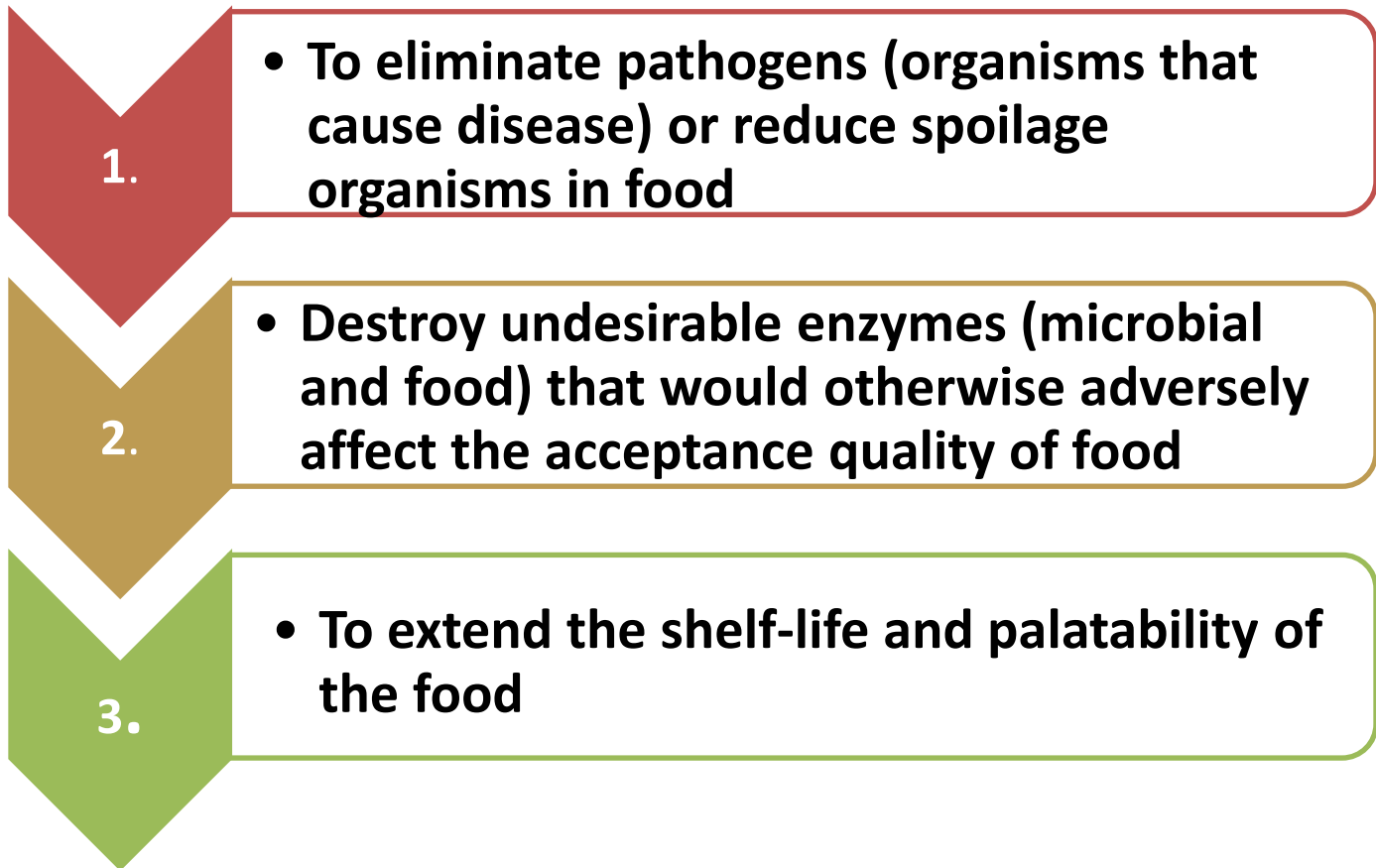


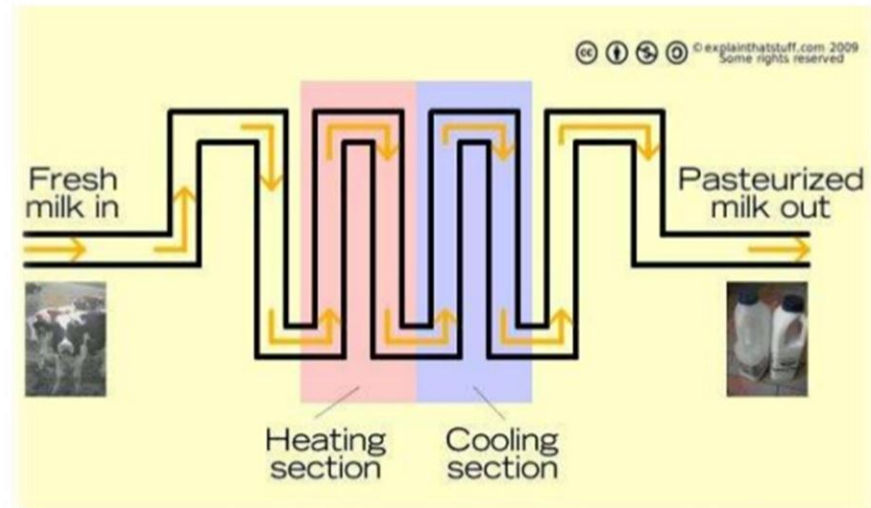
# Principle of Heat Preservation

Heating or cooking foods is a vital form of food preservation and there are many different methods of heating processes available today.





## Pasteurization of Milk



# Heat Treatment Methods

Heat treatment methods can be divided into two categories, depending on the amount of heat applied: The heat processing method may be mild or severe to preserve a food product. Mild Heat Treatment include pasteurization and blanching.

## Pasteurization

Pasteurization is a mild heat treatment (below 100 C) used for milk, liquid egg, fruit juices, and beer. The main purpose of pasteurization is to destroy pathogens, reduce bacterial count, inactivate enzymes (phosphatase and lipase) and extend shelf-life. Pathogens are microorganisms causing foodborne disease, either directly (foodborne infection) by releasing a substance that is toxic (foodborne intoxication), or via a toxin-mediated infection. A pasteurized product is not sterile, heat resistant survives and able to grow and multiply in the food after a while.

## **Pasteurization is used:**

- ✓ When more rigorous heat treatment might harm the quality of product e.g. market milk**
- ✓ Aiming to kill pathogen**
- ✓ When spoilage organisms are not very heat resistant.**
- ✓ When competing microorganisms are to be killed allowing desired fermentation by added starter organisms e.g. cheese**

**The mode of heating can be steam, hot water, dry heat or electric currents. The products are cooled promptly after the heat treatment.**

**To increase the shelf life of a pasteurized product, it is necessary to refrigerate it to delay bacterial growth. E.g. milk is pasteurized but harmless bacteria are still present. If the milk is kept outside on a warm day, the bacteria grow and produce lactic acid and the milk turns sour within a day or two.**

<b>Products</b>	<b>Pasteurization temp and time</b>
<b>Market milk</b>	<b>72C for 15 sec/63C for 30 min</b>
<b>Grape wine</b>	<b>82-85C for 1 min</b>
<b>Dried fruits</b>	<b>65.6-85C for 30-90 min</b>
<b>Ice-cream mix</b>	<b>82.2C for 16-20 sec</b>
<b>Vinegar</b>	<b>60-65.6C for 30 min</b>

To ensure that milk has been pasteurized properly, a colorimetric phosphatase test may be performed (a solution of disodium p-nitrophenyl phosphate in a buffer of pH 10.2 is used as substrate. This compound, colourless in solution, is hydrolyzed by alkaline phosphatase of milk to liberate p-nitrophenol, which under alkaline condition gives an intense yellow colouration to the solution. The liberated p-nitrophenol is measured by direct comparison with standard colour discs in a Lovibond comparator).



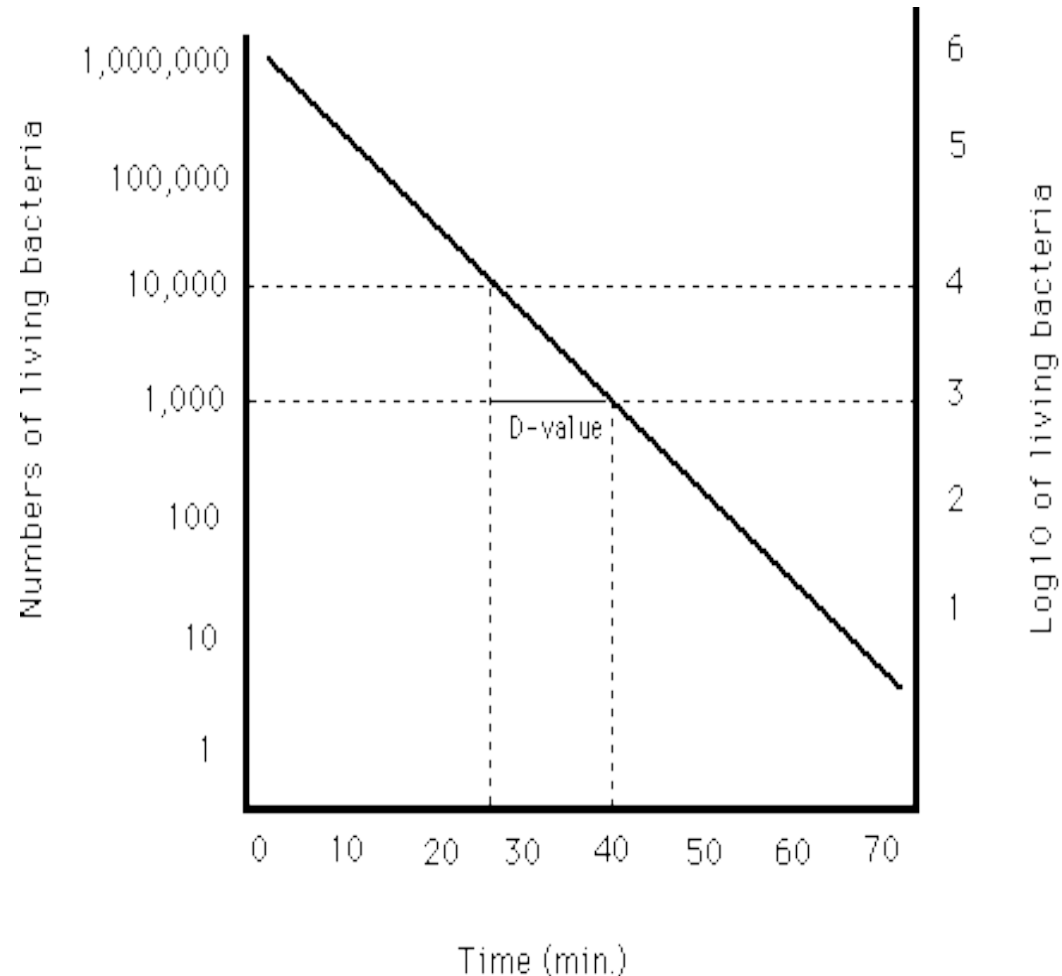
# Effect of Heat on Microorganisms

Heat denatures proteins, destroys enzyme activity, and therefore kills microorganisms at a rate proportional to the number present in the food. This is known as the logarithmic death rate (at a constant temperature, the same percentage of a bacterial population will be destroyed in a given time interval, irrespective of the size of the surviving population).

Example: 90% of the bacterial population is destroyed in the first minute of heating, then 90% of the remaining population will be destroyed in the second minute of heating, and so on (if a food contains  $10^6$  organisms and 90% are destroyed in the first minute, then  $10^5$  organisms will survive. At the end of the second minute, 90% of the surviving population will be destroyed, leaving a population of  $10^4$  microorganisms).

# Logarithmic Death Rate

Time (min)	No. of survivors
1	1,000,000
2	100,000
3	10,000
4	1,000
5	100
6	10
7	1
8	0.1
9	0.01



**Decimal reduction time is 1 minute**

**For example, a D value at 72°C is 14 min means that for each 14 min of processing at 72°C the population of the target microorganism will be reduced by 90%.**

**The D value (Decimal reduction time) is the time in minutes during which the number of a specific microbial (cells or spores) population exposed to a specific temperature is reduced by 90% or 1 log (time required to reduce the population by a factor of 10, or by one log cycle). It is expressed as  $D_T = t$  min, where T is the temperature ( $^{\circ}\text{C}$ ) and t is the time (min) for 1 log reduction of the microbial strain used.**

$$D_T = \frac{t}{\log_{10}x - \log_{10}y}$$

where x and y represent, respectively, microbial numbers before and after exposing at temperature T for t min.

**It is evident from the plot that to reach a desirable microbial level, a food with lower initial numbers will require less time (fewer D) than a food with higher initial numbers at a specific temperature.**

❖ The D value varies for different microbial species. Some microorganisms are more heat resistant than others; therefore, more heat is required to destroy them. The D value for such organisms will be higher than the D value for heat-sensitive bacteria. A higher D value indicates greater heat resistance, because it takes longer to destroy 90% of the population.

❖ Destruction of microorganisms is temperature dependent. Bacteria are destroyed more rapidly at higher temperatures; therefore, the D value for a particular organism decreases with increasing temperature.

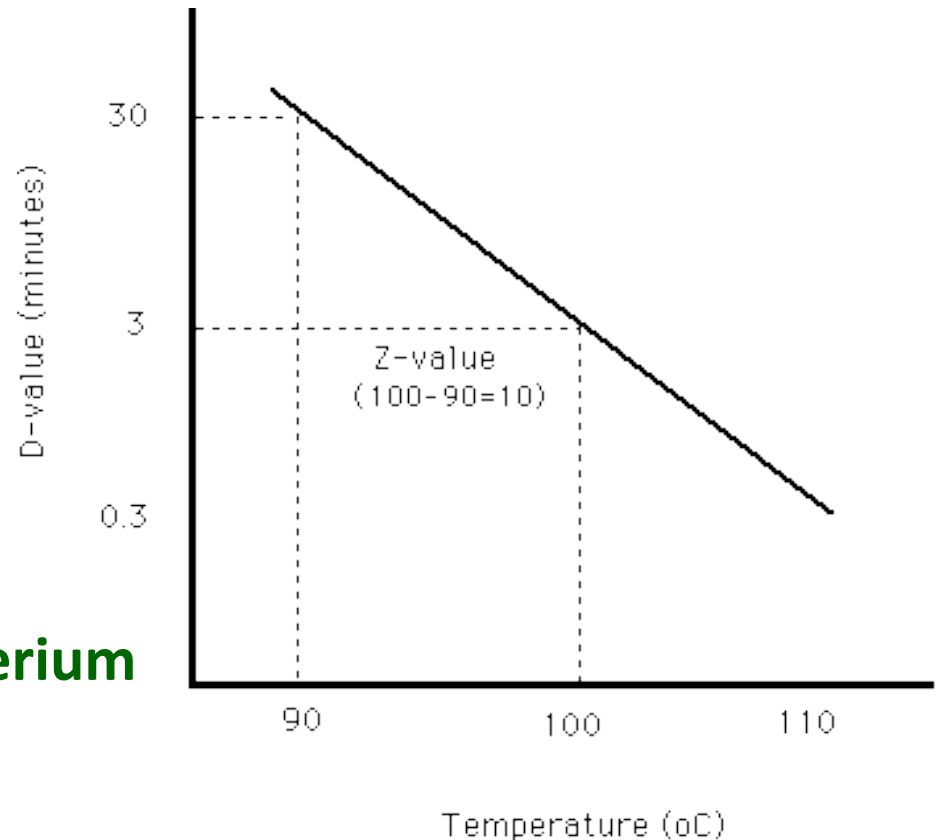
# Z- Value (Thermal Destruction Time)

It is the number of degrees the temperature has to be increased to achieve a tenfold (i.e.  $1 \log_{10}$ ) reduction in the D-value.

Z-value relates the resistance of an organism to differing temperatures.

This means that each  $10^{\circ}\text{C}$  increase in temperature will reduce our D-value by 1 log.

Z value of a spore forming bacterium is  $10^{\circ}\text{C}$



**TDP (Thermal Death Point) is the temperature at which a suspension of cells/spores is destroyed within 10 minutes.**

**$F_0$  is defined as the time in minutes required to kill all spores/vegetative cells at 121.1 °C in a unit of product.**

**The  $Q_{10}$  temperature coefficient is a measure of the rate of change of a biological or chemical system as a consequence of increasing the temperature by 10 C.**