

MEAT INSPECTORS MANUAL

RED MEAT



DIRECTORATE: VETERINARY SERVICES

VETERINARY PUBLIC HEALTH

NATIONAL DEPARTMENT OF AGRICULTURE

REPUBLIC OF SOUTH AFRICA

JANUARY 2007

FOREWORD

The delivery of meat hygiene services in South Africa has gone through various phases of change since the function was officially made the responsibility of the Department of Agriculture in the early 1960's. Little did we realise when the first Animal Slaughter, Meat and Animal Products Act, 1967 (Act No. 87 of 1967) was published in 1967, what challenges would lie ahead 40 years later. We have seen the third Act related to the delivery of meat hygiene services promulgated by Parliament. The Meat Safety Act 2000 (Act 40 of 2000), has replaced the Abattoir Hygiene Act (Act 121 of 1992) signifying, not only by the change in names of the relevant Acts since 1967 but also in the objectives of the Act, the obligation of Government to react to the needs of its clientele and to address the concerns of consumers.

The emphasis on the delivery of services as reflected in consecutive legislation since 1967, has changed gradually from a structural and process-control approach of service delivery, to a holistic approach with the focus on food safety. Growing international concern that the State should be the custodian on all matters related to food safety and provides the sanitary guarantees required by consumers and our trade partners, necessitated a change of focus on the delivery of these services. We are confident that these manuals will guide and enable all those responsible for the delivery of a meat safety service, to focus on the new challenges and to claim ownership of the initiative to establish a culture of hygiene awareness.

Over the last 40 years many teams and co-workers collected and collated material for training future meat inspection staff. This was made available to all tertiary training institutions free of charge in order to ensure that the minimum standards proposed by this Directorate would be known to all. During 2006 the task of updating, co-ordinating and maintaining this intellectual property of the Department of Agriculture, was given to Dr. T. Bergh from the Limpopo Province. All the persons involved in this work, are congratulated with what eventually emerged after many months of hard and dedicated work.

There is no doubt that this manual, being dynamic and reflecting change, will serve as a benchmark for the future to enable the delivery of meat safety services to be accessible and affordable for all.



DR. M. MAJA

DIRECTOR: VETERINARY SERVICES

DEPARTMENT OF AGRICULTURE

PRETORIA, JANUARY 2007

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Director: Veterinary Services, Private Bag X 138, Pretoria, 0001, South Africa.

INTRODUCTION

The Directorate Veterinary Services of the National Department of Agriculture was constitutionally tasked ensure that norms and standards concerning abattoir hygiene be implemented uniformly on a national basis.

Since the Department is the custodian of the “Meat Safety Act” (Act 40 of 2000) it is fitting that the Department set the standards required for meat inspection personnel.

It was decided to write a manual containing a minimum norm of required knowledge for all persons involved with meat hygiene in abattoirs as well as doing meat inspection.

With the necessary adaptation, these manuals can thus be used over a wide spectrum of training requirements and should be in the possession of all persons involved with meat inspection and hygiene-control in an abattoir.

The final manuals, after various versions, have now been revised and have been blended in such a way as to enhance a smooth transition from the basic concepts of food safety management systems, applicable to all meat disciplines, to a more specific approach for the specific disciplines.

The manuals are drafted to address the following concepts:

- Abattoir hygiene

This manual highlights the international principles of food safety management systems e.g.

- Basic microbiology
- Building requirements
- Sanitation
- Pest control
- Personnel hygiene
- Waste management & control of condemned material
- Quality control

The follow up manuals in the respective disciplines of red meat, poultry, game, ostrich & crocodile deals with the requirements specific to the trade e.g.

- Specific building requirements
- Process control
- Anatomy
- Pathology
- Diseases
- Meat inspection

A special word of thanks to all who helped redrafting these final manuals and all the hours of hard work put in to have them available for the New Year.

EDITOR:

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**MEAT INSPECTORS MANUAL
RED MEAT**

**PART II
MEAT INSPECTION**

MODULE 1

**ABATTOIR LAYOUT & CONSTRUCTION
SPECIFIC REQUIREMENTS FOR RED MEAT
ABATTOIRS & CUTTING PLANTS**

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ABATTOIR LAYOUT & CONSTRUCCION

1. Introduction

Specific requirements for red meat abattoirs

Over and above the general requirements that are specified in the module “Layout & Construction”, every specific meat trade has its own requirements that enhance the hygienic production of that specific type of meat. Abattoirs have its own specific design that will enable the workers to slaughter and dress the carcass hygienically and that will promote easy working conditions to reduce stressful working conditions that will result in unacceptable practices in the work place.

Regulations have been promulgated to ensure that the layout of the building will enhance the easy handling of carcasses and that acceptable practises are adhered to.

This module will guide you through the specific requirements needed for red meat abattoir, its cutting plants and how the process of slaughter and dressing should be done to ensure a safe and hygienic product

2. Throughput and other requirements for grades

2.1. Requirements for rural red meat abattoirs

Considering the requirements set out in Part II B(1), for an abattoir to be graded as a rural red meat Abattoir –

- (a) the throughput may not exceed two units per day;
- (b) the premises must be fenced and provided with a gate to control access of people and animals;
- (c) an offloading facility for the humane offloading of livestock must be provided;
- (d) pens must be provided to accommodate livestock at the discretion of the provincial executive officer in each case;
- (e) a crush which can also serve as a stunning pen situated adjacent to the bleeding area, must be provided;
- (f) it must consist of a room where bleeding and dressing is done;
- (g) if windows are not glazed, fly screens must be provided;
- (h) facilities to bleed an animal in a hanging position must be provided;
- (i) curbed and drained areas must be provided adjacent to the abattoir -
 - (i) for handling, washing and keeping rough offal; and
 - (ii) to hold containers with inedible products prior to removal;
- (j) doors must be provided -
 - (i) where animals enter the abattoir;
 - (ii) where carcasses and red offal are dispatched;
 - (iii) the door where animals enter the abattoir may be used for dispatching if the processes are separated in time; and

- (iv) between the dressing room and adjacent area mentioned in paragraph 4(i);
- (k) hand washing facilities must be provided in the abattoir;
- (l) a sterilizer adjacent to a hand washbasin must be provided;
- (m) toilet and hand wash facilities must be provided;
- (n) facilities to store items needed in the daily slaughter process must be provided;
- (o) the design of the abattoir must allow for future upgrading of the facility;
- (p) chilling facilities to accommodate at least the daily throughput must be provided and the proximity of these facilities must be such as not to compromise hygiene standards and be acceptable to the provincial executive officer; and
- (q) where freezing facilities are not provided for treatment of conditionally passed measily carcasses at the abattoir, such facilities must be arranged elsewhere with the approval of the provincial executive officer.

2.2 Requirements for low throughput red meat abattoirs

Considering the requirements set out in part II B (1) and (2), for an abattoir to be graded as a low throughput red meat abattoir –

- (a) a maximum throughput of 20 units per day may not be exceeded, but if only one species is slaughtered per day, the maximum throughput is–
 - (i) cattle, horses or sausage pigs larger than 90 kg – 20 units;
 - (ii) sheep or goats – 40 units; or
 - (iii) pigs – 30 units;

provided that the provincial executive officer may determine a lower maximum throughput for an abattoir on grounds of the capacity of the liairages, hourly throughput potential relative to available equipment and facilities including hanging space and chiller capacity;
- (b) the premises must be fenced and provided with a gate to control access of people and animals;
- (c) facilities to off-load animals humanely and from different vehicle levels must be provided;
- (d) a facility where livestock transport vehicles must be sanitized after off loading must be provided;
- (e) liairages and pens must be available to accommodate at least the throughput of one day;
- (f) separate areas must be provided where stunning, bleeding and dressing can be done with the understanding that the stunning area is also under roof and adjacent to the bleeding area;
- (g) a crush connecting the liairages to the restraining area must be provided;

- (h) a separate entrance must be provided to receive animals presented for emergency slaughter;
- (i) separate entrances and facilities for restraining and stunning must be provided for cattle, sheep or goats and pigs, respectively;
- (j) facilities for shackling stunned animals and bleeding in a hanging position must be provided;
- (k) a dressing rail must be provided;
- (l) the landing, shackling, bleeding and dressing areas must be separate areas except where eight or less units are slaughtered per day;
- (m) a side rail or hooks for carcasses and containers for offal, must be provided for condemned or detained carcasses and organs requiring secondary meat inspection;
- (n) a room must be provided where hides, skins, hair, heads, feet and inedible material are kept prior to removal, unless these parts are removed on a continuous basis;
- (o) a room where paunches and intestines are emptied, washed and kept must be provided;
- (p) the rooms mentioned in paragraphs (n) and (o) must –
 - (i) be separate and adjacent to the dressing room and interconnected by means of a hatch, door or walkway; and
 - (ii) have exterior doors for the removal of those materials;
- (q) separate chillers must be provided for the daily throughput –
 - (i) of carcasses and red offal, unless the red offal is removed from the abattoir on a continuous basis but within four hours after an animal has been eviscerated, and if separate dispatch facilities have been provided for red offal; and
 - (ii) of washed rough offal, unless washed rough offal is removed from the abattoir on a continuous basis but within four hours after an animal has been eviscerated;
- (r) where freezing facilities are not provided for treatment of conditionally passed mealy carcasses at the abattoir, such facilities must be arranged elsewhere with the approval of the provincial executive officer;
- (s) a dispatch area equipped to quarter, sort and mark carcasses and red offal as well as a door for dispatching must be provided;
- (t) an entrance for personnel must be provided and must be designed as an ante-chamber for cleaning purposes and must be provided with hand wash-basins, soap dispensers, hand drying facilities, a boot wash, apron wash and hooks, and

a refuse container, and separate facilities must be provided for both clean and dirty areas;

- (u) change room, shower, toilet as well as hand wash facilities must be provided on the premises for persons working at the abattoir;
- (v) dining facilities must be provided with tables and chairs or benches and must be situated so that personnel do not sit or lie on the ground or soil their protective clothing during rest periods;
- (w) a storage facility or room for items needed in the daily slaughter process must be provided;
- (x) if an office is required by the owner, a separate room must be provided;
- (y) rooms or facilities must be provided for –
 - (i) storage of cleaning equipment and materials;
 - (ii) cleaning and sterilization of movable equipment; and
- (z) a facility where meat transport vehicles must be sanitized must be provided.

2.3. Requirements for high throughput red meat abattoirs

Considering the requirements set out in part II B (1) and (2), for an abattoir to be graded as a high throughput red meat abattoir –

- (a) it must have a maximum throughput which the provincial executive officer may determine on grounds of the capacity of the liairages, hourly throughput potential relative to available equipment and facilities including hanging space, chiller capacity as well as rough offal handling and chilling capacity;
- (b) the abattoir and premises must be designed to separate dirty and clean areas and functions;
- (c) the premises must be fenced to control access of people and animals and provided with separate gates for clean and dirty functions;
- (d) facilities to off-load animals humanely and from different vehicle levels must be provided;
- (e) a facility where livestock transport vehicles must be sanitized after off loading must be provided;
- (f) liairages and pens must –
 - (i) accommodate at least the throughput of one day;
 - (ii) include restraining facilities for the examination of individual animals; and
 - (iii) include isolation pens, for sick animals, that are constructed so that waste and effluent from them cannot contaminate adjacent pens or passageways;
- (g) a crush connecting the liairages to the restraining area must be provided;

- (h) a room must be provided for restraining, stunning, shackling and bleeding animals;
- (i) separate entrances and facilities for restraining and stunning must be provided for cattle, sheep or goats and pigs, respectively;
- (j) a separate entrance must be provided to receive animals presented for emergency slaughter;
- (k) a dry landing area must be provided for shackling stunned animals before bleeding;
- (l) a bleeding rail leading to a bleeding area and facilities for bleeding animals in a hanging position as well as a return rail for bleeding chains must be provided;
- (m) a room separated from the bleeding room, equipped with dressing rails separate from the bleeding rail, must be provided where dressing can be done;
- (n) a separate room must be provided for de-hairing, singeing, de-clawing and pre-evisceration wash of pigs;
- (o) separate rooms must be provided for –
 - (i) handling and holding of hides, skins, hair and inedible material prior to removal; and
 - (ii) handling and holding of skin-on heads and feet;
- (p) a room where paunches and intestines are emptied, washed and kept must be provided;
- (q) the rooms referred to in paragraphs (o) and (p) must –
 - (i) be separate and adjacent to the dressing room and interconnected by a closable hatch only; and
 - (ii) have an exterior door for the removal of these materials;
- (r) separate chillers must be provided for the daily throughput –
 - (i) of carcasses and red offal, unless the red offal is removed from the abattoir on a continuous basis but within four hours after an animal has been eviscerated, and if separate dispatch facilities have been provided for red offal; and
 - (ii) of washed rough offal, unless washed rough offal is removed from the abattoir on a continuous basis but within four hours after an animal has been eviscerated;
- (s) where freezing facilities are not provided for treatment of conditionally passed measily carcasses at the abattoir, such facilities must be arranged elsewhere with the approval of the provincial executive officer;
- (t) separate equipped and secure rooms must be provided to –

- (i) handle and keep detained carcasses, portions and organs;
- (ii) keep condemned carcasses and material before removal from the abattoir, but if the daily throughput is less than 100 units or the condemned material is removed on a continuous basis during slaughter or a dedicated chiller is available for condemned material, such a room is not required; and
- (iii) provide hand wash, boot wash and apron wash facilities directly connected to the room mentioned in subparagraph (ii) for persons who handle condemned material;
- (u) a dispatch area must be provided, equipped –
 - (i) to quarter, sort and mark carcasses and red offal;
 - (ii) with a door for dispatching which is such that the doors of the vehicles will only be opened after docking; and
 - (iii) to ensure that the air temperature in this area is not more than 12°C when carcasses are handled and dispatched;
- (v) an entrance for personnel must be provided and must be designed as an ante-chamber for cleaning purposes and must be provided with hand wash-basins, soap dispensers, hand drying facilities, a boot wash, apron wash and hooks, and a refuse container, and separate facilities must be provided for both clean and dirty areas;
- (w) a change room, shower, toilet as well as hand wash facilities must be provided on the premises for persons working at the abattoir and separate facilities must be provided for clean and dirty areas;
- (x) dining facilities must be provided, for clean and dirty areas, with tables and chairs or benches and must be situated so that personnel do not sit or lie on the ground or soil their protective clothing during rest periods;
- (y) office accommodation and ablution facilities must be available for meat inspection personnel;
- (z) a storeroom must be provided for items needed in the daily slaughter process;
- (aa) office facilities must be separate from bleeding and dressing areas;
- (bb) suitably equipped rooms and facilities must be provided for sterilization of movable equipment;
- (cc) a room or rooms for storage of cleaning equipment and chemicals must be provided;
- (dd) facilities must be provided for wrapping, packing and cartoning (where applicable);
- (ee) separate storage facilities must be provided for wrapping material and packing material, if both materials are kept;
- (ff) access to a laboratory must be possible; and

- (gg) a facility where meat transport vehicles must be sanitized must be provided.

2.4. Requirements for high throughput cutting plants.

Considering the requirements set out in Part II B (1) and (2), to be graded as a export cutting plant –

- (a) it must have a maximum throughput which the provincial executive officer may determine on grounds of the capacity of the holding chillers, hourly throughput potential relating to available equipment and facilities as well as chiller or freezer capacity;
- (b) the premises must be fenced and provided with a gate to control access of people and animals;
- (c) if meat is intended for sale to the public, separate facilities as required by the provincial executive officer must be provided;
- (d) separate equipped rooms must be provided for –
 - (i) receiving of unwrapped carcasses and meat intended for cutting;
 - (ii) receiving of cartoned meat intended for cutting;
 - (iii) removal of meat from cartons and wrapping and thawing where applicable;
 - (iv) cutting and wrapping at an air temperature below 12 °C;
 - (v) packing, marking and labelling at an air temperature below 12 °C;
 - (vi) making up of new cartons used for packing meat;
 - (vii) dispatching of wrapped and packed meat at an air temperature below 12 °C;
 - (viii) dispatching of unwrapped carcasses and meat at an air temperature below 12 °C; and
 - (ix) washing and sterilizing of equipment;
- (e) separate bulk storage facilities or rooms must be provided for –
 - (i) wrapping material; and
 - (ii) packing material;
- (f) separate storage facilities or rooms must be provided for items in daily use, such as –
 - (i) hand equipment;
 - (ii) wrapping material;
 - (iii) clean protective clothing; and

- (iv) cleaning materials and chemicals;
- (g) separate chillers or freezers must be available for –
 - (i) unwrapped carcasses and meat;
 - (ii) packed meat;
 - (iii) holding frozen meat if required; and
 - (iv) blast freezing meat if required;
- (h) ablution facilities and toilets must be provided and the access routes to the cutting room must be under roof;
- (i) an entrance for personnel must be provided and must be designed as an ante-chamber for cleaning purposes and must be provided with hand wash-basins, soap dispensers, hand drying facilities, a boot wash, apron wash and hooks, and a refuse container, and separate facilities must be provided for both clean and dirty areas;
- (j) sterilizers with water at 82°C must be provided or, as an alternative, a valet system where handheld equipment are collected on a regular basis and sterilized in a central sterilizing facility may be used, with the understanding that strategically placed emergency sterilizers are still required; and
- (k) extraction facilities for vapour control must be provided.

3. Additional requirements for low and high throughput red meat abattoirs

3.1. Offloading ramps

Offloading ramps, movable or stationary –

- (a) must be so constructed to avoid injury of animals during offloading and provide a stable area to facilitate the free movement of animals;
- (b) may not have open spaces between the offloading ramp and the vehicle;
- (c) must be at the same height of the vehicle for which it is used.
- (d) must have guide rails;
- (e) must have permanent non-slippery floor at a slope of not more than 20°;
- (f) may not have sharp protruding edges or any other features that may cause injury; and
- (g) must have adequate artificial lighting if animals are offloaded at night.

3.2. Liairages and holding pens

Liairages and holding pens –

- (a) may not be closer than six meters from, and not be situated higher than, the abattoir;
- (b) must be constructed of cleanable, non-absorbent and durable material;
- (c) must be so constructed and maintained to avoid injury of animals;
- (d) must have sides not less than 1.8 m in height for cattle and horses and one meter for sheep, goats and pigs;
- (e) must have permanent floors that are curbed and drained;
- (f) must be so constructed to render the floors and drain covers non-slippery;
- (g) must be fitted with gates which are a minimum of 800 mm wide for sheep, goats, calves and pigs and 1800 mm for cattle and horses;
- (h) must be roofed where pigs and sheep or goats are kept;
- (i) must be equipped with cold water sprayers for pigs;
- (j) must be fitted with water troughs at a height of 900 mm for cattle and horses and 300 mm for sheep, goats or pigs or water nipples for pigs;
- (k) must have well drained manure slabs for kraal manure prior to removal except if manure is removed directly into a vehicle;
- (l) must be provided with wash points, hoses and reels; and
- (m) used to isolate suspect animals must in addition to above have solid walls and gate and must not drain across other pens or pose any other contamination risk.

3.3. Feeding animals

Where animals are fed in a lair age or pen –

- (a) a hay rack or food trough which may be removable must be provided;
- (b) hay racks must be free from the floor; and
- (c) feed must be kept in a storeroom that is vermin proof, specifically provided for this purpose if feed is to be stored on the premises.

3.4. Liairage capacity

- (1) The number of animals per lair age or pen must be limited so as to allow a minimum floor space of –
 - (a) 1.75m² per cow or horse;
 - (b) 0.75m² per heavy pig or calf; and
 - (c) 0.50m² per smaller pig, sheep or goat.
- (2) Liairages must be provided with permanent notices indicating the capacity per species of each pen.

3.5. Liairage passages

Passages in liairages and pens –

- (a) must have permanent floors that are curbed and drained in a manner conducive to free movement of animals;
- (b) must be so constructed to render the floors and drain covers non-slippery;
- (c) may not be less than 1.8 m wide for cattle, horses and at least 1.0 m wide for sheep, goats and pigs; and
- (d) must be well maintained and kept free of loose objects.

3.6. Crushes or races

- (1) Crushes or races must be well maintained and kept free of loose objects.
- (2) Must be so constructed to render the floors and drain covers non-slippery.
- (3) Crushes for herding animals between liairages and the stunning area must have an inner width of not more than 0.9 m.
- (4) Crushes must be designed so that the stunning pen is not visible from the crush or liairages.
- (5) The section of the crush or race that leads directly into the stunning box must have solid sides.

3.7. Stunning, hoisting and bleeding

- (1) For humane restraining of all species immediately prior to stunning there must be provided –
 - (a) a stunning box, approved by the national executive officer, to restrain cattle and horses;
 - (b) a restraining pen of 2m x 2m or, preferably, a crowding pen provided with a hinged gate to facilitate floor space reduction for sheep, goats and pigs;
 - (c) a restraining pen or stunning box must be provided for large, difficult boars and sows; and
 - (d) any other means of restraining approved by the provincial executive officer.
- (2) For stunning of animals there must be provided –
 - (a) a silenced captive bolt stunner;
 - (b) an electrical stunning apparatus; or
 - (c) any other stunning apparatus approved by the national executive officer.
- (3) The operational parameters for stunning must be displayed on the stunning apparatus or in the stunning area.
- (4) Equipment must be provided to shackle and hoist stunned animals into position, for bleeding.
- (5) Facilities for collecting and storing of blood in closed containers prior to removal and disposal must be provided.

- (6) The minimum clearance for rails and equipment in bleeding areas –
 - (a) for cattle bleeding, from rail to floor in the case of a crawl beam is 4.8 m and a fixed rail is 4.4m; and
 - (b) for sheep bleeding, from rail to floor is 2.3 m.

3.8. Dressing and evisceration facilities

- (1) The minimum clearance for rails and equipment in dressing areas –
 - (a) for cattle dressing, from rail to floor is 3.4 m; and
 - (b) for sheep dressing, from rail to floor is 2.2m.
- (2) The clearance between equipment and dressing rails must in all cases be such that carcasses do not touch equipment and is at least 1000 mm from walls.
- (3) Rails with hooks fixed to a wall must be 400 mm from the wall, and meat hanging from such hooks may not touch the floor or wall.
- (4) Rails must be at least 700 mm from columns, pillars or the side of a doorway through which carcasses must pass.
- (5) Separate bleeding and dressing areas must be provided in an abattoir if more than one species of animal is slaughtered at the same time.
- (6) Dehairing of pigs, including finishing and pre-evisceration wash, may only be done in the pig dehairing area.

3.9. Meat inspection facilities

- (1) Containers, racks and platforms and any other equipment required for meat inspection must be provided in an abattoir.
- (2) Marked, leak proof and lockable containers or other means to handle and hold condemned and inedible material prior to removal, must be provided.

3.10. Chillers

- (1) Chillers must be provided to hold at least the daily slaughter throughput.
- (2) The minimum clearance for rails in chillers and freezers –
 - (a) for cattle and horses or sheep or goats on cradles with extension rods, is 1000 mm from the wall and 900 mm between overhead carcass rails; and
 - (b) for sheep, goats and pigs, if hung separately, is 330 mm from the wall and between overhead carcass rails.
- (3) Spacing of units on the line should be such as to ensure airflow between carcasses or sides with a minimum of 660 mm length of rail per unit.

3.11. Dispatch areas

Dispatch areas must be equipped for –

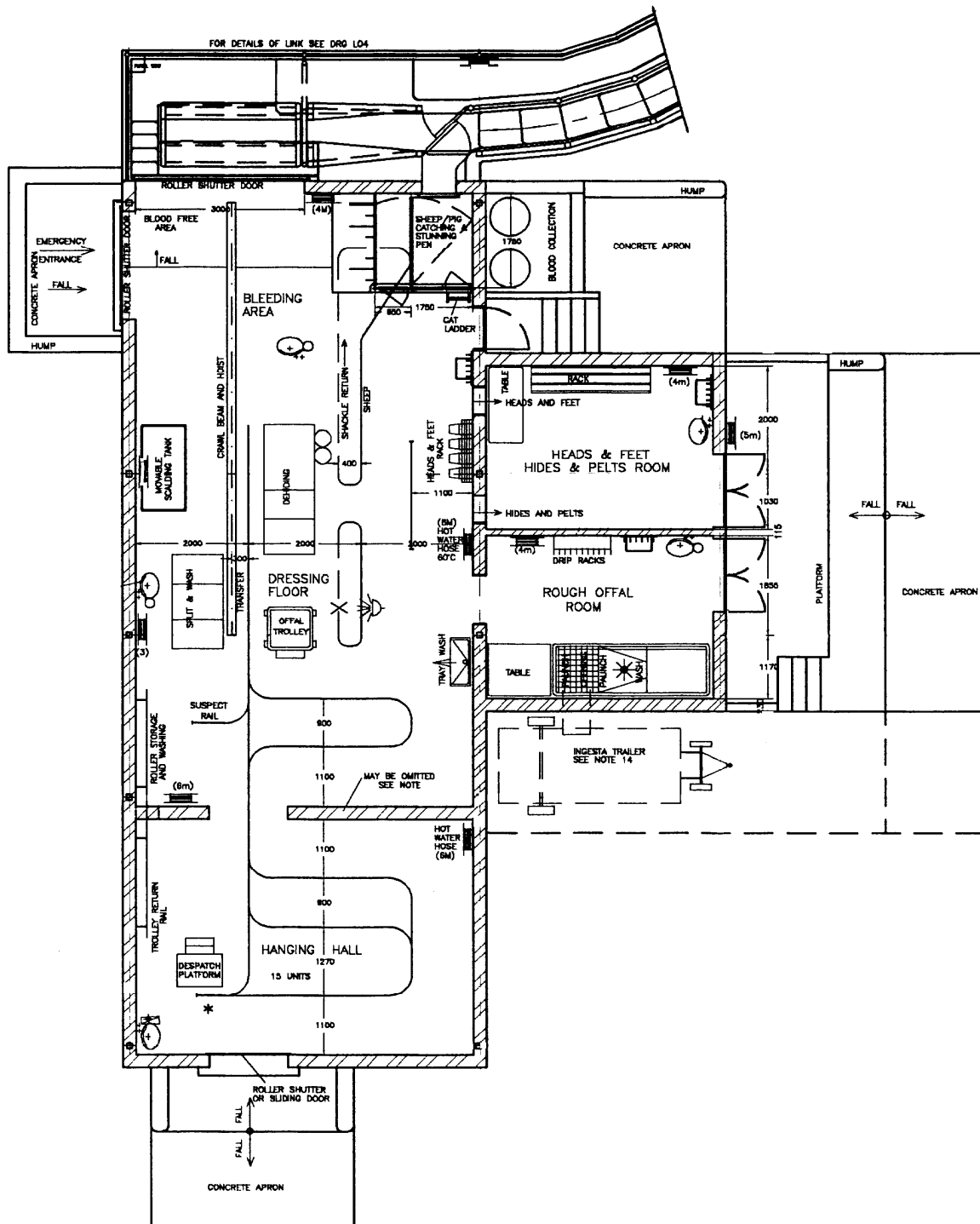
- (a) quartering, marshalling and loading of carcasses;

- (b) collection and transport, avoiding cross or contra flow, of used roller-hooks to the sanitation facility; and
- (c) sterilization of saws and other cutting utensils.

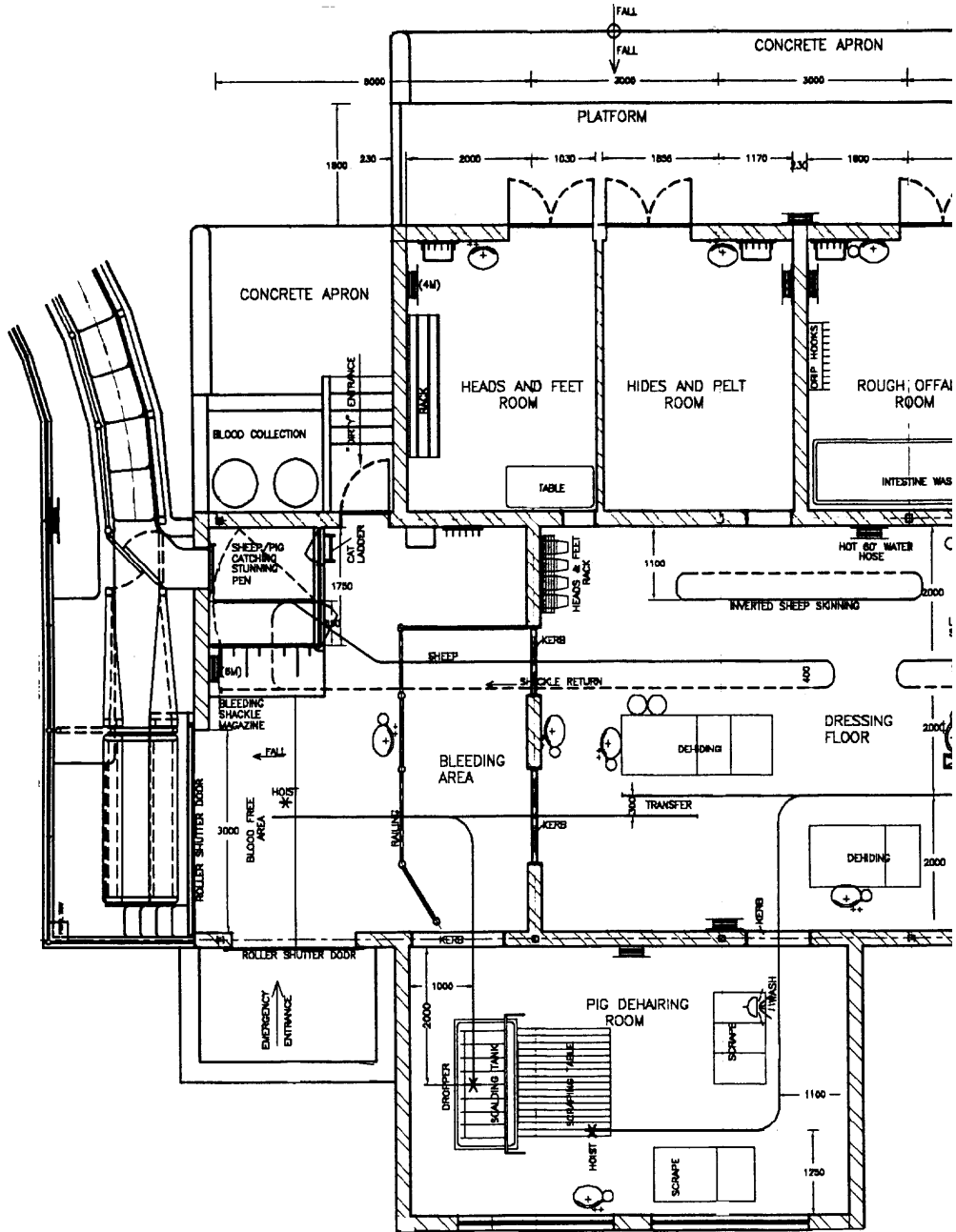
4. STANDARD DESIGN DRAWINGS FOR RED MEAT ABATTOIRS

The following floor plan drawings serve to give some insight into the lay out of smaller animals.

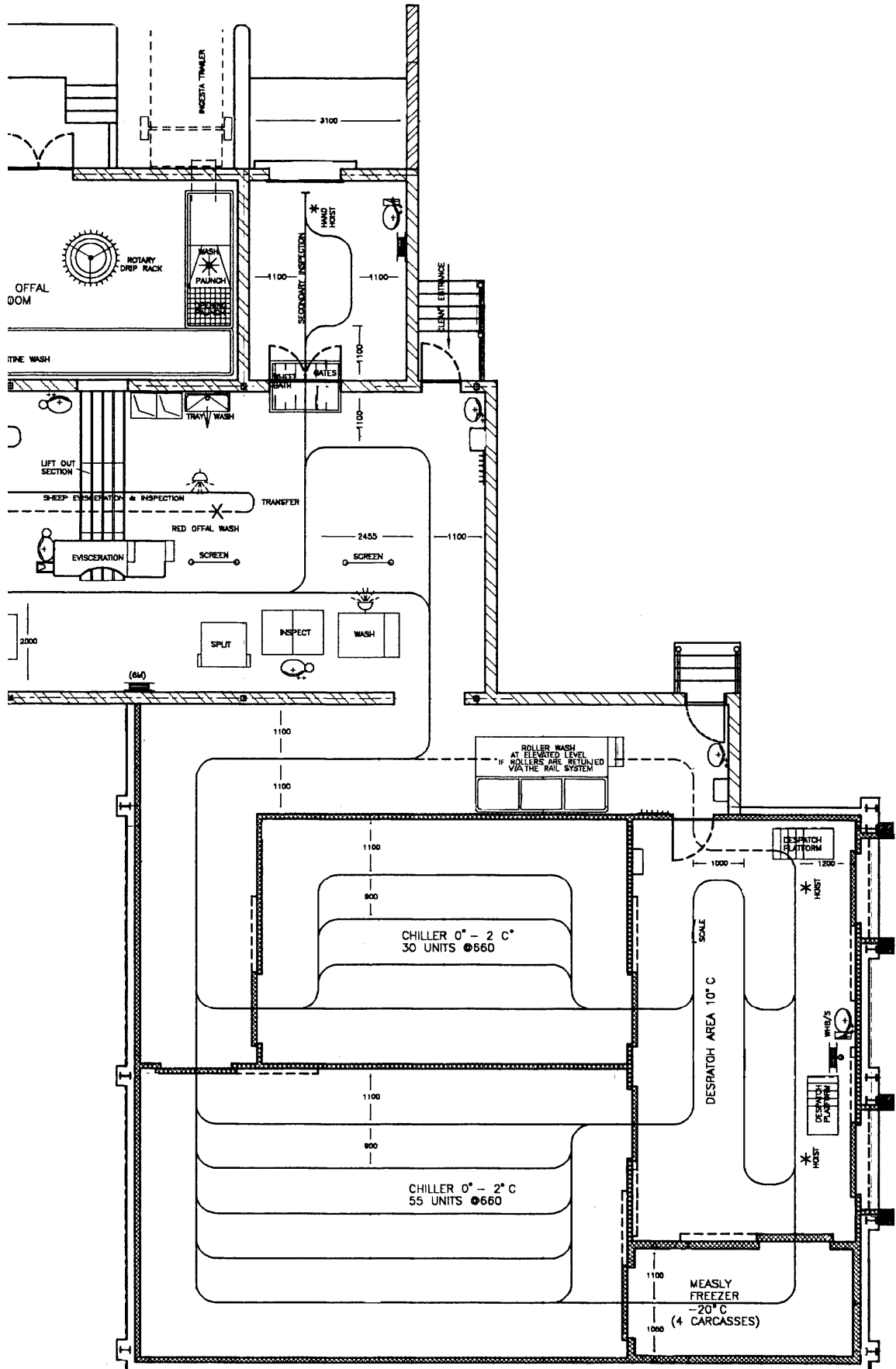
LOW THROUGHPUT RED MEAT ABATTOIR



HIGH THROUGHPUT RED MEAT ABATTOIR (PART 1)



HIGH THROUGHPUT RED MEAT ABATTOIR (PART 2)



MEAT INSPECTORS MANUAL
RED MEAT

PART II
MEAT INSPECTION

MODULE 2
SLAUGHTER & DRESSING

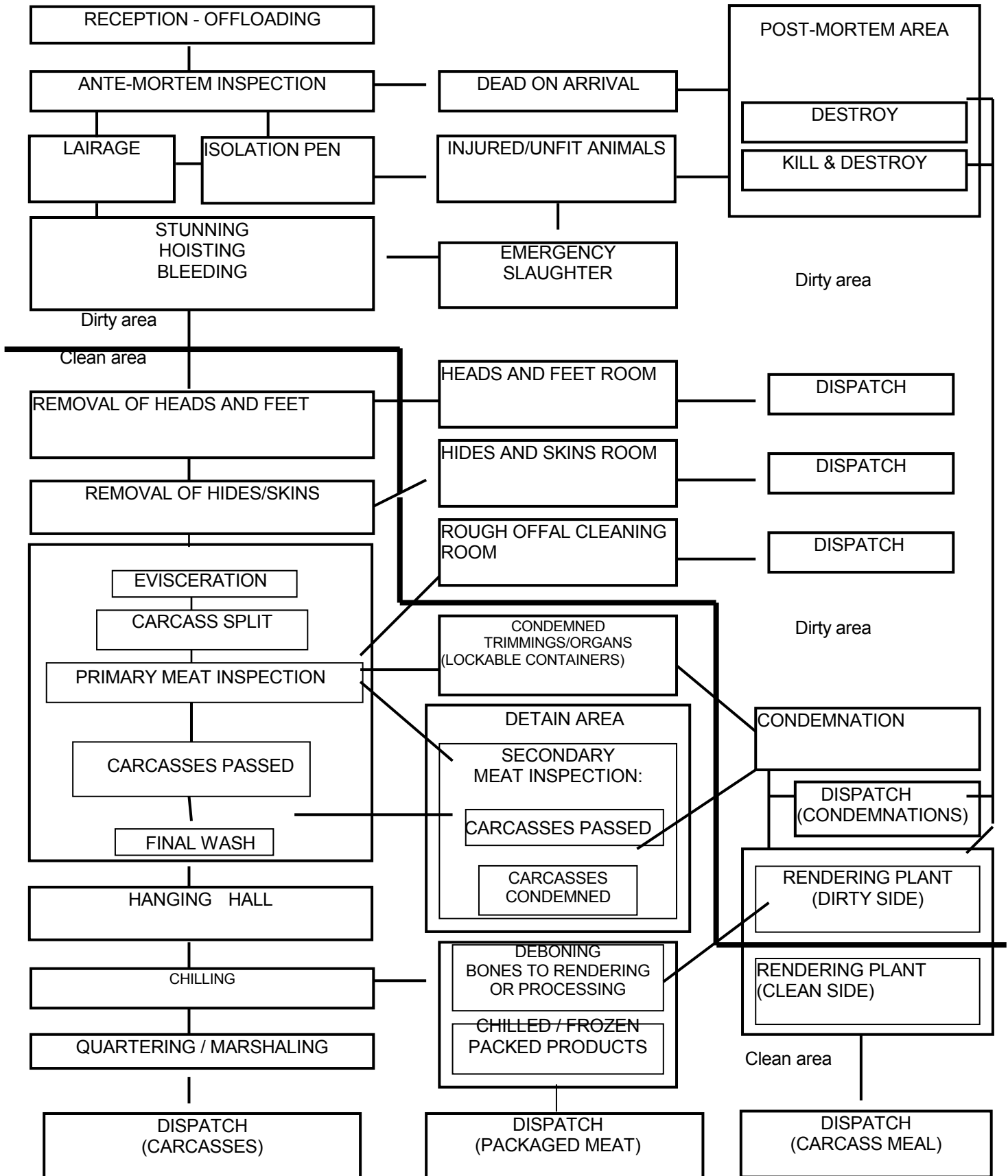
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SLAUGHTER AND DRESSING

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SLAUGHTER AND DRESSING

1. FLOW DIAGRAM OF A RED MEAT ABATTOIR

The diagram below gives some idea of the working of a larger red meat abattoir. Personnel movements are however not shown.



2. ANIMAL WELFARE ASPECTS AT ABATTOIRS

INTRODUCTION

1. Legislation governing the prevention of cruelty to animals specifically pertaining to the transport, lairaging, stunning and sticking of animals
 - (a) Animal Protection Act no. 71 of 1962.
 - (b) Meat Safety Act no. 40 of 2000.
2. Transport and Handling of Livestock
3. Lairage
4. Welfare of animals during stunning and sticking
5. Ritual Slaughter

Animal welfare considerations are becoming increasingly important, both in South Africa and internationally. Practices which may once have been deemed acceptable are now being reassessed and modified according to new knowledge and changing attitudes. High standards of animal welfare are not only important legally, but also have direct economic benefits by enhancing productivity and helping to facilitate international market access.

2.1 Legislation governing the prevention of cruelty to animals specifically pertaining to transport, lairaging and stunning and sticking of animals at abattoirs

Animal protection act no. 71 of 1962

This Act was transferred to the Department of Agriculture from the Department of Justice and is currently being revised by all organisations involved in Animal Welfare. This Act deals with all the aspects of the prevention of cruelty to animals and the prosecution of persons who carry out an act of cruelty towards an animal as defined by this Act.

Meat Safety Act (Act No. 40 of 2000)

This Act stipulates the responsible handling of animals at abattoirs and the humane slaughter of animals. Part VI of the Standing Regulations of this Act specifies the humane slaughter of animals with regard to lairaging, proper supervision and ante – mortem inspection and stunning of animals at abattoirs.

2.2 Transport and handling of livestock

Extensive research has proved that a better quality meat with a longer shelf life can be produced if livestock are handled with greater patience, understanding and humaneness. The livestock industry loses millions of rands annually as a result of bruising and injuries caused by loading, unloading and transport of livestock. The bruised portions of the carcass have to be removed at the abattoir since these portions are condemned as being unfit for human consumption. Hence, it is necessary to ensure that slaughter animals reach their destination without delay and in as good and healthy a condition as possible.

Objectives

- (a) To deliver uninjured, unsoiled and rested animals to the abattoirs
- (b) To ensure responsible and humanitarian handling of livestock at all times and in all situations
- (c) To aim at positive preventative measures with a view to avoiding the financial loss associated with severe injuries, which could include condemnation due to bruising and even death.

The detrimental effects of transport on slaughter stock can be grouped under two main headings, namely stress and injuries.

Stress factors

If an animal is under stress when slaughtered, the quality and shelf-life of the carcass and subsequent meat will be adversely affected. During transport the animal is exposed to unfavourable stimuli centering on the unfamiliarity of the scene, extremes of temperature, hunger and thirst. As a result of all these stress factors exceptional amounts of adrenaline are produced by the affected animal and released into its bloodstream.

Glycogen reserves in muscles are reduced and blood sugar increases. There is consequently less lactic acid

available, which in turn leads to shorter shelf-life and less tender meat. Blood supply to the musculature is increased and this can result in the carcass not bleeding out well.

The meat of stressed animals may also undergo undesirable changes, such as the so-called “dark cutters” and “Pale Soft Exudative” “PSE” (watery) pork .

Injuries during transport

Injuries and stress are interrelated, one giving rise to the other. Transport injuries cause financial losses from deaths in transit, from condemnation of carcasses and portions of carcasses as a result of bruising, and from the lower grading of trimmed carcasses.

Factors in transport: injuries and stress

Watering and feeding

Cattle, sheep and goats should be provided with food and water up to the time that the journey commences. Pigs should not be fed within 12 hours prior to the commencement of a journey not longer than six hours.

Prior to the start of any journey, pigs should be placed in a well-ventilated area for at least three hours and loading should not be earlier than one hour before the proposed departure time.

Loading and offloading

Since transport begins at the point of loading it is of the utmost importance that adequate provision should be made for loading and off-loading without danger of injuries and unnecessary exposure to stress.

Important factors at the loading/offloading bay are:

- (a) The height of the bay must not be less than that of the vehicle
- (b) There must be no danger of animals falling over the sides of the bay
- (c) The bay must be designed in such a way that vehicles, when backed against the loading platform, shall fully cover the gap to such a platform
- (d) The floor of the platform must be roughened to prevent slipping
- (e) All surfaces must be cleaned regularly and no loose articles (tins, wire) should be left lying around.

Off-loading facilities at the abattoir play an important role in the prevention of injuries and the reduction of stress factors. It is at this point especially that animals require calm and quiet handling. Movable gangways must conform with the following specifications:

- (a) The floor must be fitted with cleats at suitable spacing to prevent slipping
- (b) There must be non-see-through side panels to prevent animals falling off or balking away from using the gangway
- (c) They must be long enough so that the angle of descent does not cause slipping
- (d) They must be broad enough for easy passage

Off-loading platforms of varying heights to accommodate all types of vehicles are recommended. Otherwise, especially at smaller abattoirs, there should be adjustable gangways. Both these methods have proved effective in practice.

Transport

Most injuries occur during transport and are connected with the construction of the vehicle. It is important that a vehicle used to transport livestock be designed for the purpose for which it is to be used. To minimise unnecessary injuries and hence stress, the following factors are of great importance:

- (a) **The floors of the vehicle must be solid and impervious.** This is especially so in the case of double and multiple decked vehicles. If there are gaps in the floor, animals on the lower decks are soiled by excreta from the upper deck. In the case of single decked trucks, excreta pollutes the road and since most abattoirs are sited in populated areas, soiling of the roads can be a hazard.
- (b) **Grids or cleats.** The floor of the vehicle must be fitted with raised ridges in the form of grids or cleats to prevent slipping and injury.
- (c) **Spaces between floor and side panels.** Gaps or holes in the floor and/or between the floor and side

panels are often the cause of injury, especially bone fractures.

- (d) **Sharp points or corners.** These would obviously contribute to injuries and must be eliminated in the construction of the vehicle.
- (e) **Partitions.** It is necessary to provide partitions in all vehicles, when only one species is being transported. Partitions help to stabilize the load and reduce the effect of braking and cornering by limiting movement.
- (f) **Ventilation.** In double decked trucks serious attention must be paid to ventilation, especially for sheep and pigs. The space between levels must be sufficient to allow free movement of air.
- (g) **Shelter.** Protection against the elements can prevent soiling and even deaths during transport, especially in the case of pigs transported over long distances or in warm weather. Provision must be made for at least 80 % shade cloth or solid covering over the top if pigs are transported during the heat of the day for periods in excess of two hours. The effect of roofing on air circulation must be considered.
- (h) **Sides of the vehicle.** The sides of the vehicle and partitions when used to separate animals should be of a height not lower than the shoulder joint of the largest animal being transported. In the case of horses and cattle other than calves the minimum height should be 1800 mm and 750 mm in the case of any smaller animal.
- (i) **Exhaust fumes.** The exposure of animals to exhaust fumes should be actively guarded against since such fumes interfere with respiration and can even cause death. No vehicle must ever be totally enclosed.
- (j) **Floor space.** The floor space per animal should be as follows :
 - 1,4 square metres per adult bovine
 - 0,3 square metres per small calf
 - 0,4 square metres per sheep and goat
 - 0,3 square metres per porker
 - 0,4 square metres per baconer
 - 0,8 square metres per other adult pig.

Where vehicles are provided with two or more decks for the transport of pigs and sheep, the height between the decks should not be less than 1 m. For cattle the height between the upper and lower deck should not be less than 1,6 m.

Other important points to consider in the transport of animals

- (a) Do not overload vehicles – Not more than twelve adult cattle may be loaded into a single truck – obviously this will play a significant role in bruising and injuries of animals
- (b) Do not load too few animals – this will also lead to increased injuries and stress.
- (c) Do not load sick, weak or tired animals; separate horned from hornless animals; do not mix strange animals with animals used to each other, do not leave loose articles in the vehicle; Do not use sand on the floor of a vehicle as all these factors contribute to stress and injuries in animals.

Supervision

The off-loading and general handling of animals in the abattoir should be supervised by trained and responsible personnel. Good supervision can prevent injuries especially at the smaller abattoirs.

Trucks and drivers

Drivers should not park vehicles on a slant. Animals are able to lock the joints of their legs and rest in a standing position only if the surface on which they stand is reasonably level.

Drivers should at no time handle a vehicle in such a manner as to cause swaying or swerving of the vehicle, or take corners too fast. They should not travel at an excessive speed but drive as smoothly as possible.

2.3 Watering, distance and duration of journey

Any animal transported must be moved with a minimum of distress and be promptly off-loaded on arrival at the destination.

Animals other than pigs should not be transported by road for a period of more than 36 hours from the time of embarkation. During the course of a journey exceeding 36 hours, animals should be off – loaded at intervals not exceeding 24 hours and given a continuous period of 12 hours for rest and recovery, feeding and watering.

Off-loading for the purpose of watering, feeding and resting should be effected only at places where such off-loading will not result in contraventions of the Road Traffic Ordinance or cause avoidable distress to the animals.

2.4 Unfit animals

Unfit animals and animals that are obviously pregnant should not be transported. If any animal should become unfit during the course of the journey, then it should not be carried longer than is necessary to get it to a place where emergency slaughter can be carried out as soon as possible.

2.5 Liairaging of animals

Cattle, goats, sheep and pigs should be penned separately. In the case of pigs, pigs from different origins should be penned separately, in accordance with their origins. Depending on the size of the animals and the duration of time that the animals will be penned, the penning space should not be less than:

- (a) For each adult bovine – 1,74 square metres floor area
- (b) For bacon type pigs and small porkers, sheep and goats – 0,56 square metres floor space
- (c) For heavy pigs and young calves – 0,74 squared metres floor area

In the case of pigs, water sprays or hoses must be used for cleaning and cooling hot, dirty or fractious pigs.

Fractious animals should not be penned with other animals.

Provision must be made in pens for -

- (a) Facilities such as racks, mangers or other suitable feed containers which are easy to clean and will allow the feeding of the animal away from the floor.
- (b) Facilities for the safe and humane keeping and handling of animals.
- (c) A water trough with an adequate and accessible supply of clean, portable water at all times.
- (d) Sufficient facilities for the adequate and regular cleaning of pens.

The pens should always be maintained in a good state of repair and sharp points such as jagged ends or protruding nuts and bolts which could cause injury to animals must be removed or suitably dealt with. Protection from sun, rain and cold winds should be provided.

Animals should not be penned in overcrowded conditions and the floor of the entire pen, including the off-loading banks, passages, races and pens must be so constructed as to provide acceptable non – slip surfaces that can be regularly cleaned and kept suitably dry and in a condition fit for the holding of livestock.

2.6 Emergency slaughter and the resting of animals

Animals that are to be found suffering from pain, terminal disease/injuries or are unable to leave the transport vehicle of their own accord on arrival at the abattoir are to be approved for emergency slaughter or dispatched directly to the post-mortem area for destruction.

Animals that are exhausted or are suffering from stress that may be reversed by liairaging, are to be rested overnight. They are to be subjected to a further ante-mortem inspection the next day before their slaughter may be approved by the Veterinarian or the Meat Inspector.

2.7 Lairage time at the abattoir

- (a) A minimum lairage time of one hour is to be imposed on all slaughter stock except in the case of emergency slaughter where animals may be slaughtered immediately. If deemed necessary by the Veterinarian or Meat Inspector, this time period may be extended.
- (b) If after the minimum lairage time and ante –mortem inspection, the stock are found to be calm, rested and healthy, they may be approved for slaughter.
- (c) Pigs that have been in transit for a period greater than 12 hours are to be rested overnight.
- (d) Animals that are held longer than 24 hours must be subjected to a further ante-mortem inspection during the 24 hours preceding slaughter.
- (e) No animal shall be kept in a lairage awaiting slaughter for a period exceeding 72 hours and calves and pigs shall not be kept longer than 48 hours, unless extension of these periods is authorised in special circumstances by the Veterinarian.

2.8 Feeding of animals at abattoirs

- (a) If ruminants, (excluding calves) are to be slaughtered within 48 hours of arrival at the abattoir, it is not necessary to provide them with feed.
- (b) If the 48 hour period is exceeded or if deemed necessary by the Veterinarian or Meat Inspector on arrival, ruminants must be provided with sufficient, suitable roughage.
- (c) If a 24 hour period is exceeded or if deemed necessary by the Veterinarian or Meat Inspector on arrival, Pigs are to be fed ground grain
- (d) Unweaned calves and pigs (i.e. under 3 months of age) and unweaned lambs and kids (ie under 2 months of age) are to be fed milk or milk substitute if they have been waiting on slaughter for longer than 12 hours.

2.9 Animals that give birth en route or at the abattoir—the mother or the young are to be

- (a) removed from the abattoir
- (b) slaughtered within the 72 hour limit and the young destroyed – subject to the decision of veterinarian.
- (c) the mother slaughtered within the 72 hour limit while the young is removed for hand-rearing – subject to the decision of the veterinarian.

Quarantine Abattoirs: The mother and her young must be slaughtered within the 72 hour limit and her young destroyed – subject to the decision of the veterinarian.

2.10. Welfare of animals during stunning and sticking

It is important that adequate restraint of the animal is achieved in order to gain easy access to the head

Stunning

- (a) Whether stunning is to be achieved by means of electric or captive bolt apparatus, the apparatus concerned shall be examined and tested before use each and every day it is to be used, and at adequate intervals during the day.
- (b) Continued use of any stunning apparatus is very exhausting, often dangerous and consideration should therefore be given to relieve the operator before a level of exhaustion is reached such that he becomes indifferent, insensitive or careless.
- (c) Serious considerations should be given to providing the operator with effective ease of access to the animal to be stunned so as to reduce the avoidable elements of danger of effort. It is obvious therefore that a restrainer conveyer system is far more efficient than stun boxes or other apparatus which allows excessive movement of the animal's head and body.
- (d) The apparatus should be such that stunning can be achieved with repeatable accuracy which requires that the operator can stand in safety close to the animal to reduce reaching and physical effort.
- (e) Operators must be made to understand that the stunning procedure whether electric or captive bolt renders the animal unconscious for only a very short period of time and that bleed-out must be achieved whilst the animal is insensitive to pain and before it begins to recover consciousness. Therefore regardless of the system used the aim should be to ensure that both carotid arteries and jugular veins results are cut and separated as expeditiously and physically as possible.
- (f) Cutting both carotid arteries and jugular veins results in brain failure with consequent unconsciousness, but when only one carotid artery is cut brain failure will not occur within approximately seventy seconds. If the carotids are missed altogether and only the jugulars are cut the animal can take as long as five minutes to die.
- (g) With electrical stunning, it is necessary that the operator be trained and supervised to ensure that the correct current flows for the approximately calculated period through the correctly positioned electrodes placed across the brain in order to ensure the efficiency of electroplectic stunning.
- (h) Similarly with the use of the captive bolt correct charge (grade of cartridge) in a suitable and efficiently maintained captive bolt pistol must be precisely and firmly applied to the head of the animal to be stunned.

Practical recommendations

Head only electrical stunning in sheep, goats and pigs

Species	Minimum current level during stunning	Maximum stun/ stick interval
Sheep and goats	1 Amp 200 Volts	15 seconds
Lambs and Kids	0,6 Amp 160 Volts	15 seconds
Weaned pigs	1,3 Amps 240 Volts	15 seconds
Grown out pigs	1,3 Amps 240 volts	15 seconds

Notes

1. Time of application of electrodes is 5 to 7 seconds at 240 volts and 7 to 10 seconds at 180 volts.
2. Electrodes must be placed so that they span the brain.
3. In order to ensure rapid brain death following exsanguination, it is imperative that both carotid arteries (or the blood vessels from which they arise) are severed.
4. An apparatus that produces a constant *current* is preferred to one that produces a constant *voltage*.
5. The apparatus must have a visible current sensor indicating current under load.
6. A suitable method of restraint which prevents movement offers advantages; these include more reliable stunning, worker safety and minimising of carcass quality defects.
7. Where any difficulty is experienced in correctly applying the stunning tongs to heavily horned sheep and goats, the captive bolt pistol should be utilized.
8. All large boars should be stunned by means of the captive bolt pistol. (Cognisance must be taken that in this event PSE meat may result.)
9. The contact points of the stunning tongs must be long and sharp enough to penetrate the wool to ensure proper contact with the skin of the animal being stunned.
10. Pigs should be wetted prior to electric stunning.
11. Electric prodders should not be used on pigs.
12. The contact points of the stunning tongs should be cleaned and serviced from time to time to ensure maximum current flow.

Captive bolt stunning of cattle sheep and goats

Humane stunning and slaughter of animals using the captive bolt method depends on three factors:

1. the position of the shot on the animal's head (See annexure A)
2. the speed of the bolt on impact with the head, and
3. the stun/stick interval.

Shooting position

Heavily fleeced sheep and large boars should not be stunned with electric stunners but stunned with an appropriately charged captive bolt pistol.

Cattle

The frontal position must be employed. This is the intersection of imaginary lines connecting the outer canthus of each eye with the opposite ear. The poll position, on the back of the animal's head, does not consistently offer an effective stun, and must be avoided.

Sheep and goats

A shot aimed at the crown of the head and pointing straight down should be used in preference to the poll position. Where the poll position must be used because of the presence of horns, the shot should be placed immediately behind the base of the horns and aimed towards the mouth.

Bolt speed

The bolt speed produced by captive bolt pistols will vary according to their design.

Cattle

Incidences of poor stunning, not caused by inaccurate shooting can be attributed to insufficient bolt speeds. Assuming that the maximum strength cartridge is being employed and that the gun is in good working order, this can only be rectified by the use of a more powerful pistol. This problem becomes particularly evident when large animals such as bulls are being stunned. The manufacturers recommendations regarding the appropriate cartridge strengths must be viewed as the minimum requirements from a stunning point of view. Exceeding the recommendations will only increase the likelihood of effective stunning.

Sheep and goats

The bolt speeds produced by the existing pistols exceed the minimum requirements for sheep and goats. The prime consideration is therefore to ensure accuracy in shooting, and proper maintenance of the gun.

Stun/stick interval

When the poll position is employed in stunning sheep, the stun/stick interval should be as short as possible, and in any case, not exceed 15 seconds. The captive bolt pistol should never be applied in the poll position on any animal unless absolutely necessary.

Effective stunning in the frontal positions in both cattle and sheep usually results in irreversible loss of sensibility. However, in order to prevent suffering and impairment to meat quality, the stun/stick interval should be kept to the absolute minimum for all animals.

Captive bolt stunning of porkers and baconers whilst being effective from a humanitarian point of view, can cause severe convulsions leading to carcass quality problems, and is not recommended, and therefore, electrical stunning procedures are preferable.

Recognition of an effective stun

An effective stun cannot be diagnosed solely on the grounds that the animal has collapsed. A well defined tonic phase, involving retraction of both front and back legs, followed by relaxation of the animal no less than 15 – 20 seconds following the stun, along with the absence of breathing and a fixed position of the eye may be used to recognise effective stunning.

Causes of reduced bolt speed

Reduced bolt speed is a common cause of poor stunning. Bolt speed can be severely reduced when the requirements for gun maintenance are not met. Bolt speed is reduced wherever the combustion space behind its base is increased, as when the bolt fails to retract fully. Poor maintenance can be recognised by failure of the bolt to retract to its full extent following each shot.

It is essential that guns are stripped down and cleaned, according to the manufacturer's recommendations at the end of each day's operation. Faulty or damaged parts must be replaced immediately. In plants using pneumatic stunners the compressor should be regularly maintained and daily checks made on the air pressure to ensure that it is adequate.

Minimum bolt speeds

A minimum bolt speed of 20m/sec for sheep and 45m/sec for cattle is recommended. However, these are only approximate guidelines, since it is the energy involved in the impact of the bolt with the animal's head which defines the effectiveness of the stun, and this energy is influenced by the gun's design.

Slaughter knives

It is recommended that slaughter knives with a minimum length of 250 mm and 180 mm for cattle and sheep respectively, be used for "throat – cutting " purposes, and that such knives shall be kept suitably sharp.

2.11 Ritual slaughter

Kosher slaughter

- (i) The Veterinary/Hygiene Officer must satisfy him/herself that the facilities for Ritual slaughter at the abattoir

and that the procedures for such slaughter, have been approved by the Directorate Food Safety and Veterinary Public Health, Department of Agriculture.

- (ii) It is necessary to check that the equipment and facilities to be used during the operation are in working order
- (iii) The restraining of the animal to be slaughtered shall be effected as swiftly and painlessly as possible
- (iv) The slaughter man, his assistants and Schochet operating the rotating box, immobilising or slaughtering an animal are not permitted to delay in the performance of their respective functions during the slaughter
- (v) An armed Captive Bolt Pistol shall be readily accessible to effectively stun the animal in the event of the Shochet not rendering the animal unconscious within three seconds of the cut.
- (vi) An effectively armed Captive Bolt Pistol shall be correctly applied after the cut within the period prescribed by the Livestock Welfare Coordinating Committee

Halaal slaughter

The above conditions shall mutatis, mutandis apply to Halaal slaughter, except that the animal being slaughtered may be rendered unconscious prior to the ritual cut being effected.

3. STUNNING

The aim here is to render the animal unconscious as soon as possible so as to prevent pain and suffering during the killing process. The animal must remain unconscious until death. The need for stunning is acknowledged all over the world, and no slaughtering may be done at an abattoir unless the animal has been stunned in the approved manner.

Facilities and equipment

The pen or other area in which stunning takes place must be designed in such a way as to completely restrict the animal's freedom of movement so that stunning can be done with a great deal of accuracy.

Cattle

Cattle must be handled in a facility, which restricts movement to the minimum. Small abattoirs handling only a few cattle usually have a cheap but effective cattle-stunning box. This is essentially a modified crush of which one side swings up and allows the stunned animal to roll down a short slope (about 0,46 metres high) and into the abattoir. Further details and the plans for these stunning boxes are obtainable from the Director: Veterinary Services.

In South Africa the only instrument used to stun cattle is the captive bolt pistol. The correct situation for the stunning box is just outside the slaughter hall. It should preferably be roofed.

Pigs

Pigs can be stunned in a small casting pen or conveyor belt apparatus, or in a small, separate stunning area. The best apparatus to use is electric tongs, for reasons which will be explained later, but where electricity is unavailable a captive bolt pistol must be used.

Large pigs can also be restricted in a stunning box. The separate stunning area mentioned above can consist of a cage with bars, 2,4 x 2,1 metres, with swing gates; it should be inside the building in the dry landing area. Pigs should be hosed down in the crush leading to the stunning box prior to stunning. This not only reduces pollution of the water in the scalding or soaking tank; it also has a calming effect and ensures better conductivity during electrical stunning.

Sheep and goats

Sheep and goats, like pigs, are stunned in a small-restricted area. Electric tongs should once again be the method of choice, but failing that a captive bolt pistol must be used.

Procedures and methods for Captive bolt pistol

There are two main types. The most widely used has a bolt, which penetrates the skull. The other has a mushroom-shaped head, which stuns the animal by concussion. The pistol can be fired by cartridges or air pressure.

Correct stunning points for various species

Cattle

Aim for the point of intersection of two imaginary lines running from the highest point of each eye to the lowest point at the base of the opposite horn. The barrel of the pistol should be placed firmly against the skull and at right angles to the head. In old or heavy cattle the ridge of bone down the centre of the face must be avoided. Place the barrel 1 cm to one side of the ridge.

People who use a captive bolt pistol for stunning cattle must know where to stand. The operator must never stand in front of the animal, as it will jerk its head away when the pistol is aimed. The best position for the operator is just behind the animal's head. When it looks up, the pistol can be quickly brought into position and fired. A light above the stunning box encourages the animals to look up.

Tapping an animal on the back or making a sound to attract its attention will usually make it look up. A mistake frequently made is to try and follow the moving head with the pistol. The best method is to wait until the head is fairly still, and then to use the captive bolt pistol in one movement like a striking snake.

Calves

Same as for cattle. Aim for a slightly lower point, however, as the upper part of the brain is not as well developed as in adult animals.

Sheep

- a. Hornless: Place the pistol against the highest point of the head above the base of the ears and aim towards the throat.
- b. Horned: Aim behind the centre of the ridge between the horns, with the barrel pointing towards the mouth.

Goats

As for horned sheep.

Pigs

Aim about 2 cm above eye level, on the middle line, and aim upwards and into the head.

A properly stunned animal should have no eye reflexes. The head must be completely relaxed and incapable of movement. The ears must flop and the tongue loll.

Electric tongs

Correct stunning points for various species

As we have mentioned, this is the method of choice for pigs, sheep and goats. It would appear to be used for cattle as well in some overseas abattoirs. The correct positioning of the electrodes is very important. Proper electrical stunning depends on the maximum flow of electricity through the brain. For pigs the best position is on either side of the head, under the ears and level with the horizontal line through the highest point of the snout. A similar position also applies for sheep and goats. Apart from the correct positioning, the following factors also play an important role in determining the level of effectiveness of electrical stunning:

1. **The voltage.** This must be high enough to overcome the resistance of body tissue.
2. **The amperage.** This is the most important factor; it causes depolarisation of nerve tissue with consequent loss of consciousness.

3. **Duration of the application.** This is usually 2-4 seconds for calves, goats and sheep and 2-10 seconds for pigs.
4. **The frequency of the electric current.**
5. The condition of **the electrodes**, for example sharp or blunt. **The pressure** with which they are applied. A dry or wet **skin**.

Proper electrical stunning will cause the animal's legs to collapse, so it will fall. Next there will be stretching of the legs and upward bending of the neck. Paddling movements of the feet may occur. If the neck arteries are not severed, the animal will later regain consciousness.

The amperage and voltage will vary according to the type of equipment and the size of the animal. In general a current of 0,8-2 A is used for all animals, while the voltage will vary from ± 110 volts for a small pig to 250 volts for a large one.



4. HOISTING

All animals must be bled in a hanging position away from the floor. For this reason the bleeding area must be high enough and there must be a hoist, especially in the case of cattle and pigs.

Once an animal has been stunned, it rolls out of the stunning box and into an area known as the dry landing area. A bleeding chain is then attached just above the hoof of one hind leg and the animal is hoisted aloft by means of an electric hoist. As soon as the animal is over the adjacent bleeding area, sometimes a trough, its neck arteries are severed.

These processes must be carried out rapidly, as the arteries must be severed within one minute of stunning.

The bleeding rail must be high enough for the animals to hang above floor level. This requirement contributes a considerable amount to the costs of a small abattoir where cattle are slaughtered, but it is essential. Recommended bleeding heights above floor level are:

Cattle

- i. On a crawl beam - 4,88 to 5 metres
- ii. On a bleeding rail - 4,5 to 4,8 metres
- iii. Bleeding hook or pulley - The lowest point of the hook at 4,2 metres

Pigs

- i. 3,8 metres
- ii. With correct planning large pigs can use the cattle bleeding rail and small pigs the sheep rail.

Sheep:

2,4 metres

5. CUTTING THE THROAT

The incision is made after the animal has been hoisted up and is hanging over the bleeding trough or bleeding area.

Care must be taken that all the blood vessels in the neck are severed but the spinal cord remains intact.

The blood vessels in the neck must be cut within one minute of stunning. In this period the blood pressure rises greatly. If the blood vessels are not severed in good time, blood splash will be caused by tiny haemorrhages in the muscles and organs.

The bleeding knife must be sterilised before each new animal is cut. Where large numbers of animals are slaughtered, several knives should be in use. Any animal has a dirty skin which contains large numbers of bacteria. The knife becomes contaminated when it cuts through the skin. This could cause bacteria to enter the blood stream and spread through the body. The knife must therefore be sterilised regularly in order to prevent a build-up of bacteria and the transfer of these to other carcasses.

A hand basin/sterilizer must be provided within a convenient distance from the bleeding point. Heat causes blood to coagulate, so the knife should be rinsed with cold water before it is placed in the sterilizer.

6. BLEEDING

If all is well, we now have an animal, which was stunned, fell on to a dry landing area, and was hoisted by one hind leg; its neck arteries and veins were cut within a minute. The animal is hanging in a bleeding area, perhaps over a trough.

At least 6-8 minutes must be allowed for bleeding cattle, 5-6 minutes for pigs and 3-4 minutes for sheep. If shorter periods are allowed, blood will drip on the dressing floor, causing contamination in this work area or a loss of blood meal where by-products are manufactured.

The bleeding trough floor must slope steeply in the direction of a floor drainage opening situated directly below

the bleeding point.

It is advisable to drain the blood separately, so there should be a second opening for washing water. The opening, which is not in use, must be closed with a plug.

There are still problems attached to the disposal of blood other than by processing in a sterilisation plant. If blood is disposed of in the drainage system it overloads the purification works, while unpleasant odours emanate from septic tanks into which it is drained.

Larger abattoirs in particular experience problems with the burying of blood.

The minimum time allowed for bleeding and the amount of blood per species are:

Cattle:	6 minutes	13 – 15 litres blood
Calf:	5 minutes	2 – 7 litres blood
Sheep:	5 minutes	1,3 – 2 litres blood
Pig:	6 minutes	2 – 4 litres blood

The provision of a boot-washing trough at the exit prevents bloody boots from contaminating the passageways outside the bleeding area.

There should be access to the bleeding area for animals, which are unable to walk. A paved and drained area will have to be provided in front of the entrance for these animals.

Pigs often do not have their throats cut but are stuck (with a knife in the heart).

7. ELECTRICAL STIMULATION

Introduction

One of the most important quality features of meat is its tenderness; consumers attach great importance to this. For decades now, meat scientists have been concentrating on methods which can be used to guarantee the purchaser the tender product possible.

In 1749 the American statesman and scientist, Benjamin Franklin, discovered that an electric current passed through a carcass during the slaughtering process ensured exceptionally tender meat. This technique is applied all over the world to produce meat of good quality.

Electrical stimulation

When an electric current is passed through the carcass of a freshly slaughtered animal, it causes the muscles to contract. This contraction requires energy, so ATP and glycogen are used up rapidly. When the electric current is interrupted, there is still enough glycogen and ATP left in the muscles to enable them to relax (calcium pumps need ATP). When the carcass enters the cooling room the glycogen and ATP reserves are low but the muscle temperature is still high - far from the 15-12° which causes cold shrinking. Because the energy reserves are low, rigor mortis begins more quickly while the muscle temperature is still high. This means that rigor mortis takes place in relaxed muscles. The sarcomere lengths are normal, so the meat retains its inherent tenderness to a considerable extent.

Local research has indicated that the application of electrical stimulation to cattle carcasses in South African conditions is very successful in combating cold shrinking. When electrical stimulation is applied within 40 minutes of death for 120 seconds, with a potential difference of 500 volts and a frequency of some 12,5 Hz, the pH of the muscles falls within two hours of stimulation to below 6,00; this indicates that the glycogen levels have largely been exhausted. When the carcasses are then quick-cooled to 0° C, a difference in the toughness of loin cuts from opposite sides of stimulated and non-stimulated carcasses was found of from 122% to 78%. The occurrence of cold shrinking is therefore effectively prevented, and the inherent quality of the meat in respect of tenderness can be passed on to the consumer.

Practical factors affecting the effectiveness of electrical stimulation

Various factors influence the effectiveness of electrical stimulation in practice. Electrical stimulation is much more effective when applied directly after death, for a very simple reason. Muscle contractions depend on an impulse reaching the muscle cells. This is usually done via the nervous system. Nerves are well branched in

the various carcass muscles. If the nervous system can be used to carry the electric current, this will reach most of the muscles and therefore cause effective stimulation. The nervous system can however only be utilised within 40 minutes of death, after which it is no longer suitable for transmitting electrical impulses. The sooner after death the electrical stimulation takes place, the more effective it will be. The duration of stimulation must also be systematically modified according to the length of time between death and electrical stimulation. About 60 seconds of stimulation is sufficient 10 minutes after death, but 40 minutes after death 120 seconds will be required if a potential difference of 500 volts is used. The construction of an abattoir may in some circumstances make it impossible to stimulate a carcass shortly after death, and might also render impossible a stimulation period of 120 seconds. In these cases higher potential differences will be needed to achieve effective stimulation.

This all indicates that the best time for the application of electrical stimulation is during or straight after bleeding. Carcasses can however also be stimulated after bleeding, before or after evisceration and even after halving. Stimulation takes place in an area completely isolated by safety panels and notices so that the safety of staff is not endangered in any way.

The effectiveness of the electrical stimulation must be checked periodically. Aspects to be checked include the potential difference being used, and whether the carcass is responding to stimulation. The carcass muscles should contract visibly, although this in itself does not indicate whether the stimulation is powerful enough. Even very small electric currents will cause contractions, but these will be completely insufficient to make any significant reduction in energy reserves. A good indicator is the pH value of the M. longissimus thoracis (thorax or chest muscle), which should be under 6.00 within 2 hours of death. It must be borne in mind however that DFD carcasses will not have the energy reserves to reach this pH value.

Other Advantages Of Electrical Stimulation

The contraction of muscles during electrical stimulation, if this is done during or immediately after the bleeding process, causes blood to be pumped out of the carcass more effectively. This reduces blood drips on cold-room floors.

Electrical stimulation not only prevents cold shrinking, but also leads to meat ripening more quickly. Meat needs to be ripened for a shorter time, which is economical in terms of cold-storage space and capacity.

Electrical stimulation also speeds up the onset of rigor mortis.

The cherry-red colour which meat develops on being cut is also accentuated, and the meat colour looks brighter and the fat whiter.

Carcasses can be chilled and frozen more quickly, which saves energy, and also ensures a better microbiological quality of carcasses and meat.

After the application of effective electrical stimulation, carcasses can be de-boned warm and cuts or muscle groups then vacuum packed for quick-chilling or freezing. No cold or defrost shrinking will take place. This system also reduces the chilling or freezing capacity required. Only meat is frozen, not empty spaces or unnecessary bones. It is necessary to note however that electrical stimulation has no effect on the tenderness of connective tissue.

8. DEHEADING

The head is removed after the bleeding process. The cut must be made in line with the animal's ears to ensure that the hide or skin will keep the right shape. The head must not be removed from the carcass until bleeding is over. Once the head has been removed it is de-masked; this is optional and depends on market requirements. At the same time the tongue is removed, the nasal cavities are rinsed and the head dehorned where applicable. An important requirement is that the head which has been removed must be identifiable as part of the relevant carcass for inspection and grading purposes.

9. REMOVAL OF THE HIDE/SKIN

The factors which determine the suitability of a tanned hide or skin do not start with the curing process, but with the removal of the hide or skin from the carcass. When once it has been removed from the carcass, the handling it receives immediately thereafter is of vital importance for the retention of quality. The final shape of the hide or skin is more important than most people realise. The value of the processed hide or skin depends on the way in which the cutting lines are made on the carcass.

Factors to be kept in mind during the removal of hides or skins are:

1. Hygienic, clean conditions will help to maintain the quality of the hides, skins and wool.
2. Contact between the meat and the hide or skin must be prevented at all costs.
3. Use a flaying knife, and handle it with care because hides and skins can be badly damaged by cuts and flaying marks, and this lowers their value.
4. The hide or skin must be removed from the carcass immediately after slaughter while it is still warm, as this makes its removal easier.
5. As little blood as possible should come into contact with the hide or skin.
6. Do not sacrifice the value of the hide or skin for the sake of the carcass. If correct flaying methods are used, neither needs to be damaged.
7. Do not use a flaying knife if it is possible to pull the hide or skin off the carcass, especially in the case of sheep where the skin can be eased off by hand.
8. All cuts to the hide or skin must be made from the inside to the outside to prevent contamination.
9. Contamination of the carcass because of dirty hands, hooks, rollers and protective clothing must be prevented.
10. To prevent contamination, lactating udders must be cut off as soon as possible and placed in a container.

Factors to be remembered during the dressing process

Dressing must be done in such a way that:

- hide/skin damage is kept to the minimum and where possible eliminated completely
- no excess blood appears on the hide/skin
- no damage is done to fat or meat on the carcass
- contamination is not transmitted to the carcass from the hide/skin on hands, instruments or equipment
- no hairs or pieces of skin are left on the dressed carcass
- all sexual organs or parts of them are completely removed
- cow udders are removed on the slaughter line and placed in containers
- no unnecessary and injudicious cuts, excisions and marks are made on carcasses during the meat inspection
- the forequarter is sawn or cut through in such a way that no damage occurs to the carcass or the offal
- during evisceration contamination by stomach or intestine contents, uterus contents, urine or gall is prevented
- no part or parts of the innards (offal) are left in the carcass
- damage to any offal is prevented during dressing or eviscerating
- carcasses are halved without deviating from the centre line of the spinal column to prevent damage to any meat cuts
- all spinal marrow is removed from halved carcass
- all loose blood vessels, fat, bone, glands, membranes and removable blood from the neck and carcass are removed during the final dressing process
- all remaining blood is removed from the neck and shoulder sections by pumping the front leg

Additional requirements in the case of pigs

- internal bleeding in the neck and shoulders is prevented by using an over arm thrust in the sticking process
- carcasses do not stay in the scalding tank too long
- damage from the dehairing machine is avoided
- all hooves or parts of hooves are removed
- no hair or stubble appears on any part of the carcass
- during scalding, colour changes are avoided by ensuring that no blood is burnt on to the carcass
- when cutting the anus the opening must be as small as possible in order to prevent the unnecessary excision of meat and damage to the leg joint section

10. EVISCERATION

Evisceration means the removal of the viscera or gut from the carcass. It follows immediately after the removal of the hide/skin in the case of sheep, cattle, horses etc. and after the dehairing and rinsing of pigs.

For cattle either a mechanical evisceration table or individual paunch/gut holders can be used for the reception and inspection of these products. Facilities must be provided for the eviscerator to do his job hygienically. In the case of a mechanical conveyor belt, boot washing, apron washing and other washing/sterilising facilities must be made available.

The evisceration platform used at smaller abattoirs must be provided with a hand basin/steriliser. In all cases there must be facilities for the sterilisation of the evisceration platform or offal containers.

Important points during evisceration

- Evisceration must take place as soon as possible after slaughter.
- Before evisceration the anus must be dressed and removed.
- Damage to any organs such as the bladder, uterus, gall bladder, paunch or gut must be avoided at all costs. These organs contain bacteria (in the case of pigs, especially salmonella) which can contaminate both the inside and the outside of the carcass.
- It is not possible to clean the contaminated surfaces by washing. These surfaces will have to be cut away in order to get rid of all visible contamination.
- The eviscerator must not cut into any organ, nor may he remove the gall bladder from the liver. The gall bladder must also not be emptied on to the floor, but must be placed in a suitable container and taken to the retention/condemnation room where it will be emptied and gallstones recovered.
- It is of the utmost importance that **hands should be washed regularly** during this process. All knives/saws used for dressing must also be sterilised regularly and must never be put down on the floor.
- Organs in the carcass must not be separated during evisceration. Only the spleen and caul may be removed.
- Special precautions must be taken when working with brucellosis reactors. All staff involved in the flaying, evisceration and inspection of such carcasses must wear protective goggles, gloves and masks as well as their normal protective clothing.

11. OFFAL HANDLING

11.1. Red Offal

- (1) Red offal must be washed with clean running water, hung on hooks or placed in containers and chilled in a red offal or carcass chiller, to reach a core temperature less than 7°C within 16 hours, but it need not be chilled at the abattoir if dispatched on a continuous basis to the chilling facilities, the proximity of which must not compromise hygiene standards and be approved by the provincial executive officer and on condition that a separate route for dispatch is provided.
- (2) Red offal may not be stored, or come into contact, with rough offal.
- (3) Further separation, cutting and packing of red offal must be done in a separate area or room.
- (4) Where red offal is packed in cartons, containers or plastic bags for dispatch, chilling or freezing –
 - (a) it may only be done in a separate area or room and equipment must be provided for this function;
 - (b) storage facilities for clean empty bags or containers, for a day's use, must be provided; and
 - (c) bulk storage facilities must be provided for packing material.
- (5) Cartoned offal may not be stored in the same chiller as carcasses or un-cartoned offal.

11.2. Washing of rough offal

- (1) Rough offal must be removed from the dressing room to the offal room directly adjacent and connected thereto, after being passed, where paunches and intestines must be –
 - (a) separated and emptied of its contents;
 - (b) washed with clean running water; and
 - (c) hung on hooks for cooling and drip drying before and during chilling.
- (2) Equipment must be provided for the emptying of rumens and intestines and the ruminal and intestinal content must be removed continuously.
- (3) Where washed paunches or intestines are packed in containers or plastic bags for dispatch, chilling or freezing, a storage facility for clean bags or containers, for a day's use, must be provided.
- (4) Edible washed rough offal must be stored in a chiller at an air temperature not exceeding minus 2 ° C, but it need not be chilled at the abattoir if dispatched on a continuous basis to the chilling facilities, the proximity of which must not compromise hygiene standards and be approved by the provincial executive officer.

11.3. Cleaning of rough offal

- (1) The process as well as the equipment used to clean offal must be approved by the provincial executive officer.
- (2) A room which is so large and so arranged that the hygiene of the operation is assured, must be provided to clean paunches.
- (3) Separate containers must be used for pre-scalded paunches, and those that have been cleaned.
- (4) Cleaned offal must be removed after cleaning.
- (5) Separate rooms must be provided for –
 - (a) dehairing of cattle hooves and sheep heads and feet; and
 - (b) skinning, de-fleshing and splitting of heads and the recovery and packing of brains.
- (6) Where clean products derived from the heads are packed in containers or plastic bags for dispatch, chilling or freezing –
 - (a) it may only be done in a separate room or area and equipment must be provided for this function; and
 - (b) a storage facility for clean bags or containers, for a day's use, must be provided.
- (7) Where cleaned rough offal is packed in containers or plastic bags for dispatch, chilling or freezing –
 - (a) it may only be done in a separate room or area and equipment must be provided for this function; and
 - (b) a storage facility for clean bags or containers, for daily use, must be provided.
- (8) Cleaned offal and clean head meat must be stored in a chiller at an air temperature not exceeding minus 2 °C, but it need not be chilled at the abattoir if dispatched on a continuous basis to the chilling facilities, the proximity of which must not compromise hygiene standards and be approved by the provincial executive officer.

12. HALVING THE CARCASSES

Carcasses must be sawn through to simplify handling during loading and to make possible an effective carcass inspection.

Because of the large numbers of carcasses being handled, most abattoirs use electric carcass saws.

Special attention must be given to the following while carcasses are being sawn:

Carcasses must be sawn straight down the middle so as not to damage expensive cuts. If the carcass is cut off-centre, this may affect its classification

13. MARKING CARCASSES

13.1. Specifications for stamps, marks and ink used

- (1) All stamps or roller marks used to mark any carcass or meat must be constructed of a non-toxic, non corrosive material and must be so constructed as to be readily cleanable.
- (2) The following stamps are required:



- (3) The stamps must contain –
 - (a) the abattoir registration number; and
 - (b) the wording shown in sub regulation (2) which must be in at least two official languages, one of which must be English.
- (4) The minimum sizes of stamps are 60 mm in diameter for the round mark shown in sub regulation (2).
- (5) The letters on the stamps must be readable and may not be less than 8 mm high.
- (6) Marks printed on wrapping material may be smaller than the sizes stated in sub regulations (4) and (5) to suit particular circumstances provided they are approved by the provincial executive officer.
- (7) A purple coloured ink is required where stamps are applied to carcasses or meat and must be manufactured of harmless, edible ingredients approved for use on foodstuffs as described in the Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act No. 54 of 1972).
- (8) The marks must be placed, in case of –
 - (a) cattle, sheep, pig and horse carcasses, on each quarter of the carcass and for pigs, an additional stamp on the head; and
 - (b) cattle, calves and horses, on the heads, if skins are removed.

13.2. Roller-marking

In addition to regulation 112, the owner may use a method of roller marking on red meat carcasses, where such marking contains the words and number stated in regulation 112(3), provided that such roller mark may only be used at abattoirs where meat classification is done.

13.3. Wrapping, packing and labelling at export approved cutting plants

- (1) All labels used on meat must –
 - (a) be printed on food grade paper or plastic printing material and treated in the same hygienic way as in contact wrapping material; and
 - (b) include the information required by regulation 112(3) as well as any other information required by the provincial executive officer.
- (2) Where products are individually wrapped, food grade wrapping material on which the mark of approval is printed or a label, printed with such mark, must be used and wrapping bearing the mark of approval may not be re-used after opening.
- (3) In the case of bulk packing, containers or cartons must be clearly marked with a facsimile of the mark of approval clearly visible and of readable size.
- (4) A container must be clearly marked on both ends with information required by the Agricultural Products Standards Act, 1990 (Act No.119 of 1990), as well as –
 - (a) the name, address and registration number of the establishments in which the meat was packed;
 - (b) the net weight of the contents;
 - (c) an accurate description of the contents;
 - (d) the date packaged or a code which enables the date of packaging to be determined; and
 - (e) directions regarding the temperature at which the product must be stored.

13.4. Security of stamps

- (1) The stamp of approval must be kept and used under control of a registered inspector;
- (2) when not in use the stamp must be kept in safe custody to the approval of the registered inspector; and
- (3) a stamp of approval must never be used at an abattoir where the abattoir number differs from the number on the stamp.

13.5. Use of marking equipment

- (1) Stamps and roller marking equipment must be cleaned and sterilized regularly during use.
- (2) All marking equipment must be kept hygienically, away from the floor and other dirty surfaces.
- (3) Marks must be applied in such a manner that it is clearly legible on the carcass or meat.

13.6. General

- (1) No person may place a stamp of approval on, or remove such mark from any carcass, part thereof, meat or a wrapping, packing or container, except under the supervision of a registered inspector.
- (2) The registered inspector may at any time re-inspect a carcass or meat in an abattoir, notwithstanding that it may already have been passed for consumption and, if upon re-inspection he or she is of the opinion that it is no longer fit for human or animal consumption, he or she must remove the stamp of approval by trimming, and such meat must be condemned.

14. FINAL TRIMMING OF CARCASSES

After inspection and before the final washing, all approved carcasses can be finally trimmed and the following removed or cut off:

- Spinal cord
- Left-over bits of skin and intestines
- Portions of male and female genitals
- Bloody membranes on the inside of the neck, and the aorta

15. WASHING THE CARCASS

After a carcass has left the final inspection point, it is sprayed with water to remove all blood, slight blood marks, bone dust and marrow before going to the cold room for chilling.

Remember not to wash a carcass until all contaminated portions have been cut away, as this will only contaminate it further.

Contaminated meat or fat surfaces cannot possibly be rendered microbe-free by spraying them with water. On the contrary, when surfaces that are already contaminated get washed this can actually spread the bacteria if water droplets splash on to adjacent areas and other carcasses. Contaminated surfaces must of necessity be cut away and the intestinal membranes removed in order to get rid of visible contamination. Chlorinated water can also be successfully applied after the visible contamination has been cut off.

It is not advisable to wash carcasses (with the exception of pigs) before evisceration, as this encourages slaughter hands to wash their mistakes away and it is also possible to wash away abscesses. A proper spraying of pig carcasses just before evisceration is recommended however for the removal of all hairs and dirty water from the scalding tank.

It is generally recommended therefore that only approved, uncontaminated carcasses should be washed with running water in order to remove from the carcasses any bone splinters and blood which might be present. Adequate time and rail length should be available so that the carcasses can drip dry, eliminating excess moisture in the cold room.

16. TEMPERATURE CONTROL AND STORAGE OF MEAT

The main reason for chilling meat is to control the proliferation of bacteria and certain other microbes such as yeast and moulds. In this way their shelf life is lengthened by slowing down the multiplication of organisms which cause meat to spoil and of microbes which cause food poisoning.

Other reasons for chilling meat are to reduce the rate of harmful chemical changes such as rancidity of fats, and to improve handling qualities.

The number of microbes found on the surface of the meat immediately following slaughter will depend on how hygienically the work in the abattoir has been done. Unpleasant odours and sliminess, indicating that the meat is going bad, are present when bacteria have increased to 10^7 bacteria/cm².

Number of days needed for an unpleasant smell and slime to be apparent on the surface of meat

STORAGE TEMPERATURE (°C)	TIME FROM CUTTING (DAYS)
0	20
5	10
10	5
15	5
20	3
25	2-3

16.1. Bone taint

This condition is restricted to the deep muscle tissues of heavy or excessively fat carcasses where cooling takes place very slowly. It is most frequent among animals that had been under stress, and generally occurs in the vicinity of the hip joint or sometimes in the shoulder of cattle. A characteristic sewage smell is unique to this condition, which is associated with high levels of volatile fatty acids. It is caused by the growth of mesophiles

(mostly *Clostridium spp*) arising from a source of infection in the animal.

16.2. Growth requirements for bacteria

1. Correct acidity (pH)
2. Temperature
3. Nutrients such as proteins (amino acids), carbohydrates and fatty acids
4. Water
5. O₂(aerobic) CO₂ (anaerobic).

When conditions for growth are optimal, bacteria grow and reproduce the fastest. The various kinds have different growth requirements. The time they take to double in numbers is the best indication of the growth capacity of the bacteria under given circumstances. Bacterial cells can double in numbers as quickly as every 30 minutes if conditions are favourable. This is called the **generation time**, and is fairly constant for particular bacteria in a specific environment. Under unfavourable circumstances such as during cooling, the generation time may be as slow as 24-48 hours; so bacteria double their numbers very quickly when conditions are such that the generation time is short. Under unfavourable conditions they multiply much more slowly, which extends the shelf life.

How 50 bacteria multiply over 8 hours at different generation times

LENGTH OF TIME	GENERATION TIME			
	30 MIN	1 HOUR	4 HOURS	8 HOURS
0 HOUR	50	50	50	50
2 HOURS	800	200	-	-
4 HOURS	12 800	800	100	-
6 HOURS	204 800	3 200	-	-
8 HOURS	3 276 800	12 000	200	100

As long as meat is stored at under 10°C therefore it will not readily cause food poisoning, though it may well undergo bacterial spoilage.

16.3. Chilling

Chilling is used for short term storage, while freezing is used for the long term preservation of meat. During chilling meat must be kept as close to 0°C as possible without actually freezing it.

In practice we find that low air temperatures together with high air speed leads to a lower nett weight loss.

The ideal chilling room will:

- (a) Inhibit the growth of surface bacteria;
- (b) Prepare a firm, dry carcass surface, where the risk of contamination during handling and transport will be much less; and
- (c) With a minimum mass loss of carcasses.

Both air temperature and humidity must be carefully controlled. Humidity must be maintained at about 90%-95%. If the humidity is too high, the carcasses will not dry, and if it is too low excessive dehydration and darkening of the meat will take place.

16.4. Chilling speed

The speed at which a carcass is chilled depends on:

- (a) certain properties of the carcass such as species, size and fat coverage; and
- (b) chilling conditions such as the difference in temperature between the product and the air and the rate of movement of the surrounding air.

In order to increase the speed of chilling, the following steps can be taken:

- (i) Increase the difference in temperature.
- (ii) Increase the air speed.
- (iii) Reduce the thickness of the meat.

16.5. Freezing

Aim

To extend the shelf life from weeks to months. Below -12°C bacterial growth ceases, so the shelf life of the meat is limited only by the actions of enzymes which cause fat to become rancid. The maximum shelf life at -18°C is:

5 months for pork
8 months for sheep meat, and
10 months for beef.

The maximum shelf life for pork at

-12°C is 2 months
 -18°C is 5 - 6 months
 -23°C is 9 months, and
 -30°C is 13 months.

16.6. Factors affecting freezing time

- (a) Air temperature
Lower air temperature reduces the freezing time.
- (b) Air speed
High air speed places a great working load on the refrigeration system, but reduces freezing time.
- (c) Wrapping
Covering the carcass with cheesecloth or polythene can double the freezing time. Cartons that are used for packing meat serve as insulation and freezing takes longer than if metal containers are used.
- (d) Thickness of the product
A golden rule is that the thicker a cut, the longer it takes to freeze.
- (c) Important factors to be considered in connection with the chilling/freezing facilities

A refrigeration unit which has been well designed and well maintained may still not function effectively because:

- (a) The refrigeration unit cools the air, but the air does not circulate efficiently around the heat source.

Cold air must be distributed evenly through the room, following a circular flow pattern. The fan of the condenser must not direct the cold air directly on to the carcasses, as a deflection of the air movement will affect the effective cooling of other parts of the room. The more the air is forced to move around the product, instead of through open spaces, the better. It is preferable to have the air blown at right angles to the rails instead of along their lengths.

Carcasses must be spaced evenly in the chiller. The capacity of the chiller, which is determined by the rail lengths, must not be exceeded. This will overload the refrigeration unit and lead to inefficient cooling, with the possibility of faster spoilage.

The recommended rail spaces for the different species are: 660-750 cm per beef carcass, or per 2 pork, 2 calf or 6 sheep carcasses with a minimum spacing of 5 cm between carcasses. As a result of the risk of condensation, warm carcasses must not be put into a cold room with chilled meat. It is not advisable to hang different kinds of carcasses or carcasses which differ considerably in size in the same room because the rate at which they cool down will differ.

- (b) Ice on the evaporation unit insulates the refrigeration mechanism

It is normal for ice to form on the evaporation coil. The ice must therefore be thawed and removed from the spiral at regular intervals. Water which freezes on the spiral comes from:

- losses from the carcasses by evaporation;
- warm, moist air coming in through open doors;
- the insulation, especially if this is damaged; and

- cleaning activities which leave water behind in the room.

Excessive ice formation, which necessitates more frequent defrosting, can be avoided by:

- not overloading the chiller;
- closing the door;
- repairing damaged insulation; and
- mopping up all water during the cleaning process.

16.7. Heat loss exceeds the chilling capacity

When the refrigeration unit is overloaded, the temperature rises and remains higher than it should be until the unwanted cause is removed.

In cold storage rooms the heat load includes:

- Motors of fans
- Lights
- Machinery/equipment
- Poor insulation of walls/floors
- Staff
- The product load being greater than was provided for in the design
- Warm air coming in through the doors

In the last case, air curtains can be useful to prevent warm air from entering the chiller. If this is not possible, the fans must be switched off whenever the doors are open. Another possibility is to use plastic curtains to reduce the loss of cold air while the doors of the cold storage room or freezer are open.

Loading periods must be as brief as possible. The doors of the cold-storage room must be closed as soon as the loading is completed. Avoid condensation on partly-chilled carcasses at all costs.

FACTORS TO BE CONSIDERED DURING CHILLING/FREEZING IN RELATION TO THE QUALITY OF THE MEAT

Although there are many factors in favour of chilling meat, there are others which can have a deleterious effect on the quality of the meat. If the principles of refrigeration are correctly applied, however, the disadvantages can be kept to the minimum or eliminated.

16.8. Losses through evaporation

During initial cooling and cold storage lasting up to a week the total weight lost by a carcass is usually 2%-2,5%. Most of this loss takes place during the hanging and chilling period, and represents the loss of water coming directly from the surface tissues.

Weight loss resulting from evaporation during chilling and cold storage is unavoidable. It can be limited by rapid cooling.

16.9. Drip loss

An additional loss of weight can take place for about the first two days of the chilling process in the form of drops from the cut surface. Rapid cooling reduces this loss as well. It is however well known that freezing causes more drip loss than chilling.

The rate of cooling should be monitored carefully so as to limit weight loss through evaporation and drip loss. It should be slow enough to preclude toughness (cold shrinkage) which is associated with too rapid chilling where electrical stimulation has not taken place.

16.10 Cold shrinkage

The muscles contract somewhat when rigor mortis sets in,. This is normal.

If chilling takes place too soon after slaughter and the meat is still in the pre-rigor mortis stage, serious muscular contraction will take place. When rigor mortis does set in the muscles will remain in this contracted state. This happens when the meat is chilled within 10 hours to under 10°, that is, before the pH can get down to less than 6,2. The meat will therefore be excessively tough when it is cooked and eaten.

16.11. Defrost shrinkage

When muscles are frozen before the onset of rigor mortis, that is within 10 hours of death and before the pH has fallen to 6.2, the chemical reactions which give rise to rigor mortis are ended until the muscle thaws again. The reaction is then resumed at a much faster speed, and toughness can be caused in the same way as with cold shrinkage.

16.12. Freezer burn

Freezer burn is the name given to the white or amber spots which appear on the surface of frozen meat; it arises when the meat is stored unprotected in air with low RH (relative humidity). When unprotected meat surfaces are blast-frozen, a considerable amount of freezer burn usually occurs.

The discoloured spots are caused by the sublimation of ice crystals. This forms small air pockets on the surface of the meat; they diffuse incident light and give the tissues a lighter colour. These changes in the dried tissues on the surface are irreversible even after thawing.

The sublimation of the ice crystals takes place because the water vapour pressure over the spirals of the refrigeration units is much lower than that above the surface of the meat. This phenomenon results in a thickened layer of muscle tissue forming near the surface. In its turn this prevents water from passing through it from below. Maximum freezer burn occurs when meat is frozen and then stored under conditions which prevent evaporation. The reverse also applies.

16.13. Regulatory requirements for chilling and freezing at abattoirs

16.13.1. Requirements

- (1) All chilling, freezing and cold storage facilities for meat must comply with the structural requirements for all abattoirs contained in Part II B(1).
- (2) Chillers and freezers must be equipped with dial thermometers or where required by the provincial executive officer, continuous thermo-recorders, to give an accurate indication of the air temperature within the room.

16.13.2. Temperature capability

- (1) A chiller used for chilling warm carcasses, sides, quarters or portions must be capable of providing uninterrupted cooling to reduce the core temperature of the meat to 7 °C before dispatching.
- (2) Meat, carcasses, portions and offal being frozen may not be removed from the freezer before a core temperature of minus 12 °C has been reached.
- (3)
 - (a) The defrost mechanisms for freezers and chillers must prevent the build-up of ice on the evaporator coil surfaces to levels detrimental for temperature maintenance.
 - (b) Where a chiller or freezer contains meat during a defrosting cycle, defrosting of each evaporator coil must be completed within 30 minutes.
 - (c) Drainage connections of ample size must be provided from drip trays of air cooling units and must lead to ground level outside of the room or directly into the drainage system.
- (4) A chiller or freezer must have a visible permanent notice fixed to the outside, stating –
 - (a) the cubic capacity of the room;
 - (b) the type of product which may be chilled, frozen or stored in it;
 - (c) the maximum permissible product load in kilograms or number of carcasses for that room;
 - (d) the final temperature required for the meat in degrees Celsius and the minimum period of time, in hours, which is necessary for this temperature to be achieved; and

- (e) in the case of a storage chiller or freezer, the maximum permissible mean temperature value at which meat may be introduced.

16.13.3. Loading practises for chillers and freezers

- (1) Meat must be chilled in a hanging position ensuring air circulation or, if packed in containers, stacked so as to ensure air circulation.
- (2) No meat may be stacked directly on the floor.
- (3) Warm carcasses may not be loaded into a chiller containing chilled meat.
- (4) (a) No carcass or meat which is unfit for human consumption or may have a detrimental effect on other meat may be stored in a chiller or freezer containing edible products.
(b) A carcass or meat must be removed immediately if it deteriorates to such a state as determined by the registered inspector.
- (5) No exposed meat may be stored in a freezer or chiller containing cartoned products.
- (6) Rough offal may not be stored in a holding freezer which contains carcasses, meat or red offal, unless all these products, including the rough offal, are wrapped and packed.
- (7) No non-food item or product other than meat may be stored in a chiller or freezer except in the case of holding freezers, where approval has been granted by the registered inspector.

16.13.4. Ice

- (1) The use of ice as a coolant in an abattoir is subject to prior approval of the system by the provincial executive officer.
- (2) Ice, incorporated in any system or equipment, which is utilized for the chilling of meat must be made from potable water.
- (3) Equipment or systems incorporating ice as coolant for meat must be designed and operated in such a manner that water melting off the ice will not adversely affect the product or adjacent areas.

16.13.5. Sanitation and vermin control

- (1) Equipment used in chillers, freezers or cold storage facilities, that may come into direct contact with the meat must be kept in a clean and hygienic condition, and provision must be made for cleaning and sterilizing such utensils directly after use.
- (2) Ice formation in freezers must be prevented and freezers must be defrosted and sanitized as frequently as may be required by the registered inspector.
- (3) Freezers and chillers must be free from vermin, mould and bacterial growths.
- (4) Chillers, freezers and cold storage facilities must be free from odours which may be absorbed by meat.
- (5) Chillers in regular use must be sanitized immediately after dispatching of all meat.

16.13.6. Records

- (1) Thermo-control records must be available on request by the provincial executive officer or national executive officer.
- (2) Checks must be done according to the requirements of the Hygiene Management System in practise.

17. Cutting procedures at cutting plants producing for the export market

17.1. General

- (1) Only carcasses or meat that was inspected and passed may be presented for cutting.
- (2) If carcasses or meat is received from a source other than the abattoir on the premises, the registered inspector must verify that –
 - (a) documentation pertaining to the origin of such meat is available;
 - (b) meat inspection was done on such meat and that it was passed; and
 - (c) the cold chain was maintained and that the meat core temperature is 7 °C or less.
- (3) All meat presented for cutting must be free of contamination.
- (4) No meat that exhibits signs of spoilage may be cut.
- (5) A registered inspector may at any time require any packed meat to be re-opened for inspection, and may authorize the resealing of any such opened container or carton with meat.
- (6) A linear production flow must be followed by avoiding cross flow, backtracking and accumulation or congestion of meat at any stage of the production process.

17.2. Cutting

- (1) All the cutting, dicing or mincing must be so arranged that the hygiene of all the operations is assured.
- (2) Bones derived from cutting procedures must be removed regularly to a suitable room or container provided specifically for this purpose.
- (3) Meat obtained from cutting and found unfit for human and animal consumption must be collected in properly marked containers or facilities and removed from the premises in accordance with Part VIII.
- (4) Despite regulation 36 (2), meat may be cut while warm if –
 - (a) meat is transferred directly from the dressing room to the cutting room in a single operation, the cutting room being in the same building or on the same premises as the dressing room;
 - (b) cutting is carried out immediately after transfer;
 - (c) meat that has been cut is chilled, or freezing starts, within one hour; and
 - (d) this procedure is done according to a protocol approved by the provincial executive officer.

17.3. Wrapping

- (1) Wrapping materials may not be kept in a cutting room in quantities greater than the daily requirement, and must be so stored and handled as to maintain them in a clean condition up to the moment of use.
- (2) Exposed meat may not come into contact with cartons, except where waxed cartons are used.

17.4. Temperature control

- (1) The air temperature of a room where meat is cut and packed must be maintained at or below 12 °C.
- (2) During cutting, wrapping, portioning and packing the core temperature of unfrozen meat must be maintained at or below 7 °C.

- (3) Meat that is packed for freezing must be placed in a freezer within one hour of being packed. The freezer must be capable of reducing the temperature of the meat to at least minus 12 °C within 24 hours and must thereafter be maintained at or below that temperature and frozen meat may not be dispatched at core temperatures higher than minus 12 °C.

17.5. Sanitation

- (1) The cleaning and sterilization procedure of portable and other equipment must comply with Part II C. (5).
- (2) Sanitizing and sterilizing of hand and other equipment must be done during working hours.

17.6. Further processing

Further processing must comply with the requirements set in the Requirements for Food Premises under the Health Act.

18. Loading of carcasses and meat for transport

18.1. Loading and transport in general

- (1) A vehicle used for the transport of meat must comply with the requirements set in the Requirements for Food Premises under the Health Act.
- (2) Rough offal may not be loaded in the same loading space as carcasses, portions or red offal, unless such rough offal is kept in clean, waterproof containers with tight fitting lids, complying with specifications for equipment as set in Part II B(1).
- (3) No cartoned products may be loaded in the same loading space as exposed meat.
- (4) Chilled red meat carcasses, sides and quarters must be suspended without touching the floor.
- (5) No unwrapped meat may be loaded directly onto the floor.
- (6) Where required by the provincial executive officer, the driver of a vehicle transporting meat must provide the name, address and contact details of the owner of the vehicle.
- (7) Meat returned to an abattoir or cold storage facility may be received only after re-inspection by the registered inspector, and may only be sorted and salvaged for human consumption under conditions determined by the registered inspector.
- (8) Loading of meat by informal traders must be regulated by a protocol approved by the provincial executive officer but without compromising hygiene or safety standards.

18.2. Sanitation

18.2.1. Water and equipment

- (1) There must be available for sanitation purposes –
- (a) potable or drinking water;
 - (b) hot water at a minimum temperature of 82°C in sterilizers for disinfecting hand equipment;
 - (c) water at 40°C at hand wash basins for washing of hands; and
 - (d) water at 40°C for general cleaning purposes.
- (2) The owner must supply all the necessary equipment needed for sanitation.

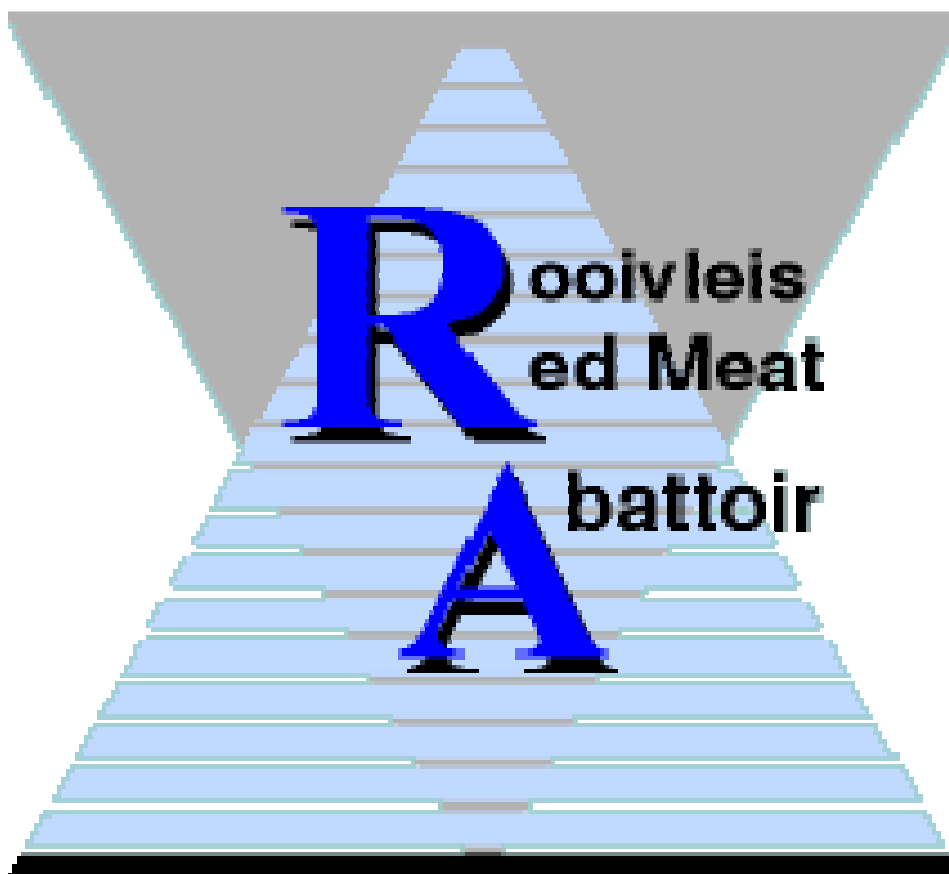
18.2.2. Sanitation programmes

- (1) Sanitation programmes must be approved by a registered inspector.
- (2) A detailed post production sanitation programme must be in place containing –

- (a) a list of all areas and rooms to be cleaned;
 - (b) the frequency of cleaning;
 - (c) step by step cleaning procedures for each area, room or equipment including ablution facilities, meat transport vehicles and lairages;
 - (d) technical sheets of chemicals used must be provided with reference to use in meat plants, active ingredients, dilution rates and applications;
 - (e) results, including microbiological monitoring, to be obtained as the objective of the sanitation programme; and
 - (f) job descriptions and a training programme for all cleaners.
- (3) Programmes must be in place for continuous cleaning during –
- (a) work periods;
 - (b) breaks; and
 - (c) shift changes.
- (4) Sanitation must commence immediately after production for the day or shift has ended, but no sanitation may commence in any area before all edible meat and animal products have been removed to prevent contamination.
- (5) A new shift may not commence before all areas, rooms and equipment have been cleaned and disinfected and an effective pre-production monitoring programme must be in place to ensure cleanliness of all facilities before production commences.

18.2.3. Chillers and Freezers

- (1) Chillers must be sanitized before a fresh load of meat is loaded.
- (2) Chillers may not be sanitized if it contains meat.
- (3) Freezers must be defrosted and thoroughly sanitized at least once a year or more often if required by a registered inspector.



Vereniging - Association

SLAUGHTER PROCESS OF LIVESTOCK

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SLAUGHTER PROCESS OF CATTLE

Stunning

Bovines are stunned with a captive bolt or pneumatic pistol. Ensure that the pistol is in good working order. The person doing the stunning must stand above and behind the head of the animal. The point of stunning is roughly at the intersection of imaginary lines drawn from the eyes to the horns. The pistol must be pressed firmly against the forehead, angled slightly in the direction of the spine, and fired. The stunning pistol kicks out a hollow rod, which penetrates the skin, skull and brain before retracting. If effectively stunned, the animal will collapse onto the bottom of the stunning box. The eye reflex test may be done to ensure effective stunning before the gate is opened.

Shackling and hoisting

After stunning, the side panel of the stunning box is opened to allow the animal to roll out onto the dry landing area. The animal is shackled by wrapping the chain of the shackle around the hind foot (left or right depending on the abattoir design) just above the hock joint, and securing it by inserting the hook into one of the chain links. The hook should point towards the carcass to ensure that it does not come loose while being hoisted. The animal is hoisted so that the roller may be placed on the bleeding rail (if a bleeding rail is in use - else a fixed bleeding point or the hoist itself will be utilised to hold the carcass in the bleeding position). Stand clear while the animal is hoisted.

Bleeding

As soon as the stunned animal is positioned over the bleeding trough, the bleeding knife is removed from the steriliser and the bleeding incision done. Two methods currently in use are the throat cut and sticking. The most common method used is the throat cut from ear to ear. The neck skin is cut through, then the trachea and oesophagus, and then further until the two main arteries have been severed, stopping before damaging the spine. Bleeding should take place within 60 seconds of stunning to facilitate maximum bleeding. The whole process from stunning to bleeding, including hoisting, should be carried out quickly and without any delays. A two knife system should be in place. Bleeding time should be at least 8 minutes.

Electrical stimulation

Directly after bleeding, clamps are attached to the ear, cheek or throat of the carcass and an appropriate current passed through for ± 50 seconds from a stimulation unit. After completion of the cycle, the cables are removed and prepared for the next animal.

Weasand rodding

Weasand rodding is done after separating the trachea from the oesophagus. Equipment is operated as per manufacturer guidelines.

Removal of front feet

The correct method is to saw the leg just before the joint. The piece that is left is removed with the hide leaving a clean joint to cut through. Because of economical considerations the following is allowed at present. With a hand knife sever the front feet at the knee joints and place the feet in the feet container.

Removal and dressing of the head

With a hand knife, make an incision between the head and the last neck vertebra and sever the neck. It may be an advantage to cut a slit in the skin flap of the head to facilitate a handgrip on the head while carrying. Hang the head by the tip of the lower jaw (nearest the teeth) on a hook on the headrail. Remove the tongue by cutting loose the connecting tissues and severing the tongue root including the two cartilage structures at the base of the tongue. If the head is left with skin on, it is regarded as dirty offal, whereas a demasked head is regarded as clean red offal and it can follow the same route as the other red offal. The head and tongue must remain identifiable with the carcass until the meat inspector has completed his inspection on the carcass.

Flaying

First hind leg

The first hind leg comprises the hoof, hock and round which is not attached to the bleeding shackle and is hanging free. With a hand knife, make a cross incision just above the tail brush and with the knifepoint make a spear cut, from under the skin, straight up the tail past the anus, between the legs, past the inguinal area (around the scrotum or udder) on the central opening line. Make a small incision through the skin between the hoof and the first joint. With a hand knife, make a spear cut from this incision towards the central opening line between the legs while cutting from the inside to the outside. The hock is flayed (air knife or hand knife) on both sides and the inner leg is flayed first after which the carcass is rotated and the outer leg or "round" is flayed down to below the tail, in the lumbar area. The skin of the anus is flayed to be removed with the hide. Remove the hoof by sawing through and not by snapping it. The area where the hoof is clipped will have no skin. Insert the hook of a dressing roller through the sinew of the hock and hoist the carcass up until the bleeding shackle can be removed, lower the dressing roller onto the dressing rail. The second hind leg will now be hanging free to be flayed. If a bleeding rail is not available, the roller is hooked into the shin, hoisted up and lowered until the weight of the carcass has been transferred to the line. The bleeding shackle can be removed and the second hind leg will be free.

Second hind leg

Make a small incision through the skin between the hoof and the first joint. With a sharp hand knife make a spear cut from this incision towards the central opening line between the legs cutting from the inside to the outside. The hock is flayed on both sides and the inner leg and flank is flayed from the middle opening line. The carcass is turned around and the outer leg is flayed to below the tail in the lumbar region. The hoof is removed, a dressing hook inserted through the sinew of the hock and the roller hoisted onto the dressing rail.

Flanks

The central opening line is now extended with a spear cut (hand knife) up to the middle of the front legs. Lactating udders and scrotums must however be removed before this incision is made. The high flanks are now flayed up to the point where the red meat becomes very thin. The left and right lower flanks are flayed until the elbows are exposed. Take great care at the flank folds as the hide can easily be damaged in this area when using an air or hand knife incorrectly.

Lumbar region and back

The skin is pulled only half way off the tail in order to carry the weight of the hide being flayed in the lumbar and back region. This method pulls the hide tight, upwards to indicate the flaying line, providing a flat flaying surface which is different to the "double hide" surface obtained when the tail skin is removed completely. Flaying proceeds from left to right down to the middle of the carcass. The tail skin is still left in place.

Neck, shoulders and forelegs

Extend the central opening line with a spear cut down to the end of the hide (throat cut). Flay the brisket area from left to right past the elbows. A spear cut is made on both forelegs. Flay the insides and then the outsides of the forelegs. Proceed to the shoulder and then the neck leaving the forequarter hide hanging loose in the region of the first neck vertebra. Continue flaying up to the area under the shoulders (hump).

Final hide removal

The hide, still being held up by the tail, is pulled tight upwards while the neck region is flayed. When completely loosened from the carcass, the weight of the hide will pull the skin off the tail and the hide will fall into the hide trough.

Splitting of the breastbone

With a hand knife, make an incision through the fat and meat onto the bone of the brisket. Split the cartilage on the top end of the breastbone with a knife and proceed to split the breastbone with a breastbone saw or handsaw down to the neck area. Sawing is done with short strokes avoiding penetration of the blade into the thoracic cavity where damage to organs or contamination could occur.

Evisceration

This is a critical procedure, which must be done with precision to avoid damage to the paunch and intestines causing contamination with its contents. Make an incision in the abdominal wall (on the central opening line) in the inguinal area. Insert the knife into this opening, handle inside and blade pointing outward, extending the incision downwards carefully by applying pressure on the knife. The incision extends to the start of the breastbone (which has been split previously). Reach inside the abdominal cavity, cut the omentum loose, and place it into a container. Remove the spleen and hang it on a hook. Loosen the rectum while carefully pulling the anus down with the left hand. Be careful not to cut into the rectum, which causes contamination or into the fillet, which will damage a prime cut. Pull the rectum and anus down towards the uterus (in cows), loosen reproduction organs and bladder making sure no leakage occurs. Separate the kidney fat and kidneys from the intestines so that they stay in the carcass. Loosen the rumen which will now fall down, being held only by the oesophagus, which is then severed about 20 cm from the rumen where it passes through the diaphragm. The stomach will now drop down into a container or onto the evisceration table.

Removal of the pluck

An incision is made into the diaphragm first on the left and then on the right while pushing the liver to one side to prevent puncturing the gall bladder. Lift the kidneys and kidney fat to cut the liver loose from top to bottom. Grasp the pluck between the liver and the lungs, taking care not to drag it on the floor, and cut the trachea loose up to the furthest point of the neck. Remove the pluck and hang on a hook for inspection.

Splitting the carcass

The splitting of the carcass is an exacting task as the two halves must be of equal size and weight for trading purposes, economical cuts and easy handling of the carcass. Band saws are most frequently used. The operator is positioned behind the carcass and starts sawing by placing the blade on the vertebra which is visible between the hind legs. The blade guides should be pressed against the carcass surface while sawing to prevent the blade from bending. Hot water at 82 °C must be available for sterilising the saw, especially after contamination.

Final finishing

Final finishing includes removal of pieces of membranes and arteries etc. from the inside neck area. The spinal cord may be removed at this stage and the forelegs can be picked up a few times to pump blood out of the shoulder area.

Final wash

This function must be done only after meat inspection has been completed. Extensive washing of the carcass should not be necessary. Bone splinters from sawing and possible blood marks on the inside of the carcass may be washed off, but it should not be necessary to wash the outside of the carcass. Washing with high pressure hoses must be avoided.

SLAUGHTER PROCESS OF SHEEP

Stunning

Sheep are stunned with an electrical stunner or a captive bolt pistol. For practical purposes the electrical method is favoured. The electrical stunner consists of a pincer, equipped with electrodes which are pressed on either side of the head, below the ears. The current is switched on by a button on the handle. Follow the manufacturer's guidelines for volts and time of application. Some models maintain the current automatically. Not too many animals should be held in the stunning pen at one time. The animals must be able to move around freely and the person doing the stunning should also be able to move freely to position himself behind a particular animal to stun it. The normal position for stunning with the pistol is between the ears and horns, pointing downwards, but this will have to be adjusted in sheep with large horns, as stunning should not be attempted at the base of the horn.

Shackling and hoisting

Sheep must be shackled directly after stunning, the direction of the chain being either right or left around the leg depending on the structural design of the abattoir. A sheep is normally shackled on the right hind leg when looked at from behind. The shackle or bleeding chain is then placed onto the bleeding rail and the stunned animal positioned over the bleeding trough so that bleeding can commence without delay.

Bleeding

The person doing the bleeding should take the head of the sheep by the mouth (lower jaw), in his left hand and pull it towards him. With the right hand, he positions his knife across the throat, just behind the lower jaw, and with a quick pulling action, severs the arteries in the neck without cutting into the neck vertebrae. Care should be taken not to "crack" the neck during this procedure. The knife should be very sharp. After bleeding an animal, the knife must be rinsed and placed in a steriliser with water at a minimum temperature of 82 °C. A two knife system should be in place. Bleeding time is at least 6 minutes.

Removal of front feet

With a hand knife sever the front feet at the knee joints and place the feet in the feet container.

Removal of the head

The head is removed first on the slaughter line, it should be placed so that it correlates with the carcass until after meat inspection and carcass classification. Removal of the head is done by pulling the head to one side by the ear and severing the neck between the first and second neck vertebra.

Flaying

Contamination of exposed meat by contact with wool or hair from the skin must be avoided.

First hock and opening line

The loose hanging leg is pulled tight, towards the flayer, and a small cross incision is made just before the heel. With the knife cutting edge facing outward, a spear cut is made from this incision up the leg, past the anus and towards the tip of the tail. The hock is flayed on both sides to reveal the Achilles heel tendon (hamstring). Remove the foot and proceed to hook the leg by the hamstring onto the dressing roller and placing the roller onto the dressing line. The bleeding chain is removed from the second leg and the bleeding roller placed onto the return rail.

Second hock and opening lines

The second leg is pulled tight towards the flayer and held under his right arm. A spear cut is made by inserting the knife just above the scrotum or udder and the incision extended up to the heel laying bare the inside of the heel. The carcass is then rotated to the left and the skin flayed off the outside of the heel up to the point where the hamstring is joined to the leg muscles. The foot is removed and placed in a container. The leg is hooked and placed on the dressing rail. The carcass should now hang spread by the two heels on the dressing rail with only the two heels skinned.

Left flank and hind leg

The central opening line is made by a spear cut from between the legs down to the beginning of the breastbone. Lactating udders and scrotums must be removed before this incision is made. The left flank is flayed from the central opening line, left towards the flank for a width of \pm four fingers. Flaying extends up to the inner thigh and down to the breast. Flaying should extend slightly to the back to avoid the dirty side of the skin from curling back onto the meat. During the whole process, the skin must be pulled tight in the correct direction to avoid cutting holes in the skin. It is important that the skin is flayed far enough to avoid the dirty side of the skin from flapping back onto the meat.

Flaying of right flank and hind leg

Flaying of the right flank is easier because the left flank has already been exposed. Slaughtering is again from the middle line but to the right hand side. What applied to the left flank applies to the right flank. From the tail, between the hind legs, the remaining skin is cut loose in the direction of the shank, up to the red part of the shank. The skin of the shank is pulled, first up and then down. The muscle and the meat at the thick shank must first be cut loose, otherwise the whole hindquarter can be ruined. The skin is pulled up beneath the tail root. It is often found that the hind legs are slaughtered first and thereafter the flanks which ends in a mess. At the end of this process the skin must be pulled loose from the tail to prevent the skin curling back.

Lumbar region and anus

The skin is cut loose beneath the tail and is carefully pulled down, using both hands, until it is in line with the sternum of the carcass. The advantage of this is that should carcass touch each other, only clean parts will come into contact. The anus is cut loose with the anus skin, but without damaging the rectum. This piece is placed in a container.

Left and right breast and flanks

The middle opening line is now extended from the cartilage part of the thorax, between the front legs, and past the throat cut made for bleeding. The skin is taken in the hand on the left side of the thorax with the left hand, close to the opening. The right hand thumb is used to separate the skin and the brisket fat. Two separate forces are at work; the left hand picking up the sheep weight, and the right hand and thumb pressing in the opposite direction. In this way the skin is removed from the brisket without using a knife, avoiding damaging the skin and carcass. The right hand side of the thorax is done in the same way. After exposing the thorax, the skin is pulled hard in the direction of the worker with one hand while the other hand is used to make "punch and turning" motions to loosen the skin up to the shoulder. An opening line is made from the upper part of the front leg up to the joint. The fist is punched in between the neck and the shoulder and back to the shin with the forearm. The skin is cut loose at the shank joint. The same procedure is repeated on the other side of the carcass by the same person (after washing hands), or another person, to avoid cross contamination.

Front legs, neck, hump, and shoulder area

The skin is cut loose on the inside of the front legs and the underside of the neck. Thereafter the skin is pulled tight in the direction of the worker to loosen the skin with the fist in the shoulder and neck areas on the left side. The same procedure is repeated on the other side of the carcass by the same person (after washing hands), or another person, to avoid cross contamination.

Final skin removal

The skin is taken with both hands and pulled down and loose from the neck. The skin is then placed in a skin trough or shute.

Evisceration

This is a critical procedure, which must be done with precision to avoid damage to the paunch and intestines causing contamination with its contents. Make an incision in the abdominal wall (on the central opening line) between the legs. Make an incision down to the breastbone. Two fingers may be used to press the intestines away from the incision while cutting. An incision is made on either side of the rectum in the pelvic canal. Two fingers of the left hand are pushed into the pelvic canal and the anus and the rectum is pulled down to the bladder and uterus in the case of ewes. These organs are then cut loose together with the large intestine up to the junction between the large and small intestines. Before above mentioned is separated from the small

intestine, the intestine should be stroked to move the contents away from where the separation is to be done before cutting. Failure to do this will result in faecal contamination of the carcass. Pull the omentum together, cut loose and place into a container. Push the rumen down with the left hand and with the same hand take hold of the reticulum pulling it out of the abdominal cavity. The oesophagus will now be visible and should be cut off. The total stomach can now be lifted out and placed into a tray for inspection. As an alternative, the intestines and stomach should be removed as a whole if above procedure cannot be accomplished without contamination.

Removal of the pluck

With a hand knife, make an incision through the fat and meat onto the bone of the sternum. Split the cartilage on the top end of the breastbone with a knife and proceed to split the breastbone with a breast saw or handsaw down to the neck area. Sawing is done with short strokes, avoiding penetration of the blade into the thoracic cavity where damage to organs or contamination could occur. Pull the thoracic cavity open and cut loose the diaphragm on both sides. Push the liver to one side to prevent puncturing the gall bladder. The pluck is cut loose along the spine and pulled down and out of the thoracic cavity, while cutting loose the oesophagus and trachea right down to the beginning of the neck (bleeding cut). The pluck is placed in a container or hung up for inspection.

Final finishing

The neck is trimmed.

Final wash

The inside of the ribcage and the neck is washed.

SLAUGHTER PROCESS OF PIGS

Stunning

The purpose of stunning is to render the pig unconscious and insensitive to pain. The stunning area must be constructed to ensure effective stunning. The two most common methods of stunning are electrical and the captive bolt pistol.

Electrical method

Follow the manufacturer's guidelines for stunning volts, amps and time.

Pigs should be washed with water in the raceway prior to stunning. This reduces contamination of the scalding tank water and improves conduction of electricity during stunning.

With electrical stunning it is important that the electrodes of the stunning apparatus are placed correctly on both sides of the head, beneath the ears, on the horizontal line through the top part of the snout. The animal's legs will fold and it will fall down. Hereafter the legs will begin to stretch and the neck stretched backwards. When the current is switched off, the pig will relax and may make walking movements.

Captive bolt pistol

Aim approximately **2 cm** above the level of the eyes, on the middle line, with the barrel pointing upwards into the head. The cartridge marked with green is used for pigs. Pigs that are stunned with a pistol tend to struggle a lot which leads to muscle tension and eventually to **PSE** (*Pale, soft and exudative*) meat.

An animal that has been effectively stunned should have no eye reflex to touch. The head should be totally relaxed and unable to move. The ears should fall down and the tongue should be relaxed.

Hoisting, sticking and bleeding

All animals should be bled in the hanging position. It is therefore important that the bleeding area be high enough so that the bleeding rail can be at least **3.8 m** above floor level.

After stunning and as soon as the pig falls down, a bleeding chain is attached just above the trotter of the hind leg. The pig is hoisted with either a manual or electrical hoist. Because of the time limit, a manual hoist is not recommended

The pig must be stuck within **60 seconds** after stunning. During stunning blood pressure increases dramatically. If the pig is not stuck in time, small arteries will start to burst and cause blood splashing in the muscles. The sticking must be carried out to avoid internal bleeding in the neck and shoulder. The operator must ensure that his knife is sharp, and that it is washed and sterilised after every pig.

The pig must be allowed to bleed for at least **6 minutes** after sticking, before dressing commences. Shorter bleeding times cause soiling of the slaughter floors and scalding tank with blood.

Scalding

If the lungs of a pig are to be recovered, it is important that the trachea is tied off to prevent soiling of the lungs with scalding tank water. The pig is put in the scalding tank until the hair can be removed easily. The temperature of the tank should be maintained between **62°C** and **64°C**. Care must be taken not to leave pigs in the scalding tank too long causing overscalding.

Washing, flaming and shaving

After coming out of the scalding tank, the pig is placed in a dehairing machine, where most of the hair is removed. Thereafter the toe nails are removed on the landing table. A scraping cone is used to clean the pig further. The pig is then transferred to the main slaughter line. Then the carcass is washed and shaved. Before commencing the flaming process, the carcass has to be washed to prevent fixation of blood and proteins on the skin causing unsightly yellow discolouration. The carcass is flamed to remove smaller hairs. After flaming, the carcass is again washed and shaved. The very last step just before evisceration is a full carcass wash.

Evisceration

This process must be completed as soon as possible.

- Cut the anus loose by making an incision next to it. Hook a finger in this cut and ring the anus while pulling it. Do not sever the rectum. Release the anus and let it drop into the carcass. Cuts must be as small as possible to prevent unnecessary damage to the hindquarter of the carcass. Care must be taken not to rupture the anus and soiling the carcass.
- Remove any lactating udders.
- Make an incision through the fat from the testes up to the thorax on the mid line of the carcass, taking care not to rupture the intestines.
- Make a small incision and pop the testes out of the scrotum.
- Cut the penis off up to the navel.
- Cut open the carcass from the abdominal cavity up to the thorax.
- Cut loose the intestines and pull the anus through
- Remove the spleen and take off the omentum
- Remove the intestines followed by the stomach, cutting loose just behind the stomach. Avoid soiling during this procedure.
- Saw through the sternum (breastbone).
- Cut loose the diaphragm while holding onto the liver. Take care not to rupture the gall bladder.
- Remove the liver together with the heart and lungs. Remember that the gall bladder may not be emptied on the slaughter floor.

It is important that damage to internal organs, (*bladder, uterus, gall bladder, stomach and intestines*) be avoided at all costs. These organs contain bacteria, and can contaminate the carcass. Washing **cannot** remove this contamination and they must be trimmed off. Workers must wash their hands frequently during evisceration.

Final trimming and washing

After meat inspection of carcasses and offal has been completed, remove:

- Spinal cord of split carcass
- Pieces of skin and intestinal remains
- Remainder of reproductive organs
- Loosened hanging blood vessels, fat, and blood that cannot be washed off

After the carcass has been trimmed, it is washed with running water to remove blood, sawdust and loose marrow. Enough time and adequate rail length must be available so that carcass can drip dry to prevent excessive fluid accumulation in the chillers.

**MEAT INSPECTORS MANUAL
RED MEAT**

**PART II
MEAT INSPECTION**

MODULE 3

ANATOMY

INDEX**ANATOMY**

1. THE SKELETON
2. THE MUSCULAR SYSTEM
3. BLOOD AND VASCULAR SYSTEM
4. RESPIRATORY SYSTEM
5. THE DIGESTIVE SYSTEM
6. THE URINARY TRACT
7. THE NERVOUS SYSTEM
8. FATTY TISSUE
9. GENITAL SYSTEM
10. THE LYMPHOPOIETIC SYSTEM
11. GLANDS OF THE BODY
12. SPECIES DIFFERENCES IN CARCASSES
13. GENDER CHARACTERISTICS AND DETERMINATION OF AGE
14. AGE DIFFERENCES SEEN IN CARCASSES

ANATOMY AND PHYSIOLOGY OF THE MEAT ANIMAL

It is necessary for the Meat Inspector to recognise the normal form and appearance of any organ or structure in order to recognise and evaluate the abnormal.

1. THE SKELETON

The skeleton supports the body and consists of bones and cartilage that is either blended together or joined by way of joints to allow movement. It protects the internal organs and the ligaments that control movement. The skeleton can be subdivided into the following:

(a) Skull

The skull houses the brain, nose, eyes and ears and is connected to the cervical vertebrae. The bones of the maxilla (upper jaw) are fused and form sheathing for the upper teeth. The mandible (lower jaw) holds the lower teeth and hinges on the maxilla.

(b) Spinal (vertebral) column

The spinal column reaches from the skull to the tail and consists of:

- Cervical or neck vertebrae Abbreviated as - N
- Thoracic or chest vertebrae Abbreviated as - T
- Lumbar or loin vertebrae Abbreviated as - L
- Sacral vertebrae Abbreviated as - S
- Coccygeal or tail vertebrae Abbreviated as - C

Each vertebra consists of a bony body, a central canal which accommodates the spinal cord, two lateral wings and one dorsal protuberance. The protuberance of the thoracic vertebra is very long and that of the lumbar vertebra very short. The spinal column is flexible. To manage this, there are cartilage discs between the vertebrae. The number of vertebrae is more or less constant for different animal species.

	N	T	L	S	C
Bovidae	7	13	6	5	18-20
Ovidae	7	13	6/7	4	16-18
Suidae	7	14/15	6/7	4	20-23
Equidae	7	18	6	5	15-20

(c) Thorax or chest

The thorax is formed by the thoracic vertebrae on the top, by the ribs on the sides and by the sternum (breastbone) at the bottom. The first 8 ribs are known as the real ribs and are connected to the sternum, while the other 5 or more are connected to the sternum with cartilage. They are known as false ribs. The space between the ribs are filled with muscles that help with breathing. The thorax is lined with a membrane called the pleura.

(d) Foreleg

This consists of the following:

- Scapula or shoulder-blade (connected to the sternum with 5 muscles)
- Humerus, radius and ulna
- Carpal bones (knee/toggle-joint)
- Metacarpal bones
- Phalanges (toes or hoof)

(e) Hind leg

It consists of the following bones from top to bottom:

- Pelvic bone (consists of three bones fused into each other)
- Femur
- Patella (Knee/stifle-bone)
- Tibia and Fibula
- Tarsal bones (heel)
- Metatarsal bones
- Phalanges

(f) Joints

A joint is formed by two or more bones or cartilage and other tissue. Bones are a fundamental part of joints.

(i) Fixed joints

Examples of fixed joints are those of the skull and the pelvis.

(ii) Slightly movable joints

This is where two bone surfaces are joined by hyaline bodies (glassy/transparent bodies), cartilage and a fibrous cartilage cushion. Examples are the joints of the vertebrae

(iii) Movable joints

These joints consist of the following tissue:

- Cartilage known as articular cartilage covers the surface of part of the bone that forms the joint.
- The capsule, that consists of strong fibrous tissue, is joined at the edge of the articular cartilage. The capsule encloses the joint cavity.
- The synovial membrane, consisting of endothelium cells provides a lining on the inside of the joint cavity. It secretes an oily fluid, synovial liquid that lubricates movement.
- Blood vessels, ganglions and nerves serve the joint.

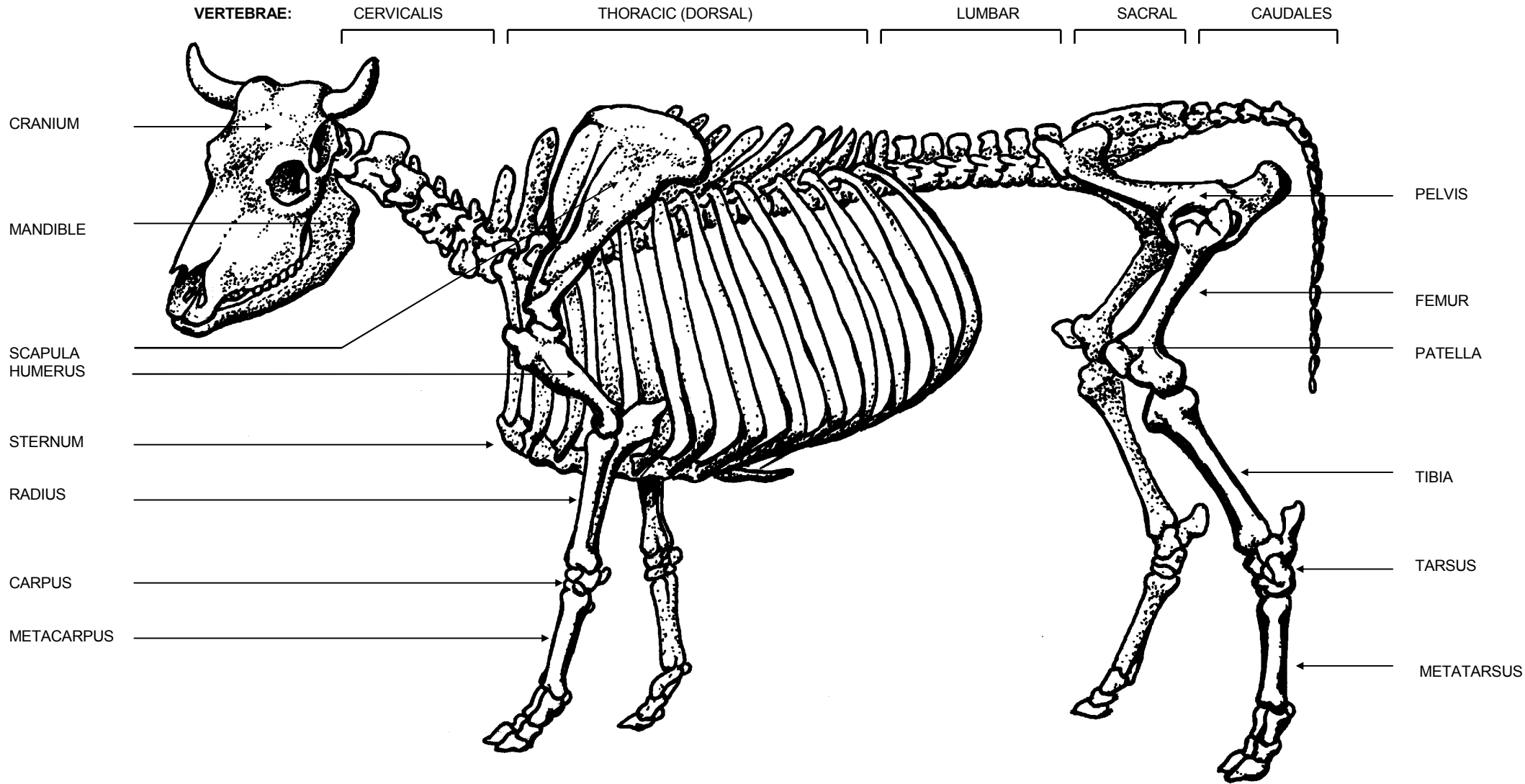
Moveable joints are classified according to the type of movement:

- Ball- and socket joints for example hip joint.
- Glide joints that allow limited movement between two flat surfaces for example joints between articular processes of two vertebrae.
- Hinge joints allow movement on one level for example the elbow.
- Protuberance joints (knob-joints) allow movement on two levels for example the joint between the skull and the mandible.
- Axial joint allows rotation of the joint for example Scapulo-humeral joint (shoulder-joint).

(g) The body cavities

- The thorax is enclosed by the thoracic vertebrae dorsally (top) by the ribs laterally (from the sides) and by the sternum ventrally (from the bottom side) and is separated from the abdomen by the diaphragm. The thorax holds the heart, lungs and part of the oesophagus, trachea, thymus (growth gland) and the large blood vessels.
- The abdomen is formed by the lumbar vertebrae caudally, abdominal muscles on the lateral and ventral sides and the diaphragm in the front. The abdomen contains the stomach, intestines, liver, spleen, pancreas, kidneys and bladder.
- The pelvic cavity is formed by the sacrum caudally and the pelvic bones on the lateral and ventral sides. The pelvic cavity contains the rectum, the bladder and in the case of early stages of pregnancy (gestation), the uterus (womb) and ovaries.

SKELETON OF A BOVINE



2. THE MUSCULAR SYSTEM

2.1 Types of muscles

There are three kinds of muscles

(a) **Striated muscles**

They form most of the muscles and are responsible for movement and are controlled voluntarily.

(b) **Smooth muscles**

They are autonomic muscles and are mostly found in the internal organs. They control among other things, the movements of the intestine.

(c) **Heart muscles**

This is a striated muscle, but autonomically controlled.

The colour of muscles differs from species to species and are also influenced by age. In bovines, muscles are usually red and firm; in young calves pale and grey-red, in sheep dark red and in pigs pale and greyish. In horses the muscles are a very dark red and when subjected to exposure, blackish.

2.2 Muscle proteins

Muscle proteins determine meat tenderness.

A muscle consists of various kinds of proteins of which two in particular play an important role in determining the toughness or tenderness of meat. They are called connective tissue proteins and contraction proteins. The former are responsible for the strength of a muscle and the latter for its ability to contract and relax, which can enable limbs to move.

Connective tissue proteins

The muscle is surrounded by a layer of connective tissue (the epimysium) from the inside of which partitions of fibrous tissue (the perimysium) enclose various groups of primary, secondary and tertiary muscle bundles and give the meat its texture. Connective tissue proteins affect the tenderness of the meat as a result of the amount occurring in the muscle and the degree of cross-binding or solubility of the collagen in the connective tissue.

Amount of connective tissue

Strong shin muscles contain large amounts of connective tissue and weaker loin and fillet muscles contain less; this is why meat differs in tenderness according to where it comes from on the carcass.

Solubility of connective tissue

The younger an animal, the fewer cross-connections (polymerisation) there are between the collagen fibres of the connective tissue. These collagen fibres are more soluble during cooking, are more easily transformed to soft gelatine and shrink less during heating than collagen from older animals. This is why the meat of younger animals is more tender than that of older ones.

Contraction proteins

The two contraction proteins which cause contraction and relaxation in muscle proteins are actin and myosin, the thin and thick protein bundles respectively, which move over and past each other during muscle movement.

2.3 Muscle movement

The following steps take place during muscle movement

A nerve impulse moves to the muscle and activates the contraction process. This impulse causes the release of calcium ions from the sarcoplasmic reticulum. This increased concentration of calcium ends the inhibiting effect of troponin and tropomyosin on the formation of actomyosin.

MgATP serves as a filler which keeps the actin and myosin filaments apart (so the muscle is in a relaxed state).

The higher concentration of calcium ions causes the bonded ATP to be released from the MgATP. The ATP releases energy when it changes to ADP.

Now the actin and myosin filaments bind (using this released energy) to form actomyosin bridges which are physically shorter than the myosin filament and consequently the actin filaments are drawn together and may even overlap - the stronger the contraction, the tougher the meat.

Muscle relaxation

For the muscle to relax it is necessary to remove the calcium ions (which happens when there are no more nerve impulses) and to provide ATP so that more MgATP filler can be formed.

Stored glycogen is the immediate source of energy for muscle activity.

The glycogen is broken down by glycolytic enzymes to pyruvic acid, which is in turn broken down in the presence of oxygen (supplied by the blood) to carbon dioxide (removed by the blood) and water. During this process ATP is made available to form MgATP.

The result is muscle relaxation.

RIGOR MORTIS

When an animal is slaughtered, it is bled until it dies. When it stops breathing, oxidation of the limited amount of blood still remaining in the lungs can no longer take place.

Muscular relaxation can therefore no longer take place in a dead animal, as the blood is naturally unable to provide oxygen for the oxidation of pyruvic acid to release ATP. There is no ATP with which to form MgATP filler, so the actomyosin filaments remain.

This permanent closure of the actomyosin filaments is called rigor mortis.

In anaerobic conditions (where oxygen is lacking), glycogen in the muscles will however change to lactic acid which accumulates and lowers the pH of the muscle to as little as 5.4.

This lactic acid in the muscle fibres will in due course lead to saturation of the muscle protein; together with the release of proteolytic enzymes from the lisosomes of the cells to assist in this breakdown of muscle protein, this will cause the meat to become tender. We refer to this as "ripening" the meat. The course of rigor mortis in rested animals in good health which were slaughtered according to normal procedures may be represented as follows:

Healthy animal

In a freshly slaughtered carcass with sufficient muscle glycogen at a pH of 7.2, rigor mortis will start developing slowly after 3-5 hours. After a further 3 hours the carcass will begin to stiffen and the development of rigor mortis will accelerate until it has developed completely by

24 hours after slaughter. The pH of such carcasses will drop to around 5,4.

Sick, stressed or tired animal

What happens if the animal is sick, excited or exhausted before slaughter? All three of these conditions cause depletion of muscle glycogen reserves, which in its turn gives rise to a reduction in the formation of lactic acid. In other words the pH of the carcass will not fall so much - to about 6,5 instead of 5,4.

These conditions have the following effects:

1. The meat is more prone to decay since certain pathogenic organisms grow more easily at a higher pH.
2. Certain anaerobic bacteria in the lymph nodes can also multiply and spread to the surrounding meat. This will reduce the shelf life of the meat.
3. In the case of large, fat animals which are cooled inadequately or too slowly, a similar multiplication of anaerobic bacteria takes place, especially in the vicinity of the hip joint and sometimes the shoulder. This is known as "bone taint".
4. The higher pH causes the water retention ability of the meat to remain good, so water is retained within the muscles. This causes what is known as DFD (dark, firm, dry) meat, also known as "black cutters".

2.4 Cold shrinking

During the first few hours after slaughter the carcass muscles still contain enough energy in the form of ATP and glycogen to enable the muscles to contract. The muscles try to retain their normal status as it was in life by means of energy consumption. This means that the calcium pumps in the muscles still try to keep the calcium concentration in the muscle cells low, preventing contraction. When the muscle temperature drops to below 15-12°, the calcium pumps are slowed by the cold. Their output falls, so less calcium is pumped out of the barrier cells. This causes the calcium concentration in the muscle cells to start to rise. The result is that the increased calcium concentration removes the inhibiting effect which actin and myosin have on muscle contraction. Actomyosin forms as a result of the binding of actin and myosin which move over each other, and the muscle contracts. This contraction continues for as long as ATP is available as a source of energy. No muscular relaxation occurs, and the muscle goes into rigor mortis while in a contracted state. The consequence is extremely tough meat. This problem is referred to as cold shrinking, and can also be termed "abnormal" toughness (Locker, 1976).

2.5 Defrost shrinking

If meat is frozen shortly after slaughter while the muscles still have sufficient reserves of energy, rigor mortis will not take place because of the inhibitory effect of freezing on many of the chemical processes concerned. Freezing damages many of the muscle organ structures such as the sarcoplasmic reticulum and the mitochondrial membranes. These two structures are among those responsible for the storage of calcium. When the muscle thaws, the calcium pours into the muscle sarcoplasm and releases the inhibitory effect of troponin and tropomyosin, so shrinking takes place which is called defrost shrinking. This differs from cold shrinking in that the calcium concentration rises much faster in muscle cells during defrost shrinking, so that the muscular contraction is far stronger and the meat is exceptionally tough.

2.6 Nutritional value of meat

Definitions

Dietetics – is the practical application of nutrition to keep a community healthy. It entails the planning of meals according to the individual's physiological and psychological needs – selection, care, preparation and presentation thereof. Correct nutrition is characterized by a healthy body. The status of good nutrition is characterized by change in bodyweight.

Nutrition – refers to the process of utilization and assimilation of food. In short, it entails the taking in of the correct food for body use; digestion of food such that the body can utilize the nutrients; absorption of nutrients in the bloodstream; utilization of the different nutrients by body cells and the excretion of waste products.

Nutrients – are the chemical ingredients in food needed by the body. Plus minus 50 types are known and can be divided into six classes namely:

- * Protein and amino-acids
- * Fat and fatty acids
- * Carbohydrates
- * Mineral components
- * Vitamins
- * Water

2.7 Chemical composition of muscle

The composition of muscle before changes have occurred in the tissue can be summarized as follows:

COMPONENTS	%
Water	75.5
Protein	18.0
Myofibrillar protein (10%)	
Sarcomeric protein (6%)	
Other protein (2%)	
Fat	3
Soluble no protein substances	3.5
Traces of minerals, vitamins, etc	0.10

2.8 Meat quality

Components Of Meat Quality Characteristics

(i) **Appearance** – which is seen by consumer and trader.

- Muscle, Fat : Bone ratio
- Visible marbling
- Muscle and colour
- Fat hardness
- Muscle texture
- Water bending capacity

(ii) **Palatability** – which the consumer taste

- Tenderness
- Chunkiness
- Flavour
- Aroma

(iii) **Nutritional value** – that which consumer expect.

Proteins, Vitamins, etc.

(iv) **Processability** – what the processor wants.

Ability to:

- retain water
- be processed
- retain attractive colour

(v) **Hygienic status and shelf life** – that which everyone wants.

No micro organisms, unpleasant odours, changes in colour, slime
Prolonged shelf life

3. BLOOD AND VASCULAR SYSTEM

This consists of the following:

(a) **Blood**

This consists of a fluid (plasma) and cells. It transports oxygen and carbon dioxide, removes waste products from tissue for elimination from the body and controls the body temperature.

- **Plasma**
A fluid consisting of different mineral salts (electrolytes), blood proteins, metabolites (metabolic products) and waste products. Prothrombin and fibrinogen are two important materials in the blood that controls blood coagulation.
- **Red blood cells**
These are round biconcave discs with an iron pigment, known as haemoglobin, and are red in colour. They are therefore called red blood cells. They transport oxygen from the lungs to the rest of the body and carbon dioxide from the tissues to the lungs. Red blood cells are manufactured in the bone marrow of long bones.
- **White blood cells**
They are bigger than red blood cells and have a clear nucleus. They protect the body from disease causing organisms. They play an important role in immunity. They are manufactured in the spleen, lymphnodes and also the bone marrow.
- **Thrombocytes (blood platelets)**
These help with blood coagulation.

(b) **Blood vessels**

- **Arteries:**
They normally have thick, muscular and elastic walls. They transport the blood from the heart to organs and tissues and the blood is normally rich in oxygen and has a bright red colour.
- **Veins:**
These are vessels with thin walls and have one-way valves to prevent the back-flow of the blood. They transport blood from the tissue to the heart.
- **Capillary vessels:**
These are small subdivisions of blood vessels, as fine as hair. They bring about the gaseous interchange between blood and tissue cells.

(c) **The heart**

Located in the thorax, anchored by the big blood vessels and surrounded by the pericardial sack that contains a small amount of fluid.

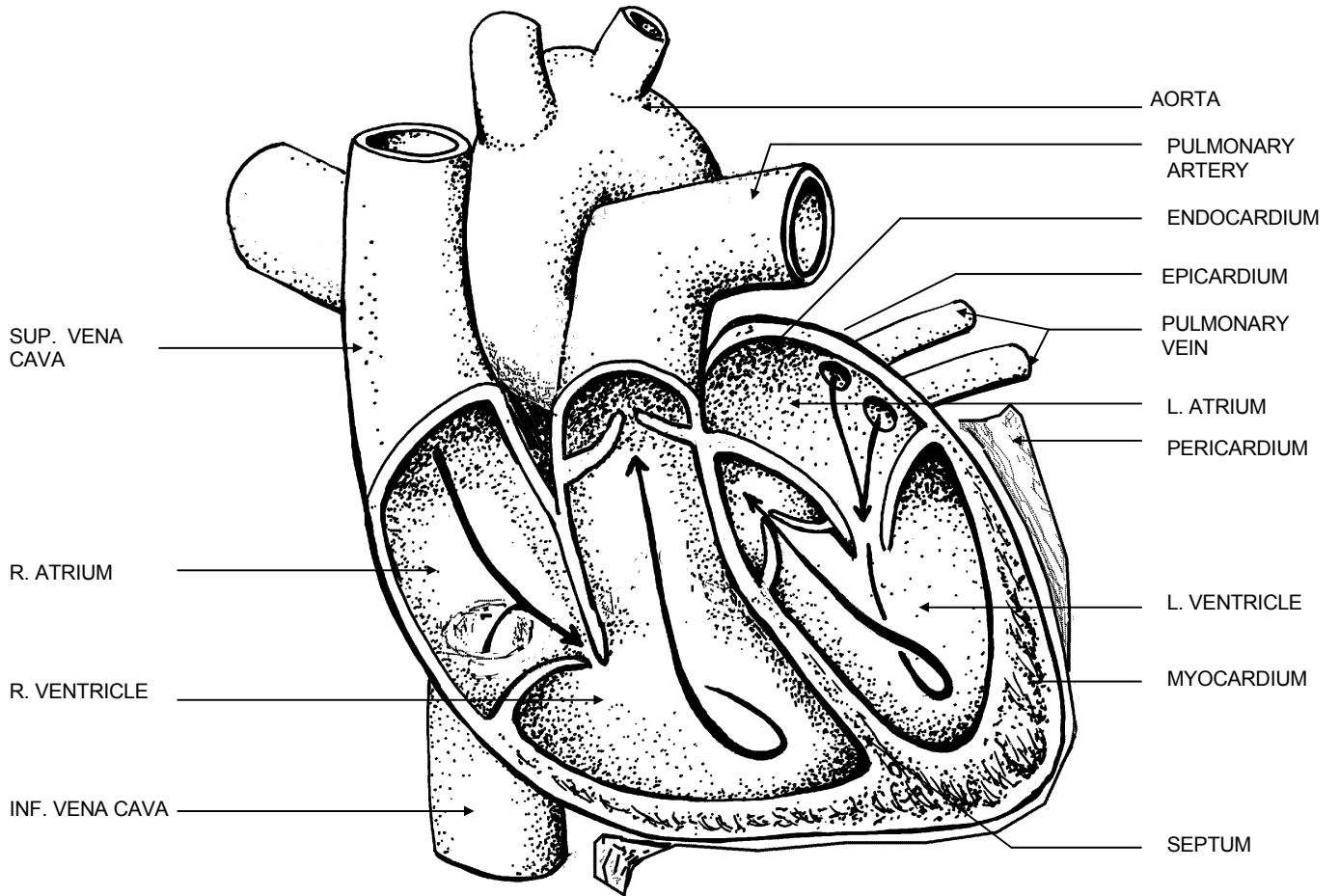
- The Epicardium or outer surface of the heart.
- The Endocardium or inner surface of the heart.
- The Myocardium or cardiac muscle between the membranes.

The heart are divided into a left and right side by a layer of muscle known as the septum that contains nerve-bundles. Each side is divided into an upper and lower heart chamber by a cardiac valve. The upper heart chambers are known as the atria and the lower heart chambers as the ventricles.

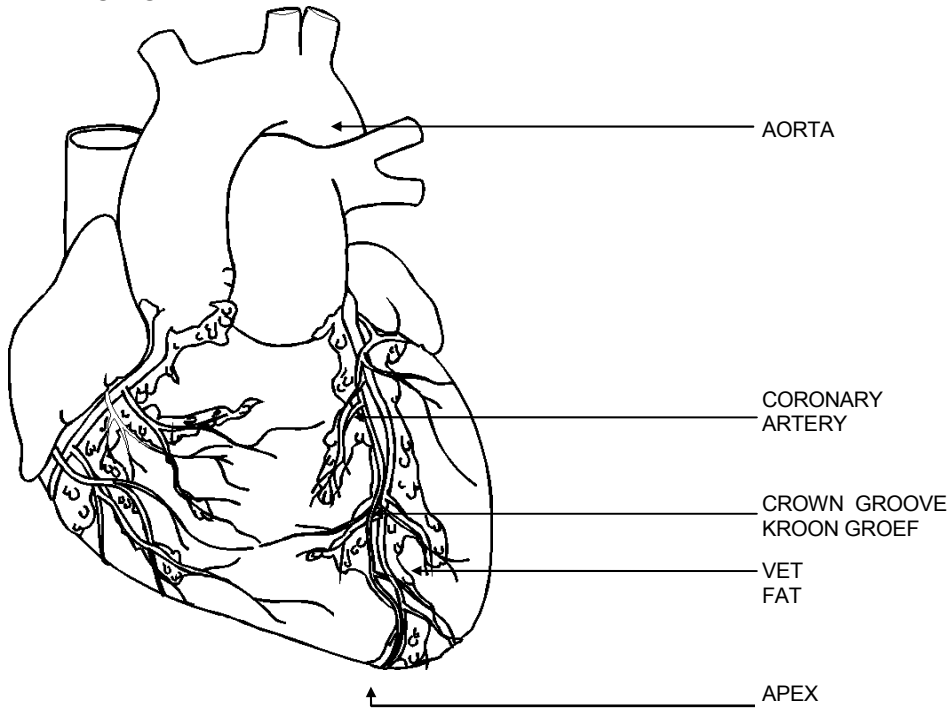
- The right atrium is a small cavity with thin walls and receives blood from the body through two big vessels.
- The right ventricle is a large cavity with medium thick walls and receives blood from the right vestibule through the tricuspid valve. It then pumps the blood via the pulmonary artery to the lungs for gas interchange. The pulmonary artery is thus the only artery carrying oxygen-poor blood.
- The left atrium (left vestibule) is a small cavity with thin walls that receive blood from the lungs via the pulmonary vein. The pulmonary vein is the only vein that carries oxygen rich blood.
- The left ventricle is a large cavity with thick walls and receives blood from the left vestibule through the mitral valve. It then pumps the blood via the aorta (main artery) to all parts of the body.

The differences in the appearance of the heart of the different species will now be shown in the following illustration:

SCHEMATIC VIEW OF THE HEART -



EXTERIOR OF THE HEART -



4. RESPIRATORY SYSTEM

Anatomically the system is divided as follows:

(a) **The nasal cavity**

This cavity is lined with a mucous membrane and divided in the middle by the septum.

(b) **The larynx**

The larynx consists of five cartilaginous structures that make it more flexible and contains the vocal cords. The epiglottis is attached to the larynx and closes the trachea when the animal swallows.

(c) **Trachea**

The trachea consists of circular, cartilaginous rings and is lined with mucous membranes. In bovines a dorsal ridge can be found on the backside.

(d) **Lungs**

The lungs consist of lobes that divide into smaller lobules. They differ from animal to animal and this can be used to distinguish between species. The membrane between the lungs is known as the mediastinum and contains the important mediastinal lymph nodes.

The trachea divides into two bronchi one to each lung. In bovines, pigs and sheep, a third accessory bronchus goes to the right lung. The bronchi do not have cartilaginous rings and divide into smaller branches until they end in alveoli where gaseous exchanges occur.

The lobes are known as the apical (front) lobe, cardial (middle) lobe and the diaphragmatic (rear) lobe.

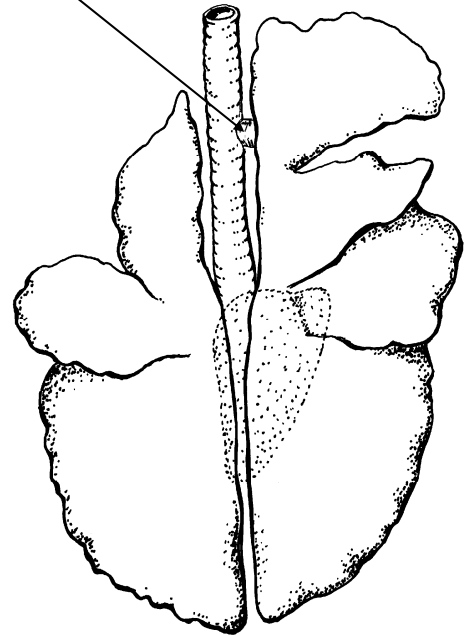
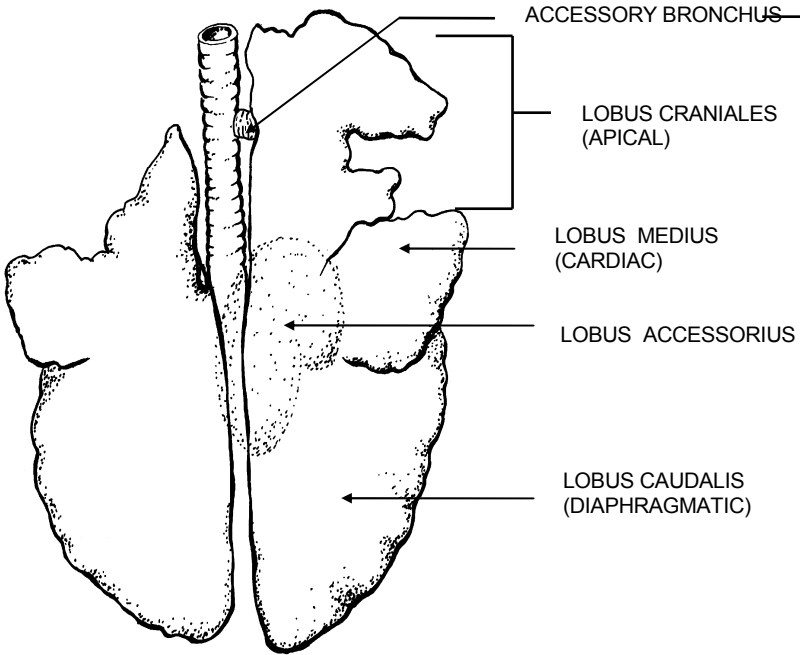
The following anatomic differences can be found:

	LEFT LUNG	RIGHT LUNG	BRONCHI	APPEARANCE
Bovine	3 lobes	4 lobes	3 accessory bronchi to right lung	Lobes clearly defined
Sheep	3 lobes	4 lobes	3 accessory bronchi to right lung	Lobes poorly defined
Pigs	3 lobes	3 lobes	3 accessory bronchi to right lung	Clearly lobed. Lungs appear spongy.
Horses	2 lobes	3 lobes	2	Lobes not clearly defined. Lungs not very long.

**COMPARATIVE ANATOMY OF THE LUNGS
VERGELYKENDE ANATOMIE VAN DIE LONGE**

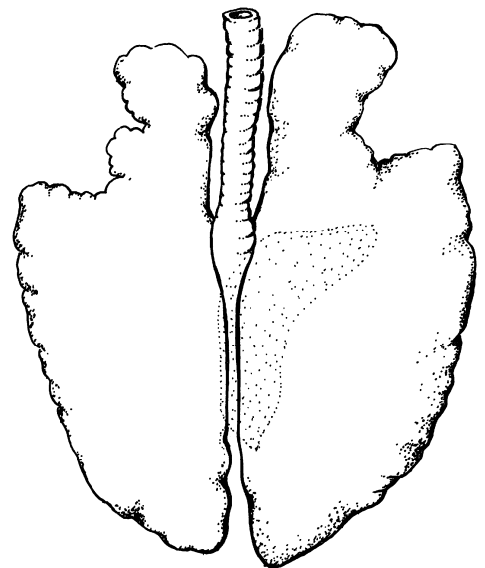
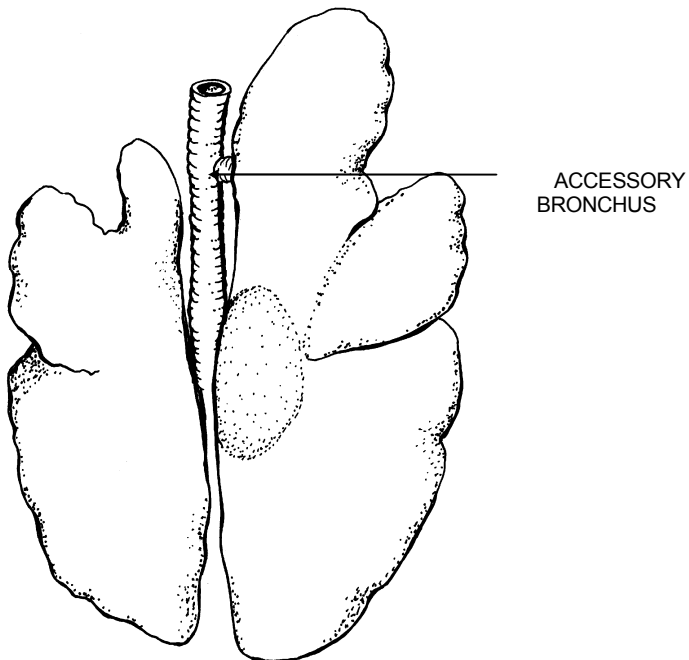
SHEEP -

- BOVINE



PIG

HORSE



5. THE DIGESTIVE SYSTEM

The digestive system consists of:

(a) The mouth

The mouth is bordered by the lips, hard (bony) palate and the soft palate (velum).

(b) The tongue

The tongue is a muscular, flexible organ attached to the mandible on the ventral side and to the lingual-bone (hyoid) caudally.

The comparison of the tongue of the different animal species

BOVINE	SHEEP	PIGS	HORSE
Corneous papillae	Corneous papillae	Smooth surface	Smooth surface
Sharp tip	Rounded tip	Sharp tip	Spatulate
Dorsal groove on top	Mid groove	No dorsal groove, Thin	No dorsal groove

(c) Oesophagus

This is a muscular tube that runs from the pharynx to the stomach. The first part of the oesophagus is joined to the trachea.

(d) Stomach

Pigs and horses have simple, single stomachs where primary digestion takes place. (See sketch)

- (1) The stomach of the pig is simple and crescent-shaped. It is pale gray on the heart's side and brown-red in the middle and is more pale and rippled towards the pylorus.
- (2) The stomach of the horse is simple and is a sharp u-formed sack of which the right side is shorter than the left side. It is relatively small.
- (3) Ruminants have a complex digestive system, which consists of the following:
 - (3.1) The rumen (paunch) is the first and the biggest sack.
 - (3.2) The reticulum (honeycomb stomach) is the smallest sack and lies just ahead of the rumen. The inside of the reticulum looks like a honeycomb. This controls the flow of food from the rumen.
 - (3.3) The omasum (leaf-stomach) lies just to the right of the reticulum and consists of numerous folds that look like leaves. The food is dried here before it goes through to the abomasum.
 - (3.4) The abomasum is the last sack and is the same as the stomach of single-stomached animals. The lining is pale red with numerous small folds. From the stomach, the food goes through the pylorus to the duodenum (small intestine).

(e) Small intestine (See sketch)

(1) **Duodenum**

This is the first short part of the small intestine with openings for the pancreatic juice from the pancreas and bile from the gall-bladder.

(2) **Jejunum**

This is the largest part of the small intestine.

(3) **Ileum**

This is the last short part of the small intestine that empties into the caecum (blind gut).

The primary function of the small intestine is the final digestion and absorption of nutrients.

(f) **Colon**

(1) The caecum forms part of the colon and are saccate in shape with an opening to the large colon.

(2) The colon is the largest part and its form varies from specie to specie. Its primary function is the absorption of water and salt to control the fluid balance in the body.

(3) The rectum (and then the anus) is the last part and open to the outside.

(g) **Mesenterium (mesentery)**

This is the peritoneum (intestinal abdominal membrane) that hangs on the spinal column. A chain of important lymphatic glands, the mesenteric glands are found here.

(h) **Omentum (abdominal plexus/net)**

This is part of the abdominal membrane that encloses the intestines.

The mesenterium and omentum are richly supplied with fatty tissue and are a very important source of eatable fat.

(i) **Liver**

This is the largest organ in the body. It lies to the left between the diaphragm and stomach and is covered with a firm membrane, the liver capsule. It is divided into lobes and is richly supplied with blood. The gal bladder lies more or less centrally on the vertical surface. Near the gal-bladder lies the important hepatic lymphnode. In healthy animals, the liver is smooth and dark brown, however, it may be light brown in the case of fat animals. The primary functions of the liver include the following:

(1) **Metabolism**

This is the breaking down of food absorbed from the small intestine into sugars for body energy. The liver also stores sugar in the form of glycogen.

(2) **Production of bile**

Old, worn-out and broken down red blood cells are transformed into bile that is excreted into the duodenum. Bile is necessary in the digestion of fat.

(3) **Detoxification**

The liver breaks down and eliminates toxins in the body.

Comparison of the livers of different animal species:

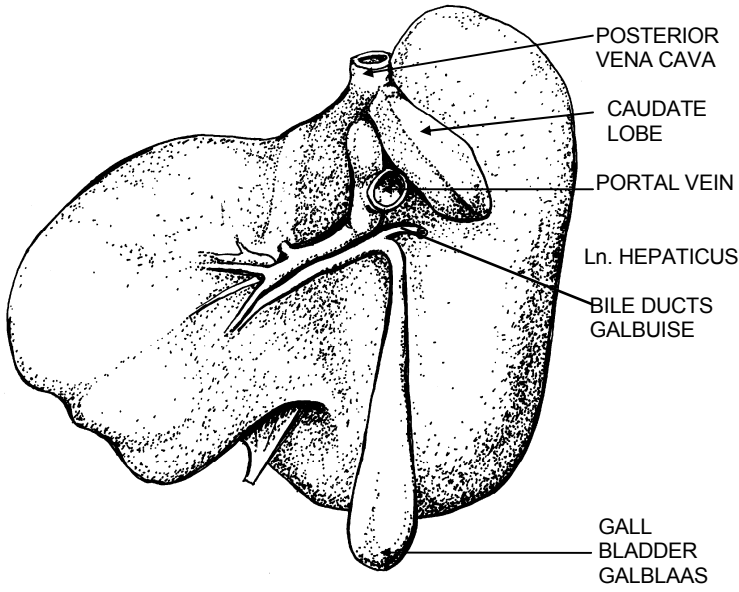
	DIVISION INTO LOBES	NUMBER OF LOBES	FORM OF LOBES	GALL BLADDER
Bovine	Indistinct	3	Caudate lobe rounded	Big, pear-shaped
Sheep	Clearly visible	2	Caudate triangular	Sausage-shaped
Pigs	Clearly visible (Moroccan leather appearance)	4		Situated in a shallow groove
Horses	Indistinct Purple-ish	3		No gall bladder

(j) **Pancreas**

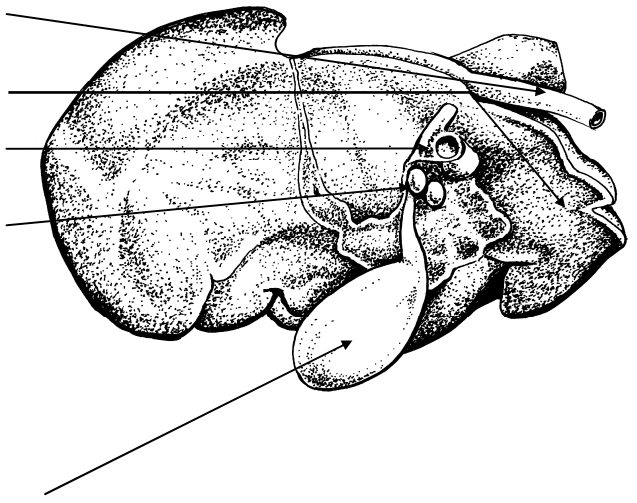
This reddish gland is situated in the fold of the duodenum. It secretes pancreatic fluids into the duodenum and insulin into the blood stream. It is responsible for sugar metabolism.

COMPARATIVE ANATOMY OF THE LIVER

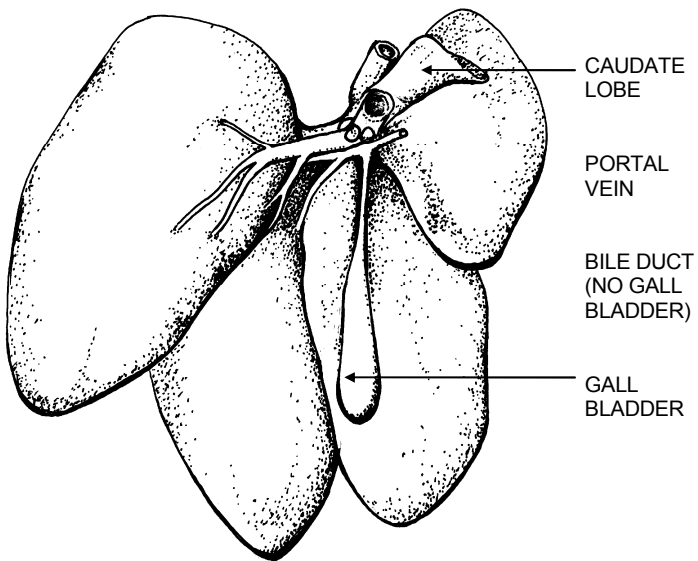
SHEEP LIVER



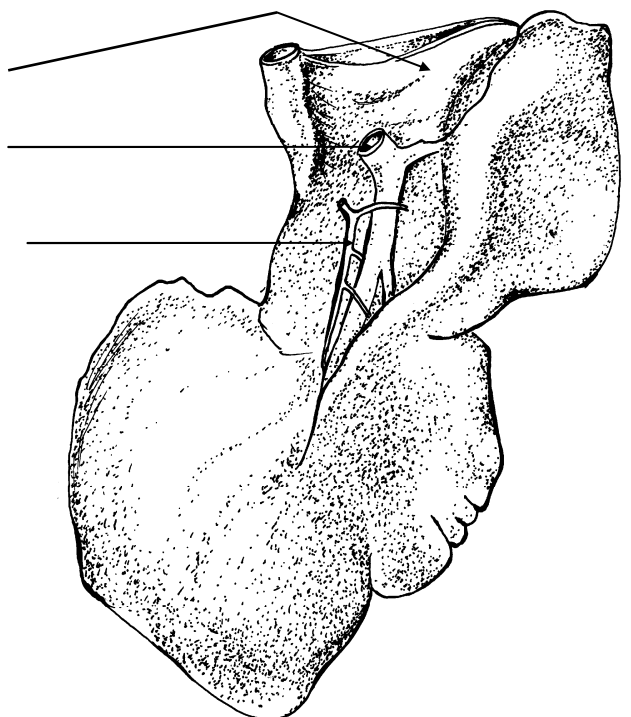
BOVINE LIVER



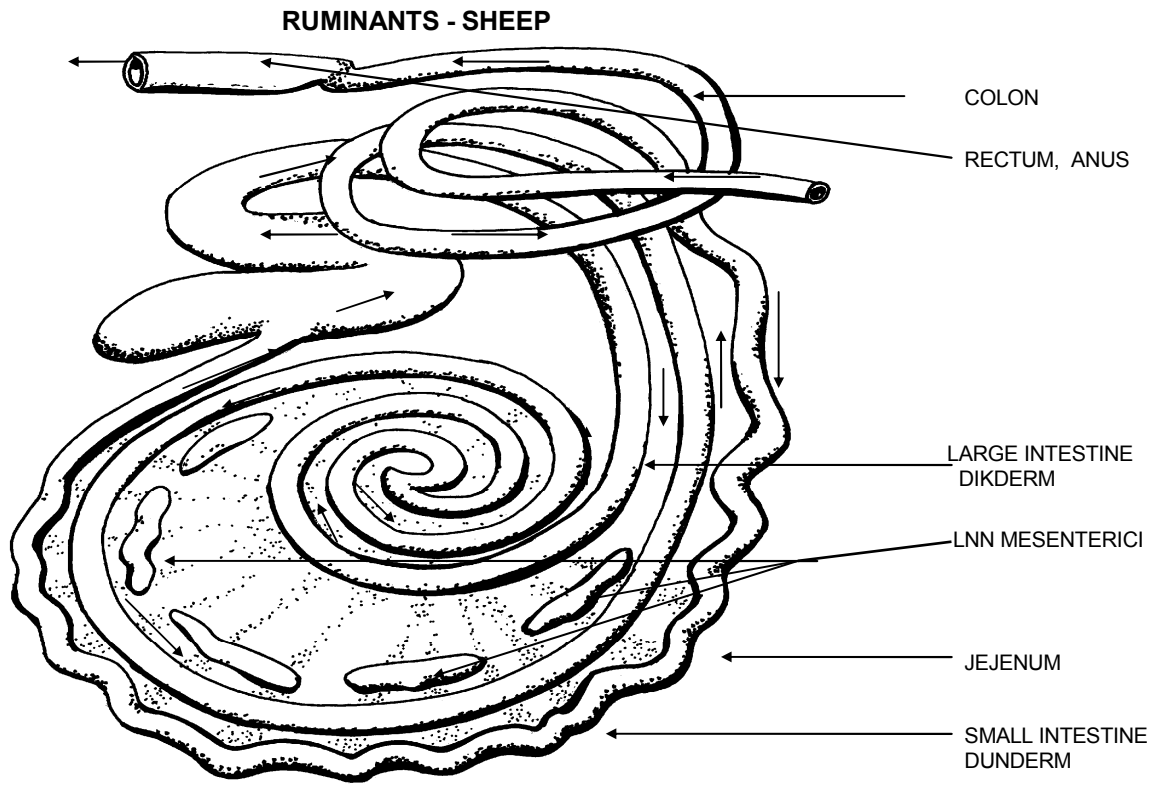
PIG LIVER



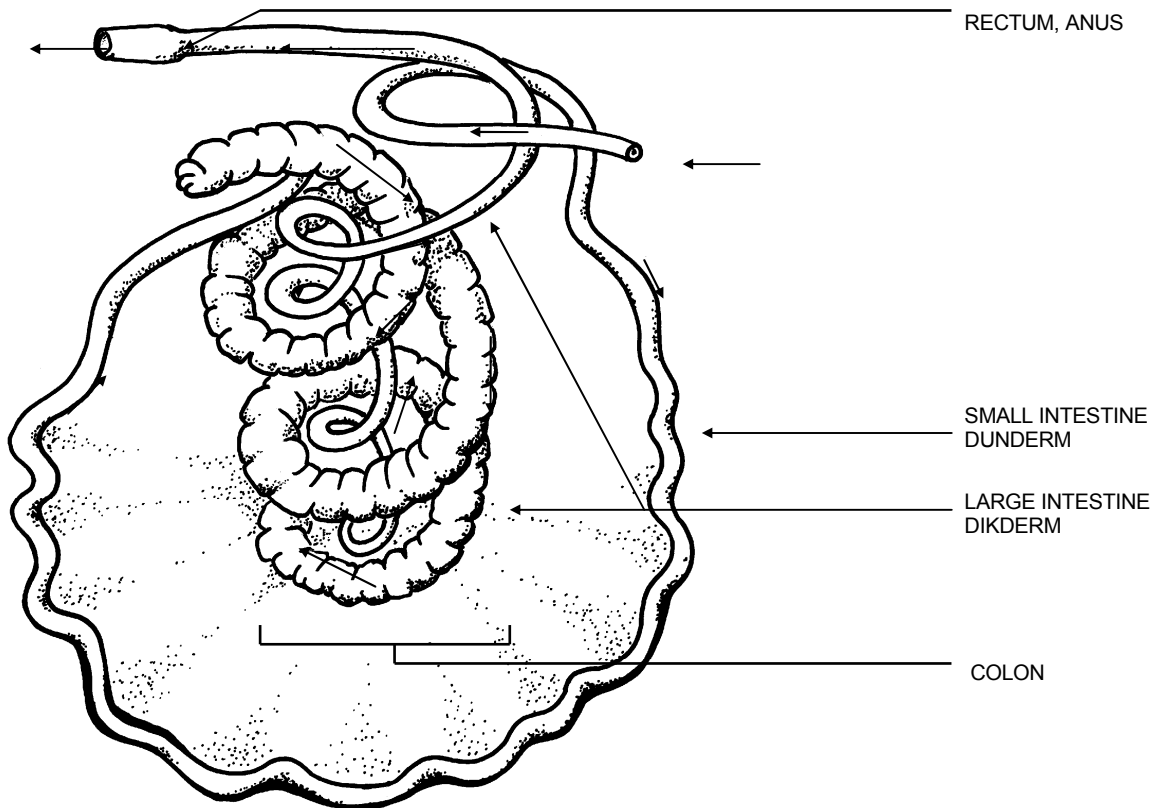
HORSE LIVER



SCHEMATIC OUTLAY OF THE INTESTINES OF SLAUGHTER ANIMALS



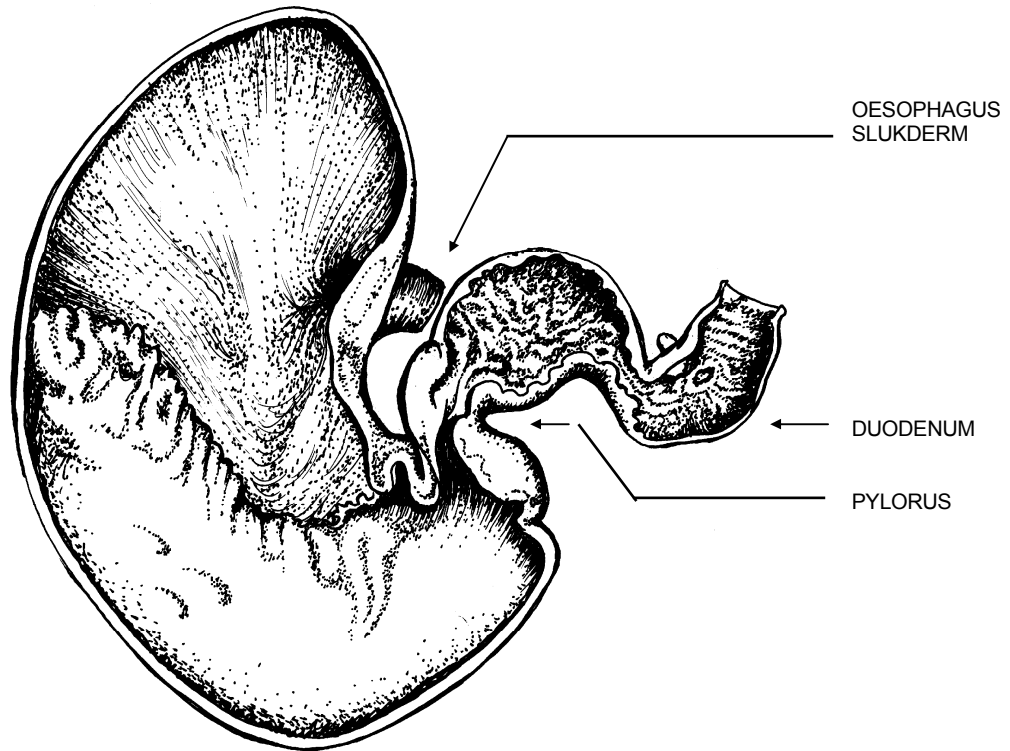
NON RUMINANTS - PIG



COMPARATIVE ANATOMY OF THE STOMACH

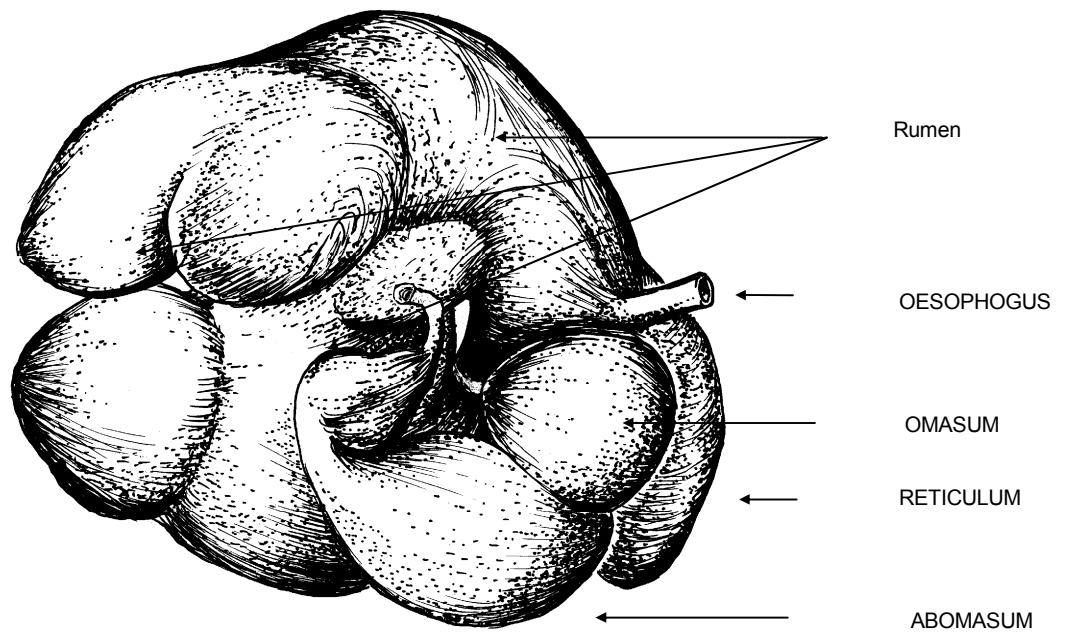
STOMACH OF HORSE

(NON RUMINANT)



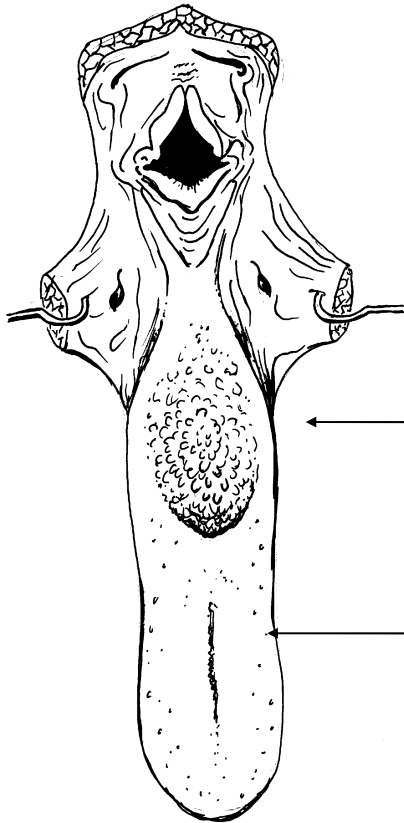
(RUMINANT)

STOMACH OF BOVINE

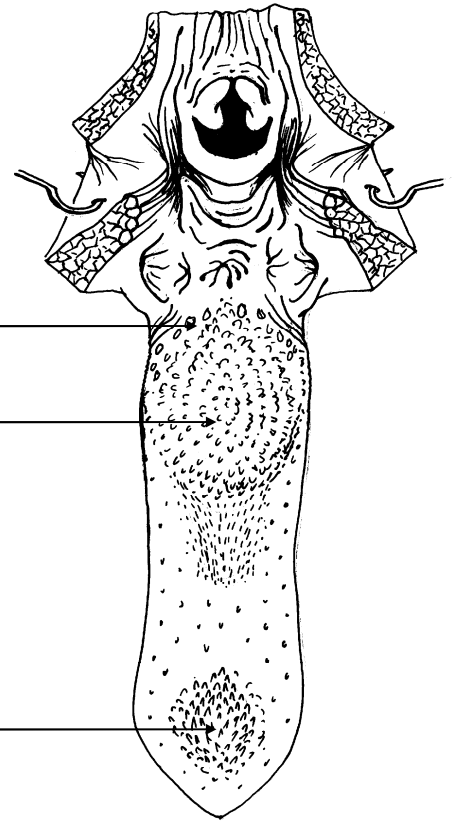


COMPARATIVE ANATOMY OF THE TONGUE

SHEEP TONGUE



OX TONGUE



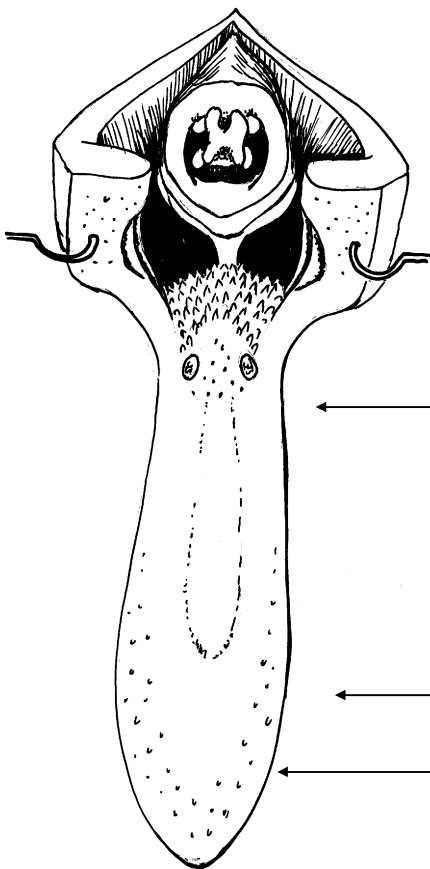
PAPILLAE VALLATAE

DORSAL RIDGE

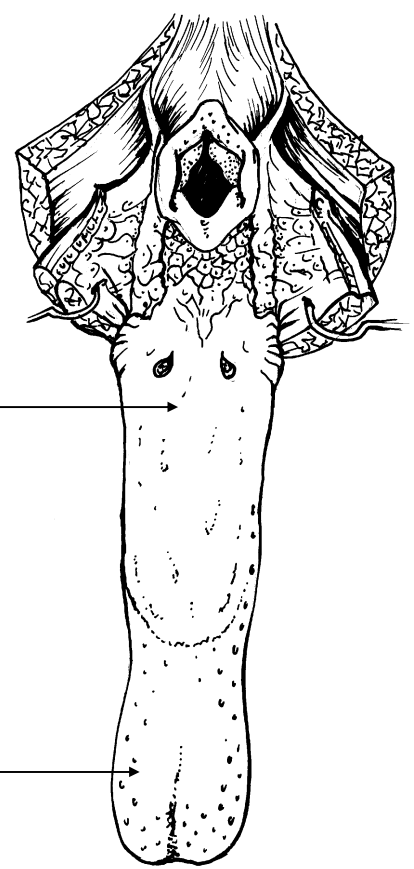
CENTRAL GROOVE

HORNY PAPILLAE

PIG TONGUE



HORSE TONGUE



NO DORSAL RIDGE

FUNGI SHAPED PAPILLAE
ARE PROMINENT

SMOOTH SURFACE
GLADDE OPPERVLAK

6. THE URINARY TRACT

Consists of two kidneys, two ureters, the bladder and the urethra.

Each kidney is covered with a thin capsule. The kidney consists of an outer part or cortex and an inner part or medulla (see sketch). Each kidney is provided with an excretion tube, the ureter, through which the urine flows from the kidneys to the bladder.

The urethra is the tube through which the urine flows from the bladder to the outside.

The function of the kidneys are mainly:-

1. Controlling the concentration of substances (Minerals, vitamins etc.) in the body.
2. Act as a filter to remove unwanted substances from the body e.g. toxins, by products of cell debris etc.

This are done by filtering the blood through a system of tubes in the kidney.

Malfunctioning of the kidneys will result that unwanted substances will build up in the body or that abnormal amounts of substances will be secreted into the urine.

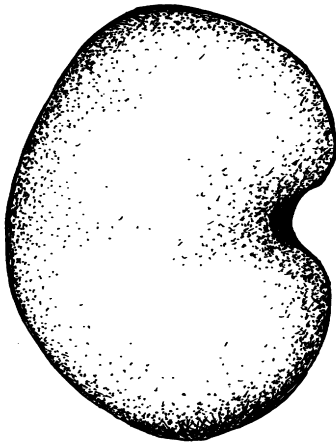
The result could be that there will be a build up of urine (uraemia) in the blood with a resultant bad smell of the carcass. An abnormal color of the urine (E.g. red) may occur when red blood cells are secreted into the urine or even a toxemia when toxins are not secreted from the blood.

Comparison of the kidneys of the different animal species:

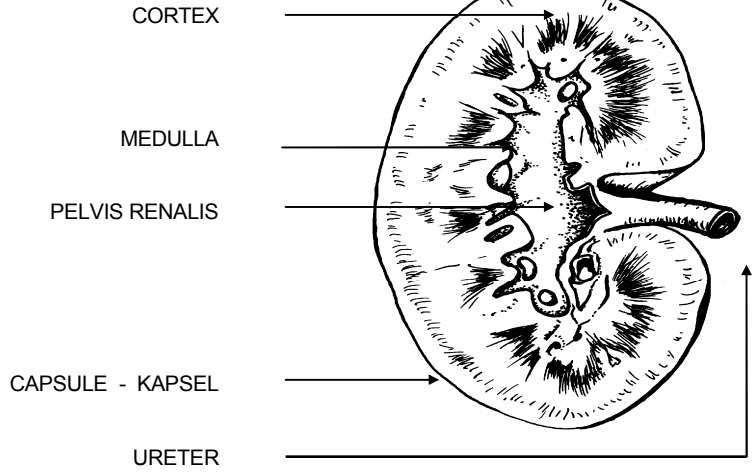
	Number of lobes	Special characteristics	Characteristics
Bovine	15-25 lobes	Left kidney hangs loose. The right kidney is fixed.	Reddish brown
Sheep/ goats	Not lobed.	Bean-shaped.	Dark brown.
Horses	Not lobed	Left kidney is bean-shaped. Right kidney is heart-shaped.	Reddish brown
Pigs	Not lobed.	Thinner and flatter than other animals. Elongated bean-shaped.	Reddish brown.

COMPARATIVE ANATOMY OF THE KIDNEY

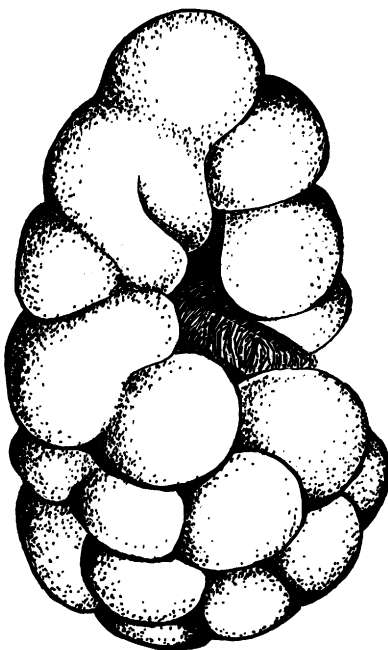
SHEEP KIDNEYS



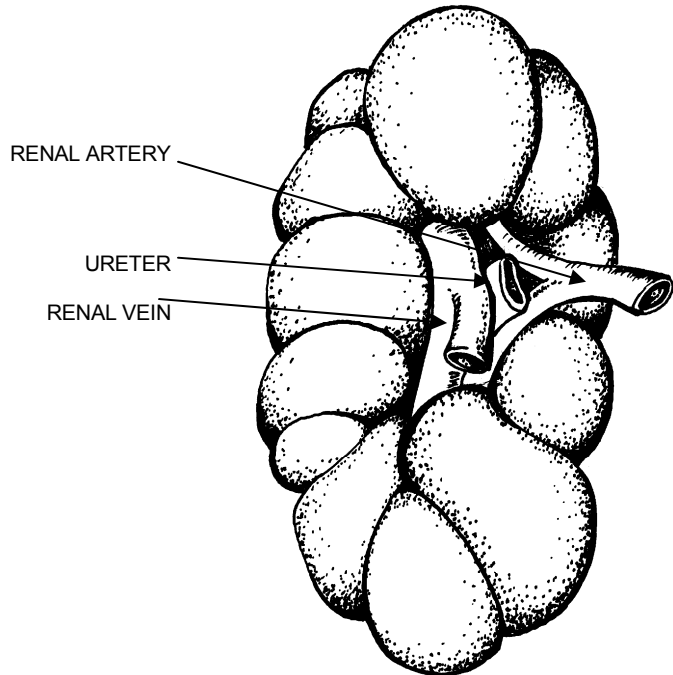
INTERNAL VIEW



LEFT KIDNEY OF BOVINE

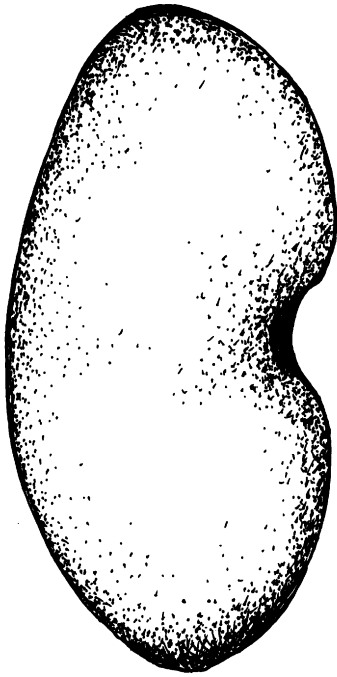


RIGHT KIDNEY OF BOVINE

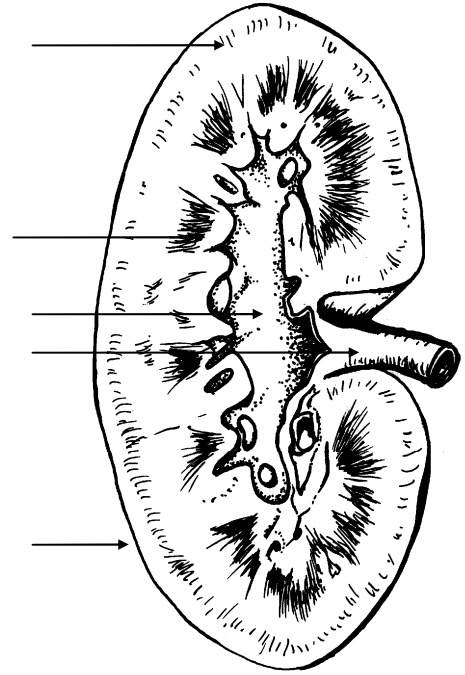


PIG KIDNEY

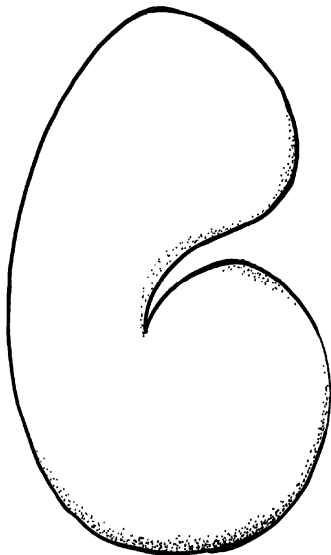
INTERNAL VIEW



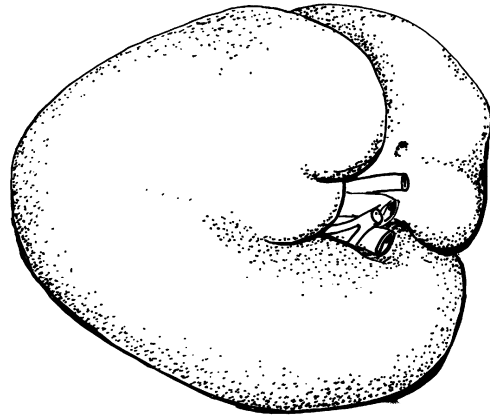
CORTEX
MEDULLA
RENAL PELVIS
URETER
CAPSULE



LEFT KIDNEY OF HORSE



RIGHT KIDNEY OF HORSE



7. THE NERVOUS SYSTEM

Can be divided into:

- (1) The central nervous system consisting of the brain and the spinal cord
- (2) The peripheral nervous system is made up of all nerve tissue outside the brain and spinal cord with their motor (muscular movement) and sensory (feeling) ends.

a) Spinal cord

The spinal cord is tube shaped and lies in the spinal canal of the vertebrae column thus being protected by the bone. On the top part, it enlarges to form the brain that is protected by the skull. The spinal cord and the brain form the central nervous system.

Between the bone and the central nervous system there are three membranes known as the meninges (cerebro-spinal membranes):

- (i) The Piamater (inside membrane) attached to the brain and the spinal cord. It contains small blood vessels running to the central nervous system.
- (ii) The Arachnoid (cobweb) is a serious membrane and secretes cerebrospinal fluid.
- (iii) The Duramater (outer membrane) is a round membrane covering the inside of the skull and the neural canal.

The functions of the spinal cord are to carry messages from and to the brain.

b) The brain

The brain consists of :

- (i) The Medulla Oblongata
Contains the centra, controlling breathing, heart rate, swallowing, etc.
- (ii) The Cerebellum
This has a corrugated surface and is divided into the left and the right hemisphere and controls muscular co-ordination.

The cerebellum and the medulla oblongata form the rear part of the brain

- (iii) The middle part of the brain is the centre for the eye reflexes.
- (iv) The cerebrum or front part of the brain consists of two big cerebral hemispheres. The cerebrum contains the higher centres for consciousness, reasoning, memory, voluntary movements, vision, hearing, etc.

c) The Eye

Consists of:

- The eyeball
- The optic nerve
- Conjunctiva
- Lachrymatory system (tears)

d) The ear

Consists of three parts:

- (i) The external ear
- (ii) The middle ear; and
- (iii) The internal ear

The external ear consists of:

- (i) The pinna is a conical organ and picks up sound waves; and
- (ii) The external auditory meatus transmits sound waves to the tympanic membrane (eardrum) which divides the external and internal ear

8. FATTY TISSUE

Fatty tissue is made up of special fibrinous cells containing large fat globules. The main component of animal fat is stearin, olein and palmatin. Body fat is derived from the intake of fats, carbohydrates and also protein

In the live animal fat is soft but will harden quickly after death. It occurs sub-cutaneously, as well as around the heart and kidneys. Also in the pleura and peritoneum in the mesentery and in smaller amounts in the tissues and most organs in the body

Fat is an energy reservoir of the body. It is a poor conductor of heat and will protect the body from heat loss. It also functions as an elastic cushion between organs. Well-fed animals contain some fat in the muscle – known as “marbling”

Fat varies in composition, colour and distribution in different species of animals

Cow	Yellow	Quite firm
Bull / heifer	White / Yellowish white	Firm
Calf	White / greyish white	Soft and gelatinous
Sheep / Goat	Very white	Very firm and brittle
Pig	Yellowish white	Quite firm and oily
Horse	Yellow	Soft and oily never marbling

9. GENITAL SYSTEM**A. FEMALE GENITAL ORGANS**

Consists of

1. Two (2) ovaries – reproductive “glands” producing ova
2. The fallopian tubes conveying the ova to the uterus
3. The uterus where the ovum will develop
4. The vagina : connecting the uterus to the vulva
5. The vulva : being the outer facet of the genitalia
6. The udder – in essence a gland of the skin, but functional part of the reproductive system

Cow uterus:

1. Consists of a small body (25 mm) and two uterine horns, each approximately 37 cm long
2. Double ridge at the base of the horns
3. Cotyledons (100). During pregnancy up to 1125 mm x 12 mm in size with a spongy consistency

Sow uterus:

Body 5 cm in length, uterine horns very long and flexible

B. THE MALE GENITAL ORGANS

1. Consists of

- a. Two testicles (testes) where spermatozoa are formed
- b. Ductus deferens – tubes from the testicles
- c. The vesiculae seminale
- d. The prostate
- e. The two bulbo urethral glands
- f. Urethra – a tube
- g. The penis

2. Bovine testicle

- a. Elongated oval shaped and weighs approximately 300g
- b. Parenchyma – yellow in colour
- c. Copious blood vessels
- d. Epididymis – narrow and attached to the testis. The head is long and curves over the upper third of the testis

3. Sheep testicle

- a. Similar to that of the bull but relatively much larger more pear-shaped and rounded (weighs approximately 280g)
- b. Fewer veins

4. Pig testicle

- a. Large and elliptic
- b. Parenchyma – grey
- c. Branched veins
- d. Distinctly lobulated
- e. Epididymis, poorly developed, cone shaped, on both sides of the testis

10. THE LYMPHOPOIETIC SYSTEM

A. THE SPLEEN

It is part of the blood and lymph system and as such rich in blood and lymphatic tissue. It is an important organ with the following functions:

1. Removes foreign material including organisms causing disease as well as old blood cells out of the circulatory system
2. Produces lymph cells and other blood cells
3. Produces anti-bodies
4. Reservoir for iron
5. Reservoir for blood and maintains blood volume levels in the circulatory system

Comparative anatomy of the spleen in different species (see sketch)

Cattle	Elongated oval	Blue greyish	Contains distinct white lymph follicles	Edges rounded in young animals
Sheep/ Goats	Shell shaped	Reddish brown		Soft and elastic
Pigs	Elongated tongue shaped	Reddish	Triangular in cross section [Omentum attached over total length]	Has 3 edges
Horses	Flat sickle shaped			

B. LYMPHATIC SYSTEM

Mentor should concentrate on Schedule 2 lymph nodes (See control list for primary meat inspection)

This system is closely related to the circulatory system and consists of :

1. Lymph

A clear fluid similar to blood plasma, but more watery, due to lower protein content. This fluid is the eventual contact medium between blood and the tissue cells to :

- a. Transmit oxygen and nutrients to the tissue cells
- b. To remove metabolic by products from the tissue cells, filter it through lymph nodes and discharge it back into the bloodstream

All body tissue cells are bathed in lymph fluid, which gather in small thin walled tubes known as lymph vessels that lead to lymph nodes

2. Lymph Capillaries

They are thin walled vessels criss-crossing the tissues of the body drawing the lymph
There are two types:

- a. Afferent vessels transporting lymph from the tissues to their lymph nodes
- b. Efferent vessels transporting lymph from the lymph nodes to the bloodstream

3. Lymph nodes

They are the filters of the lymphatic system, cleansing the lymph of any unwanted substances and are therefore very good indicators of pathology during meat inspection. They are oval to round in shape with a firm consistency enfolded by a strong capsule. When cut they appear moist. Colour may vary from grayish white to black red. They are usually much larger in younger animals

When foreign particles or lymphocytes are "digested" by lymph nodes, it will cause an irritation if it is harmful. The reactions may vary, depending on circumstances, but can be identified by one or more of the following :

- (a) Swollen. Lymph nodes are larger and more vascularised (bloody)
- (b) Bleeding may occur e.g. with African Swine Fever and Anthrax
- (c) Tissue destruction – e.g. abscess formation as seen in Tuberculosis. If the lymph nodes are unable to destroy the infectious agent it will end up in the blood stream causing septicaemia

Lymph nodes drain specific areas / organs and are therefore good indicators of pathology in its area of drainage. All lymph will pass through at least 1 lymph node on its way back to the blood, normally through several. The following Lymph nodes are important for meat inspection purposes:

(i) Lymph nodes of the thorax

Four lymph centra are found in the chest cavity:

- The Lc. thoracicum dorsales drain the chest wall on both sides (left and right)
- The Lc. thoracicum ventrales drain the chest wall
- The Lc. Mediastinales drain the mediastinum and lungs
- The Lc. Bronchiales drain the lungs and heart

The Ln. thoracales dorsalis:

Two groups of lymph nodes belong to this centrum. They lie against the dorsal body wall below the vertebral column and are separated by the *sympathetic chain* :

- Lnn. Intercostales - situated near the costo condral function of the ribs in the intercostal space
- Lnn. Thoracici aortici - situated dorsal to the aorta

Drainage area: Muscles of the shoulder, chest wall, back, diaphragm, heart, ribs thoracic vertebrae and sometimes the spleen

Lymphocentrum thoracales ventrales:

These lymph nodes are found on the sternum and there is a cranial and caudal group:

- Lnn. Sternales craniales
- Lnn. Sternales caudales

Drainage area: Muscles of the chest, shoulder girdle muscles, abdominal muscles, ribs, oesophagus, trachea, diaphragm. In the horse also the liver and in the sow the thoracic Mammae (teats)

Lymphocentrum mediastinale:

Three groups of Lnn. are distinguished

- Lnn. Mediastinales craniales lie in the cranial mediastinum, near the entrance to the chest cavity - Occurs in all spp. In the horse there are 40 – 100 small lymph nodes spread throughout the mediastinum. In cattle there are a few Lnn. near the origin of the larger arteries of the heart
- Lnn. mediastinales mediales - Found at the base of the heart to the right of the aorta arch, trachea and oesophagus
- Lnn. mediastinales caudales – In the caudal mediastinum, between the aorta and oesophagus

Horse – May be absent

Ruminants – Quite large (up to 15 cm)

Drainage area: Sternum and ribs, inner muscles of the chest, diaphragm, heart, oesophagus and trachea

Lymphocentrum Bronchale

Includes the following : Lnn. tracheo bronchales sinistri, dextri and medii. In the ruminant and pig we also find the trachea bronchales craniales at the origin of the bronchus trachealis. In the horse we find a bunch of small lymph nodules

- Ln. tracheo bronchiales sinistra – lies cranial to the left bronchus and is present in all animals
- Ln. tracheo bronchiales dexter – lies cranial to the right bronchus

Cattle – only in approximately 75% of animals

Sheep – absent

(ii) The lymphatic system of the abdomen

The dorsal abdominal wall and the abdominal viscera has four lymph centra :

Lympho centra:

- lumbar
- celiacum
- mesentericum cranialis
- mesentericum caudalis

Each centrum has various Lnn. draining a specific area

Most organs have their own lymph nodes and lies next to the major blood vessels of the particular organ

Efferent of the four centra drain into the lumbar duct (next to the aorta) or into the cisterna chyli

Lymphocentrum lumbale

These Lnn. lies next to the abdominal aorta and includes the renal Lnn.

Drainage area: Kidneys, adrenal gland, lumbar vertebrae, lumbar muscles, testes / ovaria

Lymphocentrum celiacum

This centrum includes the following Lnn :

- *Lnn. gastrici* lies next to the branches of the A .gastrica Sinistra in the inner curvature of the stomach
- These Lnn. should be incised with meat inspection in horses and pigs
- *Lnn. portales* (hepatici) lies at the porta hepatis. Must be incised during meat inspection
- *Lnn. lienalis*: In ruminants these Lnn. drain the lymph of the fore stomachs. The portal Lnn. drains the abomasum. These Lnn. must be incised during meat inspection and are situated between the atrium ruminis and the left leg of the diaphragm on the craniodorsal edge of the spleen

Efferent drain into the Cisterna chyli

Lymphocentrum mesentericum craniale

This centrum includes the jejunal, colonic and caecal Lnn. The Lnn. jejunales is by far the most important Lnn. in this group and is important during meat inspection

In the horse the Lnn. jejunales lies close to the origin of the jejunal blood vessels. In cattle they form a chain between the jejunum and last turn of the spiral. In sheep they lie between the last centrifugal and first centripetal turn of the spiral. In the pig they form a chain next to the jejunal blood vessels

Efferent drain into the Cysterna chyli

Lymphocentrum mesentericum caudalis

Lnn. belonging to this centrum lie next to the branches of the A. mesenterica caudalis in the mesocolon, must be incised in meat inspection in the pig and TB suspected or TB positive cattle

Efferent lymph vessels join with the Lnn. iliaci mediales as well as with mesentericum craniale and eventually with the Cisterna chyli or with the lumbal tubes

- *The Cysterna chyli*

The cysterna lies to the right and dorsal to the Aorta, between the origin of the diaphragmatic crura. Caudally it receives *Trunci lumbales* and cranially it is continued as the *Ductus thoracicus*

The rhythmic pulsation of the aorta probably enhances the flow of lymph in these tubes

(iii) Lymph drainage of the pelvis :

- (a) The testes is drained by the Lumbar Lnn. and not by the Lnn inguinales superficiales
- (b) The Lnn. iliaci mediales drains the pelvis and hind leg
- (c) The Ln. ischiadicus in cattle is incised during meat inspection because some lymph from the hind leg is drained through it
- (d) The Ln. inguinalis superficialis (mammarius) in the cow drains not only the udder but also the vulva. Malignant tumours in the vulva area can metastasis (spread) to these Lnn.
- (e) The anorectal Lnn. of the horse drains the anus, perineum and tail. Tumours in this area may involve this Lnn. and it should be inspected

(iv) Lymph drainage of the head

(a) Ln. parotideus : In the horse it is embedded in the posterior edge of the salivary gland ventral to the mandibular joint. In cattle it is large and must be incised during meat inspection

Drainage area: Sinuses of head, eye, ear, lips and superficial muscles of the dorsal and nostril areas. Drain mainly the caudal areas of the head. Efferent to the Lnn. retropharyngei

(b) Lnn. mandibulares : In the horse they lie in the V between the jaws. In other animals at the curvature of the jaw. Palpable in all animals

Drainage area : Much of the lymph from the nasal area, hard palate, tongues and jaws as well as facial and masticatory muscles. It drains mainly the nostril areas of the head

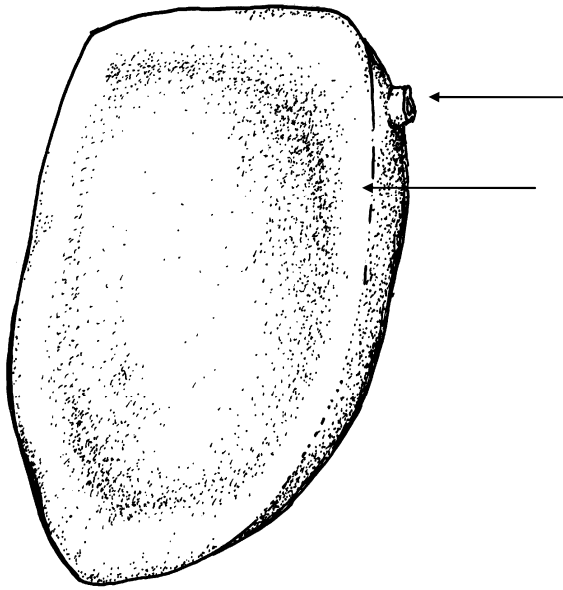
Efferent drain to the Lnn. retropharyngi and to the Lnn. cervicales profundi craniales

(c) Lnn. retropharyngi lateralis : In the horse they form a chain of small Lnn. next to the A carotis externa. They lie medially to the caudal aspect of the mandibular salivary gland. These Lnn. often form abscesses. In cattle it is a large Ln. lying cranio-ventral to the wing of the atlas and covered by the edge of the mandibular salivary gland. Drainage area: Deeper parts of the head. In ruminants all the lymph from the head passes through these Ln. Efferent Lnn. retropharyngi mediales or Lnn. cervicales profundi craniales or truncus trachealis

(d) Lnn. retropharyngi mediales - In all species they lie on the pharynx. Drainage area - Receives virtually all the lymph from the head, except in cattle where it flows through the Ln. retropharyngeus lateralis. Efferent eventually from the Truncus trachealis

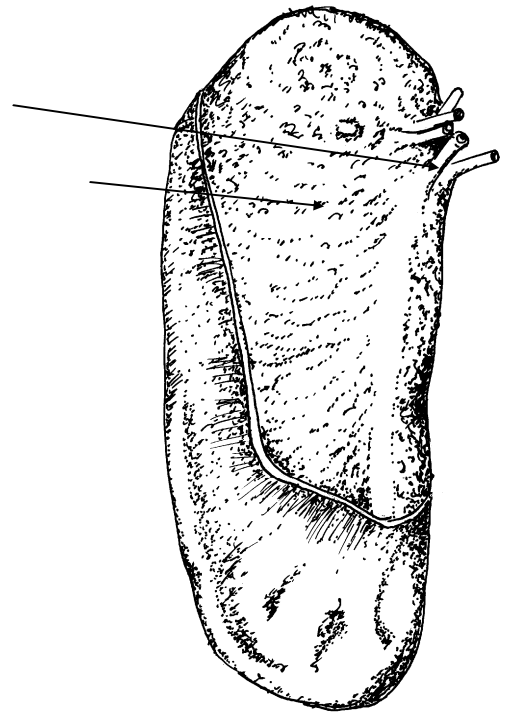
(e) Lnn. Cervicales profundi : We find cranial, middle and caudal groups. They lie next to the trachea from the thyroid gland up to the first rib. Cranial and medial groups often absent in sheep. Efferent drain into the Truncus trachealis.

COMPARATIVE ANATOMY OF THE SPLEEN
SHEEP

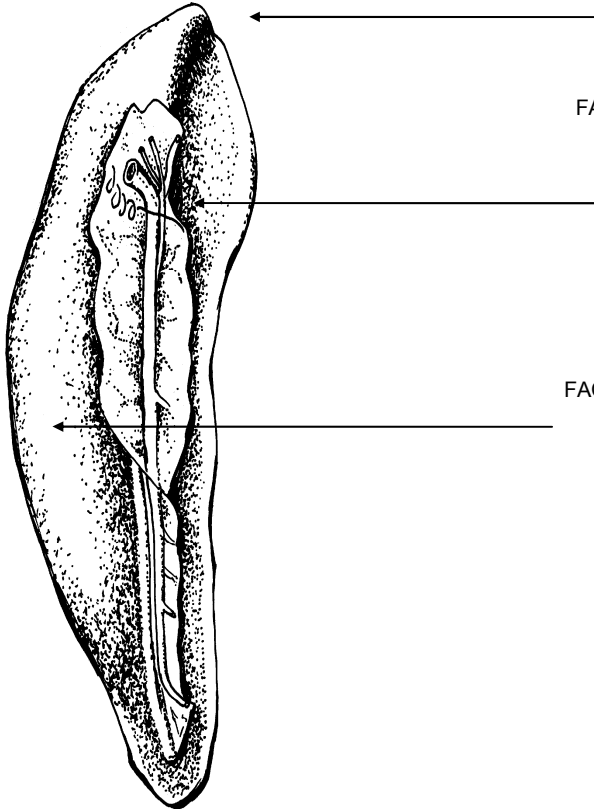


BOVINE

HILUS
FACIES GASTRICA
(VERGROEIING MET
RUMEN)
(ADHESION TO
RUMEN)

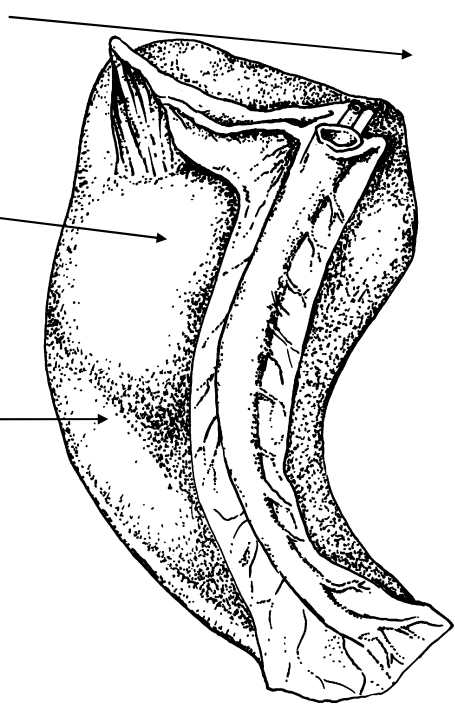


PIG

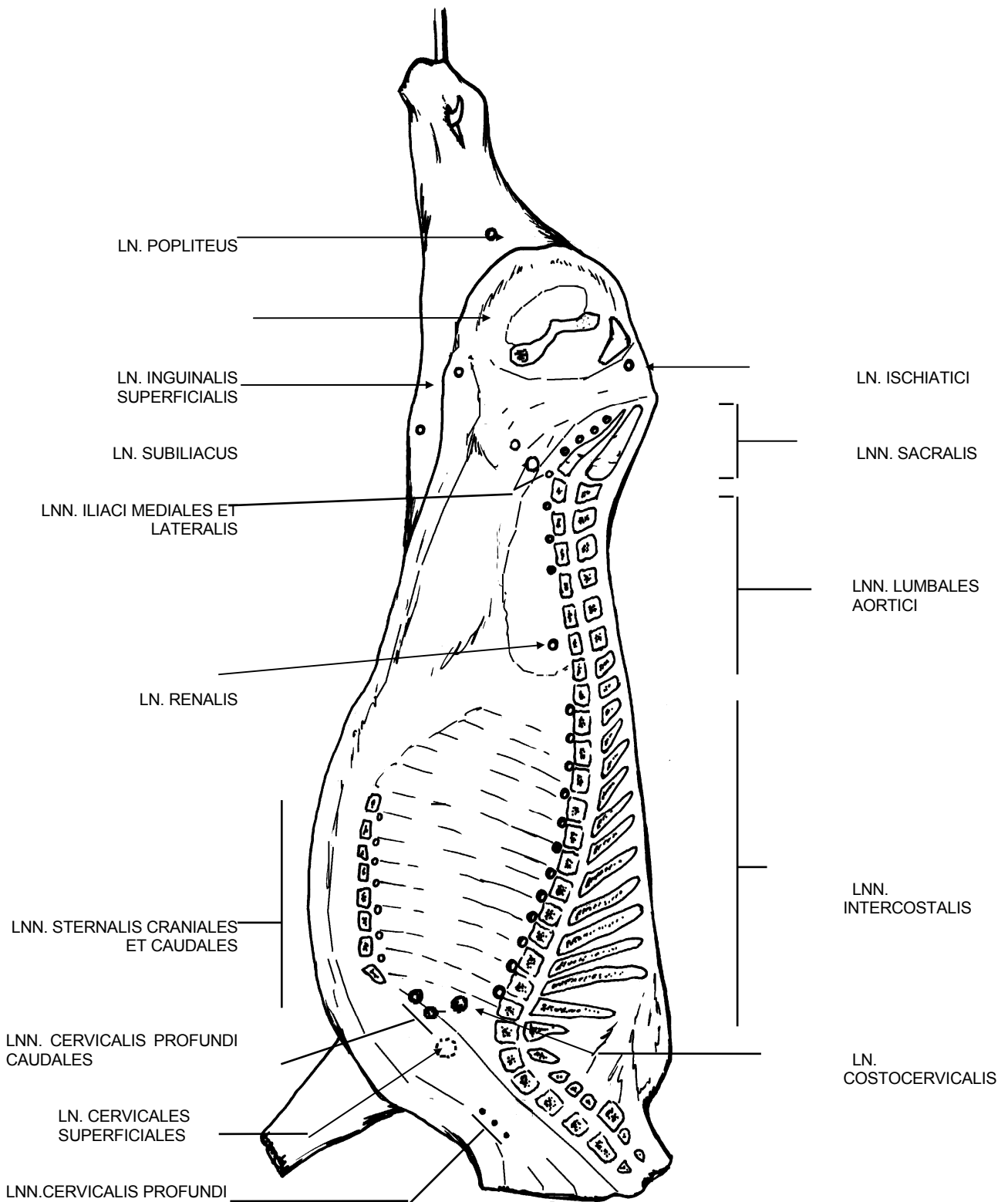


HORSE

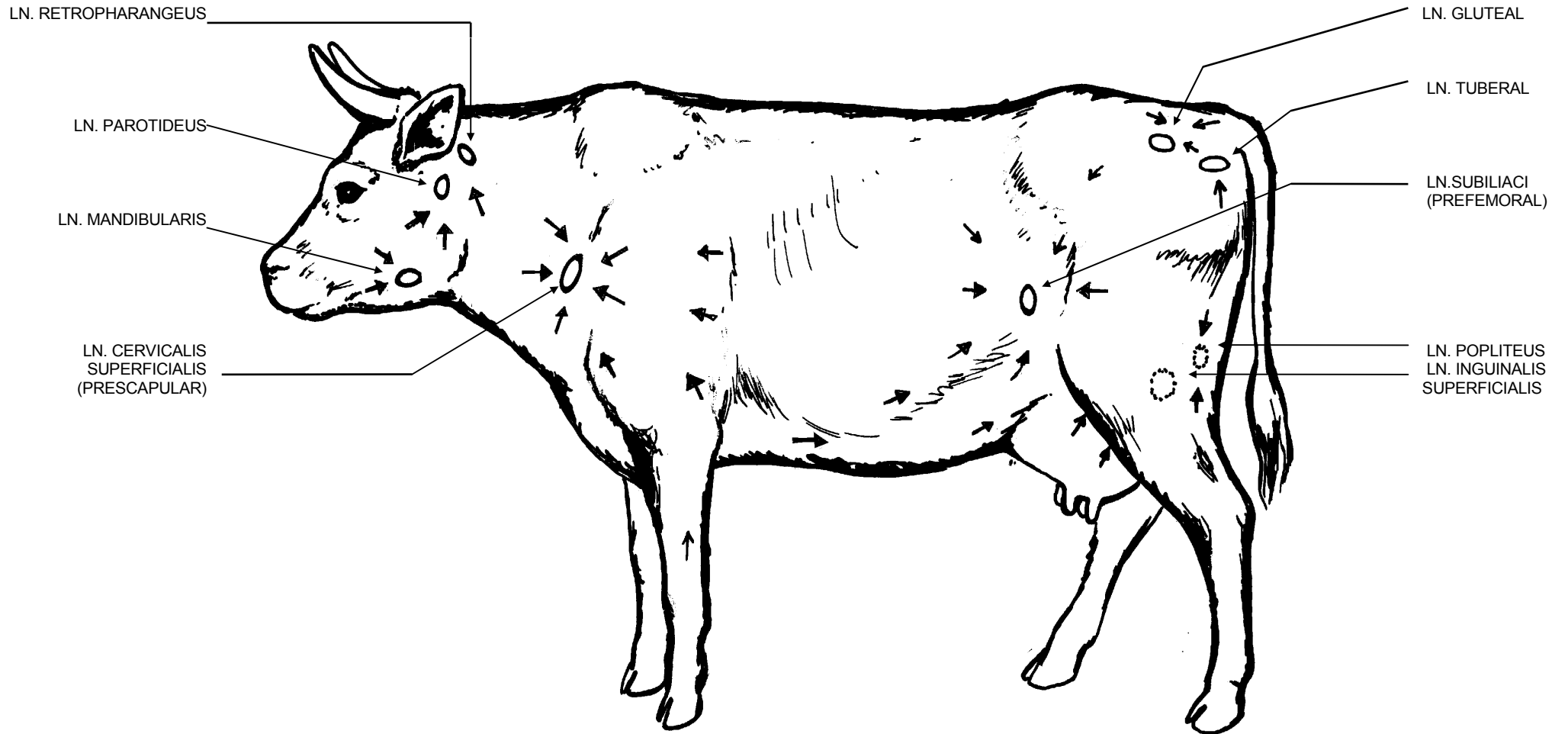
FACIES GASTRICA
HILUS
FACIES INTESTINALIS



BOVINE - INTERNAL LYMPHATIC SYSTEM



BOVINE - SUPERFICIAL LYMPHATIC SYSTEM



11. GLANDS OF THE BODY

11.1 Pituitary gland (hypophysis)

Situated at the base of the brain. It produces hormones which stimulate bone growth, the udder, ovaries and testes as well as the muscles of the uterus

11.2 Thyroid

Consists of 2 lobes either side of the side of the trachea. It produces thyroxin, which increases metabolic activity. In young animals it stimulates growth

11.3 Thymus

Consists of two lobes and extends from the heart up to the neck on either side of the trachea. Large in young animals but atrophies with age. It stimulates sexual maturity and development of the immune system

11.4 Adrenalin glands

Situated in the immediate proximity of the kidneys. Consists of a cortex and medulla. The medulla produces adrenaline, which has wide effect in the body including glycogen metabolism and the formation of lactic acid in the muscles. Factors such as excitement, stress and pain cause secretion of adrenaline resulting in reduced levels of muscle glycogen. Known as the "fight or flight reflex". Cortisone is produced in the cortex of the adrenals and has a anti-inflammatory effect

11.5 Pancreas

Produces insulin which regulates blood sugar levels as well as tripsin and pepsin the enzymes for digestion

12. SPECIES DIFFERENCES IN CARCASSES

A. *Cattle and horses*

In horses:

- a. Muscle development is more pronounced
- b. Meat is darker
- c. Fat is yellow and oily
- d. Neck is longer
- e. Horses have 18 ribs and cattle 13
- f. Ribs, thinner and more curved
- g. Legs are longer
- h. Withers longer and more upright
- i. Ulna extends to middle of radius – in cattle it forms part of the carpal joint
- j. Fibula extends to two thirds of the tibia. In cattle they are very rudimentary
- k. Kidneys are smooth. In cattle lobulated
- l. Heart has two grooves. In cattle there are three grooves

B. Sheep and goats**In goats:**

- a. Goat's meat is usually darker.
- b. Withers are sharper and chest narrower in sheep
- c. The tail in goats is usually shorter

13. GENDER CHARACTERISTICS AND DETERMINATION OF AGE**1. CATTLE****a. Cow**

- (i) Area where udder was removed can be seen
- (ii) Supra mammary Ln. often still present
- (iii) Pelvic canal wide, bone of the pelvis thinner and straighter. Tubercle small not cartilaginous
- (iv) Gracillis muscle bean shaped
- (v) Parts of broad ligament of uterus present
- (vi) General structure of bones lighter e.g. carpus

b. Bull

- (i) Muscles better developed and bone structure heavier
- (ii) Lots of scrotal fat in young bulls – less in older bulls
- (iii) Pelvic girdle narrower bones heavier. Tubercle large and cartilaginous
- (iv) Root of penis present
- (v) Bulbocavernous muscle dominant
- (vi) Gracillis muscle triangular caudal aspect covered in fat.
- (vii) Internal inguinal obvious

2. SHEEP**a. Ram**

- (i) Older rams have better developed muscles
- (ii) Open inguinal ring
- (iii) No or little scrotal fat (present in castrated rams)
- (iii) Root of penis present

b. Young ewe (has not lambed)

- (i) Carcass symmetrically developed
- (ii) Small smooth udder consisting mainly of fat

c. Ewe

- (i) Long thin neck and weak legs
- (ii) Udder tissue brown and spongy.

3. PIG**a. Boar**

- (i) Shield present; an oval well developed area of cartilaginous tissue over the shoulders
- (ii) Area where scrotum was removed (see lesion in castrated hogs)
- (iii) Bulbocavernous muscle present
- (iv) Root of penis visible
- (v) V shaped incision where penis was removed
- (vi) Retractor penis muscle present

14. AGE DIFFERENCES SEEN IN CARCASSES

1. Cattle

In cows cartilaginous bone ossify by 3 years. The pubic junction can be cut with a knife up to 3 years. Vertebral red bone marrow becomes yellow. Intervertebral and sternal cartilage ossifies

2. Sheep

- a. At birth or just after 8 milk teeth;
- b. Development of permanent teeth

Central	1–1½ years
Lateral central	1½–2 years
Lateral	2–2½ years
Canines	3 years
Cleft between central	6 years

3. Pig

Development of permanent incisors (unreliable)

Lateral	9 months
Central	12–15 months
Inner lateral	16–20 months

4. Age determination in calves

Determined by condition of hooves, teeth, umbilicus and horns. Newborn calves have soft hooves with conical processes on upper surface. The umbilicus is gray, moist and firmly attached to the umbilical ring. Scar tissue formation of the umbilicus completes by 3 weeks and all 8 immature incisors are present. At the end of the third week horn pads are present. Muscles of newly born calves are flabby and grayish red, especially those of the hind legs

Bone marrow is soft and dark red, kidney fat is soft and grayish red.

MEAT INSPECTORS MANUAL
RED MEAT

PART II
MEAT INSPECTION

MODULE 4

PATHOLOGY

Index**GENERAL PATHOLOGY**

ABSCESS
ANAEMIA
ARTHRITIS / ARTHROSIS
BACTERAEMIA
BRUISING
CACHEXIA/ EMACIATION
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CASEATION
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GENERAL PATHOLOGY

1. DESCRIPTIONS

ABSCESS

A localised, encapsulated collection of pus in a cavity formed by disintegrating tissue. In size abscesses may vary from microscopic to almost unlimited dimensions. Pus is a collection of dead disintegrating tissue cells and the body's own inflammatory cells. The general appearance of pus can be described as viscous, cream coloured fluid. Inspissated pus has a dry cottage cheese appearance.

Causes

Invasion of tissue by bacteria, fungi, protozoa and even helminths.
 Poor hygiene technique during injection procedures (leg muscles).
 Penetrating wounds.
 Pyemia (pus forming bacteria in the blood)
 Pyogenic bacteria – *Corynebacterium* and *Pseudomonas* spp.

Judgement

A single abscess may be removed if no further spread of infection or contamination with pus to the rest of the carcass can be determined.
 In case of multiple abscessation in various organs – total carcass condemnation.

ANAEMIA

Is a condition where the quantity of red blood cells in a given volume of blood is less than normal (quantitative) or a deficiency of haemoglobin in the red blood cells (qualitative) exists. Clinically it is recognised as weakness, exercise intolerance and paleness of the mucosae.

Causes

Regenerative:

Post Haemorrhagic – trauma (cuts)
 – haemorrhagic enteritis
 – haemolytic – breakdown of red blood cells by bacterial toxins, parasites etc. (redwater – Babesiosis or Gallsickness – Anaplasmosis)

Non regenerative:

Nutritional – deficiency in protein and minerals (chronic emaciation, cachexia)
 Aplastic – suppression of red blood cells synthesis in the bone marrow.

Judgement

Depends on severity or cause. Condemn in case of an infectious disease or extreme anaemia.

ARTHRITIS / ARTHROSIS

Arthritis – Inflammation of the joint (suffix–itis) and arthrosis degeneration of the joint (suffix – osis). Inflammation results in conformation changes of articular cartilage. Usually occurs in joints where weight bearing is the greatest or where there are abnormal movements.

Causes

- Bacterial – haematogenous spread (by blood). (septicaemia, bacteremia)
 – penetrating wounds, faulty transport.
 – from surrounding infected tissue (osteomyelitis, hoof abscess)

Abnormal weight bearing and conformation of joints.

Judgement

Judgement will be determined by the extent of the lesions, and the condition of the animal. Conditional or total condemnation may be done.

BACTERAEMIA

The presence of bacteria in the bloodstream that may give rise to septicaemia and pyemia.

BRUISING

Discoloration and actual haemorrhage at the site of injury. In the first 12 hours after injury the bruise is bright red, at 24 hours it is dark red, at 24–36 hours it loses its firm consistency and becomes watery and at 3 or more days it is an orange – red colour and has a soapy feel. This is one of the most common conditions seen during meat inspection and is a serious disadvantage in the meat trade.

Causes

- Trauma – during incorrect transport
 – improper handling
 – stay in inadequate lairages

Judgement

Bruising should in all cases be removed and special attention should be given to deeper damage that may not be very prominent. Extensive bruising could merit the total condemnation of the carcass.

EMACIATION

A profound and marked state of constitutional disorder; general ill health and malnutrition.

Advanced and generalised atrophy of skeletal muscle and certain organs with associated serous atrophy of fat deposits, often associated with oedema. The animal may also be anaemic. The kidney fat diminishes. The heart may lose all of its fatty tissue and the ventricles also tend to become thin.

Cause

Malnutrition
 Chronic debilitated animals
 verminosis

Judgement

Total condemnation of the whole carcass.

CACEXIA

The above process will also happen when an animal become acutely sick and it stops eating. The difference however is that the fat becomes jelly-like and will not coagulate during chilling in this case however the animal is acutely sick with sometimes signs of fever but sometimes not.

This condition is more dangerous because the animal may harbour micro organisms in the blood stream that may be harmful to the consumer

Cause

Bacteria, viruses

Judgement

Total condemnation of the whole carcass.

CALCIFICATION

Chronic lesions often become calcified. – It is the deposition of calcium (lime) salts in dead and degenerating tissues – also known as dystrophic calcification.

Parasitic infections and Tuberculosis lesions when they occur in the animal, show a marked tendency to undergo calcification. Calcification of the brisket occurs after degeneration of the fat due to pressure (animal resting on hard surfaces)

Judgement

Removal and condemnation of the affected parts if localised. If widespread condemn whole carcass. Condemnation due to aesthetic reasons.

CASEATION

This degenerative change is manifested by the conversion of firm, dry necrotic tissue into a cheesy, pasty mass composed of fine fat droplets and protein.

Where the defensive mechanism of the body is adequate the caseated material tends to become encapsulated, and eventually calcified. Diagnostic of TB

CIRRHOSIS/ FIBROSIS

Pathology of the liver whereby the normal lobular architecture is damaged and replaced with fibrous strands of connective tissue. This connective tissue can constrict and partition the organ into irregular nodules. The liver often has a lighter colour with a distinctive cobblestone appearance on the surface (hobnail liver)

Causes

Chronic heart failure
Bile duct inflammation – migrating parasites
Toxicosis – poisonous plants
Chronic inflammation

Judgement

Condemnation of the liver with careful examination of the rest of the carcass.

DEGENERATION

Damage to cells leading to reversible changes. It is a dynamic process where tissue changes are to a lower or less functional / active state. Organs with degenerative changes may have a parboiled appearance and are slightly swollen and have lost their healthy looking appearance.

Fatty changes are intracellular accumulation of fat and is a degenerative process (fatty degeneration). it is mostly seen in the:

- Liver – light brown colour and soft / friable / crumbly.
- Kidneys – slightly swollen, light brown colour.
- Myocardium – light dull brown colour.

Causes

- Hypoxia – insufficient oxygen supply to the tissues
- Toxic – plant toxins, mycotoxins and chemical toxins
- Metabolic – stress related causes

Judgement

Condemnation of affected organ or muscle group.

EMPHYSEMA

A pathological accumulation of air in tissues. This can be seen as air bubbles between the muscle fibres, or under the skin or in the lung tissue. When palpated the affected areas has a “crackling” like consistency.

Causes

- Trauma – penetration through sharp wounds, rupture of the alveoli.
- Bacterial – gas producing organisms (E coli, Clostridia)-black quarter (sponssiekte) in cattle.

Judgement

Affected areas are condemned due to aesthetic reasons. If it is due to an infectious cause with systemic or generalised lesions, total condemnation of the carcass is suggested.

ENTERITIS

Inflammation of the intestinal mucosa resulting in clinical signs of diarrhea, sometimes dysentery, abdominal pain and dehydration coupled with electrolyte loss / imbalance. The intestines are usually very red, inflamed and swollen. The contents may be catarrhal to haemorrhagic. Enteritis is most commonly seen in young animals less than three months of age.

Causes

1. *Poisoning*. Either plants or minerals. There are large numbers of these, which irritate the bowel and cause enteritis.
2. *Stress*. When animals are subjected to stress factors, their resistance is lowered and normal germs in the intestines that otherwise would not cause any harm, attack the membrane of the intestines and cause inflammation, and possibly even septicaemia. Such stress factors include transportation, strange holding pens, mixing with strange animals, cruelty, starvation, thirst, etc.
3. *Contagious diseases*. Many diseases cause a serious inflammation of the bowels - diseases such as Paratyphoid, Swine Fever, Anthrax, Colibacillosis, Johne's disease, etc.
4. *Worms*. Especially in sheep and young animals many parasites cause injury and irritation

during their life cycles.

5. *Dietary changes* : Young animals are especially prone to develop enteritis especially due to changes of diet. This dietetic enteritis is in itself not serious but due to irritation of the bowel, germs often penetrate the damaged intestinal wall and cause septicaemia.

Enteritis like most inflammations may be either acute or chronic. In arsenical poisoning for example the inflammation is usually so severe as to cause massive haemorrhage in the bowels, whereas in Johne's disease the intestinal wall becomes thickened due to chronic inflammation.

Judgement

There are so many factors to be taken into account in judging a carcass with enteritis that it is not always easy. In general if only the intestine is affected and the rest of the carcass is normal, only the intestines are condemned. If, however, the enteritis is coupled with general disease signs such as fever, enlargement of the lymph glands, hepatitis or nephritis etc., then the whole carcass is condemned.

FATTY DEGENERATION

Is a condition in which globules of fat become deposited in the cells of a tissue. It is commonly found in the liver, kidneys, heart, and muscles-which have sustained serious injury. It is known to follow mild inflammations when it is usually preceded by a condition known as cloudy swelling, and it is also very often seen in organs from animals which have been affected with chronic tuberculosis and glanders. Certain poisonous substances such as arsenic and phosphorous also bring about fatty degeneration when ingested for long periods in considerable doses.

FATTY INFILTRATION

Is found in fat animals with fat accumulation around the kidneys and in the mesentery, which shows up as white areas as if small pieces of chalk have been strewn therein. This condition is not of any pathological consequence and is caused by crystals of fatty acids.

FEVER

Fever is an abnormally high body temperature. It is a cardinal sign of acute inflammation caused by a noxious agent. Other signs of inflammation are redness, swelling, pain and loss of function.

Causes

Infectious agents – viruses, bacteria, fungi, protozoa, parasites.
Chemical and physical trauma

During a post mortem inspection, certain changes in the carcass will give an indication that the animal live, was suffering from a fever

1. An abnormal redness of the carcass
2. Meat darker than usual
3. Blood filled intercostal blood vessel and peritoneal capillaries
4. The onset of rigor-mortis is more rapid
5. Blood vessels generally are more injected with blood
6. Poor bleeding out

Judgement

Due to the possibility of underlying disease and the fact that the high level of blood in the meat reduces shelf life drastically, total condemnation of the carcass is suggested.

GANGRENE

The death of body tissue (necrosis), generally in considerable mass, usually associated with loss of vascular supply and followed by bacterial invasion and putrefaction. It occurs most frequently in tissues susceptible to contamination, e.g. skin, lungs, intestine, vagina, uterus and those in penetrating wounds. Although it usually affects the extremities, gangrene sometimes may involve the internal organs. Signs are fever, pain, darkening of the skin, and an unpleasant odour of the affected site.

Two forms are known: dry and wet (gas).

- Dry gangrene – little to no blood supply to the area, lesions are dry, light brown in colour and have a leathery appearance.
- Gas or wet – Anaerobic spore forming bacteria (Clostridia) form gas. Lesions which are gas filled may also contain blood tinged serum. Putrefaction of necrotic tissue causes foul smelling – colour is purple-green-brown to black colour.

Causes

- Mainly poor blood supply (hypoxia) –
 - Freezing, snares etc.
 - Foreign body drawn into the lungs
 - Torsion of organs
 - Contaminated wounds

Judgement

Unless the gangrene is very localised and there is no evidence of toxæmia the carcass and offal is rejected.

HEPATITIS

Inflammation of the liver. If severe there can be liver dysfunction. On inspection the liver may be swollen, with rounded borders.

Causes

- Infections – viruses, bacteria, parasites.
- Toxins – plant or chemical toxins.

Judgement

Condemnation of the liver with careful scrutinising of the rest of the carcass for signs of associated pathology.

HYDRONEPHROSIS

Caused by the mechanical obstruction to the flow of urine along the ureters. Common in pig but seen in all animals. The ureter and pelvis of the kidney are dilated and urinary pressure may lead to eventual obliteration of the kidney tissue, with the formation of a large thin-walled cyst containing urine.

HYPOSTATIC STAINING (Hypostasis)

Animals that are sick or dying and lying down for some time may suffer from poor or stagnant circulation in parts of the body or organs nearest to the ground. This is usually seen as an affect of gravity and is more pronounced in large animals. The lungs and thoracic abdominal peritoneum nearest to the ground, will be engorged with blood and stained red.

Causes

Gravity induced in animals where the blood circulation is extremely poor or non-existent.

Judgement

Carcass condemnation as the animal was moribund (dying) or dead before slaughter.

ICTERUS

Icterus is the yellow discoloration of tissues (notably white tissue - e.g. membranes, serous surfaces, cartilage, fat as well as the endothelial lining of blood vessels) by an excess of bilirubin, a pigment derived from red blood cell breakdown (destruction) in the blood.

Causes

- Haemolytic - Severe haemolysis (break down) of red-blood cells due to chemical, toxic or physical causes as well as blood parasites (Babesia or Anaplasmosis) gives rise to excessive production of bilirubin in the blood stream.
- Obstructive - Parasites or other obstructions, usually of the bile ducts, cause damage to the liver impairing its ability to remove bilirubin from the blood.
- Hepatic disease - excessive liver damage from disease or parasites resulting in the inability of the liver to remove these pigments from the blood.

Judgement

Condemnation due to aesthetic reasons. Feed or plants with a high carotene content may cause animals to have very yellow fat. This yellow fat is normal and must be distinguished from the yellow fat caused by icterus. The phase test can be used to differentiate.

INCOMPLETE BLEEDING

Incomplete bleeding can be caused by stress, ineffective stunning techniques (stun time too long or short, the stun to bleeding time too long) or an ineffective bleeding cut (throat cut or thoracic "sticking").

All the visible blood vessels may be blood filled causing the carcass to have an overall darker red colour. This is also true for organs such as the liver which may be dark purple-red in colour.

Judgement

Meat from such a carcass will have poor lasting qualities and is condemned.

IMMATURITY

The Standing Regulations prescribe that no person shall slaughter a calf, lamb, kid, pig or any other animal unless it is at least 21 days old and is in a well-nourished condition. Meat of very young animals is less valuable because (a) water content is high, (b) there is very little fat and (c) there is more bone than meat. Signs of immaturity include:

- (a) *Meat*
- (i) Watery, soft can be torn with the fingers
 - (ii) Greyish pink
 - (iii) Muscle development is weak. Jelly between muscles
 - (iv) Little or no fat round kidney, plus Oedema.

- (b) *Animal (calves)*
- (i) Eight teeth not all at same height
 - (ii) Navel cord still attached.

INFARCTS

Usually seen in kidneys. Cone-shaped, yellow or white areas of necrosis. Base of cone on the surface of organ and slightly raised. Apex of cone extends into tissue. The cause of infarction is obstruction of capillaries and starvation of the cells and tissue area serviced by those capillaries resulting in the death of the cells and tissue in a conical shaped area. The term “embolism” is also associated with this condition.

INFLAMMATION

Inflammation is a localized protective response, which serves to destroy, dilute or wall off (isolate) both the injurious agent and the injured tissues. Inflammation is both a cellular and vascular response. The classic signs of inflammation are heat, redness, swelling, pain and loss of function. There are three major components of this process:

1. Changes in the calibre of blood vessels and the rate of flow through them.
2. Increased capillary permeability.
3. Leucocytic exudation.

An inflammatory lesion is indicated by the suffix- “itis” e.g. Hepatitis or tonsillitis.

Causes

Physical damage	– injuries
Thermal	– heat or cold, radiation (sun burn) etc
Chemical agents	– caustic agents, toxins etc.
Biological agents	– bacteria, viruses, protozoa, parasites e.g.

The inflammatory changes seen have one or more of the following characteristics:

- Discolouration** – When the injury occurs, small blood vessels relax and more blood flows to the area, giving a red appearance.
- Heat** – Due to increased blood flow the area becomes warmer than the surrounding tissues.
- Swelling** – Increased blood flow and relaxation of the blood vessels in the inflamed area, allows more fluid to escape from the blood vessels into the surrounding tissues causing swelling.
- Pain** – Due to above mentioned processes nerve endings are irritated, pressure is brought to bear on nerves and also chemicals are released by the system which evoke pain.
- Lack of function** – Pressure on organs, nerves and blood supply may cause temporary and in severe cases, permanent loss of function of an organ. For instance swelling may cause a gland to stop secreting as ducts from the gland is blocked. General impairment of the body's function in the effected areas can be experienced.

Inflammation can be classified as acute or chronic:

In **acute inflammation**, the typical symptoms of redness, swelling, heat, pain and loss of function are severe.

In **chronic inflammation** a great deal of connective tissue has been deposited, manifested by adhesions and hardening of organs as in chronic inflammation of the liver or also known as cirrhosis of the liver.

Judgement

Condemnation of the affected organs or tissue. Total condemnation if the inflammatory response is wide spread through the whole body.

MASTITIS

Inflammation of the udder, more often seen in dairy cows. The udder is swollen, hot and painful to the touch and changes are noted in the normal colour and consistency. The milk usually contains small lumps, which can be seen when the milk is drained through a sieve. Mastitis can occur in **chronic** as well as **acute** forms which may be gangrenous and involve systemic changes.

Cause

Primary as well as secondary infections involving:-

Bacteria
Fungi
Yeasts

Judgement

In chronic cases the udder is removed and condemned. As chronic mastitis is not easily identified on the slaughter floor, it may be assumed that all adult udders, which have lactated, may be infected and should as a rule be condemned. Bear in mind that an udder with any grade of infection constitutes a source of contamination through exuding milk and fluids. Acute or gangrenous mastitis warrants the condemnation of the whole carcass if systemic changes are indicated or the lymph nodes indicate spreading of the infection.

METASTASIS

This is the transfer of disease from one organ or part to another not directly connected with it. It may be due either to the transfer of pathogenic (disease causing) bacteria or of abnormal cells, as in malignant tumours.

Causes

Pathogenic bacteria.
Fungi or foreign material.
Emboli of tumour cells.

Judgement

Condemnation of the affected part or whole carcass (abscessation)

MEAT ODOURS

Each species has a natural distinctive smell, which in male animals, especially billy goats and boars are very strong. Other unnatural odours may be caused by feed or foreign substances or systemic reasons.

Causes

Feed ingredients – Fishmeal, sojameal, other plants (Karoo succulents).

- Medications – Turpentine, iodoform.
- Metabolism – Abnormal metabolism – acetomia.
- Environment – Paint, insecticides, decomposing matter, freezer burn etc. will affect stored meat.

Judgement

- Detainment of carcass for 24 hours – Aesthetic reasons condemn or pass.
- Medications – Condemn. (Withdrawal periods not adhered to).
- Test procedures – Detain the carcass or meat for 24 hours. Boil a piece including some fat and test if smell or taste are still present and objectionable.

MEAT OF UNBORN ANIMALS

Not for human consumption because

- (a) aesthetic reasons;
- (b) could carry infection, e.g. C A;
- (c) very watery.

The unborn foetus has:

- (a) Shiny wet skin, yellow hooves, not worn;
- (b) navel is open, with large blood vessels;
- (c) lung is solid - sinks in water (Atalectasis).

MELANOSIS

Melanin is a natural pigment, which occurs in the skin, hair, nails and membranes. The excessive abnormal deposition of Melanin in a carcass is called Melanosis. It is most common in the lungs where it should be distinguished from anthracosis, which is an abnormal accumulation of dark carbon pigment (smoke).

There are two types of conditions, which involves an excess of melanin:

- Melanoma – a benign deposition of melanin in an organ or part of the body.
- Melanosarcoma – a malignant tumour which undergoes metastasis to other parts of the body

Judgement

Organs with an excess of melanin can be condemned for aesthetic reasons.

METRITIS

Inflammation of the uterus caused by a bacterial infection.

Judgement

Carcasses are condemned if it is affected with acute metritis which is associated with septicaemia or toxemia. In chronic cases where no toxemic signs are present, the carcass may be passed after being detained and a thorough secondary inspection done.

MYOPATHY

It is any disease or pathological process that causes changes to the muscle fibers such as degeneration, necrosis, hypertrophy, atrophy, and fibrosis. The muscles may show distinctive changes in colour i.e. chicken flesh coloured areas in red meats or steaks or white calcified areas. The muscle fibers may also be very swollen accompanied with various discolouration of red to black or excessive infiltration of fibrous connective tissue in a chronic process.

Causes

Capture Myopathy / trauma – Excessive or poor handling on the farm.
 Nutritional – Vit E / Selenium deficiency (chicken flesh colour)

Judgement

Affected areas should be carefully evaluated and severely affected carcasses totally condemned due to aesthetic reasons. Smaller areas can be trimmed.

NECROSIS

Necrosis is the death of cells while the body as a whole is still alive. Cells are irreversibly damaged. Normal tissue is shiny and translucent while dead tissues become dull, opaque with a loss of colour and is usually sunken from the surrounding tissue.

Causes

Infection – certain pathogenic bacteria and viruses.
 Disturbance of blood supply – thrombus, pressure
 Pressure – over extended period of time (sternum necrosis in cattle)
 Toxins – organic / inorganic
 Trauma – injuries etc.
 Thermal – excessive heat or cold (cooking or frost bite).
 Interference with a nerve supply – due to injury, pressure etc.

Judgement

Condemnation of the affected part or total condemnation if pathogenic or zoonotic organisms are involved.

NEPHRITIS

Infection of the kidneys causing swelling and bulging and red coloration of the organ.

Cause

Disease – Bacteria, fungi, viruses

Judgement

Will depend on level of infection and whether the carcass is uraemic or otherwise affected.

NEPHROSIS

Due to blockages, enlarged water filled areas (cysts) form within the kidney. This condition is not necessarily associated with infection and the unaffected parts of the kidney may appear and function normally.

Cause

Build up of urate crystals causing damage to the organ.

Judgement

Will depend on complications affecting the rest of the carcass.

NEOPLASM (TUMOUR)

The term is derived from a Latin word meaning “new growth” or “new formation”. A neoplasm is an abnormal mass of tissue, the growth of which exceeds and is uncoordinated with that of normal tissues. It persists in the same excessive manner after the cessation of the stimuli which evoked the cause.

Tumours are either malignant or benign. Malignant tumours grow quickly and expansively and infiltrate the surrounding tissue usually causing severe damage. They may undergo metastasis. Benign tumours like warts usually stay in one area and may disappear after time.

Types of tumours:

Adenoma – growing in connection with a gland.

Angioma – formed by a mass of small blood vessels, or spaces in which blood or lymph circulates.

Chondroma – mainly composed of cartilage.

Osteoma – mainly composed of bone etc.

Causes

Toxins – Industrial, plant, organic / inorganic.

Viruses

Judgement

Trim or condemn affected part due to aesthetic reasons. If wide spread (metastatic), total condemnation.

OEDEMA

An excessive accumulation of fluids in the intercellular spaces and body cavities

Accumulation of fluid in the thoracic cavity - hydrothorax

Accumulation of fluid in the abdominal cavity - ascites

Accumulation of fluid in the intercellular subcutaneous tissues - anasarca

Accumulation of fluid in the pericardium - hydropericardium

Accumulation of fluid in the kidney - hydronephrosis

Causes

1. Malnutrition
2. Internal parasites e.g. worms
3. Heart failure in all species
4. Liver cirrhosis (excessive connective tissue laid down in liver—common with chronic abuse of alcohol in man)
5. Chronic nephritis
6. Infectious diseases like pulpy kidney in sheep and horse sickness, etc.
7. Anaemia

Tests for oedema

The alcohol flotation test on bone marrow determines the percentage of water in the bone marrow.

Judgement

Depending on the cause—partial or total condemnation.

OMPHALOPHLEBITIS

Inflammation of the umbilical vein, and is commonly present in the early stages of navel ill.

OVERSTICKING

In-sticking, back-bleeding. Caused when slashing of the heart or severance of blood vessels of the thorax when sticking pigs. A clot of blood forms in the thorax, staining the tissues, and necessitating the removal of the parietal pleura.

PERICARDITIS

This is an inflammatory process around the pericardium. It can be thickened or be covered with a cream, fibrous membrane indicating an infectious process. In severe cases the pericardium may be adhere to the heart and interfere with the function.

Causes

Infections – bacterial, fungi, viruses.
Mechanical – migration of wire or metal, and other sharp objects from the stomach.

Judgement

Total condemnation, as this may be an indication of a Septicaemia. Condemnation of the organs (heart, liver intestines) if only a localised process.

PERITONITIS

An inflammatory process of the membrane of the abdomen (peritoneum). In early stages it may just be red. Depending on the cause, floccules of pus or adhesions between the organs and the abdominal wall may be evident or an accumulation of oedema may be present.

Causes

Infections – bacterial fungi.
Trauma – penetrating wounds or objects (from the stomach)
Spread from other inflammatory processes – (pericarditis)

Judgement

Total condemnation of the carcass if it is septicaemic.

PETECHIA, ECHIMOSIS, SUGGILATIONS

These are descriptive terms for haemorrhages seen on surfaces of the body or organs. Petechia are the smallest pin point haemorrhages < 1mm. Echinosis are larger. Suggilations are large areas which look as if it has been painted. They can all be seen sometimes in or on one surface.

Causes

Trauma, necrosis of blood-vessel walls, rupture of blood-vessel walls, hipotention, increased permeability of blood-vessel endothelium, interference with the coagulation process.

Judgement

Depending on the cause and other changes of the carcass partial or total condemnation (viraemia).

PLEURITIS

Inflammation of the inner lining of the thoracic cavity (pleura). Acute or chronic as in peritonitis

POORNESS

The animal becomes emaciated due to lack of sufficient food (winter or drought). Body fat will disappear. Muscles and fat around the kidneys is initially firm (not watery). May develop cachexia (in extreme cases—condemn)

PURULENT

It is a process characterised by pus. Pus is a creamy yellow white liquid that may be thin or very thick. It is an accumulation of neutrophilic polymorphonuclear / granulocytes.

Causes

Bacteria – Pseudomonas, Coryne bacterium.
Fungi.

Judgement

Condemnation of the affected part if localised. If the condition is wide spread or associated with wide spread contamination by pus, then total condemnation.

PYAEMIA

The spreading of puss forming bacteria through the blood stream resulting in metastatic abscessation in other parts of the body is known as Pyemia.

Muscles → lungs
Stomach → liver

Causes

All pus forming (purulent) organisms:
Bacteria – Pseudomonas, Coryne bacterium.
Fungi.

Judgement

Total condemnation if carcass is pyemic.

RIGOR MORTIS

This is stiffening of the muscles of the body. It takes place due to a lack of ATP (energy molecule) when the myosin filaments “lock”. It sets in 1-8 hours after death and starts at the most active muscles. Muscle becomes hard, opaque and shrinks. Temperature rises a little at first, then drops to that of surrounding air. It disappears 20–30 hours later due to lysis of proteins.

Rigor mortis is influenced by three factors:

Glycogen reserves in muscles – for well-fed animals it takes longer to set in.
pH of the muscle – it sets in sooner at a low pH (acid).
Temperature – chilling of the carcass retards the development of rigor.

It is important in the industry to evaluate the keeping quality of meat which is related to pH and the proper setting in of rigor.

SEPTICAEMIA (BLOOD POISONING)

A condition where pathogenic organisms are present in the bloodstream

If bacteria penetrate the body, they usually do so through a wound or through the intestine or respiratory canals. In new-born animal it often occurs through the still open umbilical cord.

An animal with septicaemia has fever and numerous small haemorrhages on serous membranes. The liver and kidneys are usually pale and the spleen enlarged, and various organs may be infected.

Cause

There are many kinds of germs that can cause blood poisoning, but those that are of special importance in meat inspection, are those that can cause disease in humans (the so called zoonotic diseases or zoonoses). These include diseases such as Anthrax or Salmonellosis (food poisoning).

TELANGICTASIS

Occurs in the livers of older cattle. Cause unknown. Visible as dark purple red sunken areas of the liver commonly called "plum pudding liver". In serious cases the liver is condemned only for aesthetic reasons

TOXAEMIA

The spreading of toxins produced by bacteria via the blood stream. Lesions or changes depend on the type of toxins and its affinity for organs or systems in the body.

Cause

Bacterial mostly – Clostridium, E. coli, Salmonella.

Judgement

Total condemnation

URAEMIA

The presence of urinary constituents in the blood, and the toxic condition produced thereby.

Typical smell of urine in the meat (test by boiling)

VALVULAR ENDOCARDITIS

Cauliflower-like masses on the heart valves (right atrium and ventricle) caused by bacteria. It is usually dark shiny red and black.

Causes

Bacterial – Via bacteraemia (bacteria in the blood) – bacteria lodge in the heart valves.

Judgement

This condition may indicate a generalised infection in the body therefore the inspector must carefully inspect the rest of the carcass for any signs of infection.

MEAT INSPECTORS MANUAL
RED MEAT

PART II
MEAT INSPECTION

MODULE 6

MEAT INSPECTION

Index**MEAT INSPECTION**

1. ANTE MORTEM INSPECTION
2. PRIMARY MEAT INSPECTION – BOVINE
3. SECONDARY MEAT INSPECTION
4. LABORATORY TECHNIQUES

1. Ante mortem inspection

1.1. Ante mortem inspections

- (1) A registered inspector doing ante mortem inspection at a –
 - (a) rural abattoir, must be at least a meat inspector or, provided exemption has been granted by the provincial executive officer, a meat examiner;
 - (b) low and high throughput abattoir, must at least be a meat inspector.
- (2) A declaration of health and origin must be provided for all animals by the owner of the slaughter stock and recorded by the abattoir owner and such health declaration must contain the following information –
 - (a) date of delivery;
 - (b) name and address of owner or farm;
 - (c) number of animals and specie(s);
 - (d) health status of the herd(s) including mortality rate; and
 - (e) medication, if given as well as withdrawal periods and dates.
- (3) An animal must be inspected on the day of arrival at the abattoir, and the inspection must be repeated on the day of slaughter if the slaughter is not done within 24 hours of arrival.
- (4) There must be a standard procedure at an abattoir to convey the information acquired in the lairages to the registered inspectors in the meat inspection area, and a method of marking specific animals for the attention of a registered inspector should be in place.

1.2. Further inspections and findings

- (1)
 - (a) All animals that in the opinion of a registered inspector, who is not a veterinarian, doing ante mortem inspection as described in regulation 79, are not fit for slaughter must be examined by a veterinarian who is a registered inspector
 - (b) The veterinarian, must decide whether such animals may be slaughtered, provisionally slaughtered or disposed of;
- (2) If the veterinarian decides that an animal mentioned in sub regulation (1)(a) may be slaughtered or provisionally slaughtered, the carcass of such animal is subject to secondary meat inspection in terms of regulation 107.
- (3) An animal may not be slaughtered if it is suspected that a forbidden substance has –
 - (a) been administered to it;
 - (b) been implanted in it;
 - (c) contaminated it; or
 - (d) been eaten by it.
- (4) No person may slaughter an animal which is on the point of giving birth or which has given birth in transit or lairage. (see also 68(11))

1.3. Handling of dead animals

- (1) All “dead on arrival” and “dead in pen” animals must be disposed of as condemned material in terms of Part VIII.
- (2) Prior to flaying or cutting up for disposal or inspection of such animals, a blood smear to rule out the possibility of Anthrax is required.
- (3) No dead or dying animal may be brought into the abattoir premises, unless it is part of a consignment of healthy animals, or may be removed from the abattoir premises.
- (4) No carcass or part thereof that has been condemned may be brought into any part of the abattoir containing edible products.
- (5) It is the owner’s choice to have a post mortem inspection done except where required by a registered inspector or where a controlled disease under the Animal Health Act, 2002 (Act No. 7 of 2002), is suspected in which case a state veterinarian must be notified.
- (6) The place and method of flaying dead animals for the purpose of regaining skins must be done according to a protocol approved by the provincial executive officer.

1.4. Quarantine

- (1) All animals suffering from a controlled disease contemplated in the Animal Health Act, 2002 (Act No.7 of 2002), must be moved to the abattoir under cover of a “red cross” permit issued by a state veterinarian at the farm and the arrival of the consignment at the abattoir must be confirmed to such state veterinarian.
- (2) If an animal is suffering from or is suspected of suffering from a controlled disease contemplated in the Animal Health Act, 2002 (Act No.7 of 2002), or if any animal has tested positive on the farm for brucellosis or tuberculosis and bears a C or T brand mark, and is not accompanied by a “red cross” permit, a state veterinarian of the Provincial Directorate: Veterinary Services, in whose area the abattoir is situated, must be notified immediately.
- (3) In the event of an abattoir being declared a prohibited or restricted area under the Animal Health Act, 2002 (Act No.7 of 2002), the provincial executive officer may instruct the owner to slaughter an animal under conditions laid down by that officer.
- (4) Vehicles that transported animals suffering from a controlled disease must be washed and disinfected as determined by a state veterinarian before leaving the abattoir premises.

1.5. Guidelines

83. A registered inspector must acquaint him/her-self of all further guidelines issued by the national executive officer regarding ante-mortem inspections.

2. Primary meat inspections

2.1. Provisions for meat inspection personnel

The provincial executive officer may determine the number of meat inspectors or meat examiners required in an abattoir after having considered the abattoir design, number of inspection stations, line speed, different species, structural and managerial aspects.

2.2. General

- (1) No carcass, part thereof, rough or red offal may be sold or dispatched from an abattoir unless inspected and approved by a registered inspector and marked with the “PASSED” mark, as contemplated in Part VII.

- (2) All relevant information, including ante mortem and health records, must be taken into consideration when doing meat inspection.
- (3) A person may not remove, cut or debone any carcass or meat prior to inspection.
- (4) A person may not remove any sign or evidence of any disease, condition, contamination or soiling by washing, trimming or any other manner prior to meat inspection, unless it is done under the supervision of a registered inspector.
- (5) No lymph nodes may be removed prior to meat inspection.
- (6) Heads, feet, rough and red offal must be identifiable with the carcass of origin until inspection is done.
- (7) Any carcass, meat or viscera which, in the opinion of the registered inspector, is not fit for human or animal consumption must be detained for secondary inspection.
- (8) A registered inspector must acquaint him or her-self of all further guidelines issued by the national executive officer regarding primary meat inspections.

2.3. *Inspection of cattle carcasses*

- (1) The registered inspector must inspect a carcass by means of observation, palpation, smell and, where necessary, incision and must take into consideration –
 - (a) its state of nutrition;
 - (b) its colour;
 - (c) its odour;
 - (d) its symmetry;
 - (e) the efficiency of its bleeding;
 - (f) any contamination;
 - (g) its pathological conditions;
 - (h) any parasitic infestation;
 - (i) any injection marks;
 - (j) any bruising and injuries;
 - (k) any abnormalities of muscles, bones, tendons, joints or other tissues; and
 - (l) the age and sex of the animal from which it was derived.
- (2) When inspecting the hindquarter, a registered inspector must inspect bilaterally –
 - (a) the parietal peritoneum, by observation;
 - (b) the *Lnn iliaci mediales et laterales* and the *Lnn subiliacus*, by multiple incisions;
 - (c) the *Lnn inguinalis superficialis*, by multiple incisions;
 - (d) the muscular part of the diaphragm, by making two incisions approximately 25 mm apart and removing the peritoneal layer to expose the muscle; and
 - (e) the kidneys, by exposure or incisions if necessary and the *Lnn. renalis* by incisions if necessary.
- (3) When inspecting the forequarter, the registered inspector must inspect bilaterally –
 - (a) the parietal pleura by observation;
 - (b) the *Lnn cervicalis superficialis*, by palpation; and
 - (c) the *M triceps brachii*, by making one deep transverse incision through the distal part of the muscle.

- (4) The sternum, ribs, vertebrae and spinal cord must be inspected on carcasses which have been split.

2.3.1. Inspection of cattle heads

- (1) When inspecting the head the registered inspector must inspect bilaterally –
 - (a) the *Lnn mandibulares*, *Lnn parotidei*, and the *Lnn retropharyngiales*, by multiple incisions; and
 - (b) the external masseters (*M. masseter*), by making two deep linear incisions parallel to the mandible, and the internal masseters (*M. pterigoideus medialis*), by making a single deep linear incision.
- (2) The registered inspector must observe and palpate the tongue.
- (3) The registered inspector must observe the skin (or external surface of de-masked heads), lips, gums, hard and soft palates, eyes and nostrils.
- (4) The tonsils must be removed after inspection as part of the slaughtering process and condemned.

2.3.2. Inspection of feet

The feet must be inspected by observation.

2.3.3. Inspection of cattle red offal

When inspecting the red offal, the registered inspector must inspect –

- (a) the surface of the visceral pleura, by observation;
- (b) the liver by palpation and incisions into the gastric surface and the base of the caudate lobe to open the bile ducts;
- (c) the hepatic lymph nodes, by multiple incisions into the *Ln. hepaticus*;
- (d) the trachea, by a lengthwise incision and the oesophagus by observation;
- (e) the lungs, by palpation and an incision in their posterior thirds perpendicular to their main axes to open the main branches of the bronchi;
- (f) the *Lnn mediastinales*, by multiple incisions;
- (g) the *Lnn bronchiales* bilaterally, by multiple incisions;
- (h) the pericardium and the heart, by an incision made lengthwise to cut through the interventricular septum and open the ventricles and two additional vertical cuts into the split septum;
- (i) the spleen, by visual inspection and if necessary by incision;
- (j) the tail, by observation;
- (k) the thyroid gland, by observation;
- (l) both sides of the diaphragm, by observation; and
- (m) the testes, by observation.

2.3.4. Inspection of cattle rough offal

When inspecting the rough offal, the registered inspector must inspect –

- (a) the visceral peritoneum as well as the omentum, by observation;
- (b) if necessary, the inner surfaces of the stomach and intestines, but this inspection may only take place in the rough offal room or detention area with separate equipment;
- (c) the gastric and mesenteric lymphnodes (*Lnn gastrici, mesenterici, cranialis and caudalis*), by observation and, if necessary by multiple incisions.

2.4. Inspection of sheep or goat carcasses

- (1) The registered inspector must inspect a carcass by means of observation, palpation, smell and, where necessary incision, and must take into consideration –
 - (a) its state of nutrition;
 - (b) its colour;
 - (c) its odour;
 - (d) its symmetry;
 - (e) the efficiency of its bleeding;
 - (f) any contamination;
 - (g) its pathological conditions;
 - (h) any parasitic infestation;
 - (i) any injection marks;
 - (j) any bruising and injuries;
 - (k) any abnormalities of muscles, bones, tendons, joints, or other tissues; and
 - (l) the age and sex of the animal from which it was derived.
- (2) When inspecting the hindquarter, the registered inspector must inspect bilaterally –
 - (a) the parietal peritoneum, by observation;
 - (b) the *Lnn iliaci mediales et laterales*, by observation;
 - (c) the *Lnn inguinalis superficialis, Lnn subiliacus, Lnn popliteus and Lnn analis*, by palpation;
 - (d) the kidneys, by exposure, observation and palpation and the *Lnn. renalis*, by palpation; and
 - (e) the muscular part of the diaphragm by visual inspection.
- (3) When inspecting the forequarter, the registered inspector must inspect bilaterally -
 - (a) the parietal pleura and thoracic cavity, by observation; and
 - (b) the *Lnn cervicalis superficialis*, by palpation;

2.4.1. Inspection of sheep and goat heads

The registered inspector must visually inspect the head and when necessary, inspect the throat, mouth, tongue and *Lnn mandibulares, Lnn parotidei*, and the *Lnn retropharyngiales*, making incisions as required.

2.4.2. *Inspection of feet*

The feet must be inspected by observation.

2.4.3. *Inspection of sheep and goat red offal*

When inspecting the red offal, the registered inspector must inspect –

- (a) the surface of the visceral pleura, by observation;
- (b) the liver, by palpation and incisions into the gastric surface and the base of the caudate lobe to open the bile ducts;
- (c) the hepatic lymph nodes, by multiple incisions into the *Ln. hepaticus*;
- (d) the lungs, oesophagus and trachea, by observation and palpation;
- (e) the *Lnn bronchiales* and *Lnn mediastinales*, by observation and palpation;
- (f) the pericardium and the heart, by an incision made lengthwise to open the ventricles;
- (g) the spleen, by observation and if necessary palpation;
- (h) both sides of the diaphragm, by observation; and
- (i) the testes, by observation.

2.4.4. *Inspection of sheep and goat rough offal*

When inspecting the rough offal, the registered inspector must inspect –

- (a) the visceral peritoneum as well as the omentum, by observation;
- (b) if necessary, the inner surfaces of the stomach and intestines, but this inspection may only take place in the rough offal room or detention area with separate equipment; and
- (c) the gastric and mesenteric lymphnodes (*Lnn gastrici, mesenterici, cranialis and caudalis*), by observation.

2.5. *Inspection of pig carcasses*

- (1) The Registered Inspector must inspect a carcass by means of observation, palpation, smell and, where necessary, incision, and must take into consideration –
 - (a) its state of nutrition;
 - (b) its colour;
 - (c) its odour;
 - (d) its symmetry;
 - (e) the efficiency of its bleeding;
 - (f) any contamination;
 - (g) its pathological conditions;
 - (h) any parasitic infestation;
 - (i) any injection marks;
 - (j) any bruising and injuries;
 - (k) any abnormalities of muscles, bones, tendons, joints or other tissues; and
 - (l) the age and sex of the animal from which it was derived.

- (2) When inspecting the hindquarter, the registered inspector must inspect bilaterally –
- (a) the parietal peritoneum, by observation;
 - (b) the *Lnn iliaci mediales et laterales*, by multiple incisions;
 - (c) the *Lnn inguinalis superficialis*, by multiple incisions;
 - (d) the muscular part of the diaphragm, by making two incisions approximately 25 mm apart and removing the peritoneal layer to expose the muscle; and
 - (e) kidneys, by exposure or incisions if necessary and the *Lnn. renalis* by incisions if necessary.
 - (f) The tail and if any signs of necrosis due to tail biting is observed, the carcass must be split and the spine examined.
- (3) When inspecting the forequarter, the registered inspector must inspect bilaterally –
- (a) the parietal pleura, by observation; and
 - (b) the *M triceps brachii*, by making one deep transverse incision through the distal part of the muscle. In the case of pigs weighing between 54 kg and 92 kg these incisions may be omitted provided that the heart is inspected and no cysticerci are found elsewhere in the carcass.
- (4) Where the carcass has been split, the sternum, ribs, vertebrae and spinal cord must be inspected.

2.5.1. Inspection of pig head

- (1) When inspecting the head the registered inspector must inspect bilaterally –
- (a) the *Lnn mandibulares and Lnn parotidei*, by multiple incisions; and
 - (b) the external masseters (*M. masseter*), by making two deep linear incisions parallel to the mandible and the internal masseters (*M. pterygoideus medialis*) by making a single deep linear incision.
- (2) The registered inspector must observe the tongue, skin, lips, gums, hard and soft palate, eyes and nostrils.

2.5.2. Inspection of pig red offal

When inspecting the red offal, the registered inspector must inspect –

- (a) the surface of the visceral pleura, by observation;
 - (b) the liver, by palpation and incisions into the gastric surface and the base of the caudate lobe to open the bile ducts;
 - (c) the hepatic lymph nodes, by multiple incisions into *the Ln. hepaticus*;
 - (d) the trachea, by a lengthwise incision and the oesophagus by observation;
 - (e) the lungs, by palpation and an incision in their posterior thirds perpendicular to their main axes to open the main branches of the bronchi;
- (f) the lungs, for contamination with water from the scalding tank and if contaminated such lungs may not be passed;
- (g) the *Lnn mediastinales*, by multiple incisions;
- (h) the *Lnn bronchiales* bilaterally, by multiple incisions;

- (i) the pericardium and the heart, by an incision made lengthwise to cut through the interventricular septum and open the ventricles and two additional vertical cuts into the split septum;
- (j) the spleen, by visual inspection and if necessary incision;
- (k) both sides of the diaphragm, by observation; and
- (l) the testes, by observation.

2.5.3. **Inspection of pig rough offal**

When inspecting the rough offal, the registered inspector must inspect –

- (a) the visceral peritoneum as well as the omentum, by observation;
- (b) if necessary, the inner surfaces of the stomach and intestines, but this inspection may only take place in the rough offal room or detention area with separate equipment; and
- (c) the gastric and mesenteric lymphnodes (*Lnn gastrici, mesenterici, cranialis and caudalis*) by observation and, if necessary by multiple incisions.

2.6. **Inspection of horse carcass**

- (1) The registered inspector must inspect a carcass by means of observation, palpation, smell and, where necessary incision, and must take into consideration –
 - (a) its state of nutrition;
 - (b) its colour;
 - (c) its odour;
 - (d) its symmetry;
 - (e) the efficiency of its bleeding;
 - (f) any contamination;
 - (g) its pathological conditions;
 - (h) any parasitic infestation;
 - (i) any injection marks;
 - (j) any bruising and injuries;
 - (k) any abnormalities of muscles, bones, tendons, joints or other tissues; and
 - (l) the age and sex of the animal from which it was derived;
- (2) When inspecting the hindquarter, the registered inspector must inspect bilaterally –
 - (a) the parietal peritoneum, by observation;
 - (b) the *Lnn iliaci mediales et laterales*, and the *Lnn subiliacus* by multiple incisions; and
 - (c) the kidneys, by exposure or incisions if necessary and the *Lnn. renalis* by incisions if necessary.
- (3) When inspecting the forequarter, the registered inspector must inspect bilaterally –
 - (a) the parietal pleura, by observation; and
 - (b) the *Lnn cervicalis superficialis*, by palpation.

- (4) Carcasses must be split after which the sternum, ribs, vertebrae and spinal cord must be inspected.

2.6.1. Examination of horse head

The registered inspector must –

- (a) examine the head by observation;
- (b) palpate the tongue; and
- (c) observe the skin, lips, gums, hard and soft palate, eyes and nostrils.

2.6.2. Inspection of feet

The feet must be inspected by observation.

2.6.3. Inspection of horse red offal

When inspecting the red offal, the registered inspector must inspect –

- (a) the surface of the visceral pleura, by observation;
- (b) the liver, by palpation and incisions to open the bile ducts;
- (c) the hepatic lymph nodes, by multiple incisions into the *Ln. hepaticus*;
- (d) the lungs, oesophagus and trachea by observation and palpation and an incision into the trachea;
- (e) the pericardium and the heart, by an incision made lengthwise to cut through the interventricular septum;
- (f) the spleen, by visual inspection and if necessary by palpation;
- (g) the tail, by observation;
- (h) both sides of the diaphragm, by observation; and
- (i) the testes, by observation.

2.6.4. Inspection of horse rough offal

When inspecting the rough offal, the registered inspector must inspect –

- (a) the visceral peritoneum, by observation; and
- (b) the outer surface of the stomach and intestines as well as the omentum, by observation.

2.7. Parasitic intermediate stages – additional incisions and treatment

Parasitic intermediate stages and treatment

- (1) A carcass, head and red offal found to be infested with one or more parasitic intermediate stages, which may be alive or calcified, must be detained and in bovine and pigs, two additional incisions must be made into each *M. triceps brachii*, parallel and proximal to the original incisions.
- (2) If one or more parasitic intermediate stages are found on the majority of incision surfaces the carcass must be condemned.
- (3) Where the infestation is not excessive the carcass and organs may be passed on condition that it undergoes treatment as described below.
- (4) A conditionally passed carcass must be identified by roller marking in red ink along its entire side with the letter "M", being a minimum of 2 cm in height.

- (5) All parts belonging to the carcass to be treated, must be identified by "M" tags.
- (6) Carcasses and organs must be treated by freezing –
 - (a) as sides in a freezer with air temperature at minus 18 °C for 72 hours;
 - (b) as sides in a freezer with air temperature at minus 10 °C for 10 days;
 - (c) to reach a deep bone or core temperature of less than minus 6 °C, confirmed by the registered inspector and in accordance with the protocol approved for the specific abattoir by the provincial executive officer;
 - (d) after deboning, in accordance with a protocol approved by the provincial executive officer and –
 - (i) the container or carton in which deboned meat is packed must be marked with the letter "M" and the date of introduction into the freezer must be indicated;
 - (ii) the core temperature of the meat inside the container must be below minus 6 °C before it can be released by the registered inspector.
 - (e) in portions in a chest type freezer according to a protocol approved the provincial executive officer.
- (7) Visible parasitic intermediate stages must be removed from the meat of a carcass that is conditionally passed and treated as described above.
- (8) Records of core temperatures, freezer temperatures and batches of containers, carcasses and organs introduced for freezing must be kept by the abattoir owner for at least six months, and must be available for inspection purposes.

3. SECONDARY MEAT INSPECTIONS

3.1. General

- (1) Suspect carcasses found during primary meat inspections in terms of sub part B, must be marked "detained" and must be subjected to secondary meat inspection by a registered inspector who is a veterinarian.
- (2) A secondary inspection, on a carcass must reveal the –
 - (a) species, age and sex;
 - (b) clotting and staining characteristics of the blood;
 - (c) organ or part of the carcass affected;
 - (d) condition or disease and the probable cause thereof;
 - (e) judgement and the motivation therefore where applicable.
- (3) Depending on the said finding, the carcass, organ or meat may be –
 - (a) passed;
 - (b) conditionally passed, subject to treatment;
 - (c) partially passed by removing the condemned part; or
 - (d) totally condemned.
- (4) Where a carcass is not passed, the owner may request a written certificate.

3.2. Emergency slaughtered animals

- (1) The meat of animals which were referred to a veterinarian, who is a registered inspector, during ante mortem inspection, as contemplated in regulation 80, must be examined by such veterinarian who must pay particular attention to –
 - (a) blood content of intercostal veins, the small vessels beneath the serosa of the abdominal wall and in the retroperitoneal fat in the walls of the pelvis;
 - (b) all visible lymph nodes after the carcass has been split and examine and loosen a shoulder and open an acetabulum from the medial aspect to observe the exposed connective tissue, fat, lymph nodes and articular surface; and
 - (c) the condition of the musculature and abnormal odours and colour of the carcass.
- (2) If regarded as necessary by the veterinarian, the carcass or meat must be subjected to laboratory examination in order to make a final decision.

3.3. Records

108. The results of the ante mortem examination, primary meat inspection and secondary meat inspection must be recorded, and where zoonotic and controlled diseases, contemplated in the Animal Diseases Act, 1984 (Act No. 35 of 1984), are diagnosed, the local state veterinarian must be notified on the day of slaughter.

3.4. Guidelines

A registered inspector who is a veterinarian, must acquaint him/her-self of all further guidelines issued by the national executive officer regarding secondary meat inspections.

3.5. GENERAL REQUIREMENTS FOR PERSONS DOING MEAT INSPECTIONS

3.5.1. Required qualifications for other persons doing meat inspection at red meat abattoirs

The other duly qualified persons to perform meat inspection services as contemplated in section 11(I)(d) of the Act are –

- (a) persons having an appropriate bio-scientific qualification as approved by the national executive officer; and
- (b) if required by the national executive officer, a certificate for Red Meat Examiners which is approved by the national executive officer and accredited by South African Qualifications Authority (SAQA).

3.5.2. Registration as registered inspector with provincial executive officer

Persons contemplated in section 11(I)(c) of the Act wishing to provide meat inspection services must register with the provincial executive officer in order to perform these services at a specified abattoir.

4. LABORATORY TECHNIQUES

1. PREPARATION OF BLOOD-SMEARS
2. PHASE TEST FOR ICTERUS
3. ALCOHOL-FLOTATION TEST FOR OEDEMA
4. DETERMINING THE CHLORINE CONTENTS OF WATER
5. PH DETERMINATION OF MEAT
6. SAMPLING FOR DISPATCH TO OTHER LABORATORIES

Although a meat examiner is not trained as a laboratory technician, there are a few tests that could be performed with just the basic skills and equipment.

These tests are mostly diagnostic procedures that can assist the veterinarian in making his judgement of a detained carcass.

All tests and procedures must be carried out according to the STANDARD PROCEDURES FOR MEAT HYGIENE LABORATORIES and include the following tests:

1. Preparation of blood-smears

- a. Bloodsmears are made to examine a blood sample for the presence of protozoa, e.g. **Babesia**, **Anaplasma**, etc., for the presence of bacteria, especially anthrax bacilli and also for conditions such as anaemia.
- b. Bloodsmears should be made as soon as possible after the death of the animal, especially if the smear is to be used for cytological studies.
- c. Blood for blood-smears is usually collected by cutting a small vein on the ear or under the tail of the animal.
- d. A small drop of the blood is then picked up with the edge of a glass slide (slide A).
- e. Pick up a second slide (slide B) and hold it between the thumb and index finger and place slide A on the flat surface of slide B at an angle of approximately 45° so that the drop of blood spreads along the entire edge at the back of slide A.
- f. Smear the blood over the surface of slide B with a single quick stroke.
- g. Air-dry the film of blood by waving it through the air until completely dry.
- h. Fix in methyl alcohol for 3 minutes.
- i. Stain for 30 minutes in 10% Giemsa stain or 5 minutes in 50% Giemsa.
- j. Air-dry and examine under the oil immersion lens of the microscope.

2. Phase test for icterus

- a. Place 2 g of kidney fat (free from connective tissue and blood) in a test tube.
- b. Add 5 ml of a 5% aqueous solution of sodium hydroxide (Na⁺OH⁻).
- c. Clamp the test tube in a thongs and heat slowly and carefully over the flame of a Bunsen burner.

NB: always keep the mouth of the test tube away from yourself and from bystanders because sodium hydroxide reaches its boiling point very suddenly and with a stormy reaction!!!

- d. Boil for 1 minute until all the fat has dissolved.
- e. Cool down the contents of the tube by holding the tube under running tap water until the tube can just be comfortably held in the hand without burning.
- f. Slowly add 5 ml of di-ethyl ether and shake carefully.
- g. Allow the suspension to stand for a few minutes until the phases has separated, i.e. a water soluble phase at the bottom of the test tube and an ether soluble phase on top.
- h. If bile salts was present in the fat, it will form a water soluble salt in the bottom phase which will then be greenish-yellow in colour.
- i. If the fat was yellow due to plant pigments (mainly carotin) the ether phase on top will show a yellowish discoloration because plant pigments are insoluble in water.
- j. Plant pigments in the fat does not justify condemnation of the carcass.
- k. If both the ether and water soluble phases show a yellow discoloration, both plant pigments and bile salts was present in the fat and condemnation of the carcass is then justified because of the presence of bile salts.

3. Alcohol-flotation test for oedema

- a. This test is used to determine the water content of bone marrow, e.g. when judging an oedematous carcass. The water content of normal bone marrow of bovines is below 25%.
- b. Three reagents are needed, namely 32%, 47% and 52% ethanol.
- c. Pour 30 ml of each of the 3 reagents into separate glass beakers.
- d. Collect bone-marrow from the suspected carcass and float a pea-sized piece in each of the 3 beakers.
- e. If the marrow sinks to the bottom in all 3 beakers, the water content is more than 50% and the carcass is condemned for oedema.
- f. If the marrow floats in 32%, but sinks in 47% and 52%, the water contents are between 40 - 50% and the judgement will depend on the physical appearance of the suspected carcass after overnight chilling.
- g. If the marrow floats in 32% and 47%, but sinks in 52%, the water contents is between 25 - 40% and the judgement will also depends on the physical appearance of the carcass after overnight chilling.
- h. If the marrow floats in all three beakers, the water contents is below 25% and the carcass could be passed.

4. Determining the chlorine contents of water

The most convenient method for determining the chlorine content of water is by using the Lovibond Comparator Method. Three chlorine values is of importance in meat hygiene, namely **Total Residual Chlorine** (the amount of chlorine originally put into the water), **Free Chlorine** (the amount of usable chlorine left in the water) and **Combined Chlorine** (the amount of chlorine that was used up to kill micro-organisms in the water). Of these 3 values, the free chlorine content is the one most frequently used.

To determine the chlorine content of water, you will need the following equipment and reagents:

- Lovibond Comparator 2000
 - Comparator Chlorine discs
 - DPD Tablets No 1 and No 3
- a. Aseptically collect a water sample from an appropriate source on the slaughter floor.
 - b. Fill the left hand tube of the Comparator with 10 ml of the sample.
 - c. Rinse out the other tube with the sample but leave about 2ml in the tube.
 - d. Add to these 2 ml of sample one DPD No 1 Tablet and allow to dissolve or crush with a stirring rod.
 - e. Make the volume up to 10 ml with the sample, mix and place in the right hand compartment of the Comparator.
 - f. Immediately hold the Comparator against a bright white light and rotate the disc until a colour match is obtained.
 - g. Record the reading as p.p.m. of **free chlorine**.
 - h. To obtain a **total residual chlorine** reading, proceed as described above but use one DPD No 1 and one DPD No 3 tablet together.
 - i. Record the reading as p.p.m. of **total residual chlorine**.
 - j. To obtain a **combined chlorine** reading, deduct the free chlorine reading from the total residual chlorine reading.
 - k. Potable water should preferably have a free chlorine reading of at least 2 p.p.m. chlorine, whereas the water in a poultry spin chiller should have a free chlorine reading of at least 50 p.p.m. chlorine.

5. pH Determination of Meat

The pH-value of a live muscle is about 7,0 - 7,1. After slaughtering, disintegration processes commence which cause a gradual lowering of the pH-value from the initial 7,0 to values between 5,0 and 6,0 after 24 hrs.

pH-1 values (1 hour after death) are used as an early detection of PSE and DFD meat and pH-24 values (24 hours after death) of normal carcasses are used to determine the requirements set out in the Standing Regulations:

- Horses - 6,1
 - Pigs - 6,4
 - Cattle - 6,3
 - Sheep - 6,3
 - Goats - 6,3
- } Ruminants all 6.3

When the pH-24 value of a carcass is higher than the above mentioned requirements, the freshness of the carcass should be re-evaluated by the Veterinarian. Provided the bacteriological test results are negative, such meat may be passed or conditionally passed by him.

- a. Apparatus and materials needed are as follows:
 - Portable pH meter
 - Suitable meat piercing electrode
 - Piercing tool
 - Standard Buffer Solutions pH 7 and pH 4
 - Wash bottle containing distilled water
- b. The best measuring site is on the **M. Longissimus dorsi** directly across the last pair of ribs. Alternatively triceps brachi, gracillis.
- c. Prior to every series of readings, calibrate the pH meter in the buffer solutions according to the manufacturers instructions.
- d. Pierce a hole in the muscle with the piercing tool.
- e. Wipe the electrode with a soft tissue and insert the electrode into the prepared hole.
- f. Take and record the pH reading.
- g. Remove the electrode from the muscle, rinse the tip of the electrode with distilled water and wipe dry with a tissue. This must be done between every reading.
- h. Repeat the procedure on other carcasses.

6. Sampling for dispatch to other laboratories

Where pathological or other samples have to be dispatched to a laboratory for analyses, the sampling procedures, use of suitable containers, etc. should be according to those prescribed by the Veterinary Institute in their ONDERSTEPSPOORT DIAGNOSTIC SERVICE MANUAL available from the Institute.

The samples could be dispatched by courier to the laboratory, or you could make use of the arrangement between the Veterinary Institute and Drs du Buisson and Partners.

MEAT INSPECTORS MANUAL
RED MEAT

PART II
MEAT INSPECTION

MODULE 6

MEAT INSPECTION

Index**MEAT INSPECTION**

1. ANTE MORTEM INSPECTION
2. PRIMARY MEAT INSPECTION – BOVINE
3. SECONDARY MEAT INSPECTION
4. LABORATORY TECHNIQUES

1. Ante mortem inspection

1.1. Ante mortem inspections

- (1) A registered inspector doing ante mortem inspection at a –
 - (a) rural abattoir, must be at least a meat inspector or, provided exemption has been granted by the provincial executive officer, a meat examiner;
 - (b) low and high throughput abattoir, must at least be a meat inspector.
- (2) A declaration of health and origin must be provided for all animals by the owner of the slaughter stock and recorded by the abattoir owner and such health declaration must contain the following information –
 - (a) date of delivery;
 - (b) name and address of owner or farm;
 - (c) number of animals and specie(s);
 - (d) health status of the herd(s) including mortality rate; and
 - (e) medication, if given as well as withdrawal periods and dates.
- (3) An animal must be inspected on the day of arrival at the abattoir, and the inspection must be repeated on the day of slaughter if the slaughter is not done within 24 hours of arrival.
- (4) There must be a standard procedure at an abattoir to convey the information acquired in the lairages to the registered inspectors in the meat inspection area, and a method of marking specific animals for the attention of a registered inspector should be in place.

1.2. Further inspections and findings

- (1)
 - (a) All animals that in the opinion of a registered inspector, who is not a veterinarian, doing ante mortem inspection as described in regulation 79, are not fit for slaughter must be examined by a veterinarian who is a registered inspector
 - (b) The veterinarian, must decide whether such animals may be slaughtered, provisionally slaughtered or disposed of;
- (2) If the veterinarian decides that an animal mentioned in sub regulation (1)(a) may be slaughtered or provisionally slaughtered, the carcass of such animal is subject to secondary meat inspection in terms of regulation 107.
- (3) An animal may not be slaughtered if it is suspected that a forbidden substance has –
 - (a) been administered to it;
 - (b) been implanted in it;
 - (c) contaminated it; or
 - (d) been eaten by it.
- (4) No person may slaughter an animal which is on the point of giving birth or which has given birth in transit or lairage. (see also 68(11))

1.3. Handling of dead animals

- (1) All “dead on arrival” and “dead in pen” animals must be disposed of as condemned material in terms of Part VIII.
- (2) Prior to flaying or cutting up for disposal or inspection of such animals, a blood smear to rule out the possibility of Anthrax is required.
- (3) No dead or dying animal may be brought into the abattoir premises, unless it is part of a consignment of healthy animals, or may be removed from the abattoir premises.
- (4) No carcass or part thereof that has been condemned may be brought into any part of the abattoir containing edible products.
- (5) It is the owner’s choice to have a post mortem inspection done except where required by a registered inspector or where a controlled disease under the Animal Health Act, 2002 (Act No. 7 of 2002), is suspected in which case a state veterinarian must be notified.
- (6) The place and method of flaying dead animals for the purpose of regaining skins must be done according to a protocol approved by the provincial executive officer.

1.4. Quarantine

- (1) All animals suffering from a controlled disease contemplated in the Animal Health Act, 2002 (Act No.7 of 2002), must be moved to the abattoir under cover of a “red cross” permit issued by a state veterinarian at the farm and the arrival of the consignment at the abattoir must be confirmed to such state veterinarian.
- (2) If an animal is suffering from or is suspected of suffering from a controlled disease contemplated in the Animal Health Act, 2002 (Act No.7 of 2002), or if any animal has tested positive on the farm for brucellosis or tuberculosis and bears a C or T brand mark, and is not accompanied by a “red cross” permit, a state veterinarian of the Provincial Directorate: Veterinary Services, in whose area the abattoir is situated, must be notified immediately.
- (3) In the event of an abattoir being declared a prohibited or restricted area under the Animal Health Act, 2002 (Act No.7 of 2002), the provincial executive officer may instruct the owner to slaughter an animal under conditions laid down by that officer.
- (4) Vehicles that transported animals suffering from a controlled disease must be washed and disinfected as determined by a state veterinarian before leaving the abattoir premises.

1.5. Guidelines

83. A registered inspector must acquaint him/her-self of all further guidelines issued by the national executive officer regarding ante-mortem inspections.

2. Primary meat inspections

2.1. Provisions for meat inspection personnel

The provincial executive officer may determine the number of meat inspectors or meat examiners required in an abattoir after having considered the abattoir design, number of inspection stations, line speed, different species, structural and managerial aspects.

2.2. General

- (1) No carcass, part thereof, rough or red offal may be sold or dispatched from an abattoir unless inspected and approved by a registered inspector and marked with the “PASSED” mark, as contemplated in Part VII.

- (2) All relevant information, including ante mortem and health records, must be taken into consideration when doing meat inspection.
- (3) A person may not remove, cut or debone any carcass or meat prior to inspection.
- (4) A person may not remove any sign or evidence of any disease, condition, contamination or soiling by washing, trimming or any other manner prior to meat inspection, unless it is done under the supervision of a registered inspector.
- (5) No lymph nodes may be removed prior to meat inspection.
- (6) Heads, feet, rough and red offal must be identifiable with the carcass of origin until inspection is done.
- (7) Any carcass, meat or viscera which, in the opinion of the registered inspector, is not fit for human or animal consumption must be detained for secondary inspection.
- (8) A registered inspector must acquaint him or her-self of all further guidelines issued by the national executive officer regarding primary meat inspections.

2.3. *Inspection of cattle carcasses*

- (1) The registered inspector must inspect a carcass by means of observation, palpation, smell and, where necessary, incision and must take into consideration –
 - (a) its state of nutrition;
 - (b) its colour;
 - (c) its odour;
 - (d) its symmetry;
 - (e) the efficiency of its bleeding;
 - (f) any contamination;
 - (g) its pathological conditions;
 - (h) any parasitic infestation;
 - (i) any injection marks;
 - (j) any bruising and injuries;
 - (k) any abnormalities of muscles, bones, tendons, joints or other tissues; and
 - (l) the age and sex of the animal from which it was derived.
- (2) When inspecting the hindquarter, a registered inspector must inspect bilaterally –
 - (a) the parietal peritoneum, by observation;
 - (b) the *Lnn iliaci mediales et laterales* and the *Lnn subiliacus*, by multiple incisions;
 - (c) the *Lnn inguinalis superficialis*, by multiple incisions;
 - (d) the muscular part of the diaphragm, by making two incisions approximately 25 mm apart and removing the peritoneal layer to expose the muscle; and
 - (e) the kidneys, by exposure or incisions if necessary and the *Lnn. renalis* by incisions if necessary.
- (3) When inspecting the forequarter, the registered inspector must inspect bilaterally –
 - (a) the parietal pleura by observation;
 - (b) the *Lnn cervicalis superficialis*, by palpation; and
 - (c) the *M triceps brachii*, by making one deep transverse incision through the distal part of the muscle.

- (4) The sternum, ribs, vertebrae and spinal cord must be inspected on carcasses which have been split.

2.3.1. Inspection of cattle heads

- (1) When inspecting the head the registered inspector must inspect bilaterally –
 - (a) the *Lnn mandibulares*, *Lnn parotidei*, and the *Lnn retropharyngiales*, by multiple incisions; and
 - (b) the external masseters (*M. masseter*), by making two deep linear incisions parallel to the mandible, and the internal masseters (*M. pterigoideus medialis*), by making a single deep linear incision.
- (2) The registered inspector must observe and palpate the tongue.
- (3) The registered inspector must observe the skin (or external surface of de-masked heads), lips, gums, hard and soft palates, eyes and nostrils.
- (4) The tonsils must be removed after inspection as part of the slaughtering process and condemned.

2.3.2. Inspection of feet

The feet must be inspected by observation.

2.3.3. Inspection of cattle red offal

When inspecting the red offal, the registered inspector must inspect –

- (a) the surface of the visceral pleura, by observation;
- (b) the liver by palpation and incisions into the gastric surface and the base of the caudate lobe to open the bile ducts;
- (c) the hepatic lymph nodes, by multiple incisions into the *Ln. hepaticus*;
- (d) the trachea, by a lengthwise incision and the oesophagus by observation;
- (e) the lungs, by palpation and an incision in their posterior thirds perpendicular to their main axes to open the main branches of the bronchi;
- (f) the *Lnn mediastinales*, by multiple incisions;
- (g) the *Lnn bronchiales* bilaterally, by multiple incisions;
- (h) the pericardium and the heart, by an incision made lengthwise to cut through the interventricular septum and open the ventricles and two additional vertical cuts into the split septum;
- (i) the spleen, by visual inspection and if necessary by incision;
- (j) the tail, by observation;
- (k) the thyroid gland, by observation;
- (l) both sides of the diaphragm, by observation; and
- (m) the testes, by observation.

2.3.4. *Inspection of cattle rough offal*

When inspecting the rough offal, the registered inspector must inspect –

- (a) the visceral peritoneum as well as the omentum, by observation;
- (b) if necessary, the inner surfaces of the stomach and intestines, but this inspection may only take place in the rough offal room or detention area with separate equipment;
- (c) the gastric and mesenteric lymphnodes (*Lnn gastrici, mesenterici, cranialis and caudalis*), by observation and, if necessary by multiple incisions.

2.4. *Inspection of sheep or goat carcasses*

- (1) The registered inspector must inspect a carcass by means of observation, palpation, smell and, where necessary incision, and must take into consideration –
 - (a) its state of nutrition;
 - (b) its colour;
 - (c) its odour;
 - (d) its symmetry;
 - (e) the efficiency of its bleeding;
 - (f) any contamination;
 - (g) its pathological conditions;
 - (h) any parasitic infestation;
 - (i) any injection marks;
 - (j) any bruising and injuries;
 - (k) any abnormalities of muscles, bones, tendons, joints, or other tissues; and
 - (l) the age and sex of the animal from which it was derived.
- (2) When inspecting the hindquarter, the registered inspector must inspect bilaterally –
 - (a) the parietal peritoneum, by observation;
 - (b) the *Lnn iliaci mediales et laterales*, by observation;
 - (c) the *Lnn inguinalis superficialis, Lnn subiliacus, Lnn popliteus and Lnn analis*, by palpation;
 - (d) the kidneys, by exposure, observation and palpation and the *Lnn. renalis*, by palpation; and
 - (e) the muscular part of the diaphragm by visual inspection.
- (3) When inspecting the forequarter, the registered inspector must inspect bilaterally -
 - (a) the parietal pleura and thoracic cavity, by observation; and
 - (b) the *Lnn cervicalis superficialis*, by palpation;

2.4.1. *Inspection of sheep and goat heads*

The registered inspector must visually inspect the head and when necessary, inspect the throat, mouth, tongue and *Lnn mandibulares, Lnn parotidei*, and the *Lnn retropharyngiales*, making incisions as required.

2.4.2. *Inspection of feet*

The feet must be inspected by observation.

2.4.3. *Inspection of sheep and goat red offal*

When inspecting the red offal, the registered inspector must inspect –

- (a) the surface of the visceral pleura, by observation;
- (b) the liver, by palpation and incisions into the gastric surface and the base of the caudate lobe to open the bile ducts;
- (c) the hepatic lymph nodes, by multiple incisions into the *Ln. hepaticus*;
- (d) the lungs, oesophagus and trachea, by observation and palpation;
- (e) the *Lnn bronchiales* and *Lnn mediastinales*, by observation and palpation;
- (f) the pericardium and the heart, by an incision made lengthwise to open the ventricles;
- (g) the spleen, by observation and if necessary palpation;
- (h) both sides of the diaphragm, by observation; and
- (i) the testes, by observation.

2.4.4. *Inspection of sheep and goat rough offal*

When inspecting the rough offal, the registered inspector must inspect –

- (a) the visceral peritoneum as well as the omentum, by observation;
- (b) if necessary, the inner surfaces of the stomach and intestines, but this inspection may only take place in the rough offal room or detention area with separate equipment; and
- (c) the gastric and mesenteric lymphnodes (*Lnn gastrici, mesenterici, cranialis and caudalis*), by observation.

2.5. *Inspection of pig carcasses*

- (1) The Registered Inspector must inspect a carcass by means of observation, palpation, smell and, where necessary, incision, and must take into consideration –
 - (a) its state of nutrition;
 - (b) its colour;
 - (c) its odour;
 - (d) its symmetry;
 - (e) the efficiency of its bleeding;
 - (f) any contamination;
 - (g) its pathological conditions;
 - (h) any parasitic infestation;
 - (i) any injection marks;
 - (j) any bruising and injuries;
 - (k) any abnormalities of muscles, bones, tendons, joints or other tissues; and
 - (l) the age and sex of the animal from which it was derived.

- (2) When inspecting the hindquarter, the registered inspector must inspect bilaterally –
- (a) the parietal peritoneum, by observation;
 - (b) the *Lnn iliaci mediales et laterales*, by multiple incisions;
 - (c) the *Lnn inguinalis superficialis*, by multiple incisions;
 - (d) the muscular part of the diaphragm, by making two incisions approximately 25 mm apart and removing the peritoneal layer to expose the muscle; and
 - (e) kidneys, by exposure or incisions if necessary and the *Lnn. renalis* by incisions if necessary.
 - (f) The tail and if any signs of necrosis due to tail biting is observed, the carcass must be split and the spine examined.
- (3) When inspecting the forequarter, the registered inspector must inspect bilaterally –
- (a) the parietal pleura, by observation; and
 - (b) the *M triceps brachii*, by making one deep transverse incision through the distal part of the muscle. In the case of pigs weighing between 54 kg and 92 kg these incisions may be omitted provided that the heart is inspected and no cysticerci are found elsewhere in the carcass.
- (4) Where the carcass has been split, the sternum, ribs, vertebrae and spinal cord must be inspected.

2.5.1. Inspection of pig head

- (1) When inspecting the head the registered inspector must inspect bilaterally –
- (a) the *Lnn mandibulares and Lnn parotidei*, by multiple incisions; and
 - (b) the external masseters (*M. masseter*), by making two deep linear incisions parallel to the mandible and the internal masseters (*M. pterygoideus medialis*) by making a single deep linear incision.
- (2) The registered inspector must observe the tongue, skin, lips, gums, hard and soft palate, eyes and nostrils.

2.5.2. Inspection of pig red offal

When inspecting the red offal, the registered inspector must inspect –

- (a) the surface of the visceral pleura, by observation;
 - (b) the liver, by palpation and incisions into the gastric surface and the base of the caudate lobe to open the bile ducts;
 - (c) the hepatic lymph nodes, by multiple incisions into *the Ln. hepaticus*;
 - (d) the trachea, by a lengthwise incision and the oesophagus by observation;
 - (e) the lungs, by palpation and an incision in their posterior thirds perpendicular to their main axes to open the main branches of the bronchi;
- (f) the lungs, for contamination with water from the scalding tank and if contaminated such lungs may not be passed;
- (g) the *Lnn mediastinales*, by multiple incisions;
- (h) the *Lnn bronchiales* bilaterally, by multiple incisions;

- (i) the pericardium and the heart, by an incision made lengthwise to cut through the interventricular septum and open the ventricles and two additional vertical cuts into the split septum;
- (j) the spleen, by visual inspection and if necessary incision;
- (k) both sides of the diaphragm, by observation; and
- (l) the testes, by observation.

2.5.3. **Inspection of pig rough offal**

When inspecting the rough offal, the registered inspector must inspect –

- (a) the visceral peritoneum as well as the omentum, by observation;
- (b) if necessary, the inner surfaces of the stomach and intestines, but this inspection may only take place in the rough offal room or detention area with separate equipment; and
- (c) the gastric and mesenteric lymphnodes (*Lnn gastrici, mesenterici, cranialis and caudalis*) by observation and, if necessary by multiple incisions.

2.6. **Inspection of horse carcass**

- (1) The registered inspector must inspect a carcass by means of observation, palpation, smell and, where necessary incision, and must take into consideration –
 - (a) its state of nutrition;
 - (b) its colour;
 - (c) its odour;
 - (d) its symmetry;
 - (e) the efficiency of its bleeding;
 - (f) any contamination;
 - (g) its pathological conditions;
 - (h) any parasitic infestation;
 - (i) any injection marks;
 - (j) any bruising and injuries;
 - (k) any abnormalities of muscles, bones, tendons, joints or other tissues; and
 - (l) the age and sex of the animal from which it was derived;
- (2) When inspecting the hindquarter, the registered inspector must inspect bilaterally –
 - (a) the parietal peritoneum, by observation;
 - (b) the *Lnn iliaci mediales et laterales*, and the *Lnn subiliacus* by multiple incisions; and
 - (c) the kidneys, by exposure or incisions if necessary and the *Lnn. renalis* by incisions if necessary.
- (3) When inspecting the forequarter, the registered inspector must inspect bilaterally –
 - (a) the parietal pleura, by observation; and
 - (b) the *Lnn cervicalis superficialis*, by palpation.

- (4) Carcasses must be split after which the sternum, ribs, vertebrae and spinal cord must be inspected.

2.6.1. Examination of horse head

The registered inspector must –

- (a) examine the head by observation;
- (b) palpate the tongue; and
- (c) observe the skin, lips, gums, hard and soft palate, eyes and nostrils.

2.6.2. Inspection of feet

The feet must be inspected by observation.

2.6.3. Inspection of horse red offal

When inspecting the red offal, the registered inspector must inspect –

- (a) the surface of the visceral pleura, by observation;
- (b) the liver, by palpation and incisions to open the bile ducts;
- (c) the hepatic lymph nodes, by multiple incisions into the *Ln. hepaticus*;
- (d) the lungs, oesophagus and trachea by observation and palpation and an incision into the trachea;
- (e) the pericardium and the heart, by an incision made lengthwise to cut through the interventricular septum;
- (f) the spleen, by visual inspection and if necessary by palpation;
- (g) the tail, by observation;
- (h) both sides of the diaphragm, by observation; and
- (i) the testes, by observation.

2.6.4. Inspection of horse rough offal

When inspecting the rough offal, the registered inspector must inspect –

- (a) the visceral peritoneum, by observation; and
- (b) the outer surface of the stomach and intestines as well as the omentum, by observation.

2.7. Parasitic intermediate stages – additional incisions and treatment

Parasitic intermediate stages and treatment

- (1) A carcass, head and red offal found to be infested with one or more parasitic intermediate stages, which may be alive or calcified, must be detained and in bovine and pigs, two additional incisions must be made into each *M. triceps brachii*, parallel and proximal to the original incisions.
- (2) If one or more parasitic intermediate stages are found on the majority of incision surfaces the carcass must be condemned.
- (3) Where the infestation is not excessive the carcass and organs may be passed on condition that it undergoes treatment as described below.
- (4) A conditionally passed carcass must be identified by roller marking in red ink along its entire side with the letter "M", being a minimum of 2 cm in height.

- (5) All parts belonging to the carcass to be treated, must be identified by "M" tags.
- (6) Carcasses and organs must be treated by freezing –
 - (a) as sides in a freezer with air temperature at minus 18 °C for 72 hours;
 - (b) as sides in a freezer with air temperature at minus 10 °C for 10 days;
 - (c) to reach a deep bone or core temperature of less than minus 6 °C, confirmed by the registered inspector and in accordance with the protocol approved for the specific abattoir by the provincial executive officer;
 - (d) after deboning, in accordance with a protocol approved by the provincial executive officer and –
 - (i) the container or carton in which deboned meat is packed must be marked with the letter "M" and the date of introduction into the freezer must be indicated;
 - (ii) the core temperature of the meat inside the container must be below minus 6 °C before it can be released by the registered inspector.
 - (e) in portions in a chest type freezer according to a protocol approved the provincial executive officer.
- (7) Visible parasitic intermediate stages must be removed from the meat of a carcass that is conditionally passed and treated as described above.
- (8) Records of core temperatures, freezer temperatures and batches of containers, carcasses and organs introduced for freezing must be kept by the abattoir owner for at least six months, and must be available for inspection purposes.

3. SECONDARY MEAT INSPECTIONS

3.1. General

- (1) Suspect carcasses found during primary meat inspections in terms of sub part B, must be marked "detained" and must be subjected to secondary meat inspection by a registered inspector who is a veterinarian.
- (2) A secondary inspection, on a carcass must reveal the –
 - (a) species, age and sex;
 - (b) clotting and staining characteristics of the blood;
 - (c) organ or part of the carcass affected;
 - (d) condition or disease and the probable cause thereof;
 - (e) judgement and the motivation therefore where applicable.
- (3) Depending on the said finding, the carcass, organ or meat may be –
 - (a) passed;
 - (b) conditionally passed, subject to treatment;
 - (c) partially passed by removing the condemned part; or
 - (d) totally condemned.
- (4) Where a carcass is not passed, the owner may request a written certificate.

3.2. *Emergency slaughtered animals*

- (1) The meat of animals which were referred to a veterinarian, who is a registered inspector, during ante mortem inspection, as contemplated in regulation 80, must be examined by such veterinarian who must pay particular attention to –
 - (a) blood content of intercostal veins, the small vessels beneath the serosa of the abdominal wall and in the retroperitoneal fat in the walls of the pelvis;
 - (b) all visible lymph nodes after the carcass has been split and examine and loosen a shoulder and open an acetabulum from the medial aspect to observe the exposed connective tissue, fat, lymph nodes and articular surface; and
 - (c) the condition of the musculature and abnormal odours and colour of the carcass.
- (2) If regarded as necessary by the veterinarian, the carcass or meat must be subjected to laboratory examination in order to make a final decision.

3.3. *Records*

108. The results of the ante mortem examination, primary meat inspection and secondary meat inspection must be recorded, and where zoonotic and controlled diseases, contemplated in the Animal Diseases Act, 1984 (Act No. 35 of 1984), are diagnosed, the local state veterinarian must be notified on the day of slaughter.

3.4. *Guidelines*

A registered inspector who is a veterinarian, must acquaint him/her-self of all further guidelines issued by the national executive officer regarding secondary meat inspections.

3.5. GENERAL REQUIREMENTS FOR PERSONS DOING MEAT INSPECTIONS

3.5.1. *Required qualifications for other persons doing meat inspection at red meat abattoirs*

The other duly qualified persons to perform meat inspection services as contemplated in section 11(I)(d) of the Act are –

- (a) persons having an appropriate bio-scientific qualification as approved by the national executive officer; and
- (b) if required by the national executive officer, a certificate for Red Meat Examiners which is approved by the national executive officer and accredited by South African Qualifications Authority (SAQA).

3.5.2. *Registration as registered inspector with provincial executive officer*

Persons contemplated in section 11(I)(c) of the Act wishing to provide meat inspection services must register with the provincial executive officer in order to perform these services at a specified abattoir.

4. LABORATORY TECHNIQUES

1. PREPARATION OF BLOOD-SMEARS
2. PHASE TEST FOR ICTERUS
3. ALCOHOL-FLOTATION TEST FOR OEDEMA
4. DETERMINING THE CHLORINE CONTENTS OF WATER
5. PH DETERMINATION OF MEAT
6. SAMPLING FOR DISPATCH TO OTHER LABORATORIES

Although a meat examiner is not trained as a laboratory technician, there are a few tests that could be performed with just the basic skills and equipment.

These tests are mostly diagnostic procedures that can assist the veterinarian in making his judgement of a detained carcass.

All tests and procedures must be carried out according to the STANDARD PROCEDURES FOR MEAT HYGIENE LABORATORIES and include the following tests:

1. Preparation of blood-smears

- a. Bloodsmears are made to examine a blood sample for the presence of protozoa, e.g. **Babesia**, **Anaplasma**, etc., for the presence of bacteria, especially anthrax bacilli and also for conditions such as anaemia.
- b. Bloodsmears should be made as soon as possible after the death of the animal, especially if the smear is to be used for cytological studies.
- c. Blood for blood-smears is usually collected by cutting a small vein on the ear or under the tail of the animal.
- d. A small drop of the blood is then picked up with the edge of a glass slide (slide A).
- e. Pick up a second slide (slide B) and hold it between the thumb and index finger and place slide A on the flat surface of slide B at an angle of approximately 45° so that the drop of blood spreads along the entire edge at the back of slide A.
- f. Smear the blood over the surface of slide B with a single quick stroke.
- g. Air-dry the film of blood by waving it through the air until completely dry.
- h. Fix in methyl alcohol for 3 minutes.
- i. Stain for 30 minutes in 10% Giemsa stain or 5 minutes in 50% Giemsa.
- j. Air-dry and examine under the oil immersion lens of the microscope.

2. Phase test for icterus

- a. Place 2 g of kidney fat (free from connective tissue and blood) in a test tube.
- b. Add 5 ml of a 5% aqueous solution of sodium hydroxide (Na⁺OH⁻).
- c. Clamp the test tube in a thongs and heat slowly and carefully over the flame of a Bunsen burner.

NB: always keep the mouth of the test tube away from yourself and from bystanders because sodium hydroxide reaches its boiling point very suddenly and with a stormy reaction!!!

- d. Boil for 1 minute until all the fat has dissolved.
- e. Cool down the contents of the tube by holding the tube under running tap water until the tube can just be comfortably held in the hand without burning.
- f. Slowly add 5 ml of di-ethyl ether and shake carefully.
- g. Allow the suspension to stand for a few minutes until the phases has separated, i.e. a water soluble phase at the bottom of the test tube and an ether soluble phase on top.
- h. If bile salts was present in the fat, it will form a water soluble salt in the bottom phase which will then be greenish-yellow in colour.
- i. If the fat was yellow due to plant pigments (mainly carotin) the ether phase on top will show a yellowish discoloration because plant pigments are insoluble in water.
- j. Plant pigments in the fat does not justify condemnation of the carcass.
- k. If both the ether and water soluble phases show a yellow discoloration, both plant pigments and bile salts was present in the fat and condemnation of the carcass is then justified because of the presence of bile salts.

3. Alcohol-flotation test for oedema

- a. This test is used to determine the water content of bone marrow, e.g. when judging an oedematous carcass. The water content of normal bone marrow of bovines is below 25%.
- b. Three reagents are needed, namely 32%, 47% and 52% ethanol.
- c. Pour 30 ml of each of the 3 reagents into separate glass beakers.
- d. Collect bone-marrow from the suspected carcass and float a pea-sized piece in each of the 3 beakers.
- e. If the marrow sinks to the bottom in all 3 beakers, the water content is more than 50% and the carcass is condemned for oedema.
- f. If the marrow floats in 32%, but sinks in 47% and 52%, the water contents are between 40 - 50% and the judgement will depend on the physical appearance of the suspected carcass after overnight chilling.
- g. If the marrow floats in 32% and 47%, but sinks in 52%, the water contents is between 25 - 40% and the judgement will also depends on the physical appearance of the carcass after overnight chilling.
- h. If the marrow floats in all three beakers, the water contents is below 25% and the carcass could be passed.

4. Determining the chlorine contents of water

The most convenient method for determining the chlorine content of water is by using the Lovibond Comparator Method. Three chlorine values is of importance in meat hygiene, namely **Total Residual Chlorine** (the amount of chlorine originally put into the water), **Free Chlorine** (the amount of usable chlorine left in the water) and **Combined Chlorine** (the amount of chlorine that was used up to kill micro-organisms in the water). Of these 3 values, the free chlorine content is the one most frequently used.

To determine the chlorine content of water, you will need the following equipment and reagents:

- Lovibond Comparator 2000
 - Comparator Chlorine discs
 - DPD Tablets No 1 and No 3
- a. Aseptically collect a water sample from an appropriate source on the slaughter floor.
 - b. Fill the left hand tube of the Comparator with 10 ml of the sample.
 - c. Rinse out the other tube with the sample but leave about 2ml in the tube.
 - d. Add to these 2 ml of sample one DPD No 1 Tablet and allow to dissolve or crush with a stirring rod.
 - e. Make the volume up to 10 ml with the sample, mix and place in the right hand compartment of the Comparator.
 - f. Immediately hold the Comparator against a bright white light and rotate the disc until a colour match is obtained.
 - g. Record the reading as p.p.m. of **free chlorine**.
 - h. To obtain a **total residual chlorine** reading, proceed as described above but use one DPD No 1 and one DPD No 3 tablet together.
 - i. Record the reading as p.p.m. of **total residual chlorine**.
 - j. To obtain a **combined chlorine** reading, deduct the free chlorine reading from the total residual chlorine reading.
 - k. Potable water should preferably have a free chlorine reading of at least 2 p.p.m. chlorine, whereas the water in a poultry spin chiller should have a free chlorine reading of at least 50 p.p.m. chlorine.

5. pH Determination of Meat

The pH-value of a live muscle is about 7,0 - 7,1. After slaughtering, disintegration processes commence which cause a gradual lowering of the pH-value from the initial 7,0 to values between 5,0 and 6,0 after 24 hrs.

pH-1 values (1 hour after death) are used as an early detection of PSE and DFD meat and pH-24 values (24 hours after death) of normal carcasses are used to determine the requirements set out in the Standing Regulations:

- Horses - 6,1
 - Pigs - 6,4
 - Cattle - 6,3
 - Sheep - 6,3
 - Goats - 6,3
- } Ruminants all 6.3

When the pH-24 value of a carcass is higher than the above mentioned requirements, the freshness of the carcass should be re-evaluated by the Veterinarian. Provided the bacteriological test results are negative, such meat may be passed or conditionally passed by him.

- a. Apparatus and materials needed are as follows:
- Portable pH meter
 - Suitable meat piercing electrode
 - Piercing tool
 - Standard Buffer Solutions pH 7 and pH 4
 - Wash bottle containing distilled water
- b. The best measuring site is on the **M. Longissimus dorsi** directly across the last pair of ribs. Alternatively triceps brachi, gracillis.
- c. Prior to every series of readings, calibrate the pH meter in the buffer solutions according to the manufacturers instructions.
- d. Pierce a hole in the muscle with the piercing tool.
- e. Wipe the electrode with a soft tissue and insert the electrode into the prepared hole.
- f. Take and record the pH reading.
- g. Remove the electrode from the muscle, rinse the tip of the electrode with distilled water and wipe dry with a tissue. This must be done between every reading.
- h. Repeat the procedure on other carcasses.

6. Sampling for dispatch to other laboratories

Where pathological or other samples have to be dispatched to a laboratory for analyses, the sampling procedures, use of suitable containers, etc. should be according to those prescribed by the Veterinary Institute in their ONDERSTEPSPOORT DIAGNOSTIC SERVICE MANUAL available from the Institute.

The samples could be dispatched by courier to the laboratory, or you could make use of the arrangement between the Veterinary Institute and Drs du Buisson and Partners.