Meat and Meat Products Processing- Level II

Based on May 2019, Version 2 Occupational standards

Module Title: - Applying Cold Chain Storage

LG Code: IND MPP2 M16 LO (1-4) LG (61-64)

TTLM Code: IND MPP2 TTLM 0920 v1

October, 2020

United Nations
Educational, Scientific and
Cultural Organization

Contents

LG #61	LO #1- Conduct storage temperature

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Observing and Measuring storage temperature
- Investigating product properties

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Observe and Measure storage temperature
- Investigate product properties

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
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6. If you earned a satisfactory evaluation proceed to “Operation sheets
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Information Sheet 1- Observing and measuring storage temperature

1.1. Meat Handling and Storage Procedures

Proper handling and storage are two of the most vital processes undertaken by staff once meat orders arrive at their point of sale. Because foodborne illnesses have not been fully eradicated yet, and food storage is often subject to human error, rigid procedures need to be followed to ensure that all products arriving for sale are checked, refrigerated immediately, and stored correctly. Poor food-handling and storage procedures can prove to be disastrous to a food service company and to customers alike.

Three factors concerning storage; the storage temperature, the degree of fluctuation in the storage temperature and the type of wrapping/packaging in which the meat is stored, are commonly believed to have the main influence on frozen storage life.

1.1.1. Storage temperature

Storage life of nearly all frozen foods is dependent on the temperature of storage and in the book a table is provided of practical storage lives of different foods at three storage temperatures.

A. Refrigerator

For safety, it is important to verify the temperature of the refrigerator. Refrigerators should be set to maintain a temperature of 40 °F or below. Some refrigerators have built in thermometers to measure their internal temperature.

For those refrigerators without this feature, keep an appliance thermometer in the refrigerator to monitor the temperature. This can be critical in the event of a power outage. When the power goes back on, if the refrigerator is still 40 °F, the food is safe.

Foods held at temperatures above 40 °F for more than 2 hours should not be consumed. Appliance thermometers are specifically designed to provide accuracy at

cold temperatures. Be sure refrigerator/freezer doors are closed tightly at all times. Don't open refrigerator/freezer doors more often than necessary and close them as soon as possible.

Figure 1 Refrigerator types

B. Chilling

Chilling is the process of cooling meat while the meat remains above its freezing temperature. The temperature of the cooling medium (air or water, for instance) doesn't matter. As soon as the meat starts to freeze, it is no longer considered a chilling process. Or Chilling can be defined as the fundamental operation in applying cold to meat to reduce its temperature quickly. This is done in a cold chamber with intensive air draught or movement.

The two important reasons of chilling process in the meat export industry are.

- 1ˢ An increasing proportion of our meat products are exported in chilled form, using vacuum packaging, or controlled atmosphere packaging.
- 2nd If we are going to freeze the product, then the meat must pass through a chilling process first. Even if we are hot-boning, the meat must always chill before it starts to freeze.

C. Freezing

Freezing is usually limited to meat to be used as buffer stock, frequently intended for export or for storage with a view to later processing.

When the preservation period is longer than that acceptable for chilled meat, freezing must be used to minimize any physical, biochemical and microbiological changes affecting quality in storage. During freezing most of the water content of the meat, about 80 percent solidifies into pure ice crystals, accompanied by a separation of dissolved solids.

A product can be considered frozen when its center has a temperature of -12°C or less. To reach this temperature the product passes through the temperature range of maximum crystallization (from -1° to -5°C). The speed of freezing is a very important factor as frozen meat quality depends mainly on the size of the ice crystal formed: the lower the speed of freezing the larger the size of the crystals.

Slow freezing facilitates the separation of solution and the migration of water out of the muscle cells which is subsequently frozen, forming rather large crystals. Quick freezing conversely produces many small ice crystals, mainly formed within the muscle cells, and reduces water migration and separation of solution. It is obvious that the latter technology will preserve the meat closer to its original quality and, particularly during thawing, moisture loss will generally be lower.
Meat can be treated before freezing, generally being refrigerated to a chilled condition. Cutting into quarters is usual, particularly for large animals, and the fat is removed from some parts because though it prevents surface desiccation it reduces the heat transfer rate, and is susceptible to damage during frozen storage.

The relationship between thickness and freezing speed favours cutting and deboning before freezing, either as lean meat packaged in cardboard boxes or cut into individual portions. This has many advantages:

- The mass to be frozen is reduced by 30 percent or more;

- Storage density is increased by 100 percent;
- Handling operations are easier;
- Deboning after thawing, which causes hygienic and exudative problems, is avoided.

Freezing is performed in tunnels or in chambers with intense air circulation called blast chambers.

- Air temperatures should be in the range of -30° to -35°C; sometimes -40°C is used. Air is circulated at high speed, from 2 to 4 m/s and up to 6 m/s.
- An air circulation coefficient of 150–300 is used inside freezing chambers. Relative humidity is maintained at 95 percent or above.

d. Cabinet development

Getting the air curtain to work properly is critical to the correct operation of the cabinet. Temperatures of the food simulants inside the cabinet can be monitored within specified store conditions to see if the cabinets meet the required specifications

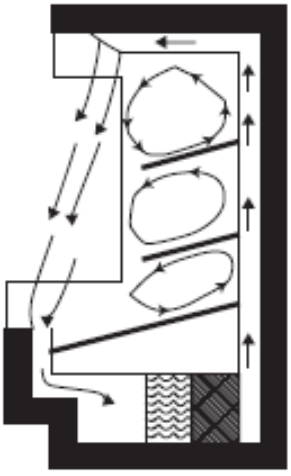


Figure 2 Multi-deck display cabinet

e. Storage Procedures

Meat should be packaged appropriately to prevent drying out, spoilage, or **freezer burn**. Whole sub-primal are often vacuum packed as soon as they are removed from the carcass and will have a long shelf life when kept in the original vacuum packaging. Cut

meat products for retail use should be wrapped in permeable film on trays or vacuum packaged after portioning. Cut meat products for food service use may be vacuum packed after cutting or stored in food-grade containers, wrapped appropriately, and stored according to food safety standards. Products for frozen storage should be vacuum packed or wrapped tightly in freezer paper to prevent freezer burn.

- Coolers should be maintained at 0°C to 2°C (32°F to 35.6°F). This is considered the safest temperature to hold meats and maintain Flavour and moisture. Water freezes at 0°C (32°F); however, meat freezes at about -2°C (29°F).

Today the most common cooling units are the blower coil type, in which cool air is circulated via coils and fans from a ceiling-mounted unit that draws air from the floor up through the cold coils and then drives air back into the cooler area. Floor areas of the cooler must be free of containers that may impede the airflow. This means that all food containers and boxes must be elevated above floor level.

For most modern coolers the **humidity** levels are built into the system and are maintained automatically.

For example, lean beef is made up of approximately 70% moisture to optimize its Flavour, sales appeal, and value. Moisture content in the air is expressed as relative humidity and is measured as a percentage.

To maintain the moisture in meats, coolers need to maintain a humidity level of approximately 75% to 80%. If the moisture level drops below 70%, shrinkage will occur. However, if the humidity level is too high, moisture will condense onto the meat and appear on the walls of the cooler, creating an excellent medium for bacteria growth and sooner-than-normal meat spoilage.

Modern meat coolers and freezers also have a built in defrost cycle, which is usually timed to activate in the early morning hours when there is less traffic in and out of the units. This important cycle is designed to melt away ice buildup on the blower coils (as they operate at below freezing temperatures) into a drain system. This part of the cycle

takes about 20 to 60 minutes. Meat freezer temperatures should be maintained at approximately -23°C to -29°C (-10°F to -20°F).

Table 1 Practical storage life (months) at different storage temperatures

Products	**Practical storage life in months**		
	-18 °C	-25 °C	-30 °C
Beef carcass	12	18	24
Roasts, steaks, packaged	12	18	24
Ground meat, packaged, (unsalted)	10	>12	>12
Veal carcass	9	12	24
Roasts, chops	9	10–12	12
Lamb carcass	9	12	24
Roasts, chops	10	12	24
Pork carcass	6	12	15
Roasts, chops	6	12	15
Ground sausage	6	10	
Bacon (green, unsmoked)	2–4	6	12
Lard	9	12	12
Poultry, chicken and turkeys, eviscerated,			
well packaged	12	24	24
Fried chicken	6	9	12
Offal, edible	4		

f. Cold truck

A refrigerator truck or chiller lorry is a van or truck designed to carry perishable freight at specific temperatures. Like refrigerator cars, refrigerated trucks differ from simple insulated and ventilated vans (commonly used for transporting fruit), neither of which are fitted with cooling apparatus. Refrigerator trucks can be ice-cooled, equipped with any one of a variety of mechanical refrigeration systems powered by small displacement diesel engines, or utilize carbon dioxide (either as dry ice or in liquid form) as a cooling agent.

Most of the long-distance refrigerated transport by truck is done in articulated trucks pulling refrigerated semi-trailers.

Vehicles for transporting meat and carcasses should be considered as an extension of the refrigerated storage. The object must be to maintain the meat temperature at or

near 0°C. Meat should be chilled to 0°C before loading. Meat should hang on rails, not on the floor. If stockinettes are put on carcasses they must be clean. Meat trucks should not carry anything other than meat.

The refrigeration is usually produced by injecting liquid nitrogen or carbon dioxide (CO_2) into the compartment or by blowing air over CO_2 chunks (dry ice). The temperature in these vans can be set and controlled to minimize the temperature rise and to avoid condensation on the meat surface

Figure 3 Clod truck

Self-check 1	Written test

Name_____ ID_____ Date_____

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (2 points each)

1. Of the following one is considered to have main influence on frozen storage life.
   A. The storage temperature
   B. The degree of fluctuation in the storage temperature
   C. The type of wrapping/packaging in which the meat is stored
   D. All
   E. None
2. The storage temperature for all species and meat types are uniform to preserve them for required period of time. (True? False)

Test II: Short Answer Questions

1. Explain the term storage life and storage temperature for different products under different temperature condition(Detail illustrate The Table) (6 point)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Information Sheet 2- Investigating product properties

2.1. Colour changes in chilling, freezing and storage of meat

Meat is defined as the flesh of animals used as food. In a narrow sense this definition is restricted to a few dozen mammalian species, but it is often widened to include musculature, organs such as liver and kidney, and the brain and other edible tissues. An even broader definition of meat includes the same parts of poultry

The appearance of meat at its point of sale is the most important quality attribute governing its purchase. The ratio of fat to lean and the amount of marbled fat are important appearance factors and another is the colour of the meat. The changes in colour of the muscle and blood pigments (myoglobin and haemoglobin, respectively) determine the attractiveness of fresh red meat, which in turn influences the consumers acceptance of meat products. Consumers prefer bright-red fresh meats, brown or grey-coloured cooked meats and pink cured meats

A. **Meat colour**

Color is used by consumers to determine if meat is fresh and safe to eat. It is the single most important driving factor in a consumer's decision to purchase meat. Myoglobin is the heme iron containing protein that gives meat its color, and it is a great source of dietary iron. Myoglobin stores oxygen in muscle cells and is similar to hemoglobin that stores oxygen in blood cells.

The more myoglobin content meat contains the darker red it will appear in color. Myoglobin content is higher in beef and lower in poultry with lamb and pork having intermediate amounts. The age of an animal will also impact the myoglobin content of the muscles with older animals having more myoglobin and darker meat. Muscles that are used for movement also have more myoglobin content than muscles used for support.

Myoglobin has three natural colors depending on its exposure to oxygen and the chemical state of the iron.

- If no oxygen is present, the meat appears purple red, like in vacuum packaged meat, and is in the deoxymyoglobin state.
- Meat is bright red when exposed to air and is typical of meat in retail display. Bright red color indicates oxymyoglobin is present.
- Meat appears tan or brown when only very small amounts of oxygen are present such as when two bright red pieces of meat are stacked on each other excluding the oxygen.
- Meat can also appear brown when the meats color life is exhausted late in display when the iron in the pigment becomes oxidized.

Metmyoglobin is the state when the iron has oxidized and is tan or brown in color.

- The nature of the illuminating light, and
- Changes taking place during reflection

Pigment	Colour
Reduced myoglobin	Purple
Oxymyoglobin	Bright red
Metmyoglobin	Brown
Denatured globin haemichrome	Brown

Table 2 Main form of pigment found in uncured meat

Instrumental measurements of meat colour are usually expressed in terms of 'lightness', 'hue' and 'saturation'. 'Hue' is the psychological appreciation of colour describing purple to red to orange to yellow, and so on and 'saturation' is the lack of greyness or increase in purity

Myoglobin is the primary meat pigment and exists as bright-red oxymyoglobin (MbO2), purple-red deoxymyoglobin (Mb), or brown metmyoglobin (MetMb). Haemoglobin which is responsible for the colour of blood plays only a small role in the colour of red meat, although it may be more significant in paler meat

In most beef muscles myoglobin is by far the more dominant pigment, whereas in the calf 20–40% of the total is haemoglobin. The main forms of the pigments found in uncured meat are given in Table 2 above.

The purple colour of freshly cut meat is due to the deoxymyoglobin. On exposure to air, it is converted to the bright red pigment oxymyoglobin, which gives fresh meat its normal desirable appearance. The brown colour of cooked meat is due to denatured globin haemichrome. In extreme conditions the pigment can decompose and green choleglobin and colourless bile pigments are formed.

The depth of the oxymyoglobin layer is controlled by several factors, the more important of which are:

- The duration of exposure
- The temperature and
- The oxygen tension
- The diffusion of the oxygen through the tissue and
- its utilization in the tissue

Factors affecting the colour of meat

I. Live animal

The pigment concentration in meat is affected by many factors affecting the live animal. These include:

- **Species** – beef for example contains substantially more myoglobin than pork.

Species	Color	Myoglobin content
Pork	Pink	2 mg/g
Lamb	Light red	6 mg/g
Beef	Cherry red	8 mg/g

- **Age**:- pigment concentration increases with age.

Age class	Myoglobin content
Veal	2 mg/g
Calf	4 mg/g
Young beef	8 mg/g
Old beef	18 mg/g

- **Muscle**:- muscles that do more work contain more myoglobin.

Muscle	Name	Myoglobin content
Locomotive	*Extensor carpi radialis*	12 mg/g
Support	*Longissimus dorsi*	6 mg/g

- **Breed.**
- **Sex**: - meat from male animals usually contains more pigment than that from female animals.

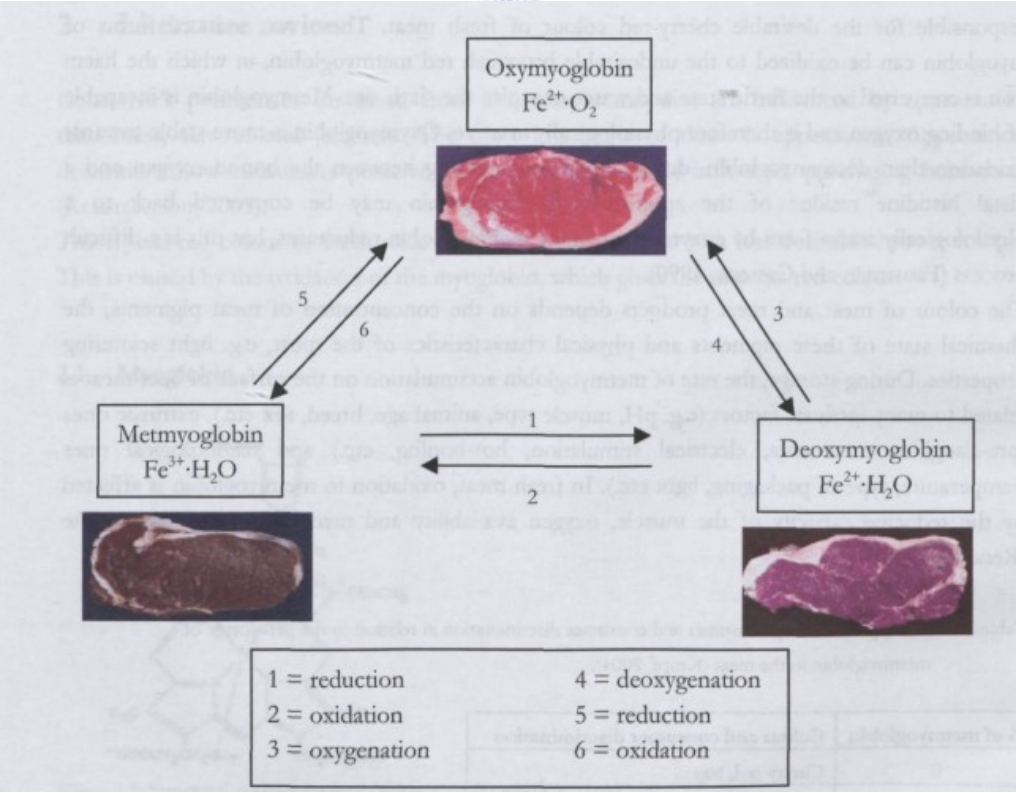


Figure 4 The three forms of myoglobin

II. Chilling

Red colour is more stable at lower temperatures because the rate of oxidation of the pigment decreases. At low temperatures, the solubility of oxygen is greater and oxygen-consuming reactions are slowed down. There is a greater penetration of oxygen into the meat and the meat is redder than at high temperatures.

III. Conditioning

Newly cut conditioned meat is known to show a brighter surface after a short exposure to air than unconditioned meat. Meat, when cut and exposed to air, ***changed from dull purple red to a bright cherry red,*** which is measured as an increase in 'lightness', a 'hue' change towards red and an increase in 'saturation'. The magnitude of the change on blooming for conditioning meat as compared with un-aged was the same size for 'lightness' but was two-fold greater for 'hue' and three-fold greater for 'saturation'. Conditioned meat, when freshly cut, was lighter but more purple than the unconditioned. After 1h exposure to air, conditioned meat had a redder 'hue' which was considerably more saturated and intense than the unconditioned samples. These changes in

lightness, hue and saturation produced by conditioning result in a brighter, more attractive appearance. The overall colour improvement was of a similar magnitude to that which occurred on blooming.

Conditioned meat is superior to unconditioned because of its eating quality and bloomed colour. However, this improved colour is not maintained on subsequent packaging for retail display. Both the improvements in the colour of conditioned meat when freshly cut and the faster accumulation of metmyoglobin can be accounted for by the diminution of the meat's enzymic activity which occurs during the conditioning process:

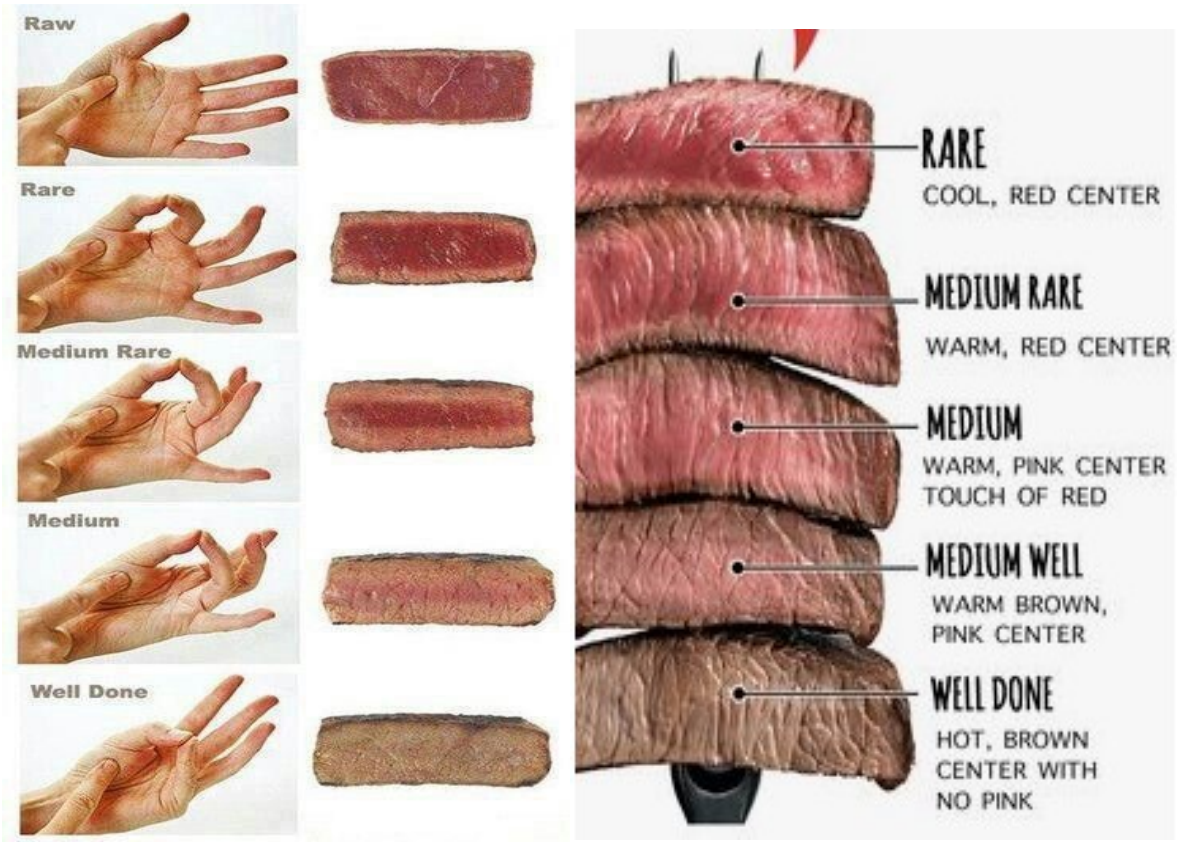


Figure 5 Meat conditioning

First, a thick layer of oxymyoglobin forms in conditioned meat because of the lowering of the rate of oxygen consumption and oxygen therefore penetrates faster and further into the tissue. Second, metmyoglobin formed

Colour when freshly cut	Lightness	Hue	Saturation
Un-aged	28.1	22.9	15.6
Conditioned	29.7	18.0	16.0
Colour after bloom for 1 h			
Un-aged	28.8	24.2	17.3
Conditioned	30.3	21.4	21.4

Table 3 Effect of conditioning for up to 22 days on meat colour when cut and after 1 h exposure to air at 2 °C

IV. Chilled storage

The muscle surface of fresh meat undergoes extensive oxygen penetration and oxygenation of myoglobin after short periods of exposure to air. The length of time meat is kept in chilled storage has an effect on the rate of colour change during retail display. Study showed that there were clear colour changes after exposure in beef longissimus dorsi muscle stored for up to 5 days at 5 °C. The degree of lightness (L), percentage of red (a) and percentage of yellow (b) all increased by 3–4 units.

The colour of meat stored for longer periods showed less intense colour changes during 5h of exposure.

Bacterial activity is another factor in pigment changes in fresh meat. The primary role of bacteria in meat discoloration is the reduction of oxygen tension in the surface tissue. Initial oxygen concentrations in packaging over approximately 0.15% will seriously compromise the colour stability of both beef and lamb. Pork appears able to tolerate oxygen concentrations above 1% without obvious detrimental effect during short-term storage at chilled temperatures.

Study has shown clearly that control of both storage temperature and oxygen content are required to stop colour deterioration in controlled atmosphere storage of beef. Samples were packaged in either N2 or CO2 containing oxygen at concentrations between 100 and 1000ppm.

V. Freezing

The colour of frozen meat varies with the rate of freezing. The speed of freezing diminished, the appearance of the product changes and at very low rates there is a marked development of translucence. Later experiments have demonstrated a direct relationship between freezing rate and muscle lightness; the faster the rate the lighter the product.

VI. Frozen storage

'Freezer burn' is the main appearance problem that traditionally affected the appearance of meat in frozen storage. Desiccation from the surface tissues produces a dry, spongy layer that is unattractive and does not recover after thawing. This is commonly called 'freezer-burn'. It occurs in unwrapped or poorly wrapped meat. The problem is accentuated in areas exposed to low humidity air at high velocities, and by poor temperature control. Since most meat is now wrapped and temperature control much improved this is less of a problem than it once was commercially.

VII. Thawing

Although the freezing rate has a marked effect on the colour of the frozen product it does not affect the lightness of the meat when thawed, with the exception of meat which has been very slowly frozen. Slowly frozen beef, which also darkened on freezing, showed considerable loss of redness after thawing.

2.2. Carcass, split carcass and range of animals

Carcass: - The muscle, bone and fat associated with the slaughter of an animal, left after the removal of the head, hide and internal organs.

A. Hygienic carcass splitting with simple equipment

Carcass splitting

For the carcass splitting saw the license holder has the option either to use dedicated equipment or to ensure that the equipment used on an OTM cattle carcass is cleaned and sanitized before being used on a UTM cattle carcass or on carcasses and parts of carcasses of other food animal species. The level of cleaning required is equivalent to

what is required when the carcass splitting saw becomes contaminated (that is, the organic material must be removed to ensure adequate sanitation).

The carcass splitting saw should separate the vertebral column in the midline to facilitate removal of the spinal cord. If the saw is equipped with an automatic rinse system, the exhaust water must be ducted away from carcasses and other edible and inedible products. The water-exhaust effluent should be adequately trapped. The trap should be emptied, cleaned and renewed as and when necessary.

In Cattle

Split the carcass down the backbone (chine) with a saw or cleaver from the pelvis to the neck (Figs 6 and 7). Sawing gives a better result but bone dust must be removed. If a cleaver is used, it may be necessary to saw through the rump and loin in older animals. The saw and cleaver should be sterilized in hot (82°C) water between carcasses. Power saws increase productivity.

Figure 6 Carcass splitting

Figure 7 Electrical carcass spilling machine

Self-check 2	Written test

Name_____ ID_____ Date_____

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (2 points each)

1. Of the following one is the factor that affects meat color
   A. Live animal
   B. Chilling
   C. Conditioning
   D. Chilled storage
   E. All

Test II: Matching (1.5 point each)

A	**B**
1. Higher myoglobin	A. Animals body left after removal of an edible parts
2. Male Animals	B. Occur in un wrapped or poorly wrapped meat
3. Lower temperature	C. Pigment oxidation decreases
4. Freezer burn	D. Contains more pigments
5. Carcass	E. Old beef

Test III: Short Answer Questions

1. Explain the three Myoglobin natural colors of meat based on exposure to oxygen (3 point)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 11 points** **Unsatisfactory - below 11 points**

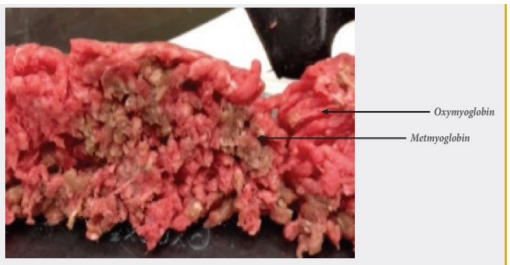
Operation sheet-1 Meat colour determination

MATERIALS:

- 2Kg of ground red (beef, lamb, mutton) meat. If ground meat is not available, the same demonstration can be done with whole cuts of red meats.
- Stomacher bags or similar container
- Oxygen-impermeable wrapping
- Refrigerator
- Sodium nitrite

STEP 1

1. Remove meat from package.
2. Examine the underside to see if the color on the bottom matches the color on the top.
3. Slice through the meat along its length.
4. Examine the color throughout the meat.



1. The picture above shows fresh ground beef. The myoglobin in the pink portions is in the oxymyoglobin state. The myglobin in the brown portions is in the metmyoglobin state.

STEP 2

1. Form two patties from the same meat package (whole meat cuts will also work).
2. Wrap one patty in oxygen-impermeable wrap and one in oxygenpermeable wrap.
3. Place both in the refrigerator, incubate for 1–2 hr and observe color changes.

1. Form meat into two flat patties

2. Wrap one patty in oxygen-impermeable plastic wrap (or similar container that is impervious to oxygen). Wrap the second patty in plastic wrap that allows oxygen. Incubate both patties in the refrigerator for 1-2 hours and compare color changes.

LG #62	LO #2- Ensure cleaning program is followed

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Establishing and maintaining cleaning programs
- Setting Cleaning schedule regularly

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1.1. Cleaning and Sanitation

Cleaning refers to removal of visible, physical/chemical dirt and to some extent bacteria from the equipment surfaces, sometime from products itself and from the processing environment. On the contrary, sanitization term is used with disinfection of the product or product contact surfaces by all killing spoilage and pathogenic microorganisms in order to avoid all possible risks of microbial contamination. Inactivation of microorganisms requires antimicrobial treatments, carried out in food industries through hot water or steam or through the application of disinfectants or sanitizers.

2.1.1. Cleaning procedures

The first step in floor and equipment cleaning is to physically remove scrap, i.e. coarse solid particles, with a dry brush or broom and shovel. This is usually referred to as **dry cleaning and wet cleaning** is followed after removal of physical scrap material. Wet cleaning could be done manually or by using high pressure nozzles. However, this would require water in sufficient quantities.

A relatively new cleaning method for the food industry, in particular the larger-scale plants, is **foam cleaning**. Water foam containing detergents and other cleaning agents is sprayed on wetted walls, floors and surfaces of equipment. The foam does not immediately run off but clings to the surfaces. This allows a longer term contact on the surfaces to be cleaned. After a sufficient impact period (min. 15 minutes) the foam is washed down with water (water hose or low-pressure water spray). As no high pressure water spraying is needed for washing off the foam, the spreading of water droplets (aerosol) in the room to be cleaned is minimized.

Figure 8 Foam Cleaning

2.1.2. Cleaning agents

Traditional cleaning substances/detergents for manual use are alkaline, such as sodium carbonates (Na_2CO_3, washing soda). These substances are efficient in dissolving proteins and fats, but may cause corrosion in tools and equipment, if their pH is 11 and above.

Ideal detergents should have the following desirable properties:

- ✓ Wetting and penetrating power-must wet, penetrate and dispose soil and remove it from walls of equipment's.
- ✓ Emulsifying power
- ✓ Saponifying power
- ✓ Deflocculating power
- ✓ Sequestering and chelating power
- ✓ Quick and complete solubility
- ✓ Should be non-corrosive to metal surface
- ✓ Economical
- ✓ Stability during storage
- ✓ Should be mild on hands
- ✓ Should possess germicidal action

Alkaline cleaning agents are generally suitable for removing organic dirt, protein residues and fat, while a**cid cleaning agents are u**sed particularly for removal of encrusted residues of dirt or protein or of inorganic deposits (scaling) such as water stone, milk stone, lime etc. On the other hand, **Neutral cleaning agents** have much less effect than alkaline or acid cleaning agents, but have mild impact on skin and materials and are useful for manual cleaning of smooth surfaces without encrusted dirt. In practice alkaline and acid cleaning substances should be used **alternatively**.

2.1.3. Disinfection techniques

The elimination of microorganisms is achieved through **disinfection**, either by using

- Hot water (or better steam) or
- Chemical disinfectants.

Chemical disinfectants are preferred for most applications in the meat industries as they are easy to use and do not involve the risk of accidents or other negative side effects such as damage to equipment by generating high humidity or water condensation, which may occur when using steam. Best results are achieved when chemical disinfection is preceded by intensive dry/wet cleaning.

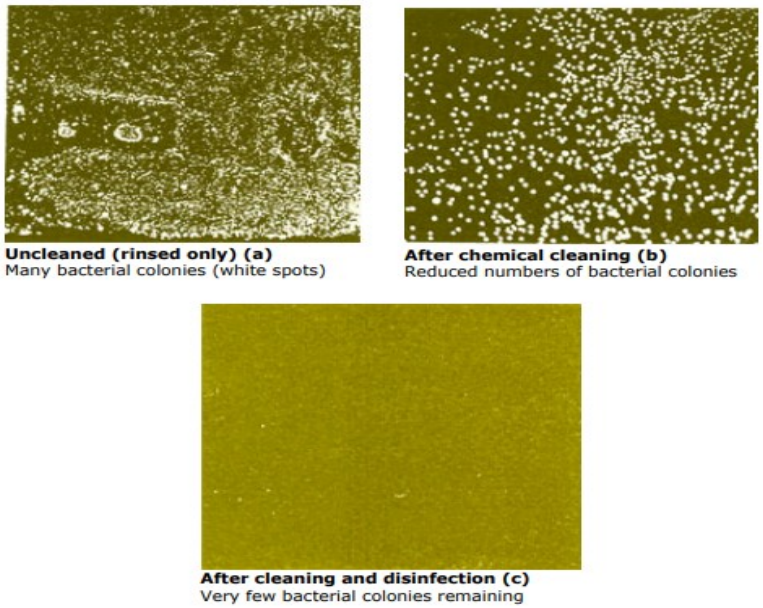

Figure 9 Effect of cleaning and disinfection on the number of bacteria

Self-check 1	Written test

Name_____ ID_____ Date_____

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (2 points each)
Wetting and penetrating power

1. Of the following one is not the desirable properties detergent
   A. Emulsifying power
   B. Deflocculating power
   C. Stability during storage
   D. None
2. Traditional cleaning substances/detergents for manual use are alkaline, such as sodium carbonates (Na_2CO_3, washing soda) **(True/ False**)
3. The first step in floor and equipment cleaning is to physically remove scrap. **(True/ False**)
4. Is foam cleaning a relatively new cleaning method for the food industry, in particular the larger-scale plants. **(True/ False**)

Test II: Short Answer Questions

1. Explain the elimination techniques of microorganisms through **disinfection** (4 point)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 12 points** **Unsatisfactory - below 12 points**

Information Sheet 2- Setting Cleaning schedule regularly

2.1. Cleaning

Dirt, food waste and other debris can be a potential source of microbiological and physical hazards and will also attract pests that can contaminate the production environment. Effective cleaning on a regular basis is essential to remove dirt and debris from the food premises. Effective disinfection of clean food contact surfaces is necessary to reduce bacteria to an acceptable level. Poorly executed cleaning programs and careless storage and use of cleaning materials may give rise to chemical hazards. Procedures are needed to prevent or minimize the risk of such hazards causing illness or injury to consumers.

Table 4 some examples and importance of cleaning

Problem	Effect	Possible outcome
Poor cleaning within the working environment	Food is contaminated by dirt from the working environment such as dust, rust flakes, lubricating oil and food processing residues	Increases the chances of cross contamination of food products by food poisoning micro-organisms
Food premises is not cleaned properly	Organic material such as meat, blood and other edible and inedible tissues can become contaminated. Moisture can accumulate	Encourages growth of microorganisms such as Salmonella
Poor cleaning	Pests are attracted to organic material	Pest species, for example, flies, beetles, rodents, are carriers of micro-organisms that can cause food poisoning
Careless use of cleaning agents	Chemicals spill on food	Lead to chemical contamination of food
Ineffective and poor cleaning	Cleaning implements are themselves contaminated during the cleaning process	Lead to cross contamination when implements are next used

2.1.1. Cleaning and effective cleaning ‘

B. Cleaning

Clean’ means free from dirt, marking, or soiling. Visibly clean surfaces look, smell and feel clean. Dirt and soil can be organic, for example, fat, blood; or inorganic, for example rust, and lime scale.

Surfaces in contact with food should be:

a. **Physically clean**: - All visible dirt / soil / residues have been removed. Best assessed using white moist wipes.
b. **Chemically clean**: - all cleaning material residues have been removed.
c. **Microbiologically clean: -** The number of micro-organisms has been reduced to a level acceptable for human health. This usually involves the use of disinfectants.

C. Effective cleaning

Effective cleaning depends on the removal of gross physical contamination followed by the correct use of chemical agents. This means using the right chemicals, applying them at the right concentration and application rate using the right equipment, and allowing them time to work.

Cleaning chemicals

- ✓ **Detergents:** - chemicals used to dissolve grease and remove dirt and soil. Appropriate acidic or alkaline products can also be used.
- ✓ **Disinfectants: -** chemicals that reduce bacteria to an acceptable level and may kill them. Products may be called germicides, bactericides or biocides. Surfaces need to be clean of grease, dirt and soil before a disinfectant is used - there is little point in disinfecting a dirty surface. As well as the main biocide components, disinfectant formulations may include:
  - surfactants to improve the wetting properties of the product and to control foam production

- sequesterants to improve suspension of any remaining inorganic soils from the surfaces, to prevent scale forming on contact surfaces and to improve the biocidal activity of the disinfectant
- stabilisers to prevent disassociation of the disinfectant when used
- alcohols to decrease drying time by evaporating off the surface and leaving it dry

✓ **Sanitisers** – two-in-one products that act as both a detergent and a disinfectant. Do not attempt to mix cleaning chemicals yourself.

- **Dilution rate**: is the quantity of water to use with a concentrated chemical before it can be used. Follow the label instructions for the specific situation.
- **Contact time:** is the time that the cleaning chemical needs to be left on the surface to work effectively and manufacturer's instructions should always be followed. Vertical surfaces can present problems when applying the correct contact time. Substances such as foams and gels may be used in the formulation to extend contact time.
- **Temperature**: may be critical for a cleaning chemical to work effectively. In general, higher temperatures are more effective but may give rise to condensation. Products that work at lower temperatures may be available.

Manufacturers and suppliers: can advise on the best chemicals to use in specific situations and on the safe and effective use of cleaning chemicals.

D. Cleaning schedule and checklist examples

Operators need to establish effective cleaning and disinfection routines. Cleaning schedules will demonstrate when and how cleaning is to be carried out. A cleaning checklist will help to make sure that no area or piece of equipment is missed and can be used to record problems and action taken.

Table 5 A cleaning schedule and checklist that can be used in the meat industry

CLEANING SCHEDULE EXAMPLE				Issued by [Name] [Date]	
Cleaning of:	**Methods, chemical, Time**	**Equipment**	**PPE**	**Frequency**	**Notes**
Room/Area[A]	**AAAA+ disinfectants**			**Daily**	
Machine [1]	**BBBB**			**D+ Breaks**	
Vehicle [1]	**CCCC**			**D**	**+ deep clean**

Table 6 **Cleaning checklist examples**

CLEANING CHECKLIST EXAMPLES								[Week 1(year)]
AREA / ITEM /								**NOTES/ACTION**
	M	**T**	**W**	**TH**	**F**	**SA**	**SU**	
Area [A]								
Machine [1]								
Vehicle [1]								
Verified by : [signature] _____ [Date]								

Self-check 2	Written test

Name_____ **ID**_____ **Date**_____

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Matching (2 points each)

A		**B**
1. Cleaning	A.	Programs
2. Physically clean	B.	Detergents and disinfectants
3. Microbiologically clean	C.	Reduced micro organisms
4. Cleaning chemicals	D.	No visible dirty
5. Cleaning schedule	E.	Free from dirty

Test II: Short Answer Questions

1. Sketch and understand the clean schedule and checklist (4 point)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 14 points** **Unsatisfactory - below 14 points**

LG #63	LO #3- Monitor chillers and freezer temperature

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Determining Ethiopian meat chilling and freezing standard (ES 4696:2007)
- Monitoring temperature of product periodically
- Maintaining temperature of chiller and freezer
- Correcting and Maintaining temperature changes on products

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Determine Ethiopian meat chilling and freezing standard (ES 4696:2007)
- Monitor temperature of product periodically
- Maintain temperature of chiller and freezer
- Correct and Maintain temperature changes on products

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Determining Ethiopian meat chilling and freezing standard (ES 4696:2007)

1.1. Introduction

To prevent or even to reduce the deterioration process, particularly microorganism development, chilling has to be carried out quickly after carcass dousing at the end of the slaughter process and the chilled state has to be maintained until the meat is processed for consumption.

Chilling can be defined as the fundamental operation in applying cold to meat to reduce its temperature quickly. This is done in a cold chamber with intensive air draught or movement. Rapid cooling of the meat surface not only slows and nearly stops the development of surface micro-organisms but also reduces weight loss and discoloration of the surface owing to haemoglobin oxidation. Different systems of primary chilling are in use (including immersion in iced water, especially for poultry) but air chilling is the most common.

The cold chambers where chilling takes place must have a low air temperature, a high air speed, a high relative humidity and a high refrigerating capacity.

- ✓ Air temperature must be in the region of 0°C, with no decrease below -1°C, which could freeze the meat surface and impair its appearance.
- ✓ Air speed can range from 0.25 to 3.0 m/s. However, for economic reasons the most common speeds in use are from 0.75 to 1.5 m/s in the empty section of the cold chamber.

Air speed over the carcasses will be much higher because of the reduction in air circulation. Increased air speed reduces the cooling period but it has a limit as there is a threshold above which fan-power consumption increases more than the chilling rate, resulting in an increase in operational costs. Also, the higher the air speed the greater the weight loss.

I. Primary chilling

Primary chilling is the process of cooling meat carcasses after slaughter from body to refrigeration temperatures. During primary chilling rapid growth of both pathogenic and spoilage microorganisms may occur. European Union legislation requires a maximum final meat temperature of 7^{o}C before transport or cutting but it does not define any limits on chilling time. However, a rapid reduction of the carcass surface temperature is required to prevent microbial growth and extent product shelf life. In addition, rapid chilling has a number of other clear advantages in product quality and production economics.

From the sanitary point of view, meat has to be chilled as soon as possible after slaughter. However, the cooling of muscle tissue to low temperatures before the development of *rigor* may result in contraction of the muscle Fibres with permanent toughening of the tissue. It has been suggested that the risk of unacceptable toughening can be avoided if cooling is very rapid

As a result of meat protein denaturation taking place in the post-mortem period, a considerable amount of previously immobilized water is released by the proteins. This water is responsible for the pink proteinaceous fluid, commonly called a “drip” or “purge.” The presence of drip, which accumulates in the container of prepackaged meat or in trays or dishes of unwrapped meat, is a major quality problem since it significantly reduces sales appeal

Another important advantage of rapid chilling is the significantly increased production yield compared to slow chilling. Meat has higher water content and thus weight loss due to evaporation during chilling can be significant.

II. Secondary chilling

After primary chilling, any following handling such as cutting, mincing etc. will increase the temperature of meat. A secondary chilling is required to reduce temperature below 7^{o}C. Secondary chilling is also of great importance in the case of pre-cooked meat products. The temperature of meat after the cooking process should be rapidly reduced from approximately 60 to 5^{o}C, to prevent or reduce growth of pathogens which survived the heat process or recontaminate the product. In addition, rapid cooling of cooked meat products is important for avoiding quality problems caused by the overcooking that occurs during slow cooling.

For meat, the main quality parameters are appearance (colour), texture, taste and juiciness. It is absolutely necessary that meat has an acceptable tenderness. Therefore, cold shortening during chilling must not occur, and appropriate ageing must be secured. However, aged meat should not be used for the manufacture of minced meat. Raw materials used in the manufacture of deep frozen foods must be of good and sound quality and be of the required degree of freshness. The freezing process should be started without undue delay, and be as rapid is practical. After thermal stabilization (equalization) the temperature of the product should be maintained at -18°C at all points.

Temperature

When the wrong temperature or a fluctuating temperature occurs, the quality loss is increased and the remaining storage life reduced. However, as long as the temperature is below about -8°C, no bacterial growth can take place. It must be stressed that most frozen fishery products have a rather short PSL which makes it essential to maintain the required temperatures throughout the freezer chain

Product temperatures up to -8°C cannot cause microbiological problems, and as transport times generally are restricted to days or weeks, the quality degradation of frozen meat will normally be negligible. In practice, as long as the meat is still frozen i.e.

the meat temperature is below -2°C, the quality will normally be only marginally affected by temperature abuses, on condition that the transport time is less than a few days.

Chilling standards

Chilling means process of lowering the temperature (cooling) of poultry carcass and parts. Poultry establishments may use water, air, combination of water and air, ice, liquid etc. for chilling.

Freezing standards

Freezing means reducing the temperature of food below the freezing point so that most of the water contained in the food turns into ice. The freezing point depends upon the concentration of different solutes in the tissue fluids.

- ✓ Freezing point for water is 0°C or below.
- ✓ Freezing point of poultry is -2°C or below.
- ✓ Frozen poultry is stored at - 18 °C (0 °F) or less.

Crust freezing "surface freezing"

The crust freezing "surface freezing" is temporary freezing of a thin outer layer of skin and muscle. The surface freezing may completely surround the bird but may not be deeper than 4 mm. Surface freezing must be easily broken with slight pressure.

Normally, surface freezing may occurs during holding and transportation. Crust freezing may be used by poultry establishments for holding poultry provided it does not compromise food safety and product meets all regulatory requirements at all times.

When the surface freezing is deeper than 4 mm and freezing cannot be easily broken with slight pressure the product must be considered to have been frozen and labeled accordingly.

Carcass parts

Refers to edible poultry parts from dressed carcasses e.g. trimmed breasts, breasts, drumsticks, thighs, legs, wings, wing drumettes, winglets, backs, stripped backs, necks (including detached necks), halves, front quarters, hindquarters, breast fillets etc.

Salvaged portions

Refers to edible poultry harvested as part of salvaging operations, for example wings, wing drumettes, breasts (with skin and/or skinless), breast fillets, legs, drumsticks, thighs, wings etc.

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Chilling time and temperature standards

The rate of temperature decline will depend upon factors such as size of the bird, chilling method, amount of insulating fat, refrigeration facility, time of contact with chilling agent and amount of poultry product moving through the chilling system.

Dressed poultry carcasses

Immediately following evisceration and washing, all dressed poultry carcasses (other an air chilled) must be continuously chilled according to the following table:

Water-chill standards for dressed poultry carcasses			
Weight of Dressed Poultry Carcasses	**Initial Time (hours) to Reach ≤ 14°C**	**Additional Time (hours) to Reach ≤ 6°C**	**Additional Time (hours) to Reach ≤ 4°C**
Under 1.8 kg	2	2	4
1.8 kg to 3.6 kg	2	4	4
3.6 kg to 5 kg	2	6	4
5 kg to 7 kg	2	8	4
7 kg to 12 kg	2	10	4
Over 12 kg	2	10	6

NB. Fresh meat must have a pH value in the range of 5.5 to 6.2. During temporary storage, especially when it is not properly preserved, the fresh meat will turn rancid and have a pH value below 5.3.

Self-check 1	Written test

Name_____ **ID**_____ **Date**_____

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (2 points each)

1. Air temperature must be in the region of 0°C, with no decrease below -1°C, which could freeze the meat surface and impair its appearance**.(True/ False)**

6.

Test II: Short Answer Questions

1. Explain the primary and secondary chilling (6 point)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 8 points** **Unsatisfactory - below 8 points**

Information Sheet 2- Monitoring temperature of product periodically

2.1. Refrigerator temperature

Refrigeration temperatures must be controlled to minimize microbiological growth. Do not over-stock refrigeration units because proper air circulation is essential for effective temperature control. Make sure the refrigerator is regularly maintained and cleaned to ensure maximum efficiency, especially during warmer weather. Don't switch off chills, refrigerators or display cabinets containing food to save on electricity costs.

2.2. Monitoring of Cold Temperatures

The measurements of temperature, air velocity and relative humidity have a significant role in producing a satisfactory product in the meat industry.

It is advisable to check all refrigerators, chill and cold display cabinet temperatures twice a day, once at the start of the working day and at some other time of the day.

- ✓ Temperatures in refrigerators and display cabinets vary at different points within the unit depending on the air circulation and efficiency of the unit. Always monitor the temperature at the warmest part of the unit.
- ✓ Air temperatures fluctuate so avoid checking the temperature of refrigerators, chills and cold displays immediately after the door or lid has been open for any significant period of time or during a defrost cycle.
- ✓ When relying on an electronic display for temperature monitoring, be aware that the reading refers to the air temperature where the probe is located so may not provide an accurate indication of food temperature. You should always back this up with an actual food reading or food simulant reading e.g. bottle of water or food gel.

- **Material Required in temperature monitoring**
  - ✓ **Thermometers**

The simplest way to check food and air temperatures is by using a digital probe thermometer. This may be supplemented by additional “in-place” thermometers located in refrigerators, chills and cold display cabinets.

Thermometers and Temperature Monitoring –Good Practice

- ✓ Have two separate, identifiable probe thermometers, one for raw food and the other for ready-to-eat food to reduce the risk of cross contamination.
- ✓ When monitoring the core temperature of large meat products, the probe must be long enough to reach the center of the product.
- ✓ Thermometers should always be kept clean and should be disinfected before and after each use. Both the body of the unit and the probe should be kept clean.
- ✓ Check that your thermometer is working correctly by taking a reading in iced water readings should be between -1°C and +1°C. Similarly, take a reading in boiling water readings should be between 99°C and 101°C. If your reading is outside these temperature ranges, the unit should be replaced or returned to the manufacturer to be re-calibrated.
- ✓ Never use mercury in glass thermometer because breakage would present a contamination risk.

Below are general guidelines for how long basic meats can be kept safely if they’re stored properly.

Type of meat	Safe storage times (in the refrigerator)	Safe storage times (in the freezer)
uncooked poultry	1–2 days	9 months (pieces) to 1 year (whole)
uncooked ground meat	1–2 days	3–4 months
uncooked steaks or chops	3–4 days	4–12 months, depending on the item
uncooked fish	1–2 days	6 months
cooked poultry, meat, or fish	3–4 days	2–6 months
hot dogs and lunch meat	up to 1 week (open package) or 2 weeks (closed package)	1–2 months

Refrigeration of carcasses

Carcasses should go into the cooler as soon as possible and should be as dry as possible. The object of refrigeration is to retard bacterial growth and extend the shelf-life.

- ✓ Chilling meat post-mortem from 40°C down to 0°C and keeping it cold will give a shelf-life of up to three weeks, provided high standards of hygiene were observed during slaughter and dressing.
- ✓ Carcasses must be placed in the cooler immediately after weighing. They must hang on rails and never touch the floor. After several hours the outside of a carcass will feel cool to the touch, but the important temperature is that deep inside the carcass. This must be measured with a probe thermometer (not glass), and used as a guide to the efficiency of the cooling.
- ✓ Maintain deep muscle temperature of 6–7° C should be achieved in 28 to 36 hours for beef, 12 to 16 hours for pigs and 24 to 30 hours for sheep carcasses. Failure to bring down the internal temperature quickly will result in rapid multiplication of bacteria deep in the meat resulting in off-odors and bone-taint.
- ✓ High air speeds are needed for rapid cooling but these will lead to increased weight losses due to evaporation unless the relative humidity (RH) is also high. However, if the air is near to saturation point (100 percent RH) then condensation will occur on the carcass surface, favoring moulds and bacteria growth. A compromise between the two problems seems to be an RH of about 90 percent with an air speed of about 0.5 m/second. Condensation will also occur if warm carcasses are put in a cooler partially filled with cold carcasses.
- ✓ The cooler should not be overloaded beyond the maximum load specified by the manufacturers and spaces should be left between carcasses for the cold air to circulate. Otherwise cooling will be inefficient and the carcass surface will remain wet, favouring rapid bacterial growth forming slime.
- ✓ Once filled, a cooler should be closed and the door opened as little as possible to avoid sudden rises in temperature. When emptied, it should be thoroughly washed

before refilling. Personnel handling carcasses during loading and unloading operations should follow the strictest rules regarding their personal hygiene and clothing and should handle carcasses as little as possible.

Self-check 2	Written test

Name_____ **ID**_____ **Date**_____

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (2 points each)

1. Thermometer working correctly can be checked by reading in iced water readings between -1°C and +1°C. **(True /False)**
2. The measurements of temperature, air velocity and relative humidity have a significant role in producing a satisfactory product in the meat industry. **(True /False)**

Test II: Matching (2 point each)

A	**B**
1. Postmortem chilling	A. 28-36 hrs for beef and 24-30hrs for sheep
2. 6-7$^{o}_{c}$ Muscle temperature	B. Chilling from 40 $^{o}_{c}$ to 0 $^{o}_{c}$

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – 8 points** **Unsatisfactory - below 8 points**

Information Sheet 3- Maintaining temperature of chiller and freezer

3.1. Influence of refrigeration on evaporative weight loss from meat

From the moment an animal is slaughtered the meat produced begins to lose weight by evaporation. Under typical commercial distribution conditions, it has been estimated that lamb and beef lose from 5.5 to 7% by evaporation between slaughter and retail sale

Weight losses from pork are probably of the same magnitude. In addition to the direct loss in saleable meat there are also secondary losses. Excessive evaporation during initial chilling and chilled storage produces a dark unattractive surface on the meat. Either this has to be removed by trimming, or the meat is downgraded and sold at a reduced price.

Freezing does not stop weight loss. After meat is frozen, sublimation of ice from the surface occurs. If the degree of sublimation is excessive, the surface of the meat becomes dry and spongy, a phenomenon called 'freezer burn'.

I. Theoretical considerations

The rate at which a piece of meat loses weight through its surface depends upon two related processes: evaporation and diffusion. Evaporation is the process that transfers moisture from the surface of the meat to the surrounding air. Diffusion transfers water from within the meat to its surface.

The rate of evaporation (*M*e) from the surface of a food is given by Dalton's law:

$$Me = mA(Pm - Pa)$$

Where

- *"M"* is the mass transfer coefficient
- *"A"* the effective area and
- "*P*m" and "*P*a" the vapour pressure at the surface of the meat and in the surrounding air, respectively.

VIII. Weight loss in practice

In a meat distribution chain, chilling, chilled storage and display, freezing and frozen storage, are considered from the point of view of weight loss. Since the majority of the loss tends to occur during chilling, it is given greater consideration than the other processes.

IX. Chilling

Immediately after slaughter the surface of the carcass is hot (*ca.* 30 °C) and wet so the rate of evaporation is high. Pork carcasses lose 0.4% moisture between 0.5 and 1.0h post-mortem when held at approximately 15°C. Spray-washed lamb carcasses show an even greater rate of weight change, *ca.* 1.0%, during this time (James, unpublished work). Consequently, the time at which initial hot weight is obtained is crucial in all weight loss measurements.

X. Freezing and frozen storage

The rate of sublimation of ice from a frozen surface is considerably slower than the rate of evaporation from a moist surface, and the ability of air to hold water rapidly diminishes as its temperature falls below 0 °C. The consequent advantage of fast freezing and using low temperatures

2.2. Time and temperature control

Inadequate food temperature control is one of the most common causes of foodborne illness or food spoilage. Such controls include time and temperature of cooking, cooling, processing and storage. Systems should be in place to ensure that temperature is controlled effectively where it is critical to the safety and suitability of food.

Temperature control systems should take into account:

- ✓ The nature of the food, e.g. Its water activity, PH, and likely initial level and
- ✓ Types of micro-organisms;
- ✓ The intended shelf-life of the product;
- ✓ The method of packaging and processing; and

- ✓ How the product is intended to be used, e.g. further cooking/processing or Ready-to-eat.

Factors controlling efficiency of chilling

- The temperature of storage is probably the most important factor determining the efficiency of chilling.
- Higher temperatures are less effective in preservation and shrinkage is also high.
- The rate of chilling is another factor that affects the efficiency of chilling, with quick chilling being markedly superior with respect to both keeping quality (retardation of surface bacterial growth) and sensory qualities (superior bloom) and shrinkage is also lesser as well.
- The air velocity is directly proportional to rate of chilling and hence thus higher velocities enhance bloom and impart greater preservative effect, but cause increased shrinkage. Hence, initial chilling of warm carcasses, sides, or quarters is carried at 7°C and the mean air speed of 0.75m/s, while in the terminal stages of chilling temperature must be maintained between -1°C and 2°C, with mean air speed of 0.5m/s.
- Meat packed on trays or in cartons the temperature must be below 3°C and mean air speed of 0.75m/s.
- Higher air circulation rates are not associated with shrinkage, especially when the carcass is fresh and still wet, wherein higher circulation rates result in rapid decrease of the carcass surface water vapour pressure, thus reducing shrinkage.
- Air circulation rates of up to 70-110 volumes of the room per hour are maintained in quick chilling to rapidly lower the temperature.
- Slower air circulation rates are beneficial once the temperature of the carcass is sufficiently lowered.
- Relative humidity of the chilling room also has an important role to play in the efficiency of chilling. High relative humidity's will reduce shrinkage but will flavour mould growth.

- A relative humidity of 95% may be maintained to chill the carcass and store chilled carcass, if storage is to be for less than 72 hours, if extended beyond 72 hours, it has to be reduced to 90%.
- Uniformity of air flow throughout the chill room is yet another factor that has a role in determining efficiency of chilling, but this itself is determined by the evenness of hanging the carcass in the chiller room.
- The recommended rail spacing in a chiller or freezer room should be 0.9m for beef, 0.7 m for pork and 0.5 m for lambs and the minimum space between carcasses on these rails should be 0.3 to 0.4m. Further, the rails should be placed 0.6 m (0.9 m, in case of header and traffic rails) clear off refrigerating equipment, walls and other fixed parts of the building to ensure hygiene and protection to walls.

The top of the chill rail from the floor level should be at least 3.3 m for beef sides, 2.7m for headless pigs and calves, 2.2 m for beef quarters, and 2m for sheep and goat.

Self-check 3	Written test

Name_____ **ID**_____ **Date**_____

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Matching (2 points each)

A

1. Weight loss of meat by evaporation
2. Rate of evaporation
3. Carcass at slaughter

B

A. 30^{o}c
B. *Me* = *mA*(*P*m - *P*a)
C. 5.5- 7% loss between slaughter and retail sale

Test II: Short Answer Questions

Explain the Factors controlling efficiency of chilling (6 point)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 12 points** **Unsatisfactory - below 12 points**

Information Sheet 4- Correcting and maintaining temperature changes on products

4.1. Maintaining Temperature

When the wrong temperature or a fluctuating temperature occurs, the quality loss is increased and the remaining storage life reduced. However, as long as the temperature is below about -8°C, no bacterial growth can take place. .

Temperature Control House Rules

Consider the various Temperature Control procedures that are followed in your business.

Write down the Temperature Control measures applied at each process step and include a Critical Limit. Guidance on suitable Critical Limits can be found at the start of this sub-section.

- ✓ Write down how you will monitor temperature control the procedure, frequency and the recording form you intend to use.
- ✓ Validate your cooking methods for products that will not be probed at the end of cooking.
- ✓ Validate the cooling method of products which rely on temperature/time combinations to ensure thorough cooking rather than a core temperature check.
- ✓ Validate your cooling method for large volume meat products, such as large joints of meat and bags of stew.
- ✓ You need to validate cooking and cooling methods once for each product and write the details down in the table at the end of this sub-section.

Critical Control Point

NB. Keep foods 4°C (39°F) or colder, the safe temperature for refrigerated storage

Keep these factors in mind when storing fresh meats, poultry, and produce:

- All carcass meats should be unwrapped and hung so that air can circulate around them. They should be stored at 1°C to 3°C (34°C to 37°F) in a walk-in refrigerator. Place absorbent paper under the meats for quick cleanup of any unwanted drips.
- Fresh meat must not be kept too long. Boned meat should be kept no longer than three days. Individual cuts should be used within two days, preferably on the day they are cut.
- Individual meat cuts such as steaks, chops, stewing meat, and ground meat should be kept covered on plastic or stainless steel trays at 2°C to 4°C (36°F to 39°F).
- Fresh poultry should be packed in ice and stored in the refrigerator.
- Fresh seafood should be packed in ice, stored at −1°C to 2°C (30°C to 34°F) and used as soon as possible.
- Store raw products on the lower shelves of the refrigerator, below cooked products.

Storage

- Always refrigerate perishable food within 2 hours 1 hour when the temperature is above 90 °F (32.2 ºC).
- Check the temperature of your refrigerator and freezer with an appliance thermometer. The refrigerator should be at 40 °F (4.4 ºC) or below and the freezer at 0 °F (-17.7 ºC) or below.
- Cook or freeze fresh poultry, fish, ground meats, and variety meats within 2 days; other beef, veal, lamb, or pork, within 3 to 5 days.
- Perishable food such as meat and poultry should be wrapped securely to maintain quality and to prevent meat juices from getting onto other food.
- To maintain quality when freezing meat and poultry in its original package, wrap the package again with foil or plastic wrap that is recommended for the freezer.

Canned foods are safe indefinitely as long as they are not exposed to freezing temperatures, or temperatures above 90 °F. If the cans look ok, they are safe to use. Discard cans that are dented, rusted, or swollen. High-acid canned food (tomatoes, fruits) will keep their best quality for 12 to 18 months; low-acid canned food (meats, vegetables) for 2 to 5 years

Monitoring and Recording

You must carry out suitable monitoring to ensure that your Temperature Control House Rules are implemented at all times. Any failure to adhere to these Rules should be considered to be a very serious matter and must trigger Corrective Action to prevent the supply of unsafe food.

Corrective Action (What to do if things go wrong)

Corrective Action should be predetermined and written which include:-

- ✓ Continue arranging until the Critical Limit is achieved.
- ✓ Revise your temperature/time combination for a specific product.
- ✓ Call a maintenance engineer to repair defective equipment.
- ✓ Corrective Actions should be recorded in the ***All-in-One*** record or in the ***Individual Temperature*** records. This will help you to ensure that any failure is not repeated and demonstrate that no unsafe food was supplied.
- ✓ Records of monitoring and any Corrective Action(s) taken should be kept for an appropriate period of time to demonstrate that your HACCP based system is working effectively.

Table 7 Temperature Control format for storing, Cooking and Cooling process steps require

Process Step	**Temperature Control Measure and Critical Limits**	**Monitoring Method, Frequency and Records used**
Delivery		
Refrigerated storage(refrigerators/chills)		
Frozen storage		
Preparation(Including defrosting)		
Cooking		
Cooling		
Reheating		

Corrective Actions

1. _____
2. _____
3. _____
4. _____

Signed ……..…. Date …….....…….

Position in the business …….....……

Self-check 4	Written test

Name_____ **ID**_____ **Date**_____

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (2 points each)

1. Wrong temperature or a fluctuating temperature result in the quality loss increment and reduce the remaining storage life. **(True/ False)**
2. Corrective Actions should be recorded in the All-in-One record or in the Individual Temperature records. **(True/ False)**

Test II: Short Answer Questions

1. Sketch the Temperature Control format for storing, Cooking and Cooling process steps require**.(6 point)**

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Operation sheet -1. Performing refrigerator clean up

1. Avoid “Over packing.” Cold air must circulate around refrigerated foods to keep them properly chilled.
2. Wipe Up Spills Immediately, getting rid of spills (especially drips from thawing meats
3. Open the required part of refrigerator
4. Use non electric conducting materials or remove it from the power sources to avoid electric shocks
5. Clean The Fridge Out Frequently. Make this task part of your storage room cleaning routine activities!

LAP TEST	Performance Test

Name_____ ID_____ Date_____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

1. Perform refrigerator cleaning activities

LG #64	LO #4 Monitor product handling and identification

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying and labeling products based on customers preference
- Communicating and confirming customer's requirements
- Confirming and arranging Temperature and storage requirements
- Completing and computing documentation order

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify and label products based on customers preference
- Communicate and confirm customer's requirements
- Confirm and arrange Temperature and storage requirements
- Complete and compute documentation order

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to "Operation sheets
7. Perform "the Learning activity performance test" which is placed following "Operation sheets" ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to "Operation sheets".

Information Sheet 1- Identifying and labeling products based on customers preference

1.1. Measurement of carcass characteristics

Usefulness of measurement techniques for predicting composition in both the live animal and its carcass should be judged on the following:-

- Accuracy
- Precision (repeatability)
- Cost
- Practicability

There is a range of new technologies available for the measurement or estimation of some traits. Many measurements taken on the carcass are used in the trading of carcasses or primals. They are used to assign the meat to different trading specifications. In some instances they are also used for grading the meat.

1.1.1. Traditional carcass measurements

I. Carcass weight (kg)

Meat, carcass is dressed and trimmed according to a standard carcass definition for all major meat species. This standard carcass is then weighed hot (Hot Standard Carcass Weight- HSCW) at the end of the slaughter chain, before being transferred to the chillers.

The weight of a carcass is reflected not only in kilograms meat yield, but also in the size of individual cuts, and therefore impacts on consumer requirements. Carcass weight also affects slaughter and processing costs. Heavier carcass are more efficient for the abattoir as unit processing costs can be offset against increased kilograms of red meat yield in the boning room.

Figure__

Figure 10 Hot standard beef carcass

II. Carcass fat depth (mm)

A one-dimensional measurement of the subcutaneous fat depot is often used as a measure of carcass fatness. The composition of the carcass, particularly the amount of fat, has become more important in recent years due to the demand by domestic consumers for less fat in the meat they consume. As fat is the most variable of the carcass tissues, it is also closely related to meat yield. Once the level or amount of fat in

the carcass has been estimated it is then possible to indirectly determine the yield of saleable meat.

The functional relationship between fat depth or fat coverage and the proportion of muscle or saleable yield in the carcass has been studied extensively for the three major meat species.

Grading Regulations for Meat

Grading is carried out on the animal carcass, which must already be approved for health and safety standards and bear an inspection stamp. Grading categorizes carcasses by quality, yield, and value, and provides producers, wholesalers, retail meat operations, and restaurants the information they need to purchase a grade of meat that suits their particular needs. Grading is also intended to ensure that the consumer has a choice in selecting a consistent and predictable quality of meat.

Beef Grading

The grader assesses several characteristics of a beef carcass to determine quality

Table 8 Carcass Grading

Beef Characteristics	**Beef Carcass Quality Factors**
Maturity (age)	The age of the animal affects tenderness.
Sex (male or female)	Pronounced masculinity in animals (males) affects meat colour and palatability (texture and taste).
Conformation (muscle shape)	Meat yield is influenced by the degree of muscling.
Fat (colour, texture, and cover)	Fat colour and texture (white as opposed to yellow) influence consumer acceptability, whereas fat cover affects meat yield.
Meat (colour, texture, and marbling)	Meat marbling affects quality: juiciness and tenderness. Colour and texture influence consumer acceptability.

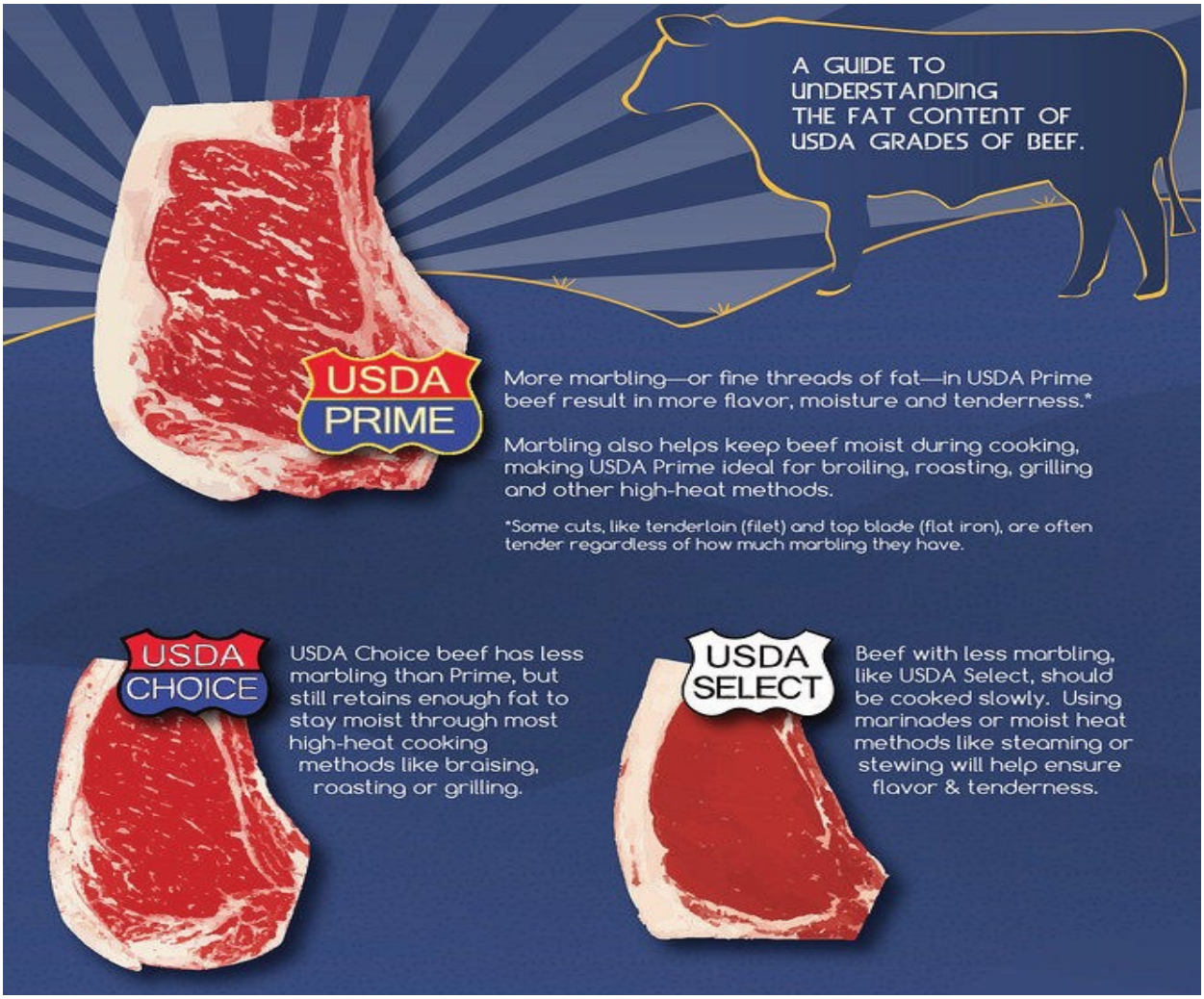

Figure 11 Marbling in USDA Beef grades.

Well-marbled meat usually indicates that the cooked meat will be juicy and tender, and the amount of marbling is a factor that is used to determine the grade of beef, specifically for the A grades. Beef grading is discussed in detail later in the book.

A guide to understanding the fat content of USDA grades of beef.

- **USDA Prime:** More marbling or fine threads of fatin USDA Prime beef result in more flavor, moisture and tenderness. Marbling also helps keep beef moist during cooking, making USDA Prime ideal for broiling, roasting, grilling and other high-heat methods. Some cuts. Like tenderloin (filet) crd top uade (flat iron). cre often tender regardless of how much marbling they have.

- **USDA Choice:** USDA Choice beef has less marbling than Prime, but still retains enough fat to stay moist through most high-heat cooking methods like braising, roasting or grilling.
- **USDA Select:** Beef with less marbling, like USDA Select, should be cooked slowly. Using marinades or moist heat methods like steaming or stewing will help ensure flavor & tenderness.

Meat Fibres and Tenderness Factors

Under cross-sectional inspection, muscles from different parts of the animal's body display bundles of fibres that appear as irregularly shaped polygons. The bundle size and thickness of the **connective tissue septa** determine the texture of the muscles: those with small bundles and thin septa have a fine texture, and those muscles with larger bundles and more connective tissue with thick septa have a coarser texture.

The finer the texture the more precision of movement from the muscle, such as tenderloin (Figure 12). The coarse-textured muscles, such as shanks and shoulders (Figure 8), are the heavy working muscles of the body that support the full weight of the animal and therefore require less precision of movement.

Figure 12 Fine-textured meat shown on beef tenderloin

Figure 13 Coarse-textured meat shown on beef shoulder pot roast

Science can help explain why some muscles on a beef animal are more tender than others. There are actually three types of skeletal muscle, known as **twitch fibres**, with differing speeds of movement and with different colours:

1. Fast glycolytic (white): These are fast twitch fibres; they are found in skeletal muscle, such as shanks, shoulders, and hips, and are known as “voluntary muscles.” They require no oxygen and they move faster.

2. Fast oxidative (red): These are slow twitch fibres; they are found in the diaphragm, heart, arteries, and veins, and are known as “involuntary muscles.” They require oxygen to operate and they move slowly.

3. Slow oxidative (red/white intermediate): These are slow/fast twitch fibres; they are found in precision muscles, such as the tenderloin and strip loin, that don’t need to move as fast as skeletal muscles.

Self-check 1	Written test

Name…… ID……. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (2 points each)

1. Of the following one is not useful measurement techniques for predicting composition in both the live animal and its carcass should be judged

A. Accuracy
B. Precision (repeatability)
C. Cost
D. Practicability
E. None

2. Grading is also intended to ensure that the consumer has a choice in selecting a consistent and predictable quality of meat **(True/False)**
3. There are actually three types of skeletal muscle, known as twitch fibres, with Similar in speeds of movement and similar colours. **(True/False)**
4. USDA Choice beef has less marbling than Prime. **(True/False)**
5. The bundle size and thickness of the connective tissue septa determine the texture of the muscles. **(True/False)**

Test II: Short Answer Questions

1. Explain the detail the USAD grading parameter (4 point)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 14 points** **Unsatisfactory - below 14points**

Information Sheet 2- Communicating and confirming customer's requirements

2.1. Customers communication

An effective customer communication process contributes to the success of any organization's quality management system and ultimately to the success of the organization itself. Conversely, many problems that an organization experiences with its customers can often be traced back to poor communication.

Consumers routinely use product color and appearance to select or reject products, and suppliers of muscle food products must also create and maintain the desired color attributes.

The color of muscle foods revolves around myoglobin, the primary red pigment in meat. However, ultimate perceived color is affected by many factors such as:-

- ✓ Species
- ✓ Animal genetics
- ✓ Nutritional background
- ✓ Postmortem changes in muscle (especially the dynamics of PH and meat temperature decline)
- ✓ Inter- and intramuscular effects
- ✓ Postmortem storage temperatures and time
- ✓ A whole host of processing (including antimicrobial interventions)
- ✓ Packaging, and display and lighting variables.

2.2. Establishment-Product Information and Consumer Awareness

Product Information and Labeling All packaged food products shall carry a label and requisite information shall be there as per provisions of Food Safety & Standards (Packaging &Labelling) & Regulations made there under so as to ensure that adequate and accessible information is available to the next person in the food chain to enable

them to handle, store, process, prepare and display the food products safely and correctly and that the lot or batch can be easily traced and recalled if necessary.

2.3. Consumer Awareness and Complaint Handling

- Information shall be presented to consumers in such a way to enable them to understand its importance and make informed choices. Information may be provided by labelling or other means, such as company websites, education programs and advertisements, and may include storage, preparation and serving instructions applicable to the product.

- The slaughter house/processing unit shall have a system to handle product complaints with identified person or people responsible for receiving, evaluating, categorizing, investigating and addressing complaints.

- Complaints shall be accurately categorized according to safety concerns and other regulatory concerns, such as labelling and shall be investigated by appropriately-trained technical personnel.
- An effective complaint handling system should comprise the following:
  - ✓ Policy and complaints handling procedure
  - ✓ Clear identification of all possible complaint sources
  - ✓ Complaint capturing and categorizing based on the health and safety risk
  - ✓ Investigation and root cause analysis (RCA)
  - ✓ Corrective action
  - ✓ Complaint trending and analysis
  - ✓ Continual improvement

2.4. The customers auditor's approach

a. Customer communication falls into three general categories:

- ✓ An organization's general communication to existing or potential customers such as advertisements or marketing information.
- ✓ Specific information relating to a customer enquiry, requirement or order
- ✓ Communication in response to customer feedback and complaints

b. Some or all of the following means of an organization's general customer communication may be observed by the auditor: Product information, which includes:-

- ✓ Advertising material
- ✓ Web sites
- ✓ Product catalogues

The auditor would verify the product information to confirm that it is readily available to customers or potential customers and provides information that is up-to-date and accurate. The auditor could also query, for example, how often advertising material, web sites and product catalogues are reviewed to reflect the organizations current product offerings and services and what measures are taken if a particular product is modified, discontinued or no longer available.

Some or all of the following means of an organization's specific customer communication may be observed by the auditor:

b) Enquiries, contracts or order handling, including amendments

- ✓ Quotations
- ✓ order forms
- ✓ confirmation of order
- ✓ amendment to order
- ✓ delivery documentation
- ✓ invoices • credit notes
- ✓ e-mail & general correspondence
- ✓ visit reports or notes to/from customer

c) Customer feedback and complaints management process

- ✓ Letters in response to complaints
- ✓ Acknowledgments

Self-check 2	Written test

Name_____ **ID**_____ **Date**_____

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (2 points each)

1. Of the following one is not an effective complaint handling system in customer handling.
   A. Understanding policy and complaints handling procedure
   B. Clear identification of all possible complaint sources
   C. Taking Corrective action
   D. Complaint trending and analysis
   E. None
2. Of the following one is general customer and industry communication mechanisms.
   A. Advertising material
   B. Web sites
   C. Product catalogues
   D. All

Test II: Short Answer Questions

1. Explain the customers communication categories detail (3 point)
2. Explain the importance of communication in meat and meat products processing industry. (3 point)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

Information Sheet 3- Confirming and arranging Temperature and storage requirements

- Rapid cooling of the meat surface not only slows and nearly stops the development of surface micro-organisms but also reduces weight loss and discoloration of the surface owing to hemoglobin oxidation. Different systems of primary chilling are in use (including immersion in iced water, especially for poultry) but air chilling is the most common.
- The cold chambers where chilling takes place must have a low air temperature, a high air speed, a high relative humidity and a high refrigerating capacity.
- Air temperature must be in the region of 0°C, with no decrease below -1°C, which could freeze the meat surface and impair its appearance.
- Air speed can range from 0.25 to 3.0 m/s. However, for economical reasons the most common speeds in use are from 0.75 to 1.5 m/s in the empty section of the cold chamber.
- Air speed over the carcasses will be much higher because of the reduction in air circulation. Increased air speed reduces the cooling period but it has a limit as there is a threshold above which fan-power consumption increases more than the chilling rate, resulting in an increase in operational costs. Also, the higher the air speed the greater the weight loss.
- Relative humidity during the chilling operation should be kept fairly high to prevent excessive weight loss. The recommended rate is between 90 and 95 percent, though this is the most difficult factor to control.
- Primary chilling is completed when the warmest point of the carcass has reached a temperature of about 7°C (3°C for edible offal). With current technology these temperatures can be arrived at in 16–24 hours in small carcasses and in less than 48 hours in large carcasses (centre of the hind leg). Average and surface temperatures are obviously much lower, reaching 0°C on the surface within four hours; this is important to slow microbial proliferation.
- Quick chilling has its problems, cold shortening being the most common. Cold shortening can often be seen in beef and mutton, when the meat, still in its pre-rigor

phase, reaches temperatures of 10°C or lower. These conditions cause irreversible contractions of the muscle tissue which toughen the meat even after prolonged ripening.

- Quick primary chilling also signifies an increase in investment and higher operational costs. The chilling period can be reduced by lowering the air temperature (surface freezing risks) or increasing air speed (higher operational costs) or both. Occasionally cold chambers are refrigerated in advance to reach lower temperatures than those in operation (-5°C/-6°C for beef; -10°C/-12°C for pork), taking advantage of thermal inertia to offset the effect of warm meat loads.
- Quick primary chilling can be performed in small chambers or in cooling tunnels. In cold chambers it is carried out in two or three phases. During the first phase the air temperature is maintained at about 0°C, carefully controlling the risk of superficial freezing while air movement is maintained at a high level. For large carcasses, after 10–12 hours the air circulation inside the store is reduced, maintaining temperature and humidity conditions; this second phase lasts another six to 10 hours. After this period the meat is transferred to cold storage chambers where the carcass temperature is stabilized, concluding the third phase.
- Small cold chambers used for chilling must be designed so their capacity can be filled in two hours at the slaughterhouse's normal work rate. The number of chambers should be sufficient for a peak working day. Particular care should be taken that warm humid carcasses are placed behind those already chilled or in the process of being chilled so that the air, which is still cold, reaches them and there is no risk of superficial condensation.
- Cooling tunnels used for chilling meat are usually of the continuous type. Here again meat is subjected to a two-phase process, with conditions similar to the cold chamber. However the temperature can be as low as -5°C for a short time. Beef carcasses can reach an average temperature of about 15°C in a four-hour period, while pork and mutton reach the same temperature in two to two and a half hours. Surface temperature decreases to 4–5 °C. During the second phase, conditions are less exacting, and an average temperature of about 4°C is stabilized after 15–16

hours in a secondary refrigerating chamber. This method is used in high-capacity slaughterhouses particularly for pig carcasses; for beef and mutton slower cooling is recommended because of the dangers of cold shortening.

Self-check 3	Written test

Name_____ ID_____ Date_____

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (4 points each)

1. Air temperature must be in the region of 0°C, with no decrease below -1°C, which could freeze the meat surface and impair its appearance. **(True/False)**

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

Information Sheet 4- Completing and computing documentation order

4.1. Storage management and Documentation

A logical storage management system must be in place, based on which it is possible to recognize rapidly and clearly which goods have been entered into storage and when. It must be possible to uniquely identify each product or packaging unit.

The first-in-first-out principle is to be followed. Storage conditions should not have any negative effects on the product properties (packaged/unpackaged).

A procedure must also be specified and known to the responsible members of staff that specifies the measures and steps in the event of a breakdown or malfunction. Here as well, the top priority must always be food safety as with all other deviations in production or storage.

In cold storage rooms compliance with the shelf life date (best-before date/Use-by date) is to be respected. Therefore, a regular checking of the best-before-date and the Use-by date must be guaranteed. Products with expired Use by date are not allowed to be sold or shipped. Products with expired best-before date must be dealt with according to internal Guidelines.

4.2. Temperature recording and monitoring

The temperature must be recorded and documented. Procedures in the event of a technical malfunction must also be described and known.
The following temperatures must be complied with in deep-freeze, defrost and meat cooling rooms (Tab.14, Tab.15).

Figure 14 Temperature requirements for foods of animal origin requiring refrigeration which are sold unpacked or self-packed

Products	Maximum temperature [°C]
Meat, fresh (except poultry)	+7
Slaughtering by-products, fresh (also ground)	+(1)
Meat preparations from EU-approved companies (SB-packed)	+4
Poultry meat (incl. poultry offal)(2)	+4
Minced meat from poultry/Meat preparations from minced meat from poultry	+4
Meat preparations from poultry meat	+4

Figure 15 Temperature in cold storage and defrosting rooms

Room	Optimum room temperature [°C]	Relative humidity [%]
Cold storage	-1 - +2	85 – 95
Defrosting rooms (with ventilation)	<10 (2-15)	ca. 90

Monitoring and controlling the chill chain

In order to obtain an efficient record of product history, temperature of both the meat or meat products and their storage environment should be monitored. Multiple measurements, at different locations, should be taken, in case of large batches or varying conditions in the chamber. Measurements can be realized either by a mechanical or electronic equipment, with or without the potential of recording and maintaining an electronic file of data.

Sensors to monitor temperature

The three principal types of sensors commercially available are thermocouples, platinum resistance and semi-conductors (thermistor). The choice depends on

requirements for accuracy, speed of response, range of temperatures to be monitored, robustness and cost.

The predominant types of thermocouples are of Type K (with nickel-chromium and nickel-aluminum alloy wires) and Type T (with copper-nickel alloy). The main advantages of the thermocouples are their low cost, facility to be hand-prepared and a very wide range of temperatures measured (from 184°C to 1600°C). Errors in the use of thermocouples are due to induced voltage from motors or transmitters, moisture and thermal gradients in other junctions, and can be increased when the ambient temperature varies widely.

Self-check 4	Written test

Name_____ **ID**_____ **Date**_____

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer (2 points each)

1. The first-in-first-out principle is to be followed. Storage conditions should not have any negative effects on the product properties (packaged/unpackaged) **(True/ False)**

Test II: Short Answer Questions

1. Explain the Temperature requirements for foods of animal origin requiring refrigeration which are sold unpacked or self-packed. (6 point)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 8 points** **Unsatisfactory - below 8 points**

Reference Materials

Books

1. Meat refrigeration, S.J. James and C.James. Cambridge England

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AKNOWLEDGEMENT

We wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

We would like also to express our appreciation to the TVET instructors and respective industry experts of Regional TVET bureau, TVET College/ Institutes, and Federal Technical and Vocational Education and Training Agency (FTVET) who made the development of this Teaching, Training and Learning Materials (TTLM) with required standards and quality possible.

This Teaching, Training and Learning Materials (TTLM) was developed on October 2020 at Bishoftu federal management Institutes

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