Unit I - Topic 3
Inspection and Grading of Meat

Introduction

Meat inspection for the domestic animal market is mandatory for beef, pork, lamb, bison, and poultry and is overseen by the Canadian Food Inspection Agency (CFIA). There are two levels of inspection in Canada: federal and provincial. Federally inspected meats can be sold and transported throughout Canada and also exported or sold internationally. Provincially inspected meats can be sold under the following two categories:

- Intraprovincially, which means the meat can be sold only within the province where the harvesting plant is located
- Interprovincially, which means the meat can be sold in a province or territory other than the one in which the harvesting plant is located

Meat **grading** measures the characteristics of carcasses and classifies them into groups of similar quality, yield, and value, which in turn assists in marketing and merchandizing the products. Grading standards and regulations are set for each species separately through government consultation with each industry. For example, beef grade standards are set by the Canadian Beef Grading Agency, a non-profit organization that relies on recommendations from an industry and government consultative committee to provide data to assist the federal government in setting guidelines. Similar processes are in place for lamb, pork, and poultry.

The Meat Inspection Process

Meat inspection is designed to determine the health of animals both prior to death (ante mortem) and after death (post mortem). In federal meat inspection plants, the process is carried out by primary product inspectors (PPIs) from the meat and poultry division of Agriculture and Agri-Foods Canada. The PPIs are overseen by a veterinarian. PPIs also do the inspection in provincial meat plants, but a veterinarian is called in only when a further diagnosis is required.

All domestic animals going into the food chain are inspected prior to harvesting (ante mortem). Some of the inspection methods are:

- Observing the animals' behaviour that may indicate any signs of disease
- Isolating animals that show signs of disease, illness, or injury
- Verifying animal identification records and tags
- Overseeing humane treatment of animals during herding and slaughter

Following harvesting, animals are inspected by either a provincial or federal inspector. In the case of beef, inspectors examine the following:

- Head, an array of lymph nodes near the tongue, and the tongue itself
- Esophagus and spleen
- Lungs and heart
- Bile duct and liver
- Other accessible carcass lymph nodes
- Diaphragm and kidneys
- Carcass internal and external surfaces

Lamb, pork, and poultry carcasses receive similar inspections that focus on the particular species and associated health issues.

Some of the hazards that may occur during the slaughter process are:

- Contamination of the carcass during the removal of the hide and digestive tract
- Cross-contamination during the splitting of the carcass
- Bacterial growth during the chilling and aging of carcasses
- Cross-contamination from specific animal tissue that is high risk for disease, such as BSE **specified risk materials (SRMs)** (e.g., spinal cord, brain)

Once the meat is approved for human consumption, the **inspection stamp** can be made along the length of the carcass. The stamp appears as a blue circle with the word “Canada” inside the circle rim, with a crown in the centre and the plant number at the bottom (Figure 13).

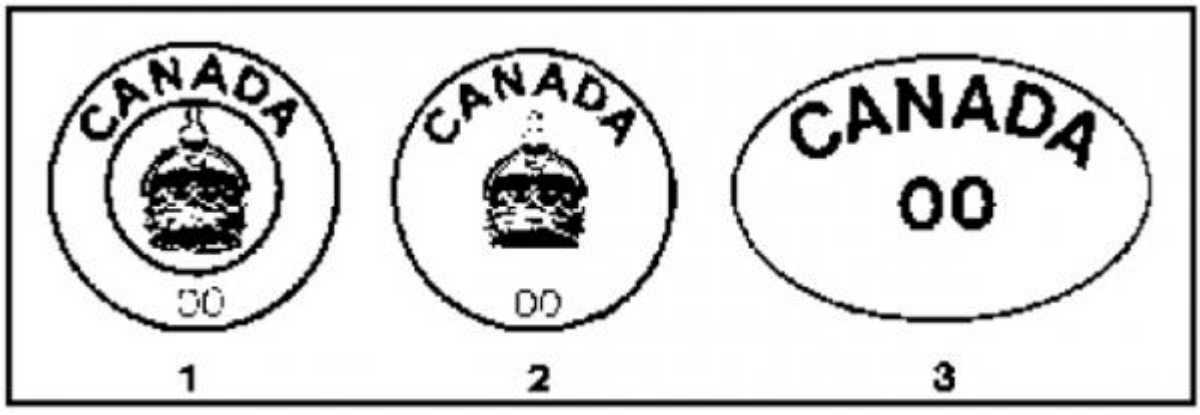

Figure 13. Meat inspection stamps (CFIA)

Grading Regulations for Meat

Meat grading for beef is governed by the Canada Agricultural Products Act and the Livestock and Poultry Carcass Grading Regulations, which also apply to all other domestic species where grading is used. Grading standards and criteria differ somewhat for each species.

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 6).

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	Meat marbling affects quality: juiciness and tenderness. Colour and

marbling) texture influence consumer acceptability.

Table 6- Beef carcass quality factors

Table 7 lists the 13 grades of beef carcasses and the colour of each **roller brand** that is placed along the length of the carcass (Figure 14).

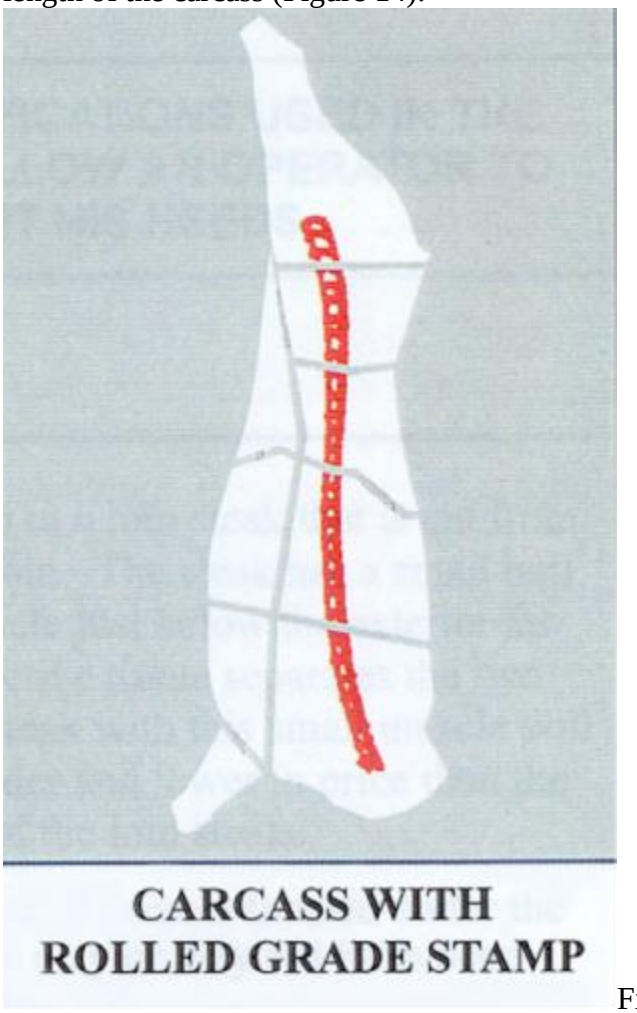

Figure 14. Rolled grade stamp on beef carcass. Image by Jakes and Associates shared under CC-BY-NC 4.0

Canada A Canada B1 Canada D1 Canada E

Canada AA	Canada B2	Canada D2	
Canada AAA	Canada B3	Canada D3	
Canada Prime	Canada B4	Canada D4	
RED	BLUE	BROWN	BROWN

Table 7- Beef grades

Beef carcasses are graded in the A category using the following determinations:

- The age of the carcass is assessed (must be youthful).
- Fat levels are assessed by measuring with a special ruler on the left side of the carcass between the 12th and 13th ribs across the ribeye muscle at the 12th rib (the front quarter of beef).
- An additional assessment of the external fat cover of both sides is made. Grade A beef has a fat covering that is firm and white or slightly tinged with a reddish or amber colour and is not more than 2 mm in thickness at the measurement site.
- A muscle score is determined from a grid depending on the width and length of the ribeye muscle. Grade A beef has muscling that ranges from good with some deficiencies to excellent.
- Ten minutes after having been exposed, the ribeye muscle shows firm and bright red in colour (bloom).

In addition, only A grade carcasses are assessed for the three lean meat yield classes. **Yield grading** is determined by measuring exterior fat thickness as well as the length and the width of the ribeye muscle at the 12th rib (Figure 15). The yield classes are indicated by a triangular-shaped stamp in red ink placed on the short-loin and rib sections of each side of the carcass. Yield classes are shown in Table 8.

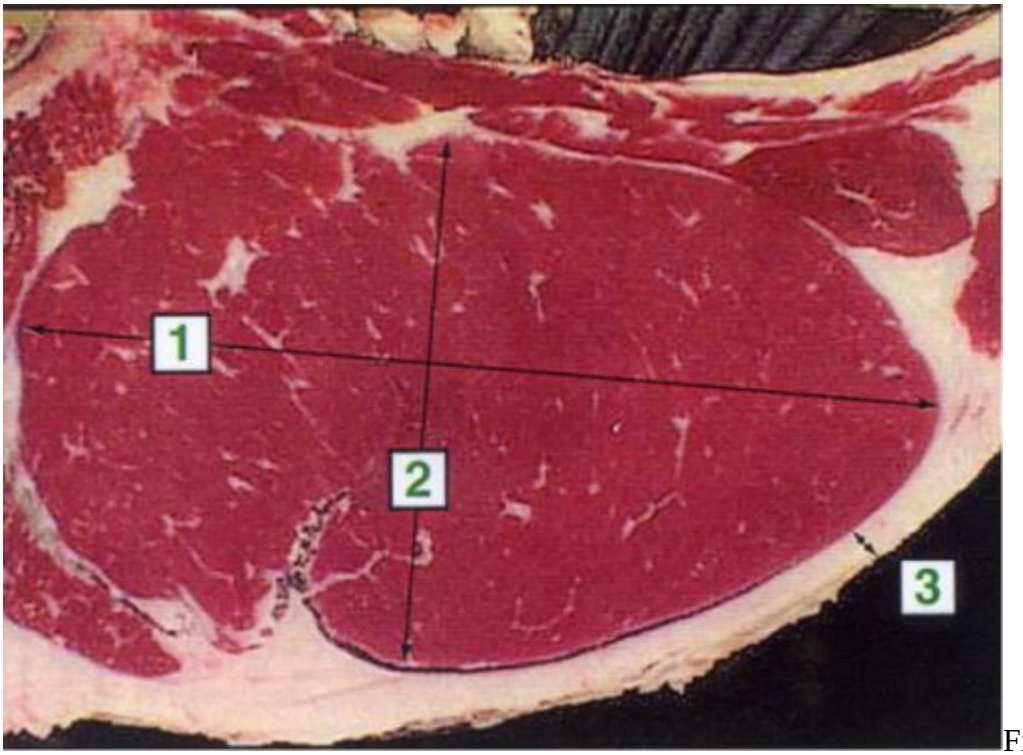

Figure 15. Measuring yield for grading showing length (1), width (2), and fat thickness (3). Photo by Jakes and Associates shared under CC-BY-NC 4.0

Yield class stamp	Meat yield
Canada 1	59% or higher
Canada 2	54% to 58%
Canada 3	53% or lower

Table 8 – Yield classes and percentages

The A grades are assessed further to determine the marbling (intramuscular fat content), as shown in Table 9 and illustrated in Figure 16.

Grade	**Marbling content**
Canada A	At the least, traces, but less than a slight amount
Canada AA	At the least, a slight amount, but less than a small amount
Canada AAA	At the least, a small amount
Canada Prime	At the least, slightly abundant

Table 9- Required marbling content of A grades

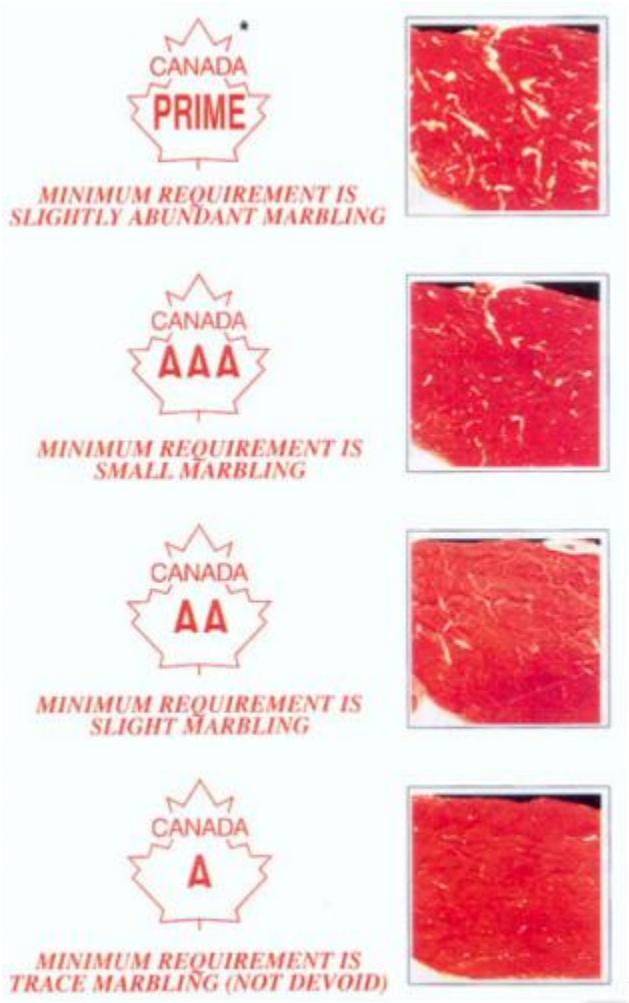

Figure 16. A grade marbling chart. Courtesy Beef Grading Centre

These marbling assessments offer the purchaser different levels of fat content to market. For example, some stores promote only AAA beef. A custom processor may want to dry age beef carcasses longer for his customers, but if he doesn't want to have too high a waste factor (with fat), he may prefer to purchase AA or A beef. Restaurants may choose Canada Prime that shows a lot of marbling, has longer aging ability (wet aging, vacuum sealed), and therefore, in the long term, is more tender.

B grade beef (blue) is still good-quality meat for eating but doesn't have the same consumer appeal as A grade. B grade beef is usually cheaper and doesn't dry age as well as A grade. Table 10 provides B grade characteristics.

Grade	Age	Muscling	Ribeye muscle	Marbling	Fat colour and texture	Fat measurement
B1	Youthful	Good to excellent, with some deficiencies	Firm, bright, and red	Devoid	Firm white or amber	Less than 2 mm
B2	Youthful	Deficient to excellent	Bright red	No requirement	Yellow	No requirement
B3	Youthful	Deficient to excellent	Bright red	No requirement	White or amber	No requirement
B4	Youthful	Deficient to excellent	Dark red	No requirement	No requirement	No requirement

Table 10- Characteristics of B grade beef

D grade beef (brown) characteristics are shown in Table 11. D2 to D4 animals are used extensively in ground meat and in the manufacturing of sausage products.

Grade	Age	Muscling	Ribeye muscle	Marbling	Fat colour and texture	Fat measurement
D1	Mature (old)	Excellent	No requirement	No requirement	Firm white or amber	Less than 15 mm
D2	Mature (old)	No requirement	No requirement	No requirement	White to yellow	Less than 15 mm
D3	Mature (old)	No requirement	No requirement	No requirement	No requirement	Less than 15 mm
D4	Mature (old)	No requirement	No requirement	No requirement	No requirement	More than 15 mm

Table 11 -Characteristics of D grade beef

E grade beef (brown) comes from youthful or mature (older) animals with pronounced masculinity, heavy shoulders, and lean and darker meat. These animals, often bulls and stags (unsuccessfully castrated bulls), are used extensively in the manufacturing of sausage products and ground meat.

Bison Grading

A new system for bison grading was developed in the 1990s. It is based on the beef grading system but takes into account the natural differences of the bison carcass. The official grading began in 1995, and on the basis of these standards the European Community (EC) approved bison sales to Europe. There are nine bison grades, which are evaluated for maturity, muscling, meat quality, and fat measurement. The grades are A1, A2, A3, B1, B2, C1, C2, D1, and D2.

Bison traditionally live longer than beef, and their bones and joints harden (ossify) more slowly. Furthermore, they are more heavily muscled in the shoulders and less muscled in the hindquarters than beef. These differences must be taken into account by the grader. Bison is now farmed in some provinces, including British Columbia and Alberta, and in several states in the United States. The product has become a popular alternative protein source, particularly with specialty meat markets and high-end restaurants.

Table 12 compares bison and beef grading.

Bison	**Beef**
9 grades	13 grades
Knife ribbed between 11th and 12th ribs	Knife ribbed between the 12th and 13th ribs
1 mm minimum fat cover for A grades	4 mm minimum fat cover for A grades
Heavily muscled fronts	Heavily muscled hinds
3 maturity divisions	2 maturity divisions

More age in A grades than beef	Less age in A grades than bison
Grade stamped brown	Grade stamped red
5 stamps per carcass side	2 stamps per carcass side
Not ribbon branded	Ribbon branded
No marbling assessment	Marble assessed
3 meat yield grades	3 meat yield % for A grades

Table 12- Differences between bison and beef grading

Veal Grading

Veal is meat from the young bovine born into the dairy industry. Most veal is sold through restaurants. However, today very few retail markets sell veal due to the low consumer demand.

Veal grading assesses both fat (creamy white) and good muscling as is done on beef, but it focuses even more on the colour of the flesh to determine the eventual grade. Veal is generally very tender due to its age and has a mild (some might even say bland) flavour, with little fat cover and marbling. There are several types of veal (Table 13).

Veal Types	**Age**	**Characteristics**	**Carcass**

			Weight
Baby veal (Bob veal)	3-30 days	Males, classified as “light,” sold whole for festive occasions and roasted whole	9-27 kg (20-60 lb)
Vealers (light)	1-3 months	Raised on milk with no restrictions on other types of feeds such as hay or grains	36-68 kg (80-150 lb)
Nature (white veal)	Up to 5 months	Very expensive, white-pinkish flesh, no iron in diet, raised in pens, limited movement permitted	82-109 kg (180-240 lb)
Calves (heavy)	Up to 5 months	Raised on milk and fed on grain-hay combinations; physically beginning to change from veal to beef	68-136 kg (150-300 lb)

Table 13- Veal types and descriptions

Youthful bovine carcasses weighing less than 160 kg (32.2 lb) (hide off) are classified as veal by the Canadian beef grading program and are graded as shown in Table 14.

Grade	Requirements
Canada A1 to A4	Carcasses with at least good muscling and some creamy white fat

Canada B1 to B4 Carcasses with low to medium muscling and an excess of fat cover

Canada C1 and C2 Carcasses failing to meet the requirements of Canada B

Table 14- Muscling requirements for veal grades

All veal carcasses are then graded for meat colour. The veal grader uses a Minolta colour reflectance meter to do this. The carcasses are assigned a numerical value based on the objective measurement of meat colour. Then the carcasses are segregated into four colour classifications, based on the meter reading values. The most pale white colour range is given a grade of 1 and is assigned an A grade provided the kidney fat and muscling meet the A standard. As meat colour becomes more pink, grades of 2, 3, and 4 are assigned.

This scientific method of assessing meat colour is being continually refined. Research is now underway to develop a meat probe that will directly measure the level of meat pigment, which is the basis of all colour analysis. Should this method of colour determination be judged superior to the current methods, this new technology will be adopted. This process of muscle and colour grading ensures that purchasers of Canadian veal can specify their exact quality requirements.

Table 15 shows how the colour ranges are assigned the correct grade.

Veal Grades	**Veal Flesh Colour**
Canada A1	White 50 +
Canada A2	Pink 40-49
Canada A3	Pale red 30-39

Canada A4	Red 0-29
Canada B1	Bright pink 50+
Canada B2	Pink 40-49
Canada B3	Pale red 30-39
Canada B4	Red 0-29
Canada C1	Pink or lighter 40 +
Canada C2	Pale or dark red 39 or less

Table 15- Colour requirements for veal grading

Table 16 shows the criteria used to establish veal grades.

Grade	**Kidney Fat**	**Muscling**
A1-A4	Covered with fat that is not excessive and is creamy white or pink tinged	At least good and free of depressions; 3 out of 4 of: 1. At least a straight profile for upper portion of leg 2. Loins wide and thick 3. Racks well covered

		4. Shoulder points well covered
B1-B4	Covered with fat deposits ranging from small to large	At least low to medium, some depressions; 3 out of 4 of: 1. Hip joints noticeable but not prominent 2. Loins with depressions 3. Racks sparsely covered with flesh 4. Shoulder points noticeable but not prominent
C1 and C2	Extremely small deposits of fat on kidneys	Deficient to excellent

Table 16- Veal grading criteria

Lamb Grading

Lamb has become an increasingly popular protein in restaurants, local markets, and high-end stores in recent years. In addition, there is a growing need to supply the diverse ethnic trade market, which includes a growing Muslim community.

The lamb grading service is delivered by the Canadian Sheep Federation, which has been accredited by the CFIA to perform this function. The current system is voluntary and is designed to provide more information to producers and consumers. However, new technology is currently being developed to improve and speed up the current system at federal plants; information can be accessed at http://www.cdnlamb.com/electronicgrading.htm

The seven lamb carcass grades are shown in Table 17, and the five mutton carcass grades are shown in Table 18.

Grades **Lamb Ribbon Brand Colour**

Canada A1, A2, A3, A4	Red
Canada B	Blue
Canada C1, C2	Brown

Table 17- Lamb grades

Grades	**Mutton Ribbon Brand Colour**
Canada D1, D2, D3, D4	Black
Canada E	Black

Table 18- Mutton grades

Currently in Canada, lamb (sheep under 12 months of age) and mutton (sheep 12 months of age or older) are graded by a generic system used in all regions. The measures to assess the grade are:

- Age, determined by the colour of the **break joint** on the front leg
- Weight
- Lean meat content and colour
- Fat content and colour
- Conformation or external shape of the carcass

These factors are further classified to determine a final grade using a formula integrating all the data collected, as noted in Table 19.

Factors	Determining characteristics
Break joint colour	Purple, red (young), or white (old)
Meat colour	Designated a C only when the carcass exhibits extremely dark meat (old)
Sex	Male or female
Fat cover	● + for excessive covering ● N for normal covering ● — for deficient covering
Conformation (shape), which then determines a muscle score of 1 to 5	● + for good to excellent ● N for medium to good ● — for marked deficiencies ● 1 indicates extreme deficiencies ● 5 indicates excellent muscling
Exterior fat depth (EFD)	Actual fat depth as measured by a ruler over the 12th rib 11 cm from carcass back midline
Fat colour	Designated with a Y when a carcass exhibits yellow fat
Weight	Indicated by warm carcass weight (WCW)

Table 19- Lamb grading criteria

Pork Grading

Requirements for pork grading are established under the authority of the Canada Agricultural Products Act and the Livestock and Poultry Carcass Grading Regulations. In commercial agriculture, pigs raised for food (pork) are usually referred to as hogs. Once the carcasses have been graded, the meat is always referred to as pork.

Hogs are popular farm animals because they mature more quickly than other animals and are ready for slaughter at approximately six months of age. Hogs must be handled very carefully during the harvesting process as they are easily stressed. To offset some of the stress they are electrically stunned (which is faster and requires quicker bleeding time) or gassed in federal plants in a special chamber that gradually removes the oxygen and then introduces carbon dioxide to ensure a painless death and means less rush prior to bleeding.

Pork from youthful hogs is very tender due to the absence of heavy connective tissue. Unlike beef, pork does not need to be aged very long. The flesh has a pinkish colour, a fine texture, and very greasy white fat that enhances the flavour of the meat. Pork is very popular in North America and other Western and European countries and is a popular item on restaurant menus; in addition, it is considered a diverse and profitable product that is increasingly in demand in manufactured products, such as the many varieties of sausages and cured products available today.

Canada has several major pork marketing agencies, such as the Canadian Pork Council and Canada Pork International, as well as provincial organizations, such as Alberta Pork and BC Pork, that promote and monitor the industry. All commercial hog carcasses are either federally or provincially inspected.

There are 12 grades of hog carcasses with criteria outlined in Table 20.

Hog Grade Classes	**# of Grades**	**Hog Criteria**
Canada Yield with 7 classes	1	Weight must be 40 kg (88 lb) or more
Canada Emaciated	1	Weight must be 40 kg (88 lb) or less

Canada Ridgling	1	Has one or two undescended testicles or has both male and female sex organs
Canada Sow 1-6	6	Must be a sow with the required back fat levels, good muscling, straight to convex profile, and barely visible shoulder joints
Canada Sow 7	1	Must be a sow deficient in muscling and finish
Canada Stag	1	A mature porcine animal, castrated before slaughter, and exhibiting pronounced masculinity at time of slaughter
Canada Boar	1	Must be a male carcass with one or more testicles but not a carcass of a ridgling

Table 20- Hog (pork) grades

Modern technology provides a quick and accurate method for grading hogs at federally inspected plants:

- An **electronic probe** is inserted between the third and fourth **ribs** on the left side of the carcass. The needle has a sensor light on the end.
- As the needle is withdrawn from the probe site, it measures meat thickness and fat levels.
- These measurements are fed into a computer, which generates a yield class estimating percentage of lean meat.

This method of grading hogs is used to establish producer payments, which are automatically sent to the farmer's bank account.

An overview of the grading process using an electronic probe can be found at https://www.westernhogexchange.com/about/marketing/GradingGrids.aspx

Principles of grading

- The purpose of meat grading is to describe the value of a carcass in clearly **defined terms** useful to the meat industry.
- Both the buyer and the seller need an impartial third party to grade the carcass.
- If the buyer and the seller have their own system of payment for high and for low value carcasses, they can save time or money by not having the carcass graded.
- Grading facilitates long distance transactions and contracts for future shipments in which one or both parties have not yet examined the carcasses.
- Three major factors determine the value of a carcass relative to market conditions, (1) **carcass weight**, (2) the **cutability** or yield of salable meat, and (3) the **quality** of the lean meat.
- All three factors are continuous variables measured in either absolute terms, such as weight, or in relative terms, such as those used by a taste panel.
- In scientific experiments, accurate carcass evaluation is necessary to search for minor differences between carcasses. But a less accurate system is adequate for commercial transactions, and the continuous spectrum of carcass properties is subdivided into a relatively small number of grades in a step-wise sequence.
- Thus carcasses placed in the same grade may exhibit small differences, but carcasses placed into different grades should exhibit much larger, and commercially significant differences.
- The important grading systems are for beef, pork and poultry. Systems exist for the other species but they are mostly ignored or used in a very simple way.

Beef grading

The first step of most beef grading systems is to place the carcass into a maturity group. Although many beef animals arrive at the abattoir with some identification, often an electronic implant, the grading system must give equal treatment to animals without identification - **where animal age is unknown**. Young cattle produce more tender beef than old cattle - so grading must first sort animals using an estimate of their age. Dentition would be useful - but the head is usually removed before grading starts. Most grading systems use the degree of replacement of cartilage by bone in parts of the skeleton revealed as the carcass is split into left and right sides.

YOUTHFUL CHARACTERISTICS (CATTLE LESS THAN ABOUT TWO YEARS)

1. Cartilaginous caps on the first few thoracic vertebrae not more than half ossified.

2. First few lumbar vertebrae with evidence of cartilage or a red line on the neural spinous process tip.

3. Neural process is red and porous spinous when split.

4. Medial view shows ribs are narrow, round, and red.

5. The sternebrae are not fused.

<u>MATURE CHARACTERISTICS</u> (CATTLE MORE THAN ABOUT TWO YEARS)

1. Thoracic caps more than half ossified.

2. No cartilage or red line on lumbar vertebrae.

3. Hard, white, flinty neural processes when split.

4. Wide, flat, white ribs.

5. Ossified sternum.

- The neural process is dorsal to the neural arch protecting the spinal cord. It is where the two sides of the arch join together. Other names are **dorsal process** and **spinous process**.
- Age estimates can only be approximate because, firstly, small- and large-framed cattle mature at different rates. Secondly, the characteristics given above are subjective.

Having eliminated older animals, attention is then usually directed at **yield grading** in the top grade of beef. Yield grading will be used by the purchaser to estimate the yield of meat from the carcass. Obviously, a carcass with a high meat yield is worth more than a carcass with a low yield. Yield grading is based on the fact it is extremely difficult to assess the bulging and length of muscles, but quite easy to assess the amount of fat on the carcass. **If we assume the amount of bone is approximately constant (usually but not always true), then carcass weight which is not fat - must be meat.** However, any reliable information on muscularity greatly improves this indirect estimate using fat alone. Thus, in many countries, carcasses are split through the posterior part of the ribcage to expose the *Longissimus dorsi* (usually the *Longissimus thoracis* which is the part of the *Longissimus dorsi* running the rib region). Some feature of the size of this muscle (area, length and/or depth) is used to help estimate meat yield. Can you see an obvious source of error? What will happen if we have an animal with a longer vertebral column **than normal?** A long carcass may have a high meat yield, even though its muscles

may not be bulging. (Review Lecture 24 again if this does not make sense.)

FEATURES OFTEN USED TO ESTIMATE MEAT YIELD

(1) An estimate of subcutaneous fat thickness, usually made where the *Longissimus dorsi* is exposed.

(2) An estimate of the visceral fat remaining on the carcass,

(3) An estimate of the cross sectional area of the Longissimus dorsi muscle at the separation of the forequarter and the hindquarter.

(4) Hot carcass weight, or an estimate made from the cold carcass weight (cold weight x 1.02).

FEATURES REQUIRED FOR HIGH-QUALITY MEAT

(1) A check the fat is not too yellow.

(2) A check the muscles are not too dark.

- Acceptable fat colour varies geographically. Consumers can detect the carotene content of fat, which is usually coupled with a diterpenoid taste in the lean (both from forage-fed animals). Some consumers like this taste (I do!), others do not. When grain fed animals dominate the market, grading systems typically down grade beef with yellow fat. Why? Because, historically, consumers in these areas associate yellow fat with meat from old cows. When the rich countries run out of oil, and cattle once again are valued as self-mobile, self-feeding meat producers - I suspect white fat will be quietly dropped as a requirement for top grade beef.
- Down-grading dark meat is far more reasonable.
- Having graded the beef carcass, it usually stamped with a hammer or roller coated with edible dye. Thus, the cautious consumer usually gets to see some or all of the stamp on the fat covering a joint of meat. The grade stamp usually has a numerical code to identify the plant of origin.

Summary. Most beef grading systems attempt to sort carcasses on the basis of both meat quality and meat yield. But the system is far from perfect. A young animal with tough meat will outrage consumers. An older animal with tender meat will be wasted. In the future, there may be better methods of beef grading - using image analysis, ultrasonics and meat quality probes. Beef grading tends to be forward looking - the grading information is passed onto meat cutters (estimated yield) and consumers (meat quality assurance). Sometimes the information is fed back to producers to award a premium for a high-quality carcass.

Pork grading

- Pork grading tends to be far less concerned with meat quality, and often simply becomes a feed-back system for rewarding producers of lean carcasses at an optimum weight. In some countries all pork is regarded as equal in quality - a foolish mistake in the long-term. In other countries, a serious effort may be made to probe pork carcasses to check their meat quality - primarily to reject PSE pork and give a premium for marbling fat.
- A advantage in grading pork is the skin often remains on the carcass until the day after slaughter. This gives the fat a well-defined outer boundary, and fat depth probes may be used to automate data collection on fat depth.
- The probe pushes into the carcass and an optical diode detects the depth of the boundary between fat and lean.
- Some probes check for PSE and marbling in the muscle.
- However, ultrasonic methods can make multiple measurements as a pork carcass is pulled through a U-shaped frame - thus giving a superior estimate of subcutaneous fat depth.
- Thus, at present, some countries use an optical probe at one point while other countries use ultrasonics.