

## E355 : Cold Chain Management

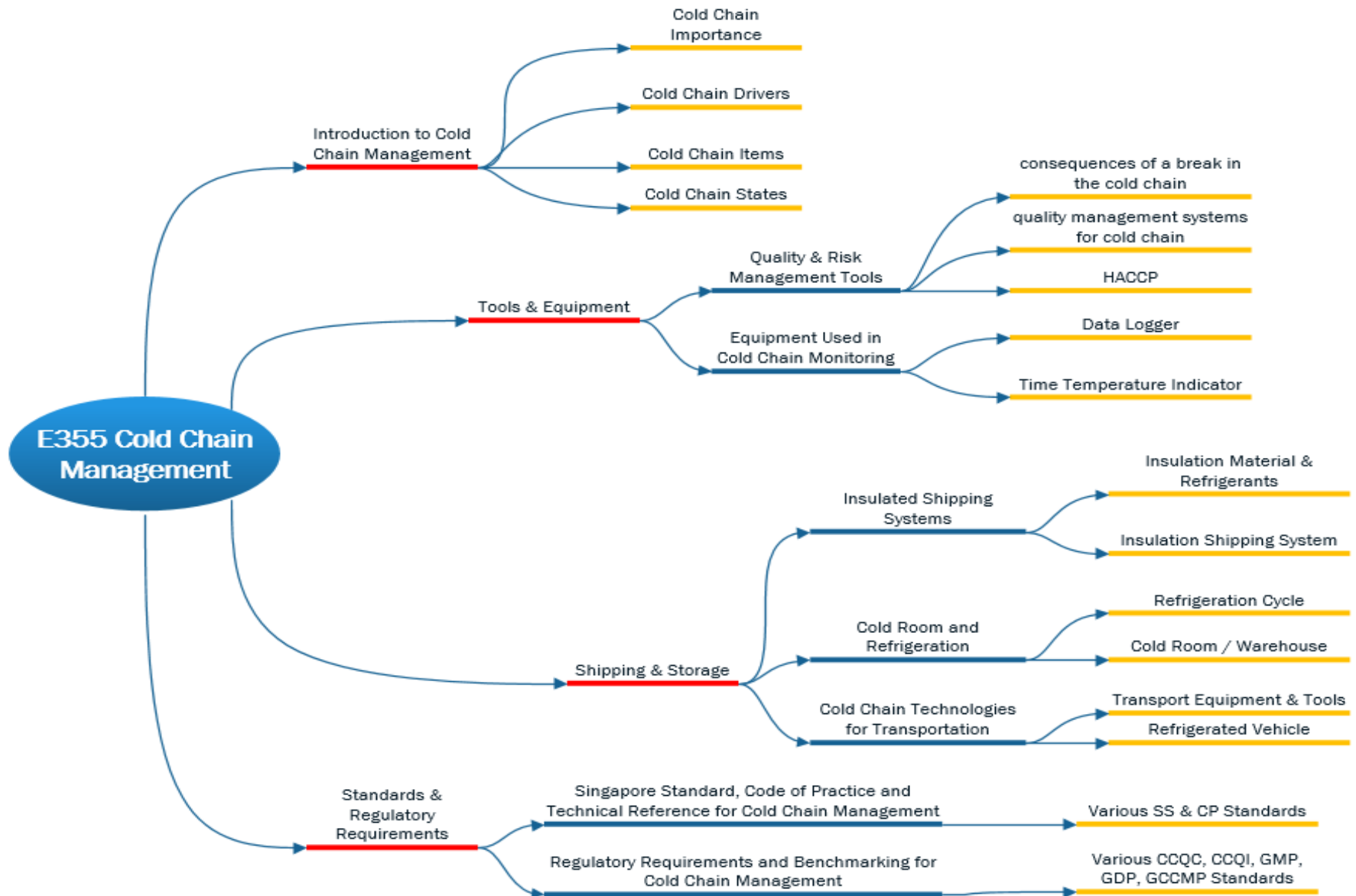
# Problem 01

## How to maintain the freshness?

- Explain the importance of cold chain management
- Explain the impact of temperature on growth of bacteria and food safety
- Define the drivers for cold chain
- Identify items which require cold chain management

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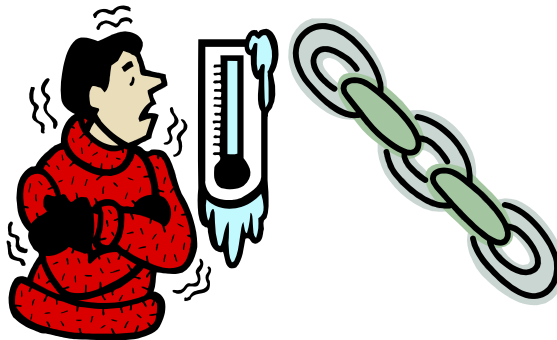
# E355 Cold Chain Management - Topic Tree



# Cold Chain



- The Cold Chain refers to the *transportation of temperature sensitive products* along a supply chain through *thermal and refrigerated* and *validated packaging methods*, in *qualified shipping containers* and the detailed logistical planning to *protect the integrity* of these shipments.



Therefore, cold chain  
is actually a special  
form of supply chain!

# Cold Chain System

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- A Cold Chain system is a series of interdependent operations in the production, distribution, storage and retailing of perishable temperature-sensitive products (PTSP).
- PTSP such as chemicals, food and drugs need to be maintained at a given temperature range to ensure product conformity and safety.
- For food in particular, cold chain
  - Provides safe and better quality food
  - Preserves nutritional and sensory qualities
  - Extends shelf-life by slowing down quality deterioration from chemical changes in food

# Global Cold Chain Market Size

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- Cold chain markets that support perishable food distribution globally are estimated to be valued at nearly **US\$250 billion**
- Cold chain in support of healthcare industries is estimated worth more than **US\$7 billion**
- The compounded annual growth rate (CAGR) of cold chain market is anticipated to reach nearly 16% over the next 5 years
- Nearly **US\$130 billion** of annual medical, biological and pharmaceutical sales are dependent on cold chain logistics to ensure the efficacy of their products

# Global Cold Chain Market Size

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- End-to-end cold chain is only as efficient and secure as the weakest link in the system. Each link in the cold chain must be maintained at the same level of integrity for the customer to receive a satisfactory products
- Global losses in the food industry total more than **US\$750 billion** annually. These losses primarily result from **lack of proper facilities, improper food safety handling procedures, and insufficient training** for those personnel working in the cold chain

# Cold Chain Applications



**Vegetables and  
fresh fruits**



**Chilled and frozen  
meat**



**Seafood**



**Dairy Product**



**Pharmaceuticals**



**Clinical trials and  
samples**

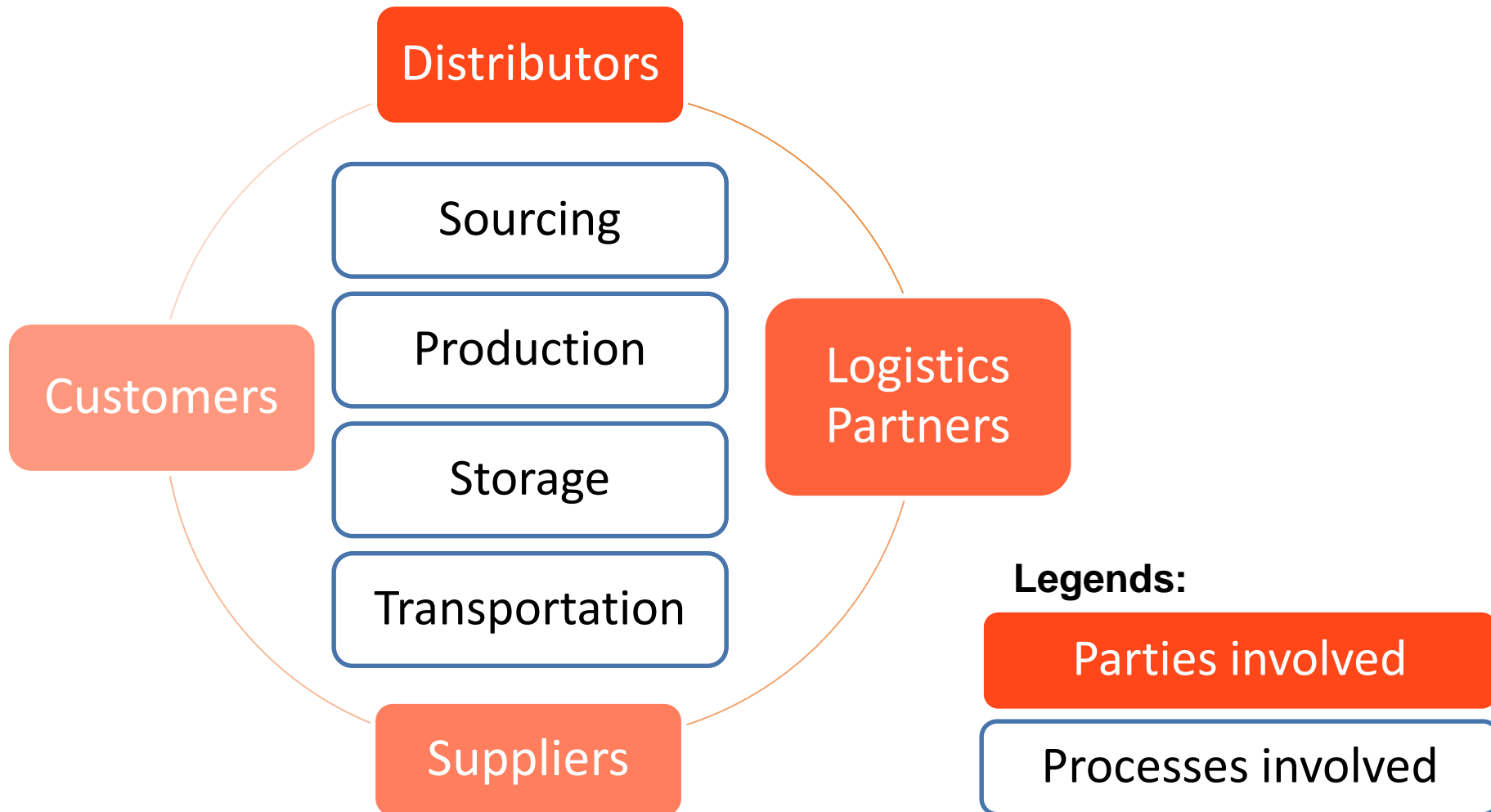


**Chemicals**



**Wine**

# Cold Chain Management Setup





# Responsibility for Cold Chain

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- The Cold Chain involves everyone starting from the processing of the food to storage till distribution
- All parties need to understand its role and know the standards to be applied, in order to ensure **freshness**, **quality** and **safety of the food** is maintained

*Note: The cold chain is only as strong as its weakest link*



# Drivers for Cold Chain

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- Meeting demands of critical consumers
- Income growth, lifestyle changes brought about by urbanization and changing family structures lead to dietary changes
- Changing consumer attitudes – they no longer accept seasonality of goods
- Environment-friendly and health-conscious consumer preferring unprocessed food such as fresh fruits and vegetables
- Convenience-minded consumers, e.g. those requiring ready-prepared meals

# Challenges in Cold Chain Systems

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- Local rules and Customs
- Transit in hot climates
- Delays outside your control – limited time required for delivery
- Excursions from approved temperature conditions without controls or monitoring
- No special procedures for goods likely to be exposed to unfavourable environments
- Avoiding contamination
- Sanitation and hygiene

# Temperature Ranges



- **Kelvin** is a unit of measure for temperature. It is one of the seven base units in the International System of Units (SI) and is assigned the unit symbol K.

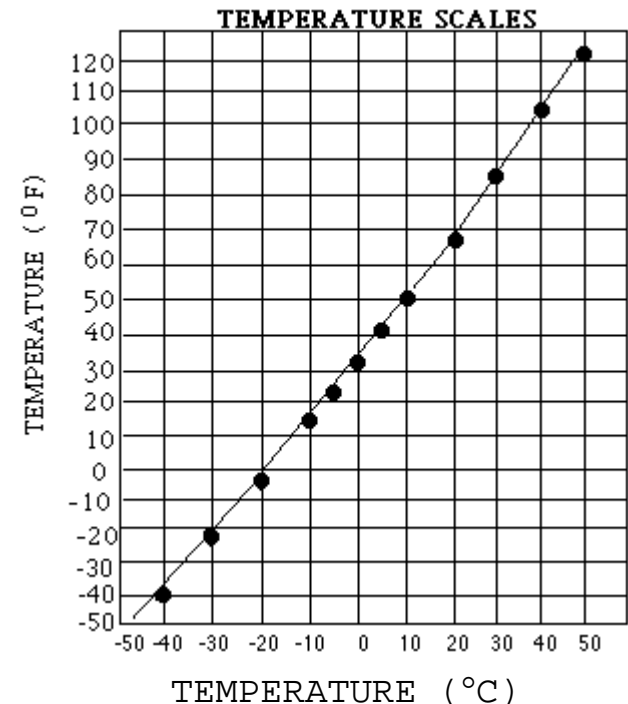
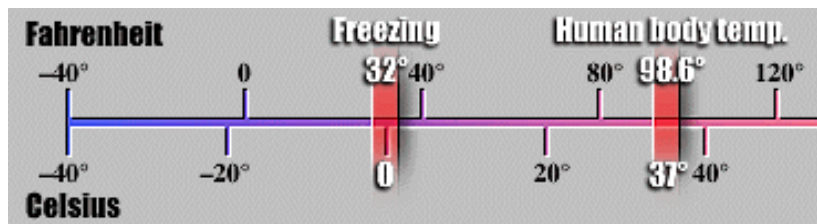
However, the two commonly used temperature scales are:

- **Fahrenheit Scale** (°F used in the US)
- **Celsius Scale** (°C, used in most other countries)

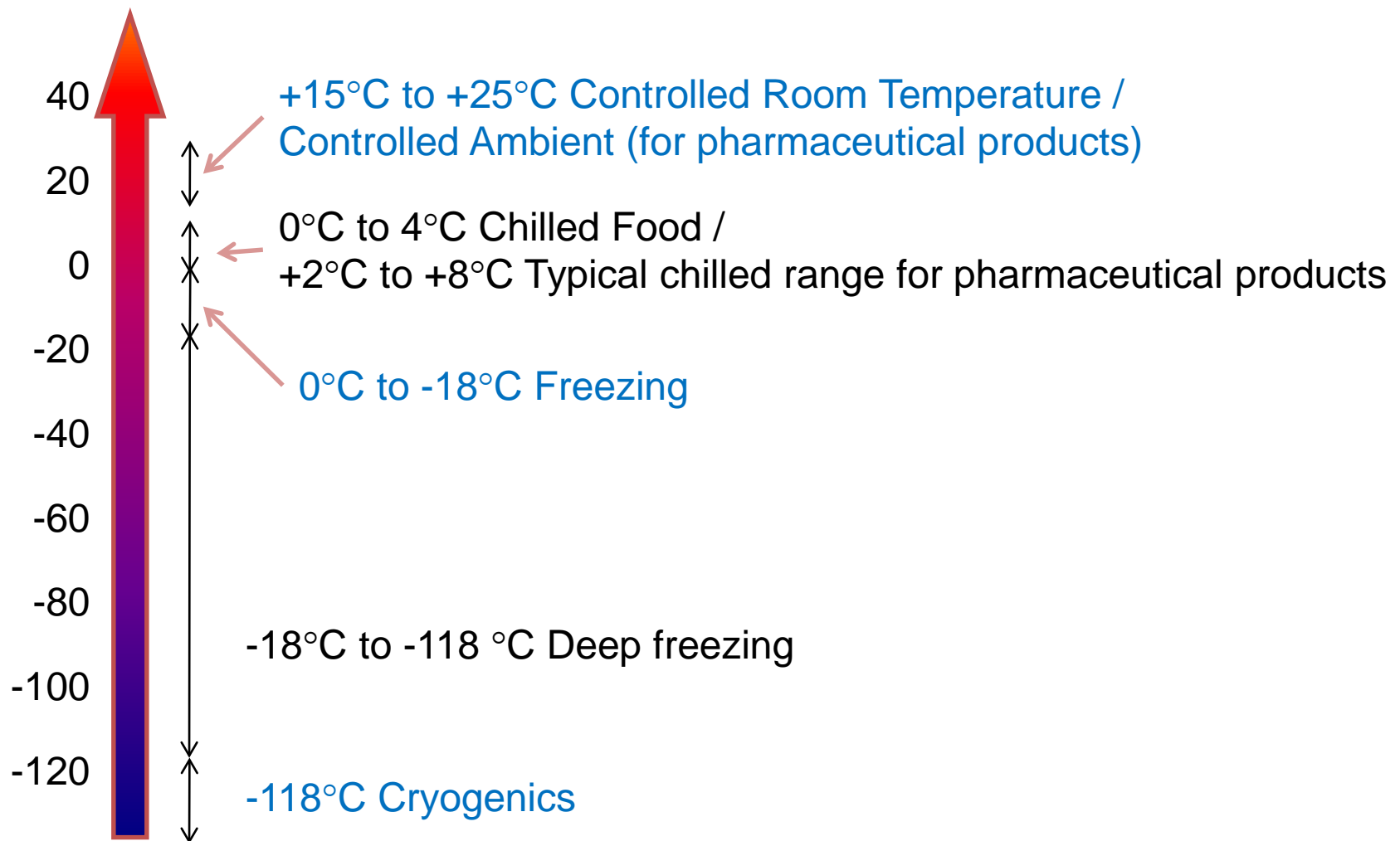
To convert between °C and °F/K,

Celsius to Fahrenheit	$(^{\circ}\text{C} \times \frac{9}{5}) + 32 = ^{\circ}\text{F}$
Fahrenheit to Celsius	$(^{\circ}\text{F} - 32) \times \frac{5}{9} = ^{\circ}\text{C}$
Celsius to Kelvin	$^{\circ}\text{C} + 273.15 = \text{K}$

e.g.  $0^{\circ}\text{C} = 32^{\circ}\text{F}$  and  $0^{\circ}\text{F} = -18^{\circ}\text{C}$



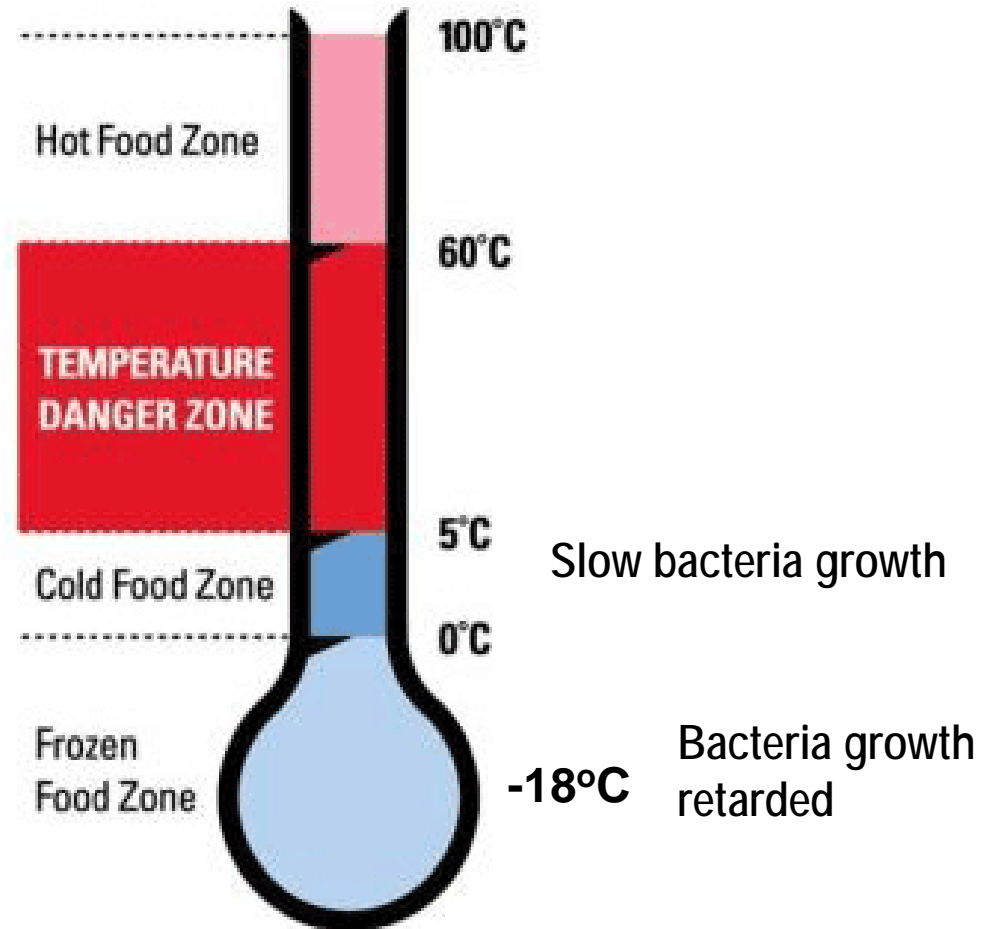
# Cold Chain Temperature Range Terminology



# Temperature- How it affects food



Temperature - food poisoning bacteria grow best in the temperature range between 5°C and 60°C. This is referred to as the 'temperature danger zone'. This means that we need to keep perishable food either very cold or very hot, in order to avoid food poisoning.



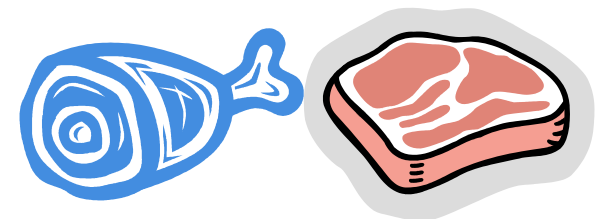
**Together, Let's Keep Food Safe!**



# Quality and Safety of Chilled/Frozen Food



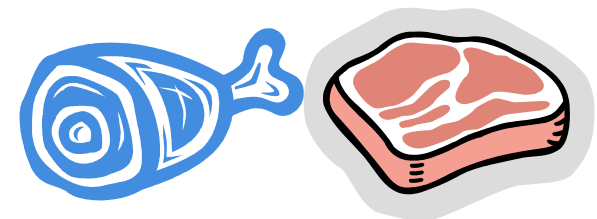
- Fresh meat is meat that is safe for consumption, i.e. with minimal amount of bacteria in it.
- Chilling involves reducing core food temperature to temperatures between 0 and 4°C
- At chilled temperatures, the growth of micro-organisms occurs slowly and food spoilage and deterioration reactions are inhibited or slowed down
- Chilled foods are perishable and they deteriorate progressively throughout their storage



# Quality and Safety of Chilled/Frozen Food



- Freezing preserves the storage life of foods – slows down the detrimental reactions that promote food spoilage and limit quality and shelf life
- Physical and biochemical reactions can still occur when recommended conditions of handling, production and storage are compromised
- Recommended storage frozen food temperatures are maintained at  $-18^{\circ}\text{C}$  or colder





# General Guideline (Safe Food Storage)

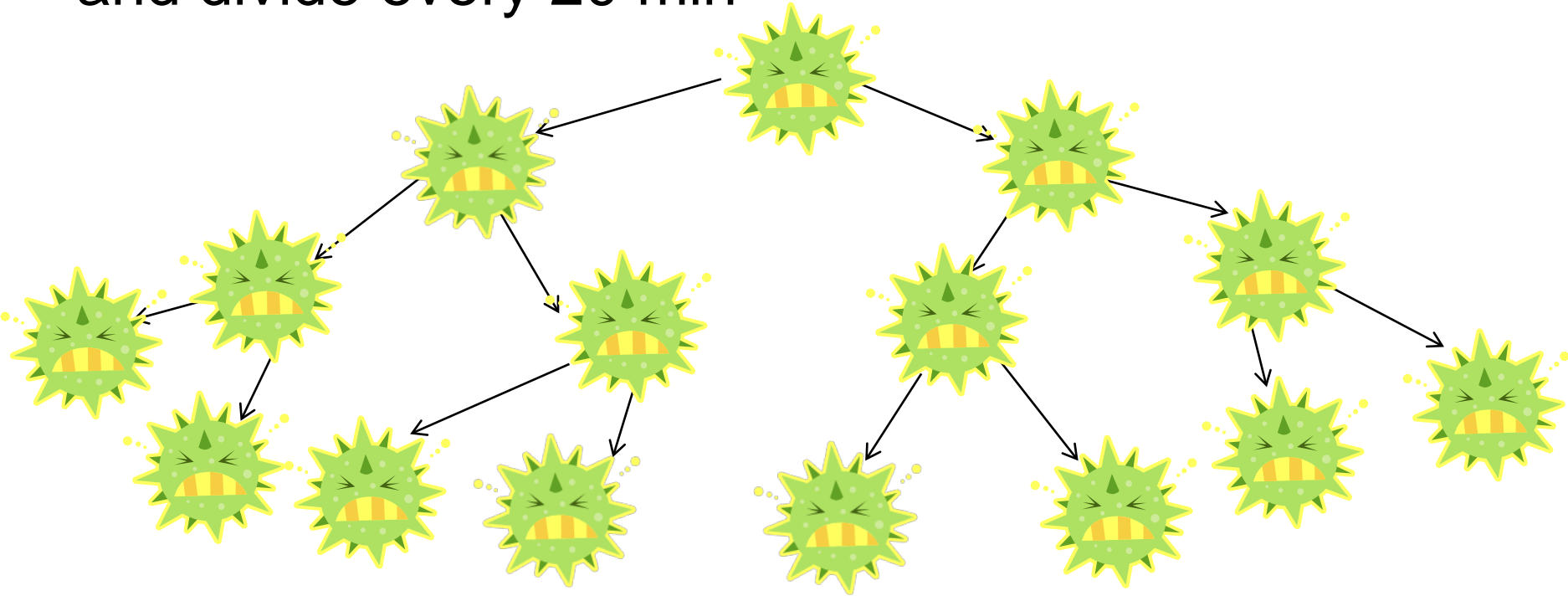


PRODUCT	REFRIGERATOR (4°C)	FREEZER (-18°C)	PRODUCT	REFRIGERATOR (4°C)	FREEZER (-18°C)
<b>Dairy Products</b>			<b>Frozen Meat and Seafood</b>		
Fresh Eggs	3 - 5 weeks	Do not freeze	Sausages	(After Thawing) 1 - 2 days	1 - 2 months
Pasteurised Milk	- opened 2 - 3 days	Do not freeze	Beef / Veal	2 - 4 days	9 - 12 months
	- unopened Use by date	Do not freeze	Lamb / Mutton	2 - 4 days	6 - 9 months
UHT Milk	- opened 2 - 3 days	Do not freeze	Pork	1 - 3 days	4 - 6 months
			Poultry	1 day	6 - 12 months
			Fish	1 day	3 - 6 months
<b>Chilled Meat and Seafood</b>			Prawns	1 - 2 days	9 - 12 months
Bacon	5 - 7 days	1 - 2 months	Oysters	- shucked 1 day	3 - 4 months
Cooked Ham	3 - 4 days	1 - 2 months		- shelled 1 day	2 - 3 months
Sausages	1 - 2 days	1 - 2 months	Fishballs (cooked)	3 - 5 days	Use by date
Beef / Veal	3 - 5 days	6 - 9 months	Meatballs	- raw 1 - 2 days	1 - 2 months
Lamb / Mutton	3 - 5 days	3 - 6 months		- cooked 3 - 4 days	2 - 3 months
Pork	2 - 3 days	1 - 2 months			
Poultry	1 - 2 days	1 - 3 months	<b>Others</b>		
Fish	1 - 2 days	2 - 4 months	Salads containing eggs, chicken, ham, tuna etc	1 - 2 days	Do not freeze
Clams, Mussels, Oysters & Squids	1 - 2 days	3 - 4 months	Tofu	- pre-packed Use by date	Do not freeze
Crabs, Crayfish, Prawns & Lobsters	2 - 3 days	2 - 3 months		- loose 1 - 2 days	Do not freeze
Cooked Prawns & Mussels	3 - 4 days	2 - 3 months			
Fishballs & Yong Tau Foo- pre-packed	Use by date	Do not freeze			
	- loose 1 - 2 days	Do not freeze			
Cooked Meatballs	3 - 4 days	1 - 2 months			

# Exponential Growth of Bacteria








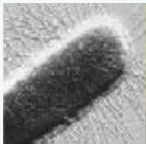
- Under favourable conditions, some bacteria may grow and divide every 20 min



- In 1 hour, 1 bacterium grow to 8 bacteria ( $2^3$ )
- In 4 hours, 1 bacterium grow to 4096 bacteria ( $2^{12}$ )
- In 8 hours, 1 bacterium grow to 16,777,216 bacteria ( $2^{24}$ )

# Bacteria that can cause food poisoning



Food Poisoning Bacteria	Disease	Incubation Period/ Signs and Symptoms	Commonly Associated Food
<b>Salmonella</b> 	Salmonellosis	<u>Incubation</u> : Usually 12 to 36 hours, or could be up to 72 hours. <u>Symptoms</u> : Diarrhoea, abdominal pain, mild fever, chills, dehydration, prostration, anorexia, nausea and vomiting. These normally last a few days. Septicaemia may occur.	Meat, poultry, eggs and their products. Other incriminated food include coconut, smoked fish, milk powder
<b>Campylobacter</b> 	Campylobacteriosis	<u>Incubation</u> : 1 to 7 days <u>Symptoms</u> : Diarrhoea (stool often foul smelling, bile stained, watery, mucoid or bloody), abdominal pain, fever, anorexia, headache, nausea. Duration 1 to 5 days.	Poultry, raw milk
<b>Listeria monocytogenes</b> 	Listeriosis	<u>Incubation</u> : Unknown incubation period. Probably 3 to 4 weeks. <u>Symptoms</u> : Fever, headache, nausea, vomiting, monocytosis, meningitis, abortion.	Widespread in the environment and can be found in raw milk, cheeses (particularly soft cheeses) raw vegetables, raw and processed meat products.
<b>Vibrio cholerae</b> 	Gastroenteritis	<u>Incubation</u> : 12 to 24 hours, but can range from 4 to 96 hours. <u>Symptoms</u> : Watery diarrhoea, abdominal pain in most cases and sometimes fever, headache, nausea.	Contaminated water, fish and shellfish.
<b>Vibrio parahaemolyticus</b> 	Gastroenteritis	<u>Incubation</u> : 12-24 hours, but can range from 4-96 hours. <u>Symptoms</u> : Watery diarrhoea, abdominal pain in most cases and sometimes fever, headache, nausea.	Contaminated water, fish and shellfish.
<b>E. coli O157:H7</b> 	Haemorrhagic colitis which may progress into haemolytic uraemic syndrome	<u>Incubation</u> : Usually 3-4 days but can range from 12 hours to 8 days. <u>Symptoms</u> : Severe stomachache and diarrhoea, which is initially watery but becomes grossly bloody. Occasionally vomiting occurs. Fever is either low-grade or absent, kidney problems may eventually arise resulting in death.	Contaminated beef, raw milk and other foods such as vegetables and cheese.

# Today's Problem



- Freshness of the food and other PTSP can be maintained with proper temperature control and overcoming of problems that may arise drives the need for cold chain management.
- After making the purchase of all the items, use ice packs provided by the supermarket to keep those food items cool while making your way home. Alternatively, you can also use a cooler bag to store the items.
- Once at home, store the food items immediately into the right compartment in the refrigerator as according to the following storage temperature:



# Today's Problem



Products	Storage Temp	Products	Storage Temp
<ul style="list-style-type: none"><li>• Chilled Pork ribs</li><li>• Yoghurt drinks</li></ul>	0° to 4°C (Chiller)	<ul style="list-style-type: none"><li>• Frozen chicken wings</li><li>• Fish ball</li><li>• Ben &amp; Jerry ice-cream</li><li>• Frozen Salmon Fillet</li><li>• Frozen Edamame</li></ul>	Below 18°C (Freezer)
<ul style="list-style-type: none"><li>• Cucumber</li><li>• Australian red and white wine</li></ul>	10° to 15°C (Chiller)	<ul style="list-style-type: none"><li>• Canned baked beans</li><li>• Mineral water</li></ul>	Ambient Temperature (Average 27°C in Singapore)

# Today's Problem



- For the shelf-life of the items, refer to slide at page 16 - General Guideline (Safe Food Storage)
- If these products not being stored at the right temperature range for certain period, food poisoning bacteria may grow, and it will affect not just the freshness, quality but the safety of the food being consumed





# Learning Objectives

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- Explain the importance of cold chain management
- Explain the impact of temperature on growth of bacteria and food safety
- Define the drivers for cold chain
- Identify items which require cold chain management