

# FDE 447

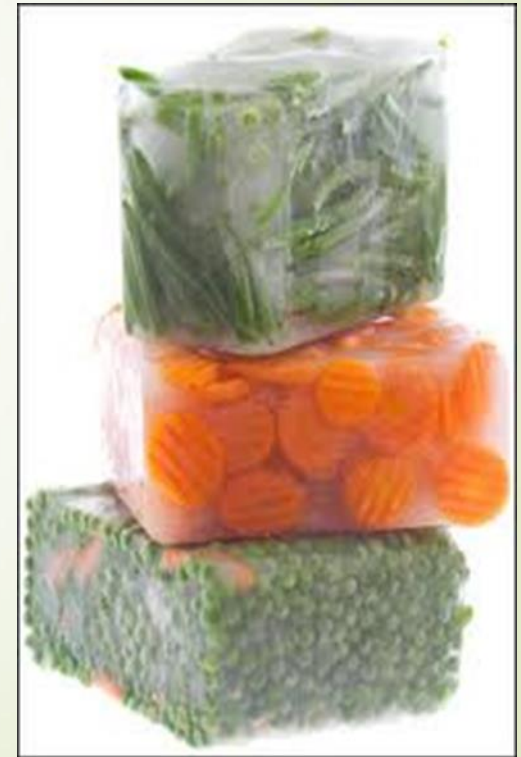
## COLD PRESERVATION TECHNOLOGY



### **Content:**

- \*What is freezing?
- \*freezing phenomenon
- \*Effect of freezing to components

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## Freezing process

It is the removal of thermal energy from the food product to the extent required to reduce the temperature below the freezing temperature of water. The thermal energy removed as a part of freezing is primarily latent heat of fusion required to convert water to ice within the product.

## Why freeze?

- ▶ In general, frozen foods are better nutritionally and organoleptically than other processed foods.
- ▶ Long shelf life
- ▶ Convenient- shorter cooking time

### **Advantages of freezing:**

Natural color, flavor, and nutritive value retained.

Texture usually better than other preservation methods

Foods can be frozen in less time than they can be dried or canned.

### **Disadvantage:**

Energy intensive

# Principles of freezing

- Extreme cold temperatures (-18 or colder than -18°C)
  - \*\* Stops growth of microorganisms
  - \*\* Slows down chemical reactions, such as enzymatic reactions
- Does not sterilize food

# Freezing

- ▶ Freezing is the process in which the temperature of a food is reduced below its freezing point and a proportion of water undergoes a change in state to form ice crystals.
- ▶ The immobilization of water to ice and the resulting concentration of dissolved solutes in unfrozen water lower the water activity of the food.
- ▶ Preservation is achieved by a combination of low temperatures, reduced water activity and, in some foods, pre-treatment by blanching.

## Goal of freezing

\*\*To prevent growth of microorganisms by:

- - Killing some bacteria (little effect)
- -Reducing water activity
- -Mechanical formation of ice crystals
- -Osmotic changes in cell fluids
- -Tying up some free water

\*\*To lower temperature enough to slow down chemical reactions

- -(every 10 °C decrease in temperature halves the reaction rate)

# Freezing

## What is the basis for freezing foods?

### Water

### Water content of foods

| <b>Food</b> | <b>Water content (%)</b> | <b>Freezing point (°C)</b> |
|-------------|--------------------------|----------------------------|
| Wegetables  | 78-92                    | -0.8 to -2.8               |
| Fruits      | 87-95                    | -0.9 to -2.7               |
| Meat        | 55-70                    | -1.7 to -2.2               |
| Fish        | 65-81                    | -0.6 to -2.0               |
| Milk        | 87                       | -0.5                       |
| Egg         | 74                       | -0.5                       |

# Water

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- ▶ When Water is chilled it reaches its max density at 4°C ( $S_g = 1$ ) and freezes at 0°C ( $S_g = 0.917$ ). That is why the ice floats in water.

## Food Composition

**Question:** WHAT ARE FOODS MADE OF?

**Answer:** WATER+CHEMICALS

\*Proteins

\*Fats

\*Carbohydrates

\*Minerals

\*Vitamins

\*Enzymes

- ▶ **Water may be free or bound to other components in the food.**

- All water in foods does not freeze

Frozen water @ -20°C

- Lamb=88%
- Fish=91%
- Egg=93%



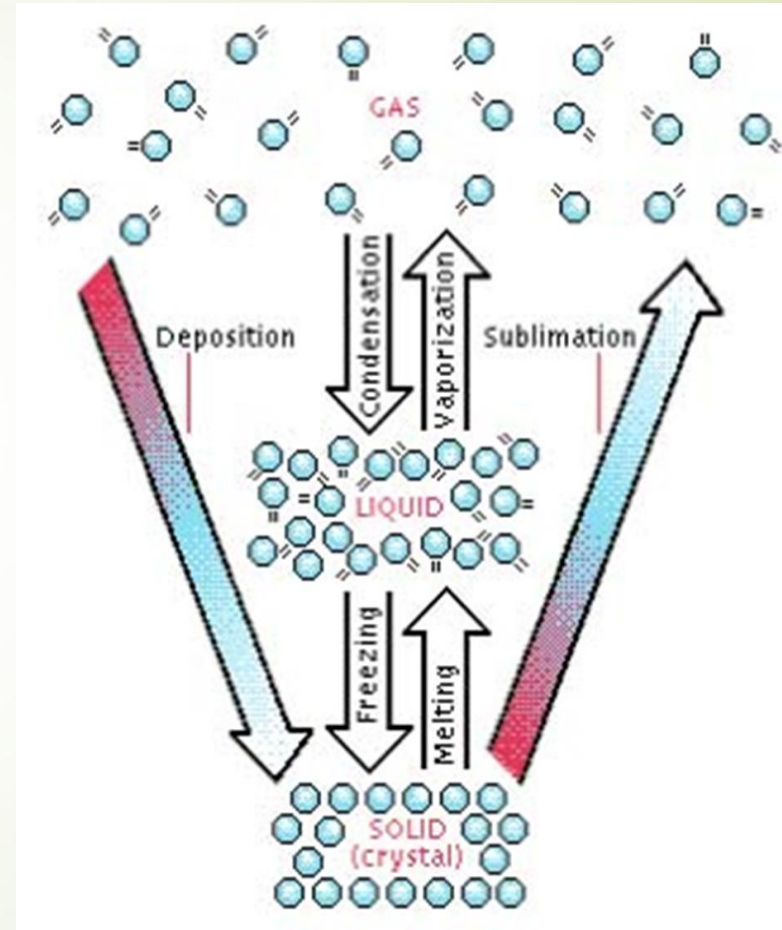
- ▶ Although food mostly consists of water, it contains lots of soluble materials
- ▶ Soluble materials slow down the movement of water molecules, and the freezing occurs at lower temperature.
- ▶ 1gmol of soluble matter will decrease (lower) the freezing point by  $1.86^{\circ}\text{F}$  ( $\sim 1^{\circ}\text{C}$ ).

### **Freezing points:**

- ▶ Fruits and vegetables  $-1.1$ -  $(-1.6)$   $^{\circ}\text{C}$
- ▶ Meat and fish  $2.2$ -  $2.8$   $^{\circ}\text{C}$

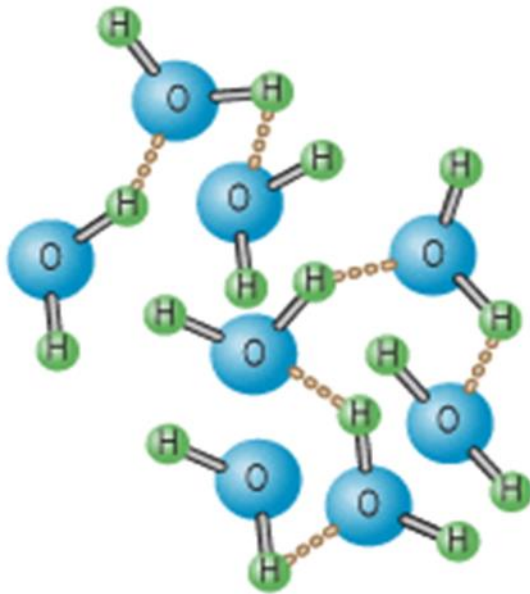
# Freezing of food

- The freezing of a food means the freezing of the water it contains.
- The water in the food is in the form of a solution in which various substances are dissolved.
- Freezing of solutions and pure water develops differently.
- The physical properties of water and ice are very different from each other.
- Therefore, the physical properties of the food change as a result of freezing.

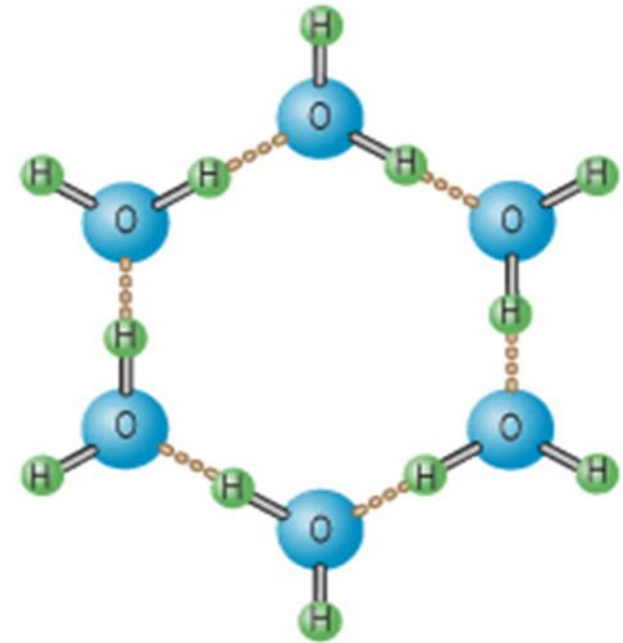


# Structure of molecules in water and ice

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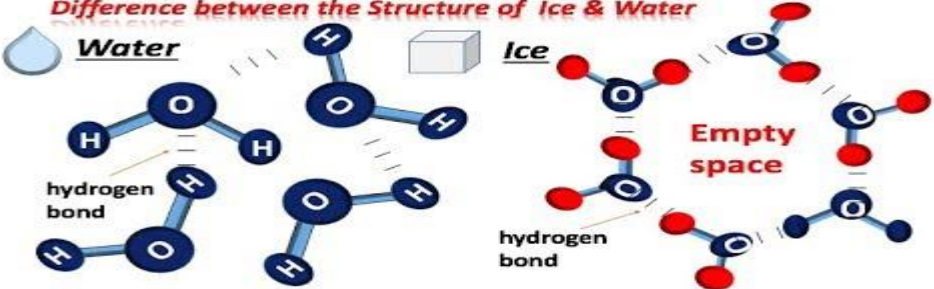
Structure of molecules in water



Structure of molecules in ice

**Difference between the Structure of Ice & Water**

**Water**  **Ice** 



**Water**  
Liquid water molecules are in constant random motion.  
Hydrogen bonds are constantly being formed and breaking up.

**Ice**  
Hexagonal crystal lattice  
Hydrogen bonds are constantly being formed.  
Large empty spaces

# Crystallization process

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The transformation from a liquid phase to a solid phase as a result of the removal of energy from a liquid is called “freezing”.

- Phase change of a pure substance can only occur at a specific temperature. For water, this temperature is 0°C.
- Whether it is pure water or a solution, nucleation (crystallization) must first occur for freezing to occur.

Core = ice crystal

- If nucleation does not occur, the liquid becomes supercooled.

Crystallization process

- Nucleation
- Crystal growth

# Crystallization process

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## Nucleation

- ▶ Homogenous
- ▶ Hetrogenous
- ▶ The nucleation formed by the freezing liquid itself is called "homogeneous nucleation" (the chance orientation and combination of water molecules).
- ▶ Nucleation catalyzed by a foreign body is called "heterogeneous nucleation« (the formation of a nucleus around suspended particles or at a cell Wall).
- ▶ Energetically it is easier for water molecules to migrate to existing nuclei in preference to forming new nuclei and heterogeneous nucleation is therefore more likely to occur in foods.