✓ Ready meals – a few days

- ✓ Shelf life in frozen storage is theoretically unlimited.

- Fresh fruits and vegetables are *live products*, and thus they continue giving off heat that adds to the refrigeration load of the cold storage room.
- The storage life of fruits and vegetables can be extended greatly by removing the field heat and cooling as soon after harvesting as possible.
- The optimum storage temperature of most fruits and vegetables is about 0.5 to 1°C above their freezing point.
- But this is not the case for some fruits and vegetables such bananas and cumumbers that experience undesirable *physiological changes*, when exposed to low (but still above-freezing) temperatures, usually between 0 and 10C.
- The resulting tissue damage is called the **chilling injury**

Chilling injury cause:

- internal discoloration,



- soft scald,

- skin blemish,

- soggy breakdown, and

- failure to ripen.

Freezing and frozen storage

Purpose:

- Absolutely stop microbiological spoilage
- To minimize biochemical and chemical changes

Principles:

In terms of micoorganisms

*Most of the microorganisms that cause food spoilage are active above 10°C.

* Microorganisms that cause food poisoning are active even at low temperatures up to 4°C, albeit slowly. At 3°C their activities cease.

According to this; There is no danger of poisoning if a food cooled down to 3°C is stored at or below 3°C.

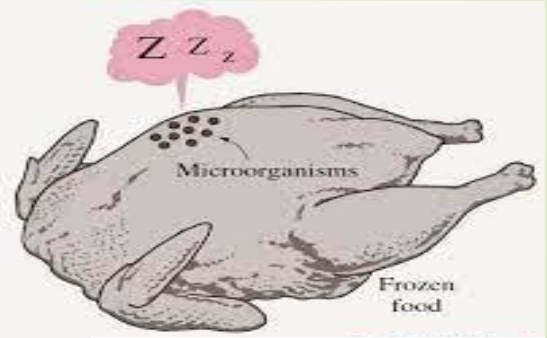
- But food can undergo a deterioration that does not harm health. The reason is the presence of some microorganisms (psychrophilic) that can operate till -10°C.

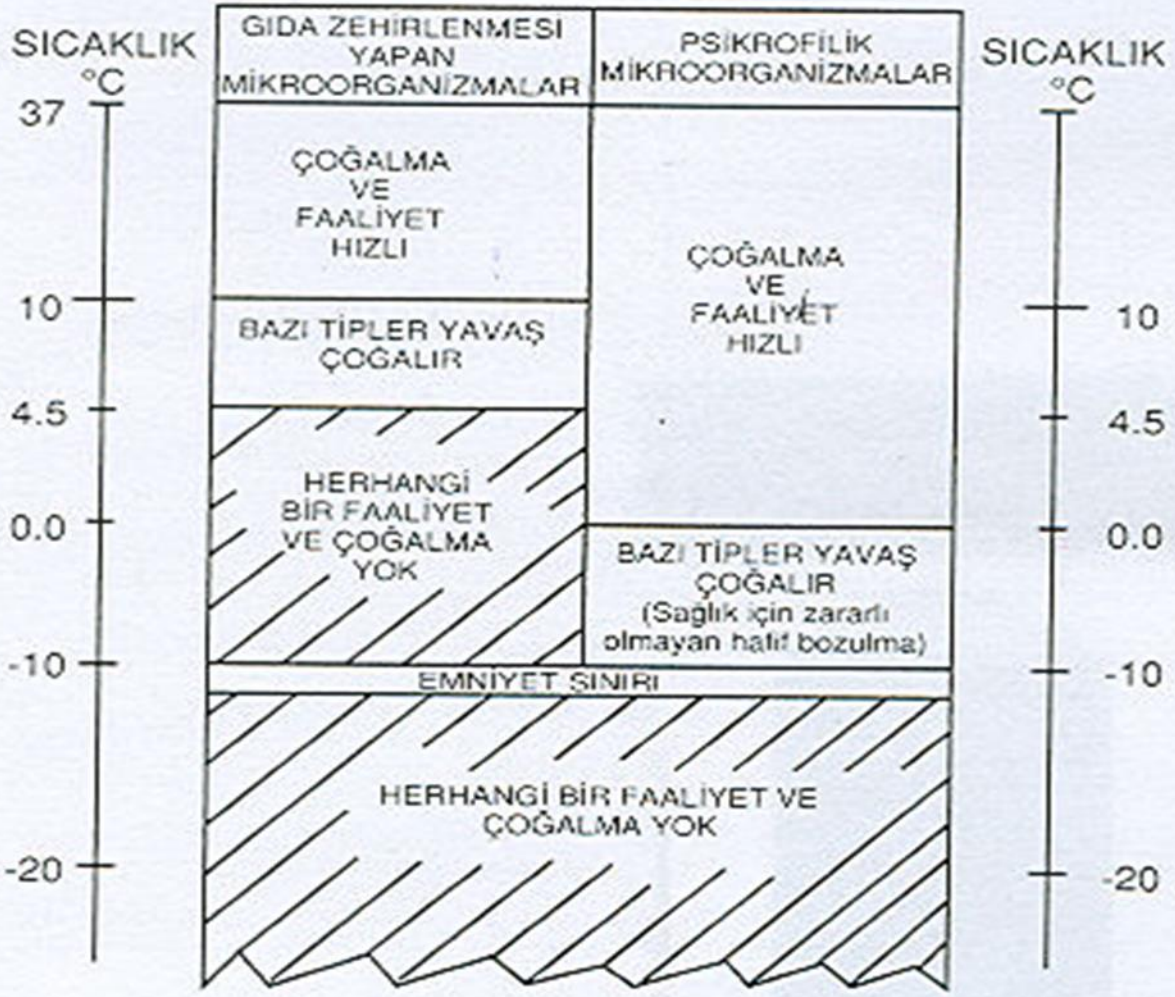
Conclusion; If a food is stored at or below -10°C, There is no microbiological problem.

Low temperature does not kill microorganisms like high temperature does. Over a long period of time, the number of microorganisms gradually decreases as a result of death. But sterility is not reached.

Food spoils quickly when thawed.

**FROZEN FOODS ARE NOT STERILE.

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BAZI TİPLER YAVAŞ ÇOĞALIR
HERHANGİ BİR FAALİYET VE ÇOĞALMA YOK
ÇOĞALMA VE FAALİYET HIZLI
BAZI TİPLER YAVAŞ ÇOĞALIR
(Sağlık için zararlı olmayan hafif bozulma)
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In terms of biochemical and chemical reactions

*Biochemical and chemical reactions occurring in frozen foods do not cause any adverse health effects. Only quality drops (e.g. color, aroma, flavor, nutritional value).

*Although the activity of microorganism slows down at low temperatures and finally stops below -10°C, biochemical and chemical reactions only slow down, never stop.

*Accordingly, the factor limiting the shelf life of a frozen food is that these reactions continue, albeit slowly.

Can any food be frozen?

- Theoretically, all foods can be preserved by freezing.

- However, some frozen foods appear to lose their pre-freezing qualities when thawed for consumption.

Commercial frozen foods

- Fruits (strawberry, cherry, apricot, raspberry (whole, chopped or in pulp)
- Vegetables (peas, green beans, corn, spinach, potatoes)
- Seafood (fish and crustaceans, direct or ready-to-eat)
- Meat (as red meats, poultry, meat products)
- Bakery products (bread, cakes, fruit and meat baked goods, dough)
- Prepared foods (pizza, desserts, ice cream, various meat and vegetable dishes)

Which foods are not frozen?

- Foods in gel or emulsion form.
- If frozen, the gel or emulsion will deteriorate during thawing.

Examples:

- Milk- Emulsion breaks down.
- The oil is separated.
- Some proteins dissolved in a colloid state are coagulated.
- Yoghurt- Gel deteriorates, syneresis is seen.