RED MEAT
Examiners Manual

STUDENT MANUAL
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.

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INTRODUCTION

The Directorate Veterinary Services of the National Department of Agriculture was constitutionally tasked to 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.

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Meat Inspectors Manual

Part I
Abattoir Hygiene

Module 1
Microbiology
Index

MICROBIOLOGY

1. INTRODUCTION
2. TYPES OF ORGANISMS
3. IMPORTANCE OF BACTERIA
4. ELEMENTARY BACTERIOLOGY
5. GROUPS OF BACTERIA
6. BACTERIAL SPORES
7. BACTERIA ISOLATED FROM RED MEAT AND POULTRY MEAT
8. MICROBIOLOGY OF MEAT PRODUCTION
9. MINIMISING BACTERIAL CONTAMINATION DURING SLAUGHTERING
10. SPOILAGE BACTERIA
11. FOODBORNE DISEASES
12. BACTERIA ASSOCIATED WITH FOODBORNE DISEASES
13. MICROBIOLOGICAL EXAMINATION
14. SAMPLING AND SAMPLING METHODS
15. MICROBIOLOGICAL ASSESSMENT OF HYGIENE
16. BACTERIA/ GROUPS OF BACTERIA EVALUATED
17. MEASURING METABOLIC ACTIVITY OF MICRO-ORGANISMS
18. INDICATORS OF POTENTIAL PRESENCE OF PATHOGENS
19. INDICATORS OF POST HEAT PROCESSING CONTAMINATION
20. STANDARD METHOD FOR TOTAL AEROBIC MESOPHYLLIC COUNTS
MICROBIOLOGY

1. INTRODUCTION

The purpose of studying abattoir microbiology is to ensure that the number of micro-organisms on the meat is as low as possible by the time it leaves the abattoir. For this purpose some knowledge of micro-organisms, how they behave and how to control them, is needed.

Definition

Microbiology is the study of micro-organisms that are small living creatures; exist as single cells or cell clusters and that are mostly free-living. (Microbial cells are thus distinct from animals or plant cells that are unable to live free in nature but can exist only as part of organisms consisting of many cells.)

Food microbiology is the study of small living creatures found in foods.

2. TYPES OF ORGANISMS

A number of small organisms are important in foods such as:

- Bacteria
- Yeasts and moulds (fungi)
- Viruses
- Protozoa

3. IMPORTANCE OF BACTERIA

Bacteria are by far the most important group encountered in red meat and poultry production and are of great concern from the standpoint of both food spoilage and foodborne disease. The fungi are less important but do cause some problems. Viruses and protozoa are of concern but more difficult to pick up in routine tests. The emphasis in this overview will be on the bacteria.

4. ELEMENTARY BACTERIOLOGY

4.1 The size, shapes and habits of bacteria

Bacteria are exceedingly small individual single celled organisms that cannot be seen with the unaided eye. They are observed under a microscope. By the time bacterial colonies can be seen with the naked eye, they consist of many (more than a billion) cells per colony. Bacteria are therefore present on surfaces in the abattoir and on the meat without our being aware of them unless they are so many that we can actually see them. By this time meat will be slimy and obviously spoilt.

Different types of bacteria differ in shape and size. They can be round, oval; rod shaped etc. and can be larger or smaller. Usually the shape and size of bacteria tells the non-specialist hardly anything about the type of organism one is dealing with.

Bacteria are everywhere except when they are deliberately excluded or destroyed. By practising good abattoir hygiene and slaughtering techniques, the number of bacteria on carcasses can be kept low or even reduced.

4.2 Requirements for Bacterial Growth

It is important to remember that, like all animals, bacteria require moisture and certain nutrients in order to grow. Meat is rich in nutrients and water and can support good growth of a variety of bacteria. In addition, there are many other environmental factors that influence the ability of bacteria to survive and grow, such as temperature, the gasses in the atmosphere around them (gaseous atmosphere), acidity (pH), etc. It is the manipulation of these growth requirements that helps us to control micro-organisms in the abattoir.
4.2.1 Method of Bacterial Growth (Multiplication)

When we speak of bacterial growth, we are really referring to bacterial multiplication. Bacteria multiply by the process of binary fission, which is 1 parent cell divides to produce 2 daughter cells (one generation); each daughter cell divides to produce 2 additional cells and so on. For example, if we assume that we have 1000 bacteria per gram of meat, and that all the bacteria multiplied as above, they would reach 1 000 000 (also written as 1x10^6) bacteria per gram in 10 generations... (1 000; 2 000; 4 000; 8 000; 16 000; 32 000; 64 000; 128 000; 256 000; 512 000; 1 024 000). From this follows that both the number of bacteria initially present as well as the number of multiplications they undergo determine the number of bacteria eventually present on the meat. Both initial numbers and growth of bacteria on carcasses must be kept low during abattoir processing.

Generation time, i.e., the time necessary to produce a generation, is an important consideration in abattoirs. Some types of bacteria have a very short generation time; only a matter of minutes, while others have a generation time of hours. An important factor influencing the generation time of bacteria is temperature. The use of refrigeration to lengthen the generation time of unwanted bacteria (e.g., spoilage bacteria) and therefore slow down their multiplication is a common and most important method of extending the shelf-life of perishable products like meat.

4.2.2 Growth Cycle

The growth cycle of bacteria consist of a short period of little or no growth (lag phase), then the population increases rapidly (the phase of logarithmic growth or log phase) toward a maximum and reaches a plateau (stationary phase), and then decreases (death phase). The lag phase is a period of adjustment during which there is considerable cellular activity but little or no cell division. Providing a less than desirable environment for multiplication such as refrigeration usually prolongs the length of the lag phase. During the log phase, cell division occurs rapidly at a fairly constant rate. During the stationary phase, a balance between cell division and cell death maintains the maximum number of live cells. Cell death during the phase of death is caused by many factors, the most prominent of which is the accumulation of the cell's own products. An example would be, in the case of fermented meat products, the accumulation of lactic acid.

4.2.3 Temperature and Bacterial Growth

Most bacterial species have a minimum, maximum, and optimum temperature for growth.

- **Psychrotrophic bacteria** – capable of growth at commercial refrigeration temperatures. Most psychrotrophic bacteria grow best at 15-25°C (59-77°F) and at slower rates under refrigerated storage. These are especially significant because many of the common red meat and poultry spoilage bacteria are psychrophils.
- **Mesophytic bacteria** – grow best at temperatures between 20°C and 45°C (68-113°F). Bacteria growing in the gastro-intestinal tract of the live animal are mostly mesophiles.
• **Thermophilic bacteria** – grow best at temperatures above 45°C (113°F). Many will not grow below 40°C (104°F).
• **Thermoduric bacteria** – capable of surviving mild heat treatments such as pasteurisation.

### 4.2.4 Gaseous Atmosphere and Bacterial Growth

• Aerobic bacteria grow only in the presence of oxygen.
• Anaerobic bacteria grow only in the absence of oxygen.
• Facultative anaerobic bacteria grow in the presence or absence of oxygen.
• Micro-aerophilic bacteria grow in an atmosphere containing less oxygen than in air.

The fact that bacteria have varying gaseous atmospheric requirements is of great significance in the red meat and poultry industries. Meat is often wrapped in plastic that is readily permeable to oxygen. Here we expect the growth of psychrotrophic aerobes. However, on vacuum packaged meat products other bacteria, such as micro aerophilic bacteria or psychrotrophic facultative anaerobes, will grow better. The special plastic material used for vacuum packaging is not permeable to oxygen.

### 5. GROUPS OF BACTERIA

As already stated, bacteria are present in all natural environments. We breathe in countless bacteria even in the purest mountain air. Most of those are not harmful, some are used by man and a small minority are undesirable.

#### 5.1 Bacteria used in foodstuff production

Some bacteria are used to produce the desirable body, texture and flavour in foods. Examples of these are fermented sausages, pickles, cheese, yoghurt, sauerkraut, vinegar, souring of sorghum beer and sourdough bread. Yeasts are used to produce ordinary bread and alcoholic beverages such as wine, barley and other beers.

#### 5.2 Spoilage bacteria

This group includes bacteria that will cause deterioration of foods through breakdown of the food constituents and/or accumulation of undesirable end products of bacterial metabolism. Poultry and meat even if produced under hygienic conditions and stored under refrigeration, will ultimately become unacceptable due to the growth of psychrotrophic spoilage bacteria.

#### 5.3 Food-Borne Pathogens

Those bacteria that is capable of causing illness in persons consuming the food. Some of the more important examples from meat include *Salmonella*, *Campylobacter*, *Yersinia enterocolitica*, *Staphylococcus aureus*, *Listeria monocytogenes*, *Clostridium perfringens*, and *Clostridium botulinum* (*Clostridium botulinum* is particularly dangerous because it produces one of the most powerful known toxins).

### 6. BACTERIAL SPORES

A few bacteria (e.g. the genera *Bacillus* and *Clostridium*) are capable of producing a body called a spore inside the cell (functionally spores resemble plant seeds). Bacterial spores are more resistant to adverse conditions such as heat, chemicals, dehydration, and irradiation than the cell itself. Thus, the cell may be killed but the spore may survive.

Among these spore forming bacteria are:

• Typical spoilage bacteria of heat processed canned foods such as the flat sour bacteria (*Bacillus steareothermophilus*) and
• Some are capable of causing food-borne disease, such as *Clostridium botulinum*, *Clostridium perfringens*, and *Bacillus cereus*.
7. **BACTERIA ISOLATED FROM RED MEAT AND POULTRY**

Members of the following bacterial genera can with greater or lesser regularity and some only rarely, be recovered from red meat, poultry and their products:

- **Acinetobacter**
- **Aeromonas**
- **Alcaligenes**
- **Arthrobacter**
- **Bacillus**
- **Bronchothrix**
- **Brucella**
- **Campylobacter**
- **Clostridium**
- **Corynebacterium**
- **Enterobacter**
- **Escherichia**
- **Flavobacterium**
- **Hafnia**
- **Lactobacillus**
- **Listeria**
- **Microbacterium**
- **Micrococcus**
- **Moraxella/Acinetobacter group**
- **Pediococcus**
- **Pseudomonas**
- **Salmonella**
- **Staphylococcus**
- **Streptococcus**
- **Yersinia**

8. **MICROBIOLOGY OF MEAT PRODUCTION**

The deep muscle tissues of healthy, slaughtered livestock contain few, if any, micro-organisms. However, their exterior surfaces (hide, hair, skin, feathers,) are naturally contaminated with a variety of micro-organisms as are their gastro-intestinal tracts. From the moment of slaughter, each processing step subjects the carcass to opportunities for contamination with micro-organisms from the exterior surfaces, utensils and equipment and, most importantly, from the gastro-intestinal tract.

Cutting of carcasses also involves the use of utensils and equipment and transfers micro-organisms to the cut surfaces. Theoretically removal of the skin should expose the sterile surface of the muscle but in practice the extra handling seems to contribute significantly to the bacterial load on the surfaces. This happens with meat production where the skin is removed early in the slaughtering process (e.g. beef, mutton, lamb, ostrich, and goat) or where the skin is removed later on (e.g. some pork cuts, skinned chicken portions).

**There is ample opportunity to contaminate the exposed tissues of the carcass with micro-organisms from:**

- exterior surface of the animal
- contents of the gastro-intestinal tract
- equipment and utensils
- workers garments and hands
- the abattoir itself (e.g. air, floor drains, water drip from ceiling)
- water (and if used, ice)
- food additives (e.g. spices for value added products)

**Therefore, we need to control this opportunity for contamination by:**

- Using properly cleaned equipment.
- Ensuring that the abattoir is properly cleaned/sanitised.
- Use hygienic methods of dressing that control contamination.
- Clean utensils at appropriate intervals during the process.
- Apply a high standard of personal hygiene.

Meat with a good shelf-life has $10^2$-$10^4$ organisms per cm$^2$. To put the numbers of organisms associated with some sources of contamination into perspective: The exterior surfaces (hide, hair, skin, feathers) of healthy, live animals and birds are naturally contaminated with large numbers of a variety of micro-organisms. In a study of live cattle, $10^7$ organisms were found per cm$^2$ of hide. The soil (ground) is also a major source of micro-organisms and has comparable numbers (10$^7$) of bacteria per gram of soil. Faeces are about 100 x more contaminated and have an APC and “coli forms” of about $10^9$ and $10^8$ per
gram of faeces, respectively. All of these can therefore serve as sources of microbial contaminants of the meat.

The hide, fleece or skin of the animal is known to be a major source of carcass contamination (pathogens and spoilage bacteria). Special care should be taken to avoid contact with the meat. Removal of hides or fleece should be carried out in a manner that avoids contact between the outside of the skin and the carcass. When the surface of the hide touches the surface of meat during removal, it can cause transfer of significant numbers of organisms to the meat surface. Likewise, hands and equipment that touch the outside of the hide can serve to transfer organisms to the meat and should not come into contact with the underlying carcass meat before thorough cleansing.

Since it is extremely difficult to obtain clean meat from dirty animals or birds, it is important that only relatively clean animals are presented for slaughtering. The cleanliness of livestock depends on husbandry, weather and climate (rainy, dry), methods of transport (stress causes defaecation and urination) and holding conditions at the abattoir. Cattle from feedlots may carry more faecal bacteria and less soil organisms than those from pastures. The modern trend is that excessively dirty animals should not be slaughtered until action has been taken to clean them. Also, strategies should be developed to reduce the number of such animals presented for slaughtering.

From the figures quoted above, it is clear that under normal conditions, the heaviest and potentially the most dangerous load of bacteria is in the animal's digestive tract. Already a small volume of material from the intestinal tract can contaminate the carcass with sufficiently high numbers of "coli forms" to cause problems so that rupturing of the intestines or spillage of the intestinal content would cause severe contamination of the carcass. It is essential that great care be taken during evisceration to keep the viscera intact.

In addition to the skin, the gastro-intestinal and respiratory tracts, urine and milk are other important animal sources of contamination. Meat handling and preparation involves contact with knives, hands and clothing of workers, processing equipment, (e.g. saws, hooks, boning tables, conveyers) and water used to wash carcasses, hands and equipment. Airborne spread of particles and aerosols will also occur in the abattoir. All of these factors can lead to the transmission of potentially hazardous organisms and contamination of carcasses. To minimise contamination, it is logical that attention should be paid to sanitation of all equipment (e.g. knife-sterilizers), well-chlorinated water, personal hygiene, hand-washing facilities near worker stations as well as the other methods of hygienic slaughtering.

An important point to remember is that microbes firmly attach to meat and skin. This process is not yet well understood but it appears to become irreversible with time – the longer organisms remain on the meat the more difficult it becomes to remove them. In poultry processing, the contact period between the meat surface and contaminating organisms is reduced by washing carcasses at intermediate points during processing before attachment occurs. The principle should not be applied to larger carcasses because too much wetting spreads rather than removes contamination. In fact, when small volumes of faeces, intestinal contents, mud or soil are spread over the carcass by rinsing, the clean areas of the carcass can become quite heavily contaminated. This is the reason why carcasses should not be rinsed. Wet carcasses also tend to spoil more rapidly - especially if wet and warm. Un-split carcasses should never be washed and split carcasses should only partially washed under lowest pressure possible.

With any delay between consumption or further processing, it is essential to cool the carcass. As far as the microbiological quality of the carcass is concerned, fast chilling is indicated to restrict microbial growth. However, too rapid chilling can lead to cold-shortening of pre-rigor muscle and a loss of tenderness. With these conflicting requirements, optimal conditions for chilling must be a compromise. During chilling, contamination may occur by carcasses touching one another, by contact with dirty floors and walls, by splashing if cleaning is carried out in a loaded chiller and from the air, especially if the filters are not regularly cleaned.

Cutting of carcasses also involves the use of utensils and equipment that transfer micro-organisms to the cut surfaces. This happens with meat production where the skin is removed early in the slaughtering process (e.g. beef, mutton, lamb, ostrich, goat) or where the skin is removed later on (e.g. some pork cuts, skinned chicken portions).
The main challenge to the meat industry in relation to hygiene is to minimise external contamination of meat with micro-organisms during all stages of the production chain.

9. MINIMISING BACTERIAL CONTAMINATION DURING SLAUGHTERING

To summarise: The meat under the skin of a healthy animal is sterile. The slaughtering process must be aimed at keeping the bacterial load on the newly exposed meat surface as low as possible and all efforts should be made to prevent bacteria from being deposited on the carcass. It is necessary to ensure that nothing that touches the exposed meat is contaminated with micro-organisms. By using the correct slaughtering techniques with this aim in mind, a high degree of sterility is indeed possible under commercial conditions. This is shown by the fact that fresh meat when vacuum packed and maintained at 0 °C, as produced for export in Australia, New Zealand and SADC countries, has a microbiological shelf-life of up to 6 months.

10. SPOILAGE BACTERIA

A number of organisms are usually associated with meat spoilage. Some of the more important of these include *Pseudomonas*, *Brochothrix*, the *Moraxella/Acinetobacter* group, lactobacilli, psychrophilic *Enterobacteriaceae* and *Psychrobacter*. Depending on the growth requirements of the particular organism and the particular conditions of packaging and storage, different organisms are able to grow and spoil the meat. For instance, *Pseudomonas* spp need oxygen for growth and are usually the main spoilage bacteria on conventionally packaged meat in oxygen permeable film at refrigeration temperatures (see section 4 above). Lactic acid bacteria can again grow and spoil the meat when the oxygen tension in the package is low (in vacuum packaged meat).

Knowing and predicting which organisms will likely cause spoilage of a particular product in a specific package is a specialised field of study.

11. FOODBORNE DISEASES

A foodborne disease is an illness in humans in which the food is or contains the causative agent. Foodborne disease due to bacteria in the food usually manifests itself in episodes of gastro-intestinal disease (diarrhoea, vomiting etc). In recent times foodborne disease has been on the increase all over the world and even first world countries experience a worrying increase in outbreaks of foodborne disease. In fact, foodborne disease has been described by the World Health Organisation as one of the most widespread public health problems of the contemporary world. It creates an enormous social, cultural and economic burden on communities and their health systems. One of the important reasons why food safety management systems like the Hazard Analysis Critical Control Point System (HACCP) has been so widely introduced is to manage and control foodborne disease.

11.1 Agents of Foodborne Diseases

- **Bacteria** – *Salmonella* spp., *Staphylococcus aureus*, *Clostridium perfringens*, *Campylobacter jejuni/coli*, *Clostridium botulinum*, *Bacillus cereus*, certain strains of *Escherichia coli* and *Listeria monocytogenes*. Probably 20 or so could be listed.
- **Chemical substances** - ciguatera, scrombroid, paralytic shellfish poisoning.
- **Parasites** - *Giardia*, *Trichinella*, *Anasakidae*.
- **Viruses** - hepatitis A, Norwalk, Snow Mountain agent.

11.2 Food borne Disease Mechanisms

- **Infection** - The food acts as a vehicle to transport the infectious agent into the gastrointestinal tract where the micro-organisms colonise and produce illness. For example: *Salmonella*, *Shigella*.
- **Intoxication** - Microbial growth in the food causes the production of toxin(s) in the food prior to ingestion. For example: *Staphylococcus aureus*, *Clostridium botulinum*, *Bacillus cereus*.
- **In Vivo Intoxication** - The food acts as a vehicle for organisms that form toxin in vivo. For example: *Clostridium perfringens* and some *Escherichia coli*.

11.3 Events Necessary for Food borne Illness to Occur
The causative agent (chemical, physical or biological) must be present in the food. It can originate from the food itself (plant or animal), from handling the food somewhere in the chain of production, from equipment or utensils and from the processing environment. Bacteria responsible for human illness can be associated with healthy or ill humans, animals or plants and with a normal or contaminated environment. For example, *Staphylococcus aureus* is common in the nasal passages of healthy humans. Pathogens such as *Salmonella*, *Clostridium perfringens*, *Staphylococcus aureus*, *Yersinia enterocolitica*, *Campylobacter jejuni* and *Listeria monocytogenes* are often present in small numbers as part of the micro-organisms on live, healthy animals.

The causative agent must be present in sufficient numbers (e.g. bacteria) or high enough concentration (toxin) to survive normal handling of the food. Some bacteria will not cause foodborne illness unless large numbers are ingested or sufficient toxin is produced. For example, the number of *staphylococci* must be about 1,000,000 (10^6) per gram of food to produce a sufficient amount of toxin to make people ill. Even for organisms that have the capability to cause illness when ingested in low numbers (for example *Salmonella*), the chance of becoming ill is much greater when large numbers of organisms are present in the food than with smaller numbers of organisms. With some notable exceptions (*Listeria monocytogenes*, *Yersinia enterocolitica*, *Clostridium botulinum E*), the common food pathogens do not grow at the typical commercial refrigeration temperatures.

A sufficient quantity of food containing enough of the agent to exceed a person's resistance must be ingested. The resistance of individuals in a population varies greatly. People most susceptible are those with low resistance like infants, small children, the elderly, pregnant women and people who are ill. More recently it was shown that a severe bout of influenza or the common cold may significantly lower resistance to foodborne pathogens.

### 11.4 Sources Of Foodborne Disease

- **Home** - 60%
- **Food Service Institutions** - 35%
- **Processing Plants** - 5%

Nearly 50% of all foodborne disease cases are associated with temperature abuse (inadequate cooling or heating) such as:

- Leaking foods at room temperature for several hours.
- Storage at too high a refrigeration temperature (keep below 5°C).
- Storage of foods in large containers in refrigerators so that it cools down only slowly (slow cooling gives time for pathogens to grow).
- When cooking meat (especially minced meat), not heating it to a core temperature of at least 70°C for 2 minutes. (Other time-temperature combinations are reaching a core temperature of 60°C for 45 minutes; 65°C for 10 minutes; 75°C for 30 seconds and 80°C for 6 seconds).
- Not keeping cooked food hot at a temperature above 50°C or as some recommend, 60°C (e.g. meat pies).
- Storage of hot food for a long time at too low a temperature (e.g. in ovens that were turned off).

Other causes of foodborne disease have to do with sanitary methods of preparation and storage:

- Wash hands before and after handling raw meat
- Clean raw meat preparation area before and after cooking
- Avoid contact with other foods
- Never allow raw food, used utensils or other surfaces likely to cause contamination to come in contact with cooked or ready-to-eat foods.
- Never use the same unwashed plate that held raw meat to serve the cooked meat (e.g. at a barbeque)
- Do not handle food if you have diarrhoea/vomiting or uncovered infected sores or cuts.
- Do not smoke while handling food and turn away from food and cover nose/mouth while coughing or sneezing.

### 12. BACTERIA MOST FREQUENTLY ASSOCIATED WITH FOOD-BORNE DISEASES
12.1 Staphylococcus aureus

Source

Sources of Staphylococcus aureus are:
- Nasal passages and skin of food handlers and animals.
- Frequently from wounds and cuts.
- Live chickens often carry *Staphylococcus aureus* and it can contaminate carcasses during abattoir processing (from e.g. defeathering machine, cross contamination during processing).

Mechanism

Frequently heat-processed food is recontaminated by a lack of sanitary practices. Food poisoning from cooked foods often occurs as a result of cross- or recontamination from raw foods. Dressed carcasses often carry *Staphylococcus aureus* so that it should be well cooked and care taken not to cross contaminate other foodstuffs.

Unsanitary practices are often followed by temperature abuse. This allows a large number of organisms to develop with the production of a heat-stable toxin that cannot be inactivated by boiling. Growth and toxin production can occur over a wide range of temperatures (10-40°C, best at 37°C). No sensory changes may be present.

Foods involved

Meats (including poultry), meat-products, salads, dairy products (cheese).

Symptoms

Nausea, vomiting, abdominal cramps, diarrhoea - onset is sudden and 1-6 hours after ingestion of the incriminated food.

Preventive measures

Cook meat, especially chicken, well (avoid cold spots when cooking directly from frozen state). Avoid recontamination of a heat-processed food. Keep susceptible foods refrigerated preferably below 5°C.

12.2 Clostridium perfringens

Source

Raw meats; part of the intestinal flora of animals.

Mechanism

Low number of *Clostridium perfringens* often present in raw meats. Some spores may survive cooking procedures. If cooked meat is improperly cooled and not thoroughly reheated, large numbers of the organism will develop in the food and be consumed and grows best at 24-27°C (107-117°F). Toxin is produced in the large intestine during sporulation.

Foods involved

Cooked (cold or reheated) meat, poultry.

Symptoms

Flatulence, cramps, diarrhoea - usually 8-24 hours after ingestion of the food.

Preventive measures
Cooked meat dishes should not be held for long periods between 20°C and 50°C (68-122°F). Prompt and proper cooling coupled with thorough reheating to 71-74°C (160-165°F) should control the problem.

12.3 Salmonella

Source

Gastrointestinal contamination, usually from animal origin. Raw products of animal origin.

Mechanism

Even with the best manufacturing practices, some cross contamination may occur during dressing operations and further handling of carcasses when infected birds are slaughtered. Control of infection at farm level is still a problem. Therefore, we can expect that some raw meat contain low numbers of intestinal bacteria, including Salmonella. Even low numbers can cause illness since the bacteria grow in the intestines. The organisms grow best at 35-37°C (95-98.6°F), but can grow at 5-45°C (41-113°F) although slowly below 10°C (50°F).

Foods involved

Meat, poultry, eggs and egg products.

Symptoms

Abdominal cramps, diarrhoea, nausea, vomiting, headache, fever, chills. Usually 20-48 hours after ingestion of contaminated food. May cause death in infants, elderly or debilitated patients.

Preventive measures

It is usually difficult because of presence of the organism in animal food stuffs. Prevention of recontamination after heating (cutting boards, hands, utensils, etc.) is a better option. Proper chilling, hot-holding, and reheating of food. Microbiological monitoring of problem foods.

12.4 Campylobacter jejuni (Campylobacteriosis)

This organism has become a serious threat to the poultry industry in the USA and will probably also have the same effects when tested for in the RSA.

Source

Intestinal tract of animals.

Mechanism

Similar to Salmonellosis. The organism is psychrotrophic - survives at 4°C for 14 days, but quite sensitive to freezing.

Foods involved

Raw milk, eggs, meat and poultry.

Symptoms

Typical infection: abdominal cramps, diarrhoea, nausea, vomiting, flatulence, fever. Long incubation period - 2 to 5 days. Moderate duration - 3 to 7 days.

Prevention measures
Same as Salmonella.

12.5 Listeria monocytogenes (Listeriosis)

Source
One of the new emerging food borne pathogens. Has been isolated from several environmental sources in food processing plants - floor drains, etc., and from a variety of foods including meat and poultry. It grows well at refrigeration temperatures and would be found in cooled areas of the abattoir, packaging and further processing areas.

Foods involved
Milk, soft cheeses, coleslaw, one outbreak associated with processed meat.

Symptoms
The Symptoms are usually expressed as a flu-like syndrome in healthy adults. This may cause serious illness (septicaemia, encephalitis, stillbirth, and death) in immune-compromised individuals and pregnant women.

Preventive measures
Good Manufacturing Practices (GMP), pasteurisation at 77°C. Monitoring program in effect.

12.6 Yersinia enterocolitica (Yersiniosis)

Source
Found in the gastro-intestinal tract of mammals and birds and been isolated from faecal material, throats, tongues and lymph nodes of swine.

Mechanism
Typical signs of food poisoning.

Foods involved
Raw milk, seafood, non-chlorinated water, pork products (esp. those containing head meats).

Symptoms
Abdominal cramps, nausea, vomiting, diarrhoea, fever. Fairly short incubation - 24 to 48 hours. Relatively short duration - 1 to 2 days. Large numbers required to cause illness.

Preventive measures
Freezing, pasteurisation, vacuum packaging.

12.7 Clostridium botulinum (Botulism)

Source
The organism is a common soil contaminant. Anaerobic Mesophylic spore former.
**Mechanism**

Production of a potent heat-labile neurotoxin in the food. Optimum temperature for growth and toxin production of the proteolytic strains is 35°C (95°F), that for non-proteolytic strains about 26°C (79°F). Non-proteolytic types B, E and F can grow and produce toxin at refrigeration temperature. Three mechanisms are possible - food botulism, wound botulism, and infant botulism. Only food botulism is discussed.

**Foods involved**

Home-canned low-acid foods that are improperly processed; also mishandled (temperature abused) dishes such as processed meat sausages (nowadays more rarely than previously), pot pies, meat dishes with vegetables (e.g. turkey loaves with onion and green pepper, stew containing unpeeled potatoes and carrots). Safety record of commercially canned low-acid foods (e.g. canned fish, meat, and vegetables) is extremely good, but the potential for error is high.

**Symptoms**

Nausea and vomiting in 12-24 hours (not always present), vertigo, double vision, difficulty in swallowing and breathing, respiratory paralysis. Fatality rate about 20% if untreated. Effective antitoxins are available.

**Preventive measures**

Most common is by destruction of vegetative cells and spores by heat as in the canning of low-acid foods. Acidification to a pH below 4.6. Addition of nitrite to prevent germination of spores. Reduction of the water activity ($a_w$) to 0.93 or lower. Water activity is the ratio of the food’s vapour pressure ($p$) over the vapour pressure of pure water ($p_o$) i.e. $a_w = p/p_o$.

12.8 **E coli (O157: H7)**

**Source**

Intestine of warm-blooded animals.

**Mechanism**

It can be spread from food handlers usually via the hands, during slaughtering, preparation and service or contamination and cross contamination during slaughtering and processing. Raw milk can also be contaminated by the organism being present on the udders or the equipment.

**Foods involved**

Meat, especially ground beef, which has not been cooked sufficiently to kill the bacteria. (E. coli forms bio films on stainless steel.)

Coleslaw, sprouts, lettuce, salami, unpasteurised milk or juice and swimming in or drinking sewage contaminated water.

**Symptoms**

Severe bloody diarrhea, abdominal cramps, little or no fever, resolves in 5 – 10 days

In some persons especially children under 5 and the elderly it can cause a complication called haemolytic uremic syndrome, in which the red blood cells are destroyed and the kidneys fail (2 – 7 % of cases). This is life threatening. Complications of these might be high blood pressure, seizures, blindness, paralysis and the effect of having part of their bowl removed.
Preventive measures

Avoid faecal contamination.
Wash hands and equipment.
Cook food thoroughly.

13. MICROBIOLOGICAL EXAMINATION

Meat must be of a high microbiological quality in order to ensure that the consumer receives a product that is not spoilt or does not carry foodborne disease. An important function of meat related legislation and enforcement is to ensure that meat is indeed prepared under conditions of acceptable hygiene. However, the modern trend is that the abattoir assumes more and more responsibility for the microbiological condition of its product. Apart from visual inspection, it is necessary do microbiological tests to ensure that the hygiene measures that cost money and time are indeed effective. By regular microbiological evaluation of the abattoir and the meat, problems in hygiene and handling etc. can be identified and most importantly, rectified.

Before embarking on microbiological examination of a foodstuff, it is logical that the specific purpose of the examination be clear and made clear to the laboratory technician. It is also logical that before choosing a microbiological test the suitability of the test for the particular purpose be evaluated. Obvious as these observations may appear, these processes are often neglected. Little wonder that many microbiological examinations are not suited to their purpose leading to little assistance towards process improvement.

Counts on solid samples (meat products, etc) are expressed as colony-forming units (CFU) per gram, while counts on liquid samples (water) are expressed as CFU per millilitre. Surface counts are expressed as CFU per 10 square centimetres.

13.1 Microbiological examination of foods and food ingredients can be placed in 3 categories:

- Tests for pathogens and their toxins (for example, *Salmonella*, *Staphylococcus aureus* and its toxin, *Listeria monocytogenes*, *Clostridium botulinum* toxin).
- Tests for organisms/groups of organisms (for example, *Pseudomonas* spp. as spoilage organisms.)
- Tests for sc. indicator organisms (for example indicators of hygiene, indicators for the potential presence of pathogens)

These tests are used by regulatory agencies and the food industry to examine foods for:

- presence or potential presence of pathogens/toxins
- presence of spoilage organisms
- estimation of the bacterial load on the meat
- lack of good manufacturing practices during production and storage
- suitability of a food or ingredient for a particular purpose

13.2 Tests for indicator organisms and agents can be grouped into 4 categories:

a. To assess numbers of micro-organisms and/or microbial activity:

- aerobic plate count
- psychrotrophic count
- mesophyllic count
- *Pseudomonas* spp count
- yeast and mould count
- direct microscopic count
- pH determination (change in the expected pH)
- organoleptic examination
b. **Presence and potential presence of pathogens:**

- *Staphylococcus aureus*
- *Escherichia coli* (certain strains like *E. coli* O157:H7)
- *Salmonella* spp.
- *Clostridium perfringens*,
- *Campylobacter jejuni/coli*,
- *Bacillus cereus*,
- *Listeria monocytogenes*

c. **Indication of potential faecal contamination:**

- Enterobacteriaceae
- coliform bacteria
- faecal coli forms
- enterococci
d. **Metabolic products of pathogens that indicate a potential health hazard:**

- *Staphylococcus aureus* toxins/thermo nuclease test
- phosphatase test

Microbiological examination usually consists of sampling, transportation and storage of the samples and their evaluation.

### 14. SAMPLING AND SAMPLING METHODS

The choice of sampling site, sample size and the number of samples to be taken for microbiological examination are probably the most important but problematical of the total microbiological evaluation procedure. It is seldom realised that the position of the sampling site on a carcass or within the abattoir often has far greater impact on the validity of the data than either the specific sampling technique used or the subsequent methods used for evaluation of the sample.

Sampling for microbiological examination must be done aseptically i.e. all organisms except those on the sample must be eliminated. Sterile equipment is needed for sampling.

#### 14.1 Sampling methods

A variety of sampling techniques is in use in the food industry. These can be either destructive or non-destructive. Some non-destructive methods break up the colonies of bacteria (e.g. swabbing, rinsing) and counts are usually higher than with those methods that replicate intact surface colonies (e.g. agar sausage, Petrifilm™ and Rodac plates). With destructive techniques a sample is removed and macerated or blended before counting. This usually gives higher and less variable results than contact plate and swab methods.

#### 14.2 Surface Count Methods

These methods are used to monitor the bacterial load on surfaces. In considering the method of monitoring to be used, cognisance must be taken of the type of surface being sampled, its chemical composition, the expected level and type of organisms on the surface and the object of the test. Some methods are designed to provide only an index of sanitation, whereas others are designed to give an accurate count of the bacteria present. Basic methods described in this manual are direct contact methods (agar sausages, Petrifilm™ and Rodac plates) and the swab and rinse methods. Some of the advantages and disadvantages of each method are given below. A fuller description of each method follows later.
• **Agar Sausage Method:**

Accuracy is relatively low but the precision of the method is high. It is very effective as a screening test for the efficacy of cleaning and disinfection of equipment and also the level of contamination on carcasses.

• **RHODAC Plate Method:**

The main advantage of this method is its simplicity of use and the fact that many samples can be taken in a short time. As in the case of the agar sausage method, the accuracy is also relatively low. A major drawback of this method is the high cost of the RHODAC plates.

• **The Petrifilm™ Plate Method**

The main advantage of this method is its simplicity of use and the fact that many samples can be taken in a short time. The prepared medium is bought and only needs rehydration before use. It also occupies little space e.g. in the incubator. Since the film is flexible, it can be used on a wider variety of surfaces than the previous agar contact techniques. A drawback of this method is the high cost of the Petrifilm™ plates.

• **Swab Method:**

This method is also effective as a screening test. It can also be used to sample areas inaccessible to the direct methods. Although this method usually yields more bacteria per sample than the direct contact methods, the recovery rate of bacteria by swabs is variable. This is because it is dependent on various factors such as the pressure used and the speed with which the swab is moved over the area. Large carcasses are often sampled using a swab made from specially purchased plastic or other material that does not contain bacteriostatic substances. There is also more labour involved when compared to the direct contact methods.

• **Carcass Rinse Technique**

The advantage of the method is that bacteria are rinsed off the inside and outside surfaces of the carcass and the organisms in the rinse medium come from all areas of the carcass. It is useful when recovery of pathogens like Salmonella is attempted. The carcass rinse technique can only be used on a small carcass like a chicken carcass.

• **Destructive methods**

Destructive methods are the more reliable methods for estimation of surface contamination. Such methods include the excision method used for surface counts on red meat carcasses, chicken portions and processed products or the removal of a portion of the neck-skin of chicken for evaluation. For the excision method a sample (cork) cutter of a known surface area is used. A cork cutter with a diameter of 25.2 mm, shall give a surface area of 5 square cm. The sample is then macerated or homogenised using a stomacher or blender. Destructive methods are usually followed in suitably equipped laboratories and are not further discussed.

### 14.3 Sampling of carcasses

Different methods can be used for the sampling of red meat carcasses. Apart from destructive testing mentioned above, non destructive techniques such as the agar sausage method, the Petrifilm™ plate method, the RHODAC plate method, the swab method as well as carcass rinse techniques are all used. Direct contact methods are relatively easy and fast. However, they are only accurate with counts <$10^4$ organisms/cm². With higher numbers present on the carcass, the colonies that grow out will coalesce and cannot be counted.
14.4 Storage of Samples

- The storing of samples to be used in total counts must be avoided as far as possible.

- Bacteria present in the sample may start multiplying under favourable conditions and this could lead to false high counts.

- If storage is unavoidable, the sample may be kept in a refrigerator or on ice at 0 to 2°C.

- Frozen samples must be allowed to thaw in a refrigerator between 1°C and 5°C for 18 to 24 hours.

14.5 Incubators and the temperature of incubation

Since samples are usually placed in an incubator during the evaluation phase, incubators and the temperature of incubation warrant some discussion.

In pathology laboratories, the temperature of incubation is usually 37°C (or between 35 and 44 °C) because animal pathogens are adapted to grow well at body temperature. However, many of the non-pathogenic bacteria that are important on meat and in poultry processing do not grow well at these high temperatures. For instance, many spoilage bacteria have a maximal growth temperature of 32 - 35°C. It makes little sense to count bacteria growing at 37°C on a product that is slowly spoiling in the refrigerator at 0-5°C!

Another reason why 37°C is used as incubation temperature is that incubators operating at 20 to 25°C need to be cooled or have to stand in an air-conditioned area where ambient temperature is sufficiently low. This adds to the outlay costs. However, microbiological evaluation is expensive and the maximal amount of (correct) information needs to be gathered through microbiological testing.

14.6 The Agar Sausage Method

This is a direct contact method used to determine total counts on flat, dry surfaces. It is most commonly used in the testing of plant equipment and utensils for efficacy of cleaning and disinfection and also to obtain total aerobic counts on slaughtered carcasses.

Principle of the method

An agar medium is solidified in a container such as a big syringe (50 - 60 ml) with a known diameter and with the front end cut off. Using the plunger of the syringe, about 5 mm of the agar is pushed out and the front surface of the agar is pressed firmly against the surface to be tested. A slice (2-3 mm thick) is cut off, placed in a Petri dish, and incubated. After incubation the number of colonies that have grown on the slice is counted and corrected to an area of 10 cm². The result is then expressed as the number of cfu/10 cm². It must be stressed, however, that this method is only used as a screening test. The result obtained are not a reliable indication of the actual number of bacteria present on the tested surface, especially irregular surfaces such as carcasses, because the agar is not able to pick up all the bacteria.

Sampling procedures

- Remove the aluminium cover and using the plunger, press out about 5 mm of the agar.

- Sterilise the knife by immersing it in the sterilising fluid and then flaming it. Repeat this process between each item. It is not normally necessary to sterilise the knife between successive slices taken from the same item or area. Sterility controls may be made and incubating them.

- Cut off a 2 - 3 mm thick slice and discard it.

- Press out another 5 mm of agar with the plunger and press the surface of the agar firmly against the surface to be sampled, taking care not to wipe the agar over the surface. Remove immediately.

- With the sterilised knife, cut off a 2-3 mm thick slice and transfer it, inoculated side uppermost, to an empty Petri-dish with the blade of the knife.
• Up to 5 slices may be sampled from one item and placed into one Petri-dish. However, three slices per item usually give a good idea of the efficacy of cleaning and disinfection, depending on the size of item.

**Incubation**

The Petri-dishes containing the slices are not inverted during incubation which is for 24 - 48 hours at 30°C. Samples from carcasses should be incubated for 48 hours.

**Counting and interpretation of the results**

After incubation the colonies on all the slices per Petri dish are counted by using a colony counter and then totalled. Regard this figure as the number of viable cfu on the test area. Correct this figure to an area of 10cm².

**Example**

The square surface of one slice is 8 cm. If three slices per item were used, the total area sampled is therefore 8 x 3 = 24 cm². The number of colonies counted on all three slices totalled for instance 252 colonies. Correct this figure to an area of 10 cm² by dividing 252 by 2.4 = 105 cfu / 10 cm².

14.7 RHODAC Plate Method

This method is also a direct contact method. It is used to determine the total counts on flat, dry surfaces. It is also suitable for testing plant equipment and utensils for efficacy of cleaning and sterilisation.

**Principle of the method**

A special disposable dish (RHODAC plate) containing a solid medium in the base, is used. The lid is removed and the agar surface pressed against the surface to be tested. The lid is then replaced and the plate incubated in an inverted position. After incubation the number of colonies grown on the surface of the medium is counted and the figure corrected to a surface of 10 cm². The back of the plate has a grid to facilitate counting of colonies. By using this simple method a great number of items can be sampled in a short period of time.

**Sampling procedures**

The RHODAC plate is one of the simpler methods to use. Just remove the lid, firmly press the exposed agar surface against the surface to be sampled, remove and then replace the lid. Care must be taken not to wipe the agar surface over the surface to be sampled.

**Incubation:**

The plates are inverted and incubated at 30°C for 24 – 48 hours to obtain a total aerobic, mesophylic count.

**Counting and interpretation of results:**

- After incubation, the colonies are counted with the aid of a colony counter or by hand.
- The figure thus obtained is regarded as the number of cfu on the sampled area.
- Correct this figure to an area of 10 cm²: For the 55 mm RHODAC plate, divide the figure by 1.73 and for the 84 mm Rodac plate, divide the figure by 2.64.
- Express the final result as the number of cfu / 10 cm².
14.8 Petrifilm™ Method used for surface sampling

Petrifilm™ plates replace conventional agar media in Petri dishes, RHODAC plates and syringes with agar. They can also be used for traditional counts of a variety of bacteria. Petrifilm™ plates are films coated with (dry) nutrients and gelling agents. The Petrifilm™ plate consists of 2 rectangular films that are joined at one side. An area of the top polypropylene film is covered on the inside with a layer of adhesive with indicator dye and a second layer with cold soluble gels. These folds over a polyethylene coated paper printed with a grid onto which nutrients mixed with cold water soluble gels are glued in such a way that the coatings on the 2 films match and form a “sandwich”. Use requires rehydration before surface contact sampling or, for traditional counts, with the diluted sample. The whole plate is thin (slightly thicker than a double layer of plastic film), takes up little space and is easily transported. They are especially convenient for use where facilities for agar preparation do not exist. Like all other types of bacterial counts, they do require incubation in an incubator. Colony counts are easy to perform since special indicator dyes in the plates stain colonies providing a contrast that makes them easy to see and a built-in grid facilitates counting colonies.

A variety of Petrifilm™ plates with different media designed to test for different organisms/groups of organisms is available. The Petrifilm™ plates come with full instruction and good illustrations for their use. Although they are relatively expensive compared to the conventional agar plates, the suppliers/manufacturers (3M Microbiological Products) are confident that savings through their use (such as costs involved with laboratory outlay and media preparation time) will soon make up for their cost per plate. Petrifilm™ plates can be used as a direct contact method. It is used to determine bacteria (aerobic counts or counts of other organisms/groups of organisms) on surfaces. Since the plate is flexible, it is also suitable for testing uneven surfaces provided that close contact can be made with the surface to be tested. It is particularly suitable to test plant equipment and utensils for efficacy of cleaning and sterilisation.

**Principle of the method:**

Petrifilm™ plates are plastic films coated with (dry) nutrients and gelling agents. Use requires rehydration with sterile water a minimum of 30 minutes (Aerobic Count) or 1-2 hours (coliform and E coli plates) at room temperature before surface contact sampling and incubation. Detailed instructions on use and evaluation are supplied by the suppliers/ manufacturers (3M Microbiological Products).

As with RHODAC plates, by using this simple method a great number of items can be sampled in a short period of time. Since no media preparation is involved it is indeed a simple and versatile system.

**Sampling procedures:**

When the gel on the film is solid, carefully lift top film portion of the hydrated plate. Avoid touching the circular growth area. The gel will adhere to the top film. Allow the circular gel portion of the top film to touch the surface being tested. Rub finger over the outer film side of the gelled area to ensure good contact with surface. Lift film from surface and rejoin the top and bottom sheets of Petrifilm™ plate. Care must be taken not to wipe the agar surface over the surface to be sampled.

**Incubation, Counting and interpretation of results:**

Incubate and count as directed in the package inserts.

- Results are given as count / 20 cm²
- Express the final result as the number of cfu / 10 cm².

14.9 The Swab Method

This method is suitable for the testing of a wide variety of surfaces, including wet surfaces. Its advantage over direct contact methods is that areas that cannot be reached by either the agar sausage or the RHODAC plate methods, can easily be sampled with the swab method. A major disadvantage is that it involves the preparation of serial dilutions from which aliquots have to be transferred to agar plates.
(A variation of the method is used to obtain an idea of the contamination of the whole carcass. The carcass is rubbed all over with a swab made from specially purchased plastic or other material that does not contain bacteriostatic substances. Serial dilutions are made in the conventional way. The surface area of the animal is determined with a special technique and the number of microbes expressed as cfu per cm\(^2\) of carcass surface.)

**Principle of the method**

A wooden swab-stick fitted with a cotton wool- or calcium alginate wool tip is used to pick up bacteria from a known surface area with the aid of a metal template with a square cut out of it. The inoculated swab is transferred to a tube containing 9 ml of a suitable dilution medium. Serial dilutions are prepared and one of the plate count methods is used to obtain a total count. The figure is then corrected to an area of 10 cm\(^2\).

**Sampling procedures**

- Remove a sterile swab from its container. Ensure that throughout the handling of the swabs, the fingers do not touch the cotton tip or the adjacent part of the stem.
- Press the sterile template against the surface to be sampled.
- Vigorously rub the swab over the area to be sampled. While doing this, so rotate the swab as to bring the whole area of the cotton tip into contact with the surface.
- Break off the tip of the swab into the bottle containing the diluant by using the neck of the bottle for leverage.
- If the swabs are sterilised individually in test tubes, the inoculated swab may be replaced into the tube and returned to the laboratory as soon as possible where it must be placed into a bottle containing the diluant.
- If commercially available sterile swabs in disposable containers are used, a bottle containing sterile inactivator solution and/or wetting agent, must also be taken with the apparatus and materials to the area to be sampled. Before the swab is used, the tip is moistened with one of the solutions.
- Shake the bottle containing the broken off swab tip, well.

**Inoculation and incubation:**

Under aseptic conditions, transfer two separate 1ml volumes of the inoculated diluents into two sterile empty Petri-dishes. To each Petri-dish add 15 ml of a suitable molten agar (cooled to 45°C) and mix well. Allow the agar to solidify, invert the Petri-dishes and incubate at 35°C for 48 hours.

**Counting and interpretation of the results:**

- After incubation, count and record the number of colonies on both plates to obtain a mesophilic count.
- Add the number of colonies counted on each of the two plates together and multiply the total number with 5.
- This figure represents the number of viable bacteria on the test area sampled and, if necessary, corrects this figure to an area of 10 cm\(^2\).
- Express this figure as the total cfu / 10 cm\(^2\) (if a template with a 10 cm\(^2\) hole has been used): Total number of colonies on both plates x 5 = cfu /10 cm\(^2\).

15. **Microbiological Assessment of Hygiene**

Before expending the effort and funds to do microbiological testing, we should first insist that equipment is clean - it must look clean, feel clean, and smell clean.

Several microbiological testing procedures may be used to help verify the effectiveness of the cleaning and sanitising programme. The most important consideration in any assessment program is to consistently evaluate a given area using the same appropriate technique so that a history may be obtained for any given pieces of equipment over a period of time.

A summary of the techniques used for hygiene assessment are:
- Direct or contact methods – These previously described methods include the agar sausage method, the RODAC plate and Petrifilm™ plate methods. The agar is brought in contact with the surface to be tested. Following incubation, the colonies on the plate are simply counted.

- Swab or rinse method – The swab method was previously described. With the traditional rinse method the object to be evaluated (meat, container or equipment) is placed into a sterile receptacle and rinsed with a measured volume (usually 90 ml) of sterile buffered neutraliser solution for the sanitizer-(or buffered peptone broth), followed by determining the bacterial population of the rinse solution. It is only practical for small objects.

- ATP Bioluminescence – The ATP bioluminescence procedure is referred to as a “real time” procedure because an incubation period is not required and cleanliness can be determined in 1 or 2 minutes. This technology thus allows processors to determine the effectiveness of their sanitation procedure immediately and to make corrections before production begins. The technique measures the adenosine triphosphate (ATP) present in a swab from an equipment surface. It uses an enzyme and its substrate (sc. luciferin – luciferase system) from fireflies in the determination. In the presence of ATP a reaction takes place and light is produced. The intensity of the light is a measure of the ATP in the swab sample and thus of the cleanliness of the surface. The method measures all ATP whether from micro-organisms or from meat residues or exudate. Since all these sources of ATP are undesirable on thoroughly clean and sanitised surfaces, it is a most useful procedure. (There are special techniques to determine whether the source of ATP is microbiological or animal with the instrument). The instrument is portable and extremely handy. At present it is rather expensive to buy and operate.

16. BACTERIA/GROUPS OF BACTERIA EVALUATED

16.1 Aerobic plate count (APC)

This is the most widely used microbiological test on foods. Its purpose is to determine the number of living micro-organisms per unit of food. In fact, it does estimate only a portion of the total viable micro-organisms because only those that can grow under the conditions of the procedure (nutrient medium, temperature, time, gaseous atmosphere, etc) will manifest themselves as colonies. Procedures must be standardised and rigidly followed if APC’s are to be used for regulatory purposes or if we want to be able to compare results.

In addition, APC’s of foods are often misinterpreted and it often requires interpretation by an expert. APC’s of perishable refrigerated foods such as milk, red meat, poultry and fish may reflect:

- the microbiological condition of the raw food
- the effectiveness of the processing method(s)
- the sanitary condition of equipment and utensils
- the temperature/time profile of storage.

Thus it is extremely important to know the origin and have as much as possible other information about the sample. Unusually high or low APC’s may have different causes. To pinpoint the source(s) of a problem when unusual high counts are observed in a product, we may have to examine the product at various points in the process. With refrigerated perishable products, even if the raw material was of excellent quality and it was processed and stored under the best of conditions, these products will with time, ultimately decrease in quality and spoil. A high APC of the final product under such conditions simply reflects continued growth of psychrotrophic bacteria and may have little to do with the original quality of the raw material, processing methods or storage conditions. In this case, spoilage of a perishable food after a certain time lapse is an expected event but the necessary background information is required to pinpoint this fact.

Several other important points need to be made to avoid misinterpretation.

- APC’s (and all other techniques that depend on bacterial growth for evaluation) estimate only living bacteria. Processing such as heat may have destroyed a significant part of a large microbial population. Other steps such as freezing, dehydration or lowering of pH may stress or kill bacteria.
• APC’s do not furnish information on microbial type. Some micro-organisms are biochemical very active and break down proteins, fats or carbohydrates - others produce fewer defects.

• Perceptible sensory defects usually do not occur until the level of micro-organisms reaches $10^6$ to $10^7$ per gram. To assess safety, knowledge of microbial types is of major importance.

16.2 Psychrotropic Count

Minor modifications in the APC procedure allow it to be applied for the determination of psychrotrophic counts. Psychrotrophic counts are often used because major perishable foods such as milk products, meats, poultry and seafood are stored for extended periods of time under refrigeration.

Psychrotrophic bacteria are capable of growth, although slowly, at refrigeration temperature and in foods. They are usually gram-negative, aerobic rods. Many psychrotrophs produce defects because they are capable of breaking down proteins and/ or fats. Several Pseudomonas species are in this category. Common procedures for estimating psychrotrophic bacteria employ plate incubation at 7°C for 10 days or at 15-25°C for 2-3 days.

16.3 Direct Microscopic Count (DMC)

The DMC provides an estimate of both living and dead micro-organisms by examination of a small quantity of food (stained with a dye) under the microscope. Because the individual cells can be seen, some information about the morphology of the micro-organisms is available. Limitations of the procedure include (1) the small amount of sample used, (2) it is useful only when very large numbers of bacteria are present in the food.

16.4 Yeast and Mould Count

This count is particularly applicable to foods where the physical-chemical characteristics of the food (a$_w$, pH, favour or select the outgrowth of yeasts and moulds).

17. MEASURING METABOLIC ACTIVITIES OF MICRO-ORGANISMS

Sensory (organoleptic) examinations (taste, odour, body, texture, colour)

Although useful for milk, meat, poultry, fish, cultured dairy products of limited general use because the result of microbial activities varies with differences in food composition. Different organism, although at the same level, may give different metabolites (aerobic packaged meats versus vacuum packaging).

The type of pH change in a food resulting from microbial activity depends upon the nature of the food, the type of micro-organism and the packaging system ($O_2$ permeable film, gaseous atmosphere). Some important applications of pH measurements include production of fermented sausages, cultured milk products and cheeses, manufacture of mayonnaise and salad dressings, and acidified canned foods.

18. INDICATORS OF POTENTIAL PRESENCE OF PATHOGENS

18.1 Staphylococci in foods

Staphylococci represent contamination with bacteria from the nasal passages, skin and lesions of humans. They are usually destroyed by heat processing. Thus their presence in heat-processed foods usually indicates recontamination after processing. Large number (about $10^6$ per gram) is needed to cause foodborne illness. Hence, when a problem occurs, we have recontamination of a heat-processed food coupled with temperature abuse. Small numbers of staphylococci can be expected in foods that are handled by employees. Larger numbers indicate growth. One must understand that small numbers of staphylococci in food may represent the survivors of a much larger population and that toxins are still present.

18.2 Escherichia coli (E. coli)

Belongs to the family Enterobacteriaceae. It is present in the intestinal tract of vertebrate animals; in
humans it forms about 1% of the total bacterial biomass. The presence of *E. coli* in a food is traditionally taken to indicate that faecal contamination may have occurred. If *E. coli* is present in a food, it is considered possible that other enteric organisms, including pathogens that occur with *E. coli* in intestines, may be present. However, it is frequently found in the complete absence of any possible faecal contamination, e.g. it can multiply in pristine natural waters, occurs on plants, in soil and even as a (growing) contaminant in an industrial fermentation such as yeast production.

In a heat-processed food, *E.coli* should have been destroyed because it is heat sensitive. The presence of this organism in such food indicates post-processing contamination from some source (equipment, people, raw foods) or, but less likely, process failure.

*E.coli* was formerly taken to be only indicative of possible faecal contamination and was not considered to be a potential pathogen. However, since it became clear that *E. coli* is a pathogen in its own right and moreover, that pathogenic strains can occur on meat, the presence of *E.coli* on meat is to be avoided. Although the presence of small numbers of *E.coli* in raw animal foods is not surprising since these foods are closely associated with the surface and intestinal contaminants of animals, international pressure is mounting to keep *E. coli* on meat and meat products as low as possible or to eliminate it. Lower and lower counts of *E.coli* on red meat and poultry are becoming the norm.

New methods (direct plate counts, Petrifilm™ plates, impedance) that allow counting of *E.coli* directly exist. This supersedes the somewhat lengthy Most Probable Number (MPN) technique. A rapid fluorogenic detection method is widely used. The method is based on the cleavage of a substance 4-methylumbelliferyl-β-D-glucuronide (MUG) that gives off a readily detected fluorescent substance when split by *E. coli*. Unfortunately, some strains of *Salmonella*, *Shigella* and *Yersinia* also split MUG so that the method is not entirely specific for *E.coli*. More importantly, some enterohaemorrhagic strains of *E.coli* (e.g. *E.coli* O157:H7) are not detected by this method. Excellent test kits exist to confirm that the organism is indeed *E. coli* should it be required.

### 18.3 Faecal coliform test

The faecal coliform procedure was established with the objective to establish the presence of *Escherichia coli* without having to go through the rather lengthy MPN procedure and IMViC testing. It is an old and cumbersome procedure and has been superseded by direct detection and counting of *E.coli*. For the determination an inoculum derived from coliform enrichment broth is placed in EC broth at a high temperature (44-45°C) to select a group of organisms in which we usually have a high proportion of *E.coli*. A positive faecal coliform test is taken to indicate a higher probability of potential faecal contamination than a positive coliform test. Since other bacteria such as *Enterobacter* and *Klebsiella* may be part of the coliform group, it is advisable to check that *E. coli* indeed does constitute a significant part of this group for the type of food under examination.

### 18.4 Coliform Test

Coliform constitute a group of bacteria that are capable of fermenting lactose with the production of acid and gas at 35°C within 48 hours. *Escherichia coli*, a member of the coliform group is common in the faeces of man and animals. Others such as *Enterobacter* are found widespread in nature such as soil, water, and plants. It is not surprising those coliforms are found in many raw foods. They are, however, easily destroyed by heat.

There are a few important, observations to be made relative to the presence of coliform in foods.

- The mere presence of coli forms in a food does not mean faecal contamination - the type must be established. Perfectly sound food may be rejected on account of an unconfirmed coliform test.
- The presence of faecal coliform or *E.coli* constitutes a much greater potential for faecal contamination and hence for the presence of enteric pathogens. Since many good procedures for the determination of pathogenic themselves are available and new ones are described it may be advantageous to do some confirmationary tests for expected pathogens.
- Presence of coli forms in a heat-processed food most likely indicates post-processing contamination from equipment, utensils, people, raw foods, etc. Process failure is also a possibility, but much less likely.
- Caution needs to be expressed in enumerating coliform bacteria from processed foods because
they are easily stressed by freezing.

18.5 Enterococci

*S. faecium* and *S. faecalis* are common enterococci of foods. Most enterococci are salt resistant, facultative anaerobes, grow at 45°C and with some exceptions grow at 7 to 10°C. *S. faecium* and *S. faecalis* may survive pasteurisation. Enterococci may originate from the intestinal tract, but frequently are associated with plants and insects. Thus, natural foods can have low populations of enterococci. The literature indicates that enterococci counts are not a reliable index of faecal contamination of foods.

19. INDICATORS OF POST-HEAT PROCESSING CONTAMINATION

19.1 Coliform Bacteria

The “coliform’ test is a test that was devised when no suitable alternative tests existed. In spite of the fact that little real value can be attached to the “coliform” test, that the results are often misleading and that superior tests for contamination exist (e.g. determining *E. coli* directly instead of establishing that it might perhaps be present), the “coliform” test is still required by many agencies. The “coli forms” constitute a group of bacteria that are capable of fermenting lactose with the production of acid and gas at 35°C within 48 hours. The rational for the test was that *E. coli*, a member of the “coliform” group, are common in the faeces of man and animals. Other “coli forms” such as *Enterobacter* are found widespread in nature such as soil, water, and plants. It is not surprising that coli forms are found in many raw foods. They are, however, easily destroyed by heat and are therefore used to indicate post processing contamination or less likely process failure.

There are a few important, observations to be made relative to the presence of coliform in foods.

- The mere presence of coli forms in a food does not mean faecal contamination had taken place – as pointed out above, the type needs to be established. The presence of faecal coli forms or *E. coli* constitute a much greater potential for faecal contamination and hence for the presence of enteric pathogens.
- Their presence in a heat-processed food most likely indicates post-processing contamination from equipment, utensils, people, raw foods, etc. Process failure is also a possibility, but much less likely.
- Caution needs to be expressed in enumerating coliform bacteria from processed foods because they are easily stressed by freezing and special methods to resuscitate them are required.

19.2 Enterobacteriaceae Count

This count is used extensively and allows enumeration of a greater variety of members of the Enterobacteriaceae. It is used for the same purpose as the coliform count.

19.3 Other Tests

19.3.1 Determination of Staphylococcus aureus toxins and the Thermonuclease Test

*Staphylococcus aureus* produces a number of thermo stable toxins. Methods exist for the direct determination of these toxins in foodstuffs. These can be purchased from some suppliers of microbiological media. Careful instructions for their use are supplied by the manufactures. This direct method of determining the toxins is preferred to a method to determine thermo stable deoxyribonuclease (TNAse), which is employed as a screening test for extensive growth of *S. aureus* in a food, and therefore for only the potential presence of toxin. Not all strains of *S. aureus* produce toxins.

19.3.2 Phosphatase Test
This is a test used for milk and some milk products to test for proper pasteurisation, potential leakage of raw product into the pasteurised supply or other post pasteurisation contamination.

20. STANDARD METHODS FOR TOTAL AEROBIC MESOPHYLLIC COUNTS

To obtain a total, aerobic, mesophyllic count of viable organisms in meat products, by-products, water, etc., the laboratory technician may use any one of the three methods described below, depending on the type of sample and personal preference.

For a total surface count, the technician may either use a direct count method (agar sausage or RHODAC plate) or the swab method (cotton or calcium alginate swabs). Total counts are used for monitoring surfaces in abattoirs to determine hygiene levels e.g. after a cleaning action.

No one method can give a complete picture of the microbial contamination on a surface. However, the swab and direct contact methods when used routinely and regularly can give a great deal of useful information provided all factors are taken into account when assessing the results.
MEAT INSPECTORS MANUAL

PART I
ABATTOIR HYGIENE

MODULE 2
GENERAL LAYOUT AND CONSTRUCTION FOR ABATTOIRS AND CUTTING PLANTS
# Index

**ABATTOIR LAYOUT AND CONSTRUCTION**

1. INTRODUCTION
2. LAYOUT
3. CLEAN AND DIRTY PRODUCTS
4. BUILDING AN ABATTOIR
5. PREMISES
6. FACTORS AFFECTING ABATTOIR WORK AREAS
7. FACILITIES FOR STAFF
8. GENERAL REQUIREMENTS FOR PREMISES, STRUCTURES AND EQUIPMENT
9. THE USE OF WATER IN THE ABATTOIR
10. DISPOSAL OF ABATTOIR EFFLUENT
ABATTOIR LAYOUT AND CONSTRUCTION

1. INTRODUCTION

“abattoir” in terms of The Meat Safety Act, 2000 (Act 40 of 2000) means a slaughter facility in respect of which a registration certificate has been issued in terms of section 8(1) and in respect of which a grading has been determined in terms of section 8(2); (i)

A well-designed and constructed structure is needed to systematically process the animal that is slaughtered. The further the process progress, the greater the risk of contaminating the product. Prevention thereof is determined by the layout and the flow patterns, which the product follows.

Hygiene is the prevention of contamination of the product.

Each function in the slaughter process has a fixed status in terms of “Clean” or “Dirty”. In choosing the premises, this important aspect must be taken into consideration. “Clean” and “Dirty” areas are separated by distance, physical barriers and in certain cases by time.

2. LAYOUT

The layout of the premises and building must be designed so that the production process moves in one direction without any cross flow of products, which may adversely affect the hygiene of the product. Live slaughter animals are received at the “dirty” end of the abattoir and meat is dispatched from the clean side of the abattoir.

2.1 “Dirty” area (pre-evisceration process)

- Livestock entrance.
- Vehicle wash bay for trucks that transported animals.
- Offloading platforms and facilities for marking animals.
- Lairage where animals are kept until they are slaughtered where applicable (shade for pigs, sheep & poultry).
- Ante mortem inspection.
- Isolation lairage for animals/birds that are or might be sick.
- Emergency slaughter facilities for hurt animals/birds.
- A post mortem inspection area for animals/birds which arrive dead or die in the lairage.
- Facilities where animals/birds can be restricted and efficiently stunned.
- Bleeding area.
- Area for electrical stimulation of ruminant carcasses.
- Facilities where condemned products are handled.
- Areas/rooms where inedible products are handled e.g. hides/pelts, horns, feathers etc.
- Including facilities for sorting grading and weigh.
- Room for the cleaning and sometimes processing of rough offal.
- Disposal of solid waste such as paunch and intestinal contents.
- Areas where rough offal is packed and cartoned.
- Chiller or freezer facilities for rough offal.
- Dispatch area for rough offal.
- Effluent pre-purification plant and holding tanks.
- Facilities for the processing of condemned products to by-products such as blood/carcass meal and tallow
- Cloakrooms, toilets, showers, washing facilities and dining room where only workers of the dirty areas have access.
- Store rooms for dirty area.
- Maintenance workshops.
2.2 “Clean” area (post evisceration process)

- Slaughter hall for the dressing of animals/birds under hygienic conditions with facilities for separating the different components.
- Area for inspection of the carcass and other edible portions in order to determine in fitness for human consumption and to prevent the spread of disease to humans and animals.
- Facilities for the retention for secondary inspection of carcasses which are suspect.
- Grading and weighing of carcasses as part of the marketing function.
- Chilling of carcasses to ensure that the quality of the product is maintained and the optimal shelf life ensured.
- Freezer facilities for storing provisionally approved carcasses with slight measles contamination.
- Sorting and loading of carcasses in a cooled area to ensure that the cold chain is not broken.
- Dispatch facilities.
- Washing bay for meat trucks.
- Office accommodation and ablution facilities for meat inspectors.
- Office for management.
- Laundry facilities.
- Laboratories.
- Cloakrooms, toilets, showers, wash facilities and dining room where only workers in the clean area have access.
- Store rooms.

3. CLEAN AND DIRTY PRODUCTS

3.1 Clean products:

Dressed carcass (includes head and feet in pigs & skin in poultry)

Red offal may be the following, depending on the species:

<table>
<thead>
<tr>
<th>Lungs</th>
<th>Pancreas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kidneys if removed</td>
<td>Clean fat (omentum)</td>
</tr>
<tr>
<td>Heart</td>
<td>Diaphragm if removed</td>
</tr>
<tr>
<td>Tongues</td>
<td>Heifer udders if removed</td>
</tr>
<tr>
<td>Liver</td>
<td>Sweetbreads (Thymus)</td>
</tr>
<tr>
<td>Tail</td>
<td>Testes</td>
</tr>
<tr>
<td>Spleen</td>
<td></td>
</tr>
</tbody>
</table>

3.2 Dirty products:

Edible:

Rough offal:
- Paunch and oesophagus
- Intestines
- Head – skin on (ruminants)
- Feet – skin on (ruminants)

Inedible:

- Hides skins
- Horns
- Hair, hooves, snout
- Feathers

Condemned products:

- Blood
- Male/female reproductive organs including lactating udders/penis
- Gall bladder
- Bladder.
Carcasses and portions of meat condemned by the meat inspector/veterinarian which poses a possible health threat. Such material must be held under secure conditions until disposed of in accordance with legislation.

Crop in case of chickens
Rectum/cloaca in chickens

4. BUILDING AN ABATTOIR

4.1 Approval

Anyone intending to erect an abattoir must contact the Provincial Directorate of Veterinary Services.

4.2. Factors to be considered when building an abattoir

The choice of a suitable site for an abattoir is most important. The factors listed below must therefore be taken into account when selecting a premise:

4.2.1 Environmental factors

(a) Drainage is affected by geological structure, nature of the soil (sandy or loam), the water table and the natural slope of the surface.

(b) Natural slope – Rainwater and runoff from the dirty area must not flow into the abattoir, nor must they flow from the dirty to the clean side of the premises. Tanks for the collection of effluent and pre-purification plants must be situated at the lowest point of the site, on the dirty side. Liarages must not be situated on higher ground than the buildings, nor must they be closer than six metres to them.

(c) Water supply – An adequate supply of potable water must be available. Consideration should also be given to the storage (storage tanks, chlorination tanks and pressure tanks) which must be on the clean side, preferably at the highest point, and treatment of water should this be necessary.

(d) Water pollution – can occur due to slaughtering and other processes and therefore the abattoir should be a reasonable distance away from any river – no process water may flow into any river.

(e) Prevailing winds – Must blow from the "clean" side (dispatch) to the "dirty" side (liarages).

(f) No source of contamination should occur in the environment in which we place an abattoir: Examples are a paint factory, foundry, sewage farm, river or residential area.

(g) Abattoirs are classified as light industries. Because water pollution does occur, the abattoir should be a reasonable distance away from any river.

(h) The site must be large enough to allow the abattoir and allied activities to be correctly situated and oriented. Provide also for future extensions.

4.2.2 Services

(a) Effluent disposal – An effective system for the disposal or removal of effluent must be provided where necessary.

(b) Electricity – There must be a reliable source of power for heating water as well as to provide for the partial or total mechanisation of the abattoir.

(c) Transport – There must be sufficient facilities for the reception of animals as well as for the removal of products.

(d) Labour – The proximity of a labour pool or reasonable access to public transport is also important.

(e) Access roads and staff separation – If this is required for the relevant grade, the "clean" and "dirty"
areas of the premises must be physically separated. Vehicles which offload live animals, loads intestines heads and feet as well as vehicles removing paunch contents, condemned material and refuse are restricted to the "dirty" area and may not enter areas where meat vehicles and staff who handle meat are to be found.

5. REQUIREMENTS FOR PREMISES

(a) Must be fenced with lockable gates in order to control the unauthorised entry of vehicles, persons and animals.

(b) The layout of the site should be such that a linear flow pattern can be maintained with live animal reception on one side and the removal of products on the other.

(c) "Clean" and "dirty" areas must be separated according to their functions as previously mentioned.

(d) Surfaces on the site must be paved or grassed. Traffic areas in the smaller abattoirs must have a surface that is dust and mud free, readily cleanable and well drained. The traffic zones of larger abattoirs must have a permanent surface. The planting of grass and shrubs creates a pleasant environment and gives the impression that the premises are well managed and cared for.

(e) From the point of view of industrial psychology it has been found that the more attractively a site is maintained, the easier it is for the workers to accept and adjust to the high standards of hygiene expected of them; they are also more likely to do so.

(f) All paved areas must provide for storm water drainage.

(g) Vehicle parking areas where carcasses are offloaded or meat is loaded under roof must have kerbstones and be drained so that they can be cleaned every day. Dirt that is washed onto grass is impossible to remove.

(h) Walkways for staff between the ablution block and the abattoir must preferably be roofed.

(i) Specific areas such as collection points for manure from holding pens and containers of paunch contents to be removed, must also be paved, drained and provided with kerbstones.

6. FACTORS AFFECTING ABATTOIR WORK AREAS

Progressive procedures to prevent the contamination of meat by organisms and other contaminants during the slaughter process must be taken.

This aim can be achieved by correct internal abattoir design. The layout must eliminate cross-flow patterns of people and products.

In designing the abattoir it is important to refer once again to the principle of a linear flow pattern.

General guidelines:

(a) During processing, product flow must be from dirtier to cleaner areas, zones or rooms. These products must not come into contact with the floor or walls, or even with equipment like platforms, and must remain within the building until dispatched.

(b) Drainage must be from clean to dirty.

(c) The airflow must be from clean to dirty.

(d) Product flow lines must not intersect or cross.

(e) Backtracking must be avoided.
Unclean products derived from slaughtering and dressing must be removed from the slaughter area as quickly as possible. Heads and skins must not be carried or passed under or around dressed carcasses on route to the exit point.

"Warm" and "cold" working areas must be distinguished.

Staff must take the shortest routes when moving to their workstations.

Hand washbasins must:
- Be readily accessible to all workers
- Be at a distance not exceeding three metres from any workstation where products are handled.
- Be available at raised platforms.
- Be available in combination with sterilizers where manual equipment is in use.
- Have taps which are operated with the foot or knee.

7. FACILITIES FOR STAFF

(a) Change rooms, toilets, showers and canteen facilities sufficient for the number of workers on the premises must be provided in terms of the Occupational Health and Safety Act 1993.
- In High throughput abattoirs physical separation is required for “clean” and “dirty” workers.
- In low throughput abattoirs where separate facilities are required, they must be situated in the "clean" and the "dirty" areas respectively.
- In low throughput abattoirs where separate facilities are not required for "clean" and "dirty" workers, the facilities must be situated on the cleaner side of the premises.

(b) Staff facilities may:
- Be in a free standing building connected to the abattoir by means of a covered walkway.
- Form part of the main structure with a ventilated lobby provided between the slaughtering area and the facilities.

(c) Staff facilities must be planned so that:
- Total separation is achieved between cloakroom/shower and toilet/urinal areas.
- Hand wash basins with foot or knee operated taps are provided at the exit to the facilities. (Numbers will depend on the number of workers.)

(d) At high throughput abattoirs there must also be separate facilities for inspection staff.

(e) An office for the person in charge should be provided.

(f) A storeroom for overalls and clean equipment normally required for the work must be provided.

(g) A separately storeroom for cleaning agents, soap and chemicals must be provided.

(h) Lockers must be provided. The basket system, as used at swimming baths, is highly recommended as an alternative to the usual lockers. It allows for greater freedom of movement in the change area as well as for easier cleaning and stricter control over the contents of the baskets, e.g. food, empty bottles etc. which might be stored together with the overalls.
8. GENERAL REQUIREMENTS FOR PREMISES, STRUCTURES AND EQUIPMENT

Structural requirements

Requirements for all abattoirs as well as export approved cutting plants and cold storage units

1. General

Premises must be of such design, construction and finish and must be so equipped, in such condition and so located that they can be used at all times for the purpose for which they were designed, equipped and appointed –

(a) without creating a health hazard; and

(b) in such a manner that meat –

(i) can be handled hygienically on these premises or with equipment on the premises; and

(ii) can be protected by the best available method against contamination or spoilage by poisons, offensive gasses, vapours, odours, smoke, soot deposits, dust, moisture, insects or other vectors or by other physical, chemical or biological contamination or pollution.

2. Premises

(1) All areas on the premises must be rendered dust and mud free.

(2) Provision must be made for storm water drainage.

(3) The abattoir must be equipped with an enclosed drainage system for the disposal of effluent and sewerage.

(4) Vehicle loading and off loading areas for dispatching and receiving of meat must be curbed, paved, drained and roofed.

3. Cross flow

The premises and buildings must be designed to ensure that –

(a) clean and dirty areas and functions are separated;

(b) no cross flow between clean and dirty areas and functions, occurs;

(c) inedible or condemned material can easily be removed on a continuous basis from areas where edible material is handled; and

(d) detained meat can be kept and examined without contaminating passed meat.

4. Requirements for interior of building and rooms

In the abattoir where meat and animal products are handled and in toilets, change rooms and dining facilities –

(a) all rooms must be of such sizes as not to compromise hygiene;
(b) floors and stairways must be –

(i) smooth, impervious, resistant to wear and corrosion and not slippery; and

(ii) free of cracks and open joints;

(c) floor drainage design and construction –

(i) must ensure that floors are sloped at a gradient of not less than 1:60 towards drainage points or channels;

(ii) must ensure that channels drain from clean to dirty areas;

(iii) must be such that drainage channels are smooth, impervious, washable and provided with grates or covers; and

(iv) must provide all drain inlets with solid traps as well as mechanisms to prevent access of vermin and obnoxious odours into the abattoir;

(d) interior wall surfaces, partitions and pillars must be –

(i) smooth, impervious, washable and light coloured;

(ii) rounded at floor to wall, as well as wall to wall, junctions with a minimum radius of 50 mm; and

(iii) rounded on top in case of walls and partitions which are not ceiling height;

(e) interior roof structures or ceilings, must be smooth, impervious, light coloured and washable;

(f) doors and doorframes must be smooth, impervious, vermin proof, light coloured and corrosion resistant;

(g) personnel entrances must have self-closing doors and be provided with hand wash-basins, boot wash and apron wash facilities and apron hooks;

(h) hatches, where provided, must have an inclined bottom edge sloping towards the dirtier side, and self closing flaps must be provided when applicable;

(i) chutes must –

(i) be smooth, light coloured and corrosion resistant;

(ii) open at least 300 mm above the floor;

(iii) be sanitizable along its entire length; and

(iv) be separate for meat, inedible material and condemned material, respectively;

(j) windows –

(i) must have light coloured, corrosion resistant frames and must be glazed;

(ii) must be fitted with fly screens when used for ventilation;

(iii) must have window sills that slope at 45°; and

(iv) may not be opened if it interconnects clean and dirty areas;

(k) all working areas must –
(i) be well ventilated; and

(ii) have artificial or natural lighting at an intensity of at least –

(aa) 540 Lux where meat is inspected; and

(bb) 220 Lux in work areas;

(l) all light fittings must be equipped with covers or splinter protectors;

(m) all electrical fittings must be waterproof; and

(n) all wall mounted equipment, structures and fittings must have a clearance of at least 50 mm from the wall.

5. Requirements for equipment

(1) Equipment –

   (a) must be corrosion resistant and non-toxic and may not taint or stain meat;

   (b) must have surfaces which are smooth, impervious and free of holes, cracks and sharp corners, and must be sterilizable; and

   (c) may not contaminate meat with lubricants.

(2) Containers used to hold meat must comply with sub regulation (1) and if the sides and bottoms are constructed with openings they must be designed so that meat cannot protrude through the openings or make contact with the floor.

6. Requirements for toilets and change rooms

(1) Toilets and urinals must be situated in a separate room with separate entrances from the change rooms.

(2) All toilets must be provided with toilet paper holders and toilet paper, hand wash-basins, soap dispensers with germicidal liquid soap and hand drying facilities.

(3) Change rooms and toilets may not have direct access into an area or room where meat is handled.

(4) Workers must be provided with clothing lockers in which to store private clothes separately from protective clothing, ensuring that private clothes and clean protective work clothes do not make contact.

(5) Workers must be provided with separate fly proof facilities in which to keep food.

7. Sterilizers

(1) Sterilizers must be readily accessible and must–

   (a) be placed on dressing platforms and within three meters of workstations, adjacent to hand wash-basins in rooms and areas where –

      (i) animals/birds are slaughtered;

      (ii) carcasses, meat and offal are detained;
(iii) condemned material is handled; or
(iv) meat is otherwise handled;

(b) be corrosion resistant and capable of sterilizing hand utensils and equipment, such as cutters and saws, at a minimum water temperature of 82°C during slaughter; and

(c) have an inlet, overflow and outlet and must drain through a down pipe directly into a closed drainage system or into an open channel, but such drainage water may not flow over the floor across areas where traffic occurs.

(2) Any other method of sterilization must be approved by the provincial executive officer.

8. Hand wash-basins

Hand wash-basins must be readily accessible and be –

(a) placed on dressing platforms and within three meters of workstations in rooms and areas where –

(i) animals/birds are slaughtered;
(ii) carcasses, meat and offal are detained;
(iii) condemned material is handled; or
(iv) meat is otherwise handled;

(b) corrosion resistant;

(c) provided with taps that are not hand or elbow operated;

(d) supplied with warm running water at not less than 40°C;

(e) provided with an inlet, overflow and outlet and must drain through a down pipe directly into a closed drainage system or into an open channel, but such drainage water may not flow over the floor across areas where traffic occurs; and

(f) fitted with a dispenser for liquid germicidal soap as well as hand drying facilities, unless the drying of hands is not necessary in the area where the basin is situated.

9. Apron-on wash-cabinets

Apron-on wash-cabinets, required in low and high throughput abattoirs, must be installed near work stations and be constructed so as to contain splashing from personnel washing their aprons while wearing it and must drain directly into a drainage system.

10. Water supply

(1) Water must be under pressure, and must conform to at least Class II according to the SANS 241 standard for drinking water.

(2) Water points must be provided with –

(a) cold water;

(b) water at not less than 40°C and equipped with hose pipes for sanitizing all areas of the abattoir; and

(c) hose reels to store hoses away from the floor unless vertical (drop) hoses are provided.
11. Containers for inedible, condemned and refuse material

(1) Sufficient theft and leak proof containers with tight fitting lids, complying with regulation 14, must be provided to keep and transport condemned material and they must be clearly marked “CONDEMNED”.

(2) Containers must be provided to collect and hold inedible material until disposal.

(3) Facilities to collect and hold blood prior to disposal must be provided.

(4) Refuse containers must be provided for the collection of general refuse at various points on the premises.

(5) Areas where waste or refuse containers are kept prior to removal must be impervious, curved and drained and the containers must be enclosed or fitted with tight fitting lids.

9. THE USE OF WATER IN THE ABATTOIR

1. Water use and volume waste water

The average water consumption of a high throughput red meat abattoir can be analysed as follows:

1. Lairage 10%
2. Slaughter and dressing 20%
3. Offal processing 25%
4. Heating water 25%
5. Creating steam 5%
6. Cooling 8%
7. Ablution, laundry, etc. 7%

The estimated average water consumption of a high throughput poultry abattoir can be roughly analysed as follows:

Dirty side:
- Receiving
- Killing 42%
- Scalding
- Defeathering

Clean side:
- Evisceration
- Chilling 35%
- Portioning
- Packing

Rendering 6%
Boilers 8%
Ablution, laundry etc.: 7%
Vacuum pumps for transporting material

2. Legal aspects regarding the use of water in abattoirs

Three Acts in particular have relevance to the application of water in an abattoir:


The Act and Regulations prescribe the availability and quality of the water used in abattoirs: Regulations 2
and 6 of Part III of the Standing Regulations prescribe the following:

A water supply of at least 900 litres per slaughter unit in a red meat abattoir and at least 15 litres in a poultry abattoir must be available under pressure and protected against contamination.

The water must be clean, potable and free of suspended material and substances that could put health at risk.

The water must be subjected to flocculation, filtration, chlorination or other treatment to ensure that:

- Total bacterial count: \(< 100/\text{ml } (30^\circ\text{C}/48\text{ hours})\)
- Coliform count: \(0/\text{100 ml}\)
- Faecal coli: \(0/\text{100 ml}\)

An adequate supply of hot water at 40 \(^{\circ}\text{C} – 45 \(^{\circ}\text{C}\) and of cold water under pressure must be available during working hours in convenient places.

The water must also meet any other standards and conditions which the Director: Veterinary Services may lay down from time to time.

(b) **The Water Act 1956 (Act 54 of 1956), as amended by the Water Amendment Act 1984 (Act 96 of 1984):**

This Act and its Amendment regulate the use of water for industrial purposes, and abattoir owners are advised to obtain a copy of this Act and to study it carefully, especially the Amendment.

Bye-laws issued by local authorities

Abattoir owners must familiarise themselves with the bye-laws issued by their local authority.

(c) **Bye-laws issued by local authorities**

Abattoir owners must familiarise themselves with the by-laws issued by the relevant local authority.

3. **Guidelines for the testing of water**

The following guidelines have been laid down by the National Executive Officer in respect of bacteriological and chemical tests on water used in abattoirs.

**High throughput**

(a) Bacteriological testing every month.

(b) Chemical testing every six months.

**Low throughput**

(a) Bacteriological testing once a year.

(b) Chemical testing once a year, except where water comes from a borehole in which case it must be tested twice a year, in the wet and the dry season.

The aim of regular water testing is to ensure that water used in abattoirs complies with the requirements laid down in Regulation 2 of Part III of the Standing Regulations.
MEAT INSPECTORS MANUAL

PART I

ABATTOIR HYGIENE

MODULE 3

PERSONAL HYGIENE
Index

PERSONAL HYGIENE

1. Introduction
2. Health requirements for workers
3. Some practical ways to improve personal hygiene and neatness
4. Protective clothing
5. Personal equipment
6. Cleaning of hand equipment
7. How to sharpen a knife
1. INTRODUCTION

Personal hygiene and health of food handlers is of the utmost importance when an effort is made to deliver a safe product of high quality to the consumer. Workers should be medically examined before employment in order to determine if they are physically fit to perform the work and also if they do not suffer from transmissible diseases, which can be transmitted through the food they handle to the consumer. They must also undergo daily fitness checks for different signs of illness. Workers must be issued daily with clean clothes in a good condition in order to protect the food from contamination and also to protect the workers against potential dangers. Each worker can contribute to good personal hygiene standards.

2. HEALTH REQUIREMENTS OF WORKERS

2.1 Food Handlers and Food borne Diseases

Meat can transfer pathogenic organisms to the people (or animals) that eat or handle it. These organisms can originate from the slaughtered bird – in other words a sick bird, or one that is a carrier of the organism – or from other sources. These sources include food handlers (people who work with food) at the abattoir, wholesalers or retailers – even the housewife in her kitchen. This discussion focuses on people employed at an abattoir. The principles can however also be applied elsewhere. Where we refer to meat handlers the same can be said of any food handler.

2.2 Legal requirements regarding the health and hygiene of workers

Visitors entering an abattoir
All persons entering an abattoir including management, visitors and maintenance personnel must be issued, by the owner, with clean suitable protective clothing complying to sub regulation 59(1).

Medical records of employees

(1) Before employment at an abattoir or its cutting plant, medical certification must confirm that a person is –
   (a) healthy and physically able to work as a meat handler; and
   (b) not a carrier of, or suffering from, a communicable disease.

(2) all medical records pertaining to medical examinations and daily fitness checks must be available to the provincial executive officer or the registered inspector.

Health checks

The owner must ensure that all personnel –

(a) are examined daily, before starting work, for adverse health conditions such as suppurating abscesses, sores, cuts and abrasions which may pose a food safety risk, and persons so affected may not work with edible products unless such conditions are covered with a firmly secured waterproof dressing so that the risk of contamination is excluded; and

(b) who were ill for three days or longer, present medical certificates to indicate that they are now fit to handle foodstuffs.
**Protective clothing**

(1) Protective clothing must be light coloured, clean, in good repair and must include safety hats, hair nets, beard nets, head and shoulder capes, white gumboots and safety boots compliant with hygiene requirements and waterproof aprons as required by the work situation.

(2) At the start of each working day or shift, the owner must provide personnel with protective clothing.

(3) The owner must ensure that such clean protective clothing is stored and handled so that it does not make contact with private clothes.

(4) Private clothes must be kept in a locker that is reserved for that purpose only.

(5) Protective clothing must be changed or cleaned when it becomes contaminated by obnoxious matter or becomes dirty.

(6) The workers in the clean and dirty areas must wear distinctive protective clothing, respectively.

(7) Protective clothing must completely cover all personal clothing.

(8) Personnel may change into protective clothing only in appropriate change rooms and items of protective clothing left in the abattoir working areas may only be placed or hung in areas designated for these items.

(9) Personnel may not sit or lie on the ground in their protective clothing during rest periods and may never wear protective clothing outside the premises.

(10) The abattoir owner must provide laundry facilities or make use of a laundry service and personnel must not be allowed to take protective clothing home to be washed.

**Injuries**

(1) All cuts and minor injuries must be covered with a durable waterproof dressing, surgical gloves or rubber finger guards.

(2) Personnel must immediately report any injury to the owner.

**Showering and washing of hands**

Personnel who handle foodstuffs must –

(a) shower before assuming duties; and

(b) wash hands and forearms with a liquid germicidal soap and running water immediately after they become soiled or after having used a toilet or when entering a working area.

**Prohibitions**

(1) Jewellery, including traditional objects, may not be worn in an area where edible products are handled.

(2) Fingernails must be short, clean and free of nail varnish.

(3) Eating, drinking or using or handling tobacco are not allowed in any area where meat is handled.
(4) Drugs, liquor or any intoxicating substance may not be brought into any part of the premises and a drugged or intoxicated person may not be allowed to enter any part of a meat handling plant.

(5) Personnel must refrain from any actions that could contaminated the product.

**Training**

All personnel must be trained in hygiene procedures and personal hygiene matters by the owner, and training records must be kept.

2.3 **Personnel hygiene**

1. **General**

The daily provision of clean, appropriate protective clothing as well as the necessary infrastructure in respect of cloakroom and toilet facilities, the provision of water, soap, toilet paper, hand wash basins etc. are all basic hygiene requirements. There are however various other regulations which affect the personal hygiene of workers as well as health aspects relating to all staff working with meat and edible products.

Some of these requirements are discussed in full for the sake of completeness, although they may seem obvious to the average person.

1.) People who are suffering from a contagious disease or are carriers of an infectious condition, or who have even been in contact with a source of contagion, may not work in any part of the abattoir where edible products are handled. This includes the slaughtering area, rough offal processing areas, storage facilities, cold storage, de-boning areas, offloading areas etc.

2.) Workers with suppurating sores on any part of the head, neck, arms or hands may not come into contact with edible products.

3.) The owner or his designated representative (hygiene manager) must ensure that the workers referred to above are not employed in areas where edible products are handled.

2.4 **Health Of Workers**

Personnel who work in abattoirs and meat handling establishments must not be carriers of any disease which can be transmitted via the meat.

**Pre-employment medical examination**

Persons who come in contact with fresh meat in the course of their work should have a medical examination prior to their employment. The manager must maintain the medical records of employees in such a manner that it is available for inspection. Medical examination of personnel must be conducted at least once a year and must be repeated when clinically or epidemiologically indicated or as prescribed by the controlling authority.

If the pre-employment examination indicates that the person is suffering from tuberculosis, or if there is any suspicion that he is suffering from TB (coughing for longer than three weeks, coughing blood, weight loss, loss of appetite, shortness of breath, pains in the chest, cold sweats and constant tiredness), then such a person must be referred immediately to the nearest tuberculosis clinic, hospital or district surgeon for examination and treatment. Such a person can only be employed as a meat handler on production of a certificate or letter from the tuberculosis clinic, hospital or district surgeon which indicates that, that person is receiving treatment for the condition and is in no danger of transmitting the disease.

**Daily fitness checks**
Care should be taken to ensure that no person, knowing to be suffering from, or is a carrier of a disease likely to be transmitted through the meat, or while afflicted with infected wounds, skin infections, sores or with diarrhea, is permitted to work or be present in any meat handling area of an abattoir or establishment in any capacity in which there is any likelihood of such a person directly or indirectly contaminating meat with pathogenic micro-organisms. Any person so affected should immediately report that illness to the manager. Such a person should then be withdrawn from his/her task as a meat handler and utilised at a position, which cannot result in contamination of the product.

All high throughput abattoirs should provide some kind of medical service (doctor, sister etc) or at least have access to such.

Export abattoirs may be forced by the importing country to comply with stricter health requirements.

The costs of any examination or test must be borne by the employer of the person concerned. Where an infectious or contagious disease has been confirmed or suspected, the Department of Health must be contacted for further action or treatment, which may be undertaken at government expense.

Apart from medical services and ongoing health control, the abattoir management must ensure that all illnesses and disease conditions are reported to higher authority (superintendent, manager etc.).

The employer must provide meat handlers with the necessary information and training in personal hygiene, and must carry out daily observations of their conditions of health. The meat handler must present himself for examination or testing if he has any suspicion that he may be unfit to handle meat.

3. SOME PRACTICAL WAYS TO IMPROVE PERSONAL HYGIENE AND NEATNESS

- Keep fingernails short and clean.
- Cover long hair with a hair net.
- Wash hands and arms thoroughly and frequently with an anti-bacterial liquid soap and warm water. The importance of clean hands and arms cannot be over emphasised.
- Do not wipe hands clean with linen roller towels, paper towels or rags.
- Wash hands immediately after using a toilet.
- Wash hands and arms immediately after contact with diseased meat, offal, blood or dirt and change contaminated clothing.
- Do not pick your nose.
- Never spit cough or sneeze near meat – always use a clean (disposable) handkerchief, which must be deposited in a refuge bin after use. Do not sneeze into your hands.
- Report any case of illness or injury immediately.
- Do not smoke, take snuff or eat and drink in any area where meat and meat products are handled.
- Use showers daily before and after work.
- Work with either meat or livestock, not both at the same time.
- Don't be a "litter bug" use the refuge bin.
- Work only in the dirty or clean areas and do not move to and fro.
- Maintain your protective clothing as clean as you can; do not sit on grass, ground, dirty walls etc.
- Cover cuts and abrasions with waterproof dressings and protective gloves or finger guards if only finger is cut.

4. PROTECTIVE CLOTHING

1. All protective clothing must be light in colour. This does not necessarily apply to workers in lairages/receiving areas and dirty areas.
2. Protective clothing comprises of the following:
   - Head covering – (hard hat – to comply with the terms of the Factory Act)
   - Long hair – (longer than the overall’s collar) must be covered by a hairnet.
   - Washable, strong and waterproof head and neck covers for workers dispatching meat.
   - Aprons – made of strong durable impervious material and may not be removed from the room in which they are utilised, and must be washed and hung on hooks during breaks.
   - Gumboots – White gumboots are required. They stain easily and therefore must be washed frequently at the boot washing facilities, which are compulsory at the entrances to the slaughter floor where meat is handled or processed. Gumboots must be cleaned before removal and stored in the change room. Care must be taken not to damage the outer shiny surface of the boots by using coarse scouring agents. Black gumboots may be worn in dirty areas.
   - Clean one or two piece overalls – Regulations stipulate that the abattoir owner will issue a clean protective overall to every worker at the start of every working day. The overall must cover all private clothing.
3. When protective clothing become contaminated with pus, bile, milk, faeces, urine etc. it must be changed immediately.
4. No private clothing may hang out under the protective clothing.
5. In cases where long-sleeved overalls can become wet, plastic forearm sleeves can be worn to keep the sleeves dry. Short sleeve overalls are preferred.
6. At larger abattoirs clean/dirty area separation must be strictly adhered to. Different coloured overalls are worn to identify the workers in the different areas, e.g. red or blue in dirty areas white in clean areas.
7. In certain situations it may be necessary for workers to make use of impervious plastic overalls (yellow rain-suits).
8. Maintenance personnel, visitors and management must also wear protective clothing while slaughtering is in process.

5. PERSONAL EQUIPMENT

- Knives
- Scabbard with chain
- Sharpening steel
- Meat–hook
- Stainless steel safety glove
- Ear protectors
Knives
Some abattoirs may issue personal knives to relevant workers. Depending however what type of abattoir and the specific arrangements at abattoirs, a valet system for the sterilizing of knives may exist. In this case the knife, scabbard, sharpening steel, hook etc. may not be a personal issue but will be issued on a daily basis by the management.

- Throat cutting or bleeding knife for cattle, sheep and horses, chickens, ostridges game or crocodiles
- Sticking/bleeding knife for pigs
- Skinning knife
- Dressing or evisceration knife
- Meat Inspection knife
- De-boning knife

Workers doing skinning and evisceration as well as meat inspection personnel must be issued with two knives to be used alternatively.

- Use one while the other is sterilised
- Dirty knives must be thoroughly washed and even scrubbed before sterilisation especially the handle and where the blade and handle meet.
- Only clean knives can be sterilised

Knife scabbards

This should only be used if workers do not stand at a particular spot (working station). In other word if they move around.

**NB** Must only be used for clean sterilised knives
The use of scabbards is generally discouraged.

Sharpening steel

Must be cleansed regularly by rinsing it off under running water and preferably not placed in a sterilizer. In cases where workers remain at a workstation the steel can be placed in a metal ring provided.

Meat hook

The meat hook is a hook provided with a handle for meat inspection purposes or used by workers pulling carcasses on the dressing line in case of red meat.

Stainless steel safety glove (Stainless steel mesh)

A stainless steel safety glove is required by the Factory Act, where workers operate dangerous equipment.

6. CLEANING OF HAND EQUIPMENT

Protein coagulates when it gets into contact with sterilizer water at 82°C and then it is very difficult to get rid of it. For this reason it is important that any equipment be rinsed before it is emerged into the hot water. Sometimes it might be difficult to get rid of fat that accumulated on the knife and the only way to
get it off will be to rinse it under hot water at 45° C where after the procedure for washing and sterilising must be followed.

The cleaning of hand equipment can be divided into cleaning at the end of the day and continuous cleaning.

Continuous cleaning occurs during the day while working on the process line. All hand equipment must be rinsed, washed and sterilised after each carcass in the case of red meat and as often as possible in the case of poultry or if it gets contaminated. Once the equipment is rinsed it needs to be sterilised in water at 82°C. It is important to remember that sterilising can only be effective if the equipment gets emerged for at least 2 min. at a time. Remember that clean equipment only stays clean as long as it does not come into contact with dirty surfaces – so it needs to be put down on clean surfaces or rather start using the equipment immediately before it accidentally gets re-contaminated.

Cleaning at the end of the day often does not get the attention it deserves. Not only should knifes and steels, aprons, hard hats, steel gloves and boots be scrubbed with a good disinfectant and a good brush but scabbards (where equipment are stored in) must be cleaned very thoroughly in order to prevent re-contamination of equipment. When cleaning knives it is important to think of safety and be careful not to cut one self. Handles of knives tend to trap fat and pieces of meat at the part where the handle and the blade meets. Therefore it is important to scrub at this point until all visible material has been removed.

Aprons must never be hung on hooks without cleaning them first.

Personnel must be motivated to keep their personal lockers in a clean and hygienic condition in order to keep out cockroaches and flies. Hand equipment must not be stored in the same locker where private clothes are kept.

Bacteriological samples (usually taken by means of the agar sausage or other direct contact method) must regularly be taken of personal equipment in order to ascertain the hygiene status of this equipment.

7. **HOW TO SHARPEN A KNIFE**

**Grindstone or whetstone**

The first step to sharpen a knife is to use an oil grindstone or whetstone. The grindstone usually has a rough and smooth side. If the knife is very blunt then the rough side will be used to sharpen the knife and thereafter the smooth side. The reason for this is that the rough side sharpens a knife quicker and that the smooth side is basically used to finalise the sharpness. The knife can be sharpened flatly or at an angle (depending on the functions for which it is required). If the knife is sharpened flatly, cutting bone in meat can be done more effectively without the knife becoming blunt rapidly and/or the cutting edge being damaged.

**Knife sharpening steel**

It can be described as an elongated, magnetic, round file with a handle. The objective with the steel is to keep the knife sharp during the course of the day’s activities.

In order to use the steel correctly, hold the steel in your left hand and the knife in your right hand (the opposite is applicable with left-handed people). Now move the sharp side of the blade on both sides of the steel in turn so that the back of the knife is sharpened to the front point with an easy arm action. The movement can be as with the grindstone, a flat action or with a slight angle, depending on the bevel required. Always make sure that the knife makes reasonably soft contact with the steel and never chop the knife against the steel.
The steel
Grindstone or Whetstone

Start by pressing down the knife lightly onto the whetstone and moving it over the surface of the stone. Keep the movement smooth and use even strokes.

Sharpen the whole blade from the point to the heel as indicated on the sketch.

The following guidelines should be taken into consideration when a whetstone is used:

1. Keep the blade at a 20° angle with the whetstone.
2. Use light, evenly strokes with the same amount of strokes on both sides.
3. Sharpen in one direction.
4. Do not over sharpen the knife.
5. End the process with a few strokes against the steel and wipe clean.
6. Wash and sterilise knife and steel before use.
MEAT INSPECTORS MANUAL

PART I
ABATTOIR HYGIENE

MODULE 4
HANDLING OF WASTE & CONDEMNED MATERIAL

Index
HANDLING OF WASTE & CONDEMNED MATERIAL

1. INTRODUCTION
2. LEGAL ASPECTS REGARDING CONDEMNED MATERIAL
3. METHOD OF PREPARING ANIMAL FEED
4. RENDERING
5. COLLECTION OF RENDERING BLOOD
6. CONDEMNED MEAT APPROVED FOR ANIMAL FEED
7. MANURE, PAUCH & VICERA CONTENT
8. FLOW DIAGRAM OF STERILISATION PLANT
9. DISPOSAL OF ABATTOIR EFFLUENT
1. **INTRODUCTION**

An ever-growing problem, especially in the case of smaller abattoirs, which are upgrading and handling greater volumes, is the increasing volumes of condemned products, not to mention paunch dung and other offal products. Although this section has been compiled from the point of the “Meat Safety Act” (Act 40 of 2000) it must be realised that the handling of any condemned material is regulated under “The Environmental Management act” and before any attempt is made to handle this material it should be clarified with the relevant authorities which are custodians of this act.

Schematic diagram indicating the different categories of waste and by-products derived at abattoirs:

(Much of the information in this section was obtained from the document “Waste Management for the Abattoir Industry RMAA Feb 2006”)
2. LEGAL ASPECTS REGARDING CONDEMNED MATERIAL

1. Handling of condemned material

(1) Carcasses, portions thereof or any edible products in an abattoir, which cannot be passed for human or animal consumption, must be –

(a) portioned and placed in a theft proof container which has been clearly marked “CONDEMNED”, in letters not less than 10 cm high, or conspicuously marked with a stamp bearing the word “CONDEMNED”; using green ink;

(b) kept in a holding area or a room or dedicated chiller provided for the purpose, except if removed on a continuous basis; and

(c) removed from the abattoir at the end of the working day or be secured in a dedicated chiller or freezer at an air temperature of not more than minus 2 °C.

(2) No person may remove a carcass, part thereof or any edible product which has been detained or condemned from an abattoir, except with the permission of a registered inspector who is a veterinarian and subject to such conditions as he or she may impose.

(3) The abattoir owner is responsible for complying with the legal requirements or conditions relating to the safeguarding and disposal of any carcass, part thereof or any edible product which cannot be passed for human or animal consumption.

2. Disposal of condemned material

Any condemned material must be disposed of by –

(a) Total incineration;

(b) Denaturing and burial of condemned material at a secure site, approved by the provincial executive officer and local government, by –

(i) Slashing and then spraying with, or immersion in, an obnoxious colorant approved for the purpose; and

(ii) Burial (After the site has been approved by Department of Environmental Affairs) and immediate covering to a depth of at least 60 cm and not less than 100 m from the abattoir, providing such material may not deleteriously affect the hygiene of the abattoir; or

(c) Processing at a registered sterilizing plant.

(d) With special approval from the Provincial Executive Officer of Veterinary Services certain of the condemned material can be made available for carnivorous animals, crocodiles and for vulture restaurants.

3. Requirements for sterilizing plants

(See regulations pertaining to the structural requirements of Sterilizing plants)

(1) A sterilizing plant must comply with the general requirements for premises, structures and equipment set out in regulations 8 to 18, which apply with the necessary changes.

(2) The premises of a sterilizing plant must be fenced and secured so as to prevent the entry of unauthorized persons, vehicles and animals, and must include-

(a) unclean areas, comprising the rooms in which material is received, stored or prepared for sterilizing as well as the entrance to the sterilizing apparatus; and
(b) clean areas, comprising the rooms in which the sterilized material is dried, milled or otherwise prepared, packed, stored or dispatched.

(3) A solid wall must separate the unclean and clean areas, and there may be no direct contact between these areas.

4. Unclean area

(1) Material of animal origin may only be received in the unclean area of a sterilizing plant and no such material may be removed from this area otherwise than through the operations of the sterilizing equipment.

(2) Foot-baths with disinfectants must be provided at all exits, as well as a wheel bath for vehicles at the unclean receiving area.

(3) The floors, walls and equipment of the unclean area of a sterilizing plant must be sanitized daily after the cessation of operations.

(4) Workers employed in the unclean area must –

(a) wear distinctively marked overalls and rubber boots;

(b) wash their hands and disinfect their boots before leaving the unclean area; and

(c) change from their soiled protective clothing and footwear and clean themselves with soap and water before leaving the premises.

(5) A person who has entered the unclean area may not enter the clean area or any area where any edible products are handled in the abattoir unless he or she has cleaned and changed as contemplated in sub regulation (4)(c).

5. Product

(1) A person may not sell the products of a sterilizing plant unless they conform with the specifications set by the Registrar in terms of the Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act No. 36 of 1947).

(2) Any material produced by processing or treatment under the provisions of this Part and intended for animal consumption or as a fertilizer must be subjected to such examination and tests as the said Registrar may specify.

6. Vehicles for condemned material

(1) A vehicle used for the transport of condemned material may not be used for any other purpose, but after cleaning and disinfection the vehicle may be used for the transport of inedible material.

(2) A vehicle may only be used for the transport of condemned material if the –

(a) load space is lockable, theft proof and sealable;

(b) internal surface is leak proof and constructed of durable material; and

(c) floor is provided at its lowest point with a drain pipe capable of being securely closed by a screw valve.

(3) The load space of a vehicle used for transporting material to a sterilizing plant must be cleaned and disinfected to the satisfaction of a registered inspector at the end of each delivery, at a place specially constructed for the purpose.
7. Specimens

(1) The registered inspector may authorise, in writing, the removal of specimens of condemned material and animal parasites from an abattoir for research and teaching purposes, and must state in the authorisation –

(a) the name of the organisation or individual conducting the research, or making the collection;

(b) the name of the abattoir of origin;

(c) the kind and amount of material removed;

(d) the purpose of collection; and

(e) how the material must be disposed of after the intended use, where applicable.

(2) The approval of the owner of the plant is required for the arrangements for the collection of specimens.

3. Methods of preparing animal food

1. Condemned Meat Product Approved for Animal Food

Operators may harvest or salvage certain condemned meat products for animal food with the consent of an official veterinarian. These products may be intended for fish, pets, zoo animals and fur animals. Condemned meat products may be used for animal food provided:

(a) They are derived from carcasses, portions or organs that are not affected with a disease transmissible to the abovementioned animals.

(b) They are derived from carcasses, portions or organs that are not affected with a disease that is a potential cause of zoonoses for handlers of this material;

(c) They are derived from carcasses, portions or organs where lesions or conditions mentioned above are removed.

Operators wishing to engage in the harvesting or salvaging of meat products for animal food must provide adequate facilities for the separation, chilling, packing, marking, storage and, if needed, denaturing of the product. An approved protocol must be provided which guarantees for the secure handling of such products.

High-risk material must be heated to a core temperature of at least 133 °C for 20 minutes at a pressure of 3 bar. The particle size of the raw material prior to processing must be reduced to at least 50 mm by means of a pre-breaker or grinder. Recording thermographs must be provided at the critical points of the heating process to monitor the heat treatment. Other systems of heat treatment may be used provided that they are approved for microbiological safety. Installations and equipment must be kept in a good state of repair and measuring equipment must be calibrated at regular intervals. The finished products must be handled and stored at the processing plant in such a way as to preclude re-contamination.

The animal feed must be free from pathogenic organisms including Bacillus anthracis and gas gangrene (clostridium) bacteria, and must not contain putrefactive or other organisms which might affect the health of animals, and all such animal feed must show no signs of decay. Animal feed must be sold in containers, which are clean and undamaged, and which have been sealed in a way permitted by the nature of the feed and of the containers.
4. Rendering Technology

Rendering of raw animal waste involves a series of drying and separating processes by which the material is sterilised and the fats and proteins are extracted to produce tallow and meat-and-bone meal. At the start of the process, the waste material has a water content of up to 70%; its removal involves relatively high-energy costs. The water effluent produced also needs to be treated to avoid pollution. The organic nature of the material creates further problems of odour pollution, requiring additional pollution abatement technology.

Technical Alternatives to Rendering

Only small amounts of animal waste are currently disposed of to landfill because only a few sites are licensed to take it and because abattoir waste is legally required to be adequately sterilised before disposal.

Incineration appears to be more suitable for dealing with whole carcasses than for waste offal, which has high water content and a low calorific value. The costs of incineration are also relatively high.

Anaerobic digestion is a process whereby organic material such as animal waste is broken down or degraded by micro-organisms operating in an oxygen-free environment. The capital and other costs of anaerobic digestion are more uncertain than for other forms of waste treatment and disposal and the technology is still in the process of development. Developments in this area show considerable promise as both a low-cost and low-pollution means of dealing with raw animal and other waste, although these newer technologies have yet to be fully tested and commercially proven.

The Markets for End Products

The principal end products from the rendering process are tallow and meat-and-bone meal.

Tallow is widely used in the manufacture of soap where coconut oil is a close substitute and in oleo chemicals where, in contrast, there is no very suitable substitute for it. Meat-and-bone meal is sold as a protein source to animal feed manufacturers. The principal source of protein used, however, is Soya bean meal and cereals provide the main ingredient of animal feed.

5. Collection and rendering of blood

After stunning, animals are bled. Facilities for the collection and storage of blood in closed containers prior to removal and disposal must be provided. An emergency entrance should be available to the slaughter area for livestock who is for example unable to walk. A paved and drained area will have to be provided in front of the entrance for the bleeding of these animals.

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

<table>
<thead>
<tr>
<th>Species</th>
<th>Time</th>
<th>Amount of Blood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>6 min</td>
<td>13–15 litres</td>
</tr>
<tr>
<td>Calf</td>
<td>5 min</td>
<td>2–7 litres</td>
</tr>
<tr>
<td>Sheep</td>
<td>5 min</td>
<td>1.3–2 litres</td>
</tr>
<tr>
<td>Pig</td>
<td>6 min</td>
<td>2–4 litres</td>
</tr>
</tbody>
</table>

Blood is rich in nutrients, especially protein, but being liquid, it readily collects dirt once it leaves the animal body. Dirt starts putrefaction which lowers the blood's usefulness, and if drained outside on the slaughterhouse grounds sanitation problems arise by virtue of its clotting property. Other nuisances created by clotted blood are stench, filth, attraction of rodents and the breeding of flies. It is of utmost importance that when blood is collected that it be handled in a hygienic manner and processed with minimum delay. The regulation of certain local authorities effectively prohibits the disposal of blood in the drainage system, which is still a common practice in smaller abattoirs in South Africa. 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. Abattoirs normally pay municipal levies if blood is disposed in this manner. Larger abattoirs in particular experience problems with the burying of blood.
The following different disposal methods are used:

- Municipal drainage
- Oxidation dams
- Buried
- Run off or spraying onto fields
- By products

**Small-Scale Processing of blood**

Where only a few animals are slaughtered per day, small-scale low-technology processing can be undertaken rather than to spill the blood to waste and create sanitation problems. Thus from say 10 cows and 3 sheep, approximately 64 kg of fresh blood can be obtained which can yield at least 12 kg of dried blood. To process this, the blood is cooked in a tank to coagulate it and is drained of liquids that collect on top after cooling. The coagulum is then broken up and spread on a tarpaulin or plastic sheeting for drying. Alternatively, the coagulated mass can be placed in a simple solar dryer for drying.

**Wet Rendering of blood**

In plants that have steam-rendering tanks, the fresh blood can be mixed with selected non-carcass components and wet-rendered. In this instance, the blood should substitute for water in the tank. An advantage here is that the protein content of the offal meal will be raised quantitatively with the addition of blood, although some amino acids may be damaged by the strong action of the heat while others may leach into the cooking water.

**Commercial Drying of blood**

A more productive approach is to process the blood under relatively reduced temperature conditions using a commercial blood drier. In principle, the blood-drier is a dry-rendering tank disposed horizontally and invested with a steam-jacket. Special devices are provided within the tank to prevent blood from coating on the interior walls and reducing drying efficiency. Blood is introduced into the tank as a coagulated mass, previously obtained by steam action. As much liquid as possible should be squeezed from the coagulum. Heating is initiated at 82 °C and progressively raised to 940°C for about three hours, and finally elevated to 100 °C for 7 hours. Drying is complete when the final moisture level in the dried product is about 12%. During drying, moisture is removed rapidly and constantly from the tank by means of condensers to which the tank is connected. Complete moisture removal is not desirable otherwise the final product would darken or char, while above the 12% level the residual moisture can cause deterioration and loss of nutrients. The protein content of the finished product is about 80%.

6. **Manure, paunch and viscera contents**

These must be disposed of in a manner which will not create a sanitary problem on the premises of the registered slaughter establishment. Storage of such wastes in the vicinity of the registered establishment is unacceptable.

**Manure, Compost and Biogas**

Digestive and excretory wastes of ruminants, collectively referred to as manure are a mixture of dung and urine and occur in two forms:

1. (1) as sweepings from liairages which are built into heaps outside the slaughter building and occasionally collected in small quantities by small-scale farmers to enrich soil fertility.
2. (2) And secondly as kraal manure which may remain permanent on the holding ground. Kraal manure is less preferred because it is often sodden with water (from rains) or mixed with earth from treading by the animals as well as straw from bedding, thus creating problems in collection and spreading on farms.
9.  **DISPOSAL OF ABATTOIR EFFLUENT**

The volume of waste water from abattoirs is 80 – 85% of the water intake. This waste water typically contains the following contaminated waste material: blood, bits of meat, fat, paunch contents, urine and dung. Each of these waste materials contributes to a high organic load as well as a considerable amount of suspended material in the waste water.

The management and treatment of waste water is a specialised subject and professional advice from consulting engineers is essential.

Most abattoirs including large ones make use of municipal sewerage systems. Where these facilities are not available alternative arrangements must be made in consultation with officers of the Department of Water Affairs. Care must in all cases be taken to avoid contamination of natural streams and water sources.

Removal of as much of the solid waste in the effluent is essential in making further processing of effluent more manageable. Excessive amounts of solids in effluent may lead to exorbitant levies by municipalities or the overloading of systems on the abattoir premises.

In a system where solids are removed effectively, the remaining fluid may be disposed of in a percolation system (French drain) or used to irrigate lands.
It is important that sewerage from toilets are not mixed with abattoir effluent but is channelled to a septic tank system associated with a French Drain.

1. **Septic tank systems**

Based on a CSIR technical guide K86 of the Institute for Water Research

A septic tank system usually consists of two main components:

- the septic tank
- the final disposal system, that is usually an underground seepage furrow.

Each of these components has specific functions and should be designed accordingly

1.1 **The functions of the components**

Raw sewerage will clog the soil, causing ineffective absorption by the sub-soil. The septic tank, however, will condition the incoming sewerage, separating the solids from the liquid phase by either setting to the bottom or collecting at the surface (float). This results in the formation of three distinct layers:

- Layer of sludge on the bottom,
- A floating layer of scum on top and
- A relatively clear liquid layer in the middle.

Bacterial digestion of organic material will cause liquefaction of the solids with associated gas formation – thus reducing the solids volume.

The only function of a soil disposal system is to get rid of the effluent from the septic tank in a safe and inoffensive manner.

1.2 **Designing requirements**

(a) **Septic tank**

The tank must function both as a sedimentation tank as well as a digester.

- The capacity of the tank should be large enough to provide ample retention time for in-flowing sewerage.
- Possible clogging of the in- and outlet and internal pipes must be limited to a minimum.
- Provision should be made for ventilation for gasses to escape.
- The possibility of passage of sludge and scum to the soil percolation system must be avoided as far as possible.

(b) **Sub-soil percolation system**

- The nature of the soil to a large extent determines the shape and size of the system.
- Locations should be such that it does not create a danger for public health or pollute either ground- or surface water.
- The clogging effect of the effluent on the surface soil must be avoided
- Facilitate full use of the available infiltration area.

1.3 **Public Health aspects of septic tank systems**

In built up areas, this system should be seen as a temporary measure. There is practically no difference between the effluent from a septic tank and raw sewerage as far as potential danger for public health is concerned. Organisms causing disease can be present in the effluent of the septic tanks. In communities where drinking water is derived from boreholes, it is usually unwise to make use of a septic tanks system.
1.4 Combined and separate disposal systems

Two types of disposal systems are in use:

1. A separate system for the ablution facilities (cloakrooms, toilets and kitchens) utilising a septic tank and a separate or common soil percolation system

2. A second system for the abattoir effluent incorporating the necessary solids/fat traps and sedimentation tanks to remove solids (pieces of meat and fat). Effluent from this system can be discharged in a separate of the same common soil percolation system

a. Designing criteria

<table>
<thead>
<tr>
<th>Holding pens</th>
<th>10%</th>
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</thead>
<tbody>
<tr>
<td>Slaughter and dress</td>
<td>20%</td>
</tr>
<tr>
<td>Offal area</td>
<td>25%</td>
</tr>
<tr>
<td>Warm water</td>
<td>25%</td>
</tr>
<tr>
<td>Steam</td>
<td>5%</td>
</tr>
<tr>
<td>Chilling</td>
<td>8%</td>
</tr>
<tr>
<td>Ablution</td>
<td>7%</td>
</tr>
</tbody>
</table>

b. Volume sewerage water

Abattoirs require a water supply of at least 900 litre per slaughter unit. The water must be available at an effective pressure and be protected against pollution

Average water consumption at a high throughput abattoir can be subdivided into:

The volume of effluent in approximately 80 – 85% of water required.

Typical abattoir effluent contains blood, pieces of meat, fat and gut. Constant urine and dung in suspension. Each of these contributes to a very high organic load.

2. Septic tanks

(a) Location:

Local authorities usually have by-laws determining the minimum distances for the placing of septic tanks from buildings and boundaries. It is recommended that the tank be located near to a driveway to facilitate cleansing by means of a vacuum tanker. From a health point of view it is sufficient to have a soil cover of 150 to 200 mm over the system.

(b) Capacity:

Calculation of capacity is based on usage per person per day with a retention period of 24 hours in the septic tank to provide for separation of scum and sludge thus providing for a relatively clear effluent.

Shape proportions and structure:

The shape of a given capacity and depth of tanks, is relatively unimportant. The liquid depth should be between 1 and 2 meters. Single compartment tanks usually give acceptable performance but if a tank is divided vertically into two compartments with the first compartment half to two thirds of the total volume, the amount of suspended solids removed from the effluent is greater

Inlet, outlet and inter-compartment arrangements:

The illustration indicates the positioning of the above in terms of the water level. To accommodate the scum accumulation, the distance between the waterline and the roof of the tank should at least 20 percent of the water depth.
Access and ventilation:

The different compartments/components should be accessible for inspection and maintenance. The location of man holes should be as such that admission is easily obtained to pipes that could block. Ventilation is usually through the inlet sewer to the vent pipe against the wall of the building.

(e) Inlet, outlet and arrangements between compartments:

Figure 1 shows the above in terms of the water level. The distance between the water level and the roof of the tank must be at least 20% of the water depth to accommodate the scum.

Materials:

Septic tanks should be constructed of materials such as concrete, bricks, coated steel or any other materials which are not subject to excessive corrosion.

3. Design and construction of soil percolation system

Location:

Percolation trenches should be located where dangerous pollution of ground water is least likely to occur.

Suitability of the soil:

There is no simple test to accurately determine if soil is suitable to absorb the effluent. The standard SABS-test gives an indication and can be used as a guide-line.

The relative proportion of sand, silt and clay determine the texture of the soil and influences the absorbing ability. The larger and more uniform the particles, the faster the percolation rate. Yellow and reddish-brown soils usually have good absorption quality, whereas a dull-grey (high clay content) has not.

Trench design:

The bulk of the effluent enters the soil through the side walls of the trench. Deep narrow trenches are therefore preferable to wide shallow trenches. A permeable layer, covered with impervious strata will require a deep trench, while the permeable topsoil, with permeable sub-soil will call for shallow trenches.

Trench construction:

Trenches should be constructed along the contours. Where two more trenches are adjacent to each other the distance in between should be twice the depth. After excavation the sides of the trenches should be roughened to restore the natural surface. Filling material should be clean and free of dust or silt. The size of the filling material is not critical and can be from 6 mm to 75 mm or more. It is advisable to have a layer of fine gravel or coarse sand against the infiltration surfaces. The trench should be filled with gravel to about 100 to 150 mm from the top. Prior to back-filling, a layer of finer gravel should be placed on top to prevent soil from entering the trench. If the length of the trench is in excess of 6 m it will become necessary to provide an open jointed distribution pipe.

The trench should be approximately 4 m in length for every 1000 litres given average absorption of the soil.
(e) Maintenance

Septic tanks require effective maintenance. When scum and sludge gets discharged into the percolation trenches, the septic tank should be emptied and the silt and foam should be removed. If this is not done, the seepage system can be damaged permanently. When a ground seepage system starts clogging, there is little to be done, but proper usage of the septic tank can extend the life time of the furrows considerably.

![Diagram of septic tank and seepage system](image)

**CROSS SECTION**

**LONGITUDINAL SECTION**

*Fig. 8 Details of trench construction.*
Fig. 5. Typical septic tank of 3 000 l capacity.

Fig. 6. Inlet and outlet arrangements.
MEAT INSPECTORS MANUAL

Part I
Abattoir Hygiene

Module 5
Pest Control
INDEX

Pest Control

1. INTRODUCTION
   a) Preventing of pests through design
   b) Preventing pest entry to the food facility
   c) Preventing pests through good sanitation
   d) Preventing pests through good housekeeping
   e) Storage practice
   f) Thresholds
   g) Self assessment or auditing programs

2. HOUSEHOLD PETS AND DOMESTIC ANIMALS

3. BIRDS
   a. Bird management procedures

4. RODENTS
   a. Recognizing rat and mouse signs
   b. Rodent management procedures

5. INSECT AND RELATED ARTHROPODS
   a. Cockroaches
   b. Stored product pests
   c. Domestic flies
   d. Occasional pests

6. SUMMARY
1. INTRODUCTION TO AN INTEGRATED PEST MANAGEMENT (IPM) PROGRAM

In an IPM program the causes of pest infestation in and around the facility are removed cost effectively and control is exercised if infestation occurs. These pests mainly include rodents, flying and crawling insects and birds.

An IPM program will include measures to:

- Eliminate breeding places and natural habitats
- Restrict access to the processing areas
- Deny pests access to food, water and harborage
- Monitor all areas of the plant regularly
- Identify the pest accurately
- Assess the best options to control the pest including procedures to eliminate those pests which eventually find their way into restricted locations.

Lasting success can be accomplished only when the reasons for the infestation are controlled

a. Prevention of pests through design

1. Short grass, neatly trimmed shrubs, paved access ways and proper drainage outside.
2. Urinals, water fountains, lockers etc. must be wall suspended and together with electrical and plumbing equipment installed against the wall in such a way that the wall is easily cleanable allowing a sanitation line. Use good quality pipe insulation.
3. All other equipment either raised or sealed to the floor with pliable material and away from the wall.
4. Smooth non-absorbent undamaged walls with no ledges.
5. Wet areas must be resistant to erosion with small joints well grouted, floors well sloped with check valves on floor drains.
6. Roofs must be smooth especially around ventilation gutters.
7. Closed glass-block windows or tough Lexan sheeting at windows prevents pest entering.
8. Doors should be of metal and have tight fitting seams and with auto closing devices.
9. Good lighting with dust tight fixtures. High intensity sodium lights are best. Keep night lights away from doors.

b. Preventing pest entry to the food facility

Full assessment and continuous modifying and maintaining of grounds and structures are essential. This is to prevent volunteer pest entry as well as to eliminate harborage, of which fecal droppings, carcasses and eggs are an indication.

To avoid pest entering as captives inspect all incoming foods, materials and vehicles inside and out. If one insect, eggs, droppings or carcasses are found-

NO ENTRY OF THE PRODUCT !!!
c. **Prevent pests through good sanitation**

Sanitation of equipment must be complete, even motor compartments of machines. Dough the size of a golf ball can support 30 cockroaches for weeks.

**e. Prevent pests through good housekeeping**

The housekeeping program must include both the inside and the outside of the plant. All trash must be removed immediately, the garbage area kept clean, containers kept closed with tight fitting lids and frequent pick-ups of trash out of garbage areas is essential.

**e. Storage practices**

There are **three basic rules** for the storage of products:

1. Off the floor.

2. Away from the wall. To create a sanitation line. The floor can be painted white to aid in detecting signs of harborage.

3. First in first out (FIFO). Applying a receiving date sticker is helpful.
f. Thresholds

In most cultures when an insect is found in food, the consumer is not interested in whether the insect is a primary consumer or a "beneficial" parasite or predator. The pest evidence is seen only as a contaminant and as an indicator of further unseen contamination. Therefore, the cultural threshold the food industry strives for is complete elimination of all food industry pests.

g. Self assessment or auditing programs

The larger corporations may have a well-staffed inspection department. Smaller organizations may be limited to multi-role staffs that have inspection responsibilities in combination with others. Some corporations may hire the services of an outside professional inspection service or a qualified consultant. To be effective, the in-house inspection program needs the following essential features:

1. Management Commitment. Full commitment and involvement by all levels of management is essential. The inspection group must report to top management who ultimately bears the responsibility for compliance with regulations. An effective reporting and follow up system is important as well as corrective actions.

2. Qualified and Motivated Personnel. Inspection personnel need to be academically qualified in environmental health, entomology, microbiology, food science, or those with equivalent experience and specialized training. Other attributes - alert, observant, good analytical judgment, honest, good communication skills.

Dedication to the IPM program must be consistently renewed with positive motivational reminders that the plant must:

a. protect the consumer
b. operate in compliance with GMP’S
c. avoid enforcement actions
d. maintain a respected trade name

Other motivational tools could be competitions, sanitation workshops, training sessions and the demonstration of visible top management interest.

3. Inspection Tools and Guidelines. Personnel must have knowledge of the quality standards from a regulatory, as well as a corporate point of view in order to determine if the plant is in compliance. Normal tools include, but are not limited to: flashlight, black light (rodent urine) camera, pyrethrum aerosol, spatula, scrapers, pliers and a magnifying glass. Additional tools include paper and pencil for notes, a backpack vacuum cleaner and perhaps a caulking gun to seal cracks and crevices as they are found.

2. HOUSEHOLD PETS AND DOMESTIC ANIMALS

may under no circumstances enter the grounds or facility. Urine, feces and shedding cause a major health risk in food facilities. Appropriate fences, gates and personnel training should be in place.

3. BIRDS

Birds near or in facilities is a contamination risk because:

1. Their dry, dusty droppings may contain fungus spores which can cause the human disease Histoplasmosis. Treating with any good acaricide following label directions is necessary and should be handled with care to avoid contamination.
2. Ectoparasites such as mites, made homeless when pigeons are removed, may migrate into areas where humans are.

3. Bad odor and filth in nesting and feeding areas.

a. **Bird management procedures**

Remove sources of food like grain spills, weeds and garbage as well as sources of water.

**Exclusion:** Prevent birds from roosting or nesting inside or near the plant by screening out openings with galvanized mesh, rustproof wire or plastic bird netting.

**Repellents:** Sticky bird repellents can be used in possible roosting areas. Should be replaced regularly and not subjected to very hot or cold temperatures.

**Electric roosting repellents** provide a weatherproof system. Ask the advice of pest control operators experienced in installing these devices.

Other repellents that have been used such as revolving lights, noise makers, high frequency sound vibrations or tape recorded noise generally have only temporary effect and, at best, only move birds into another area.

**Suppression or population reduction methods** must be performed in conjunction with sanitation and exclusion. Methods of suppression include:

**Nest removal** with appropriate cleaning up.

**Trapping:** Several different types of traps can be used. Pre-baiting and the use of decoy birds increases trap effectiveness. Trapped birds must be removed daily.

**Shooting:** Shooting with a .22 caliber or #1 2 bird shot by responsible individuals and with permission from local ordinances.

**Chemical management:** Chemical management with avicides or other pesticides in certain situations may be the only means of effective management. Pesticides may not be used in a manner inconsistent with the label. Decisions as to the need, type of toxicant used and manner in which it is used should be made by professionals.

4. **RODENTS**

Domestic rodents constitute a major pest problem to the food industry. They eat any foodstuff and contaminate much more than they eat, resulting in products that must be destroyed.

There are three major domestic rodents;

<table>
<thead>
<tr>
<th>Droppings</th>
<th>Brown rat</th>
<th>Black rat</th>
<th>House mouse</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Large in size 55 / day av.</td>
<td>Smaller, slightly curved 59 / day av.</td>
<td>Small pointed ends 50 or more / day</td>
</tr>
</tbody>
</table>

a. **Recognizing rat and mouse signs**

Rats and mice are habitually nocturnal and secretive and their signs are found in secluded places like rubbish piles or under boxes or vegetation. From the rodent signs, one can tell the species present and whether a rodent infestation is current or old, heavy or light.

**Droppings:** Fresh droppings of feces are usually moist, soft, shiny, and dark, but in a few days they become dry and hard. Old droppings are dull and grayish and crumble when pressed with a stick.

**Runways:** Rodents like concealment, best routes of escape and shortest distances to resources. Rats habitually use the same runways between food, water, and harborage. Rats prefer continual body contact with at least one vertical surface, such as a fence or wall which becomes greasy. Rats also
follow "odor trails." Outdoors, their runways are narrow pathways of beaten earth swept clear of debris. Undisturbed cobwebs and dust in a runway indicate that it is not in use.

**Rub marks:** Dark greasy rub marks form along runways. Rub marks are soft when fresh and flakey when older. The rub marks of the Norway rat are mostly found near ground or floor level, while those of the roof rat mostly overhead as swing marks beneath beams or rafters at the point where they connect to the walls. Mice do not leave detectable rub marks except when the infestation is heavy.

**Burrows:** The Norway rat prefers burrows for nesting and harborage; the roof rat burrows only occasionally. Burrows are found in earth banks, along walls, under rubbish or concrete slabs, and in similar places. If a burrow is in use, the entrance will be free of cobwebs and dust. Fresh rub marks on hard packed soil, food fragments and droppings and freshly dug earth at the opening indicate a well established and presently used burrow.

**Gnawing:** Rodents gnaw almost anything to gain entrance or obtain food. Small chips of wood or other materials indicate recent gnawing. With age, wood gnawings become dark and smooth from weathering and from frequent contact with the rodent's body.

**Tracks:** Fresh tracks are sharp and distinct, whereas old tracks are covered with dust and are therefore less distinct. To see tracks in the dust, the inspector should hold a flashlight at an angle that causes the tracks to cast distinct shadows. Tail marks are also often visible in dust or tracking patches.

**Urine stains:** Rodent urine will naturally fluoresce under ultraviolet illumination (black light). But other substances like optical bleach will also fluoresce under a black light. For positive identification use Urease-Brom Thymol-Blue test paper. Moisten with water, cover with a cover glass. If a bluish spot appears after three to five minutes it is rodent urine. An older stain will be yellow to white.

**b. Rodent management procedures**

Removing or reducing available food and harborage with good housekeeping, storage and maintenance practices are essential in rodent management. Failure to combine the necessary elements of a sanitation program will result in the failure of the rodent management program, in spite of baiting and trapping activities.

**Non-chemical management: trapping**

Traps are non-toxic and can be disposed of immediately but can be labor intensive.

There are a variety of traps to choose from and can be used according to the label.

Here are some final tips for using rodent traps:

- Eliminate sources of food as much as possible before trapping
- Maintain traps by cleaning and keeping well oiled
- Store traps in plastic bags to keep them from absorbing repellent odors such as pesticide odors
- Do not pet cats or dogs before handling traps, simply wash your hands if you think any odors persist
- Snap traps that are warped should be replaced as they will scare rodents when they rock

**Chemical management: rodenticide use**

After taking every practical measure to build rodents out and to eliminate their food and harboraages, we can supplement these preventive controls with the use of rodenticides. Their toxic effects are not limited to rodents, they can harm people or other animals as well. The professional pest manager must know and understand the use of rodenticides and strictly follow label directions. Tamper proof (resistant) bait stations with spilling trays should be selected and placed out of the reach of animals, children or uninformed persons. Rodenticide label requirements must also be followed precisely.
There are two major types of rodenticides set apart by their toxic action on the rodent: Anticoagulants which cause capillary damage and non-anticoagulants which vary in their mode of action. Both have strengths and weaknesses that must be considered. Always follow label instructions carefully.

**Tracking powders**

Tracking powders’ use is not recommended due to risk of food contamination.

**Fumigating rodent burrows**

Fumigants are poisonous gases that are very acutely toxic to people, pets, rodents and most insects. Fumigants can be applied to outdoor rodent burrows only. Fumigation will kill both the rodents and their ectoparasites in the burrow.

5. **INSECTS AND RELATED ARTHOPODS**

Only a small portion of insects are relevant in the hygiene management of food plants. A few of the most important are discussed here.

a. **Cockroaches**

Cockroaches contaminate our food with their droppings, their bodies, and with bacteria they carry. Cockroaches vary somewhat in their appearance and habits. All have chewing mouth parts, are flat, brownish or dark colored. The eggs of cockroaches are enclosed in a capsule which contains several eggs (highly reproductive). The young resemble the adults, but are smaller and do not have wings.

They are omnivorous, which means simply that they can eat anything such as their own cast skins, live or dead plant material, leather, glue, hair, wallpaper, fabrics and starch in book bindings and almost any human food. They have very secretive habits and move fast which protects them from detection and destruction.

**Cockroach pest management**

Most cockroaches seek out warm, moist, dark harborages that are narrow or tight e.g. sewers, floor drains, garbage disposals, inside wet equipment, motor housings and bathrooms. They travel mainly along intersections, such as along the back edge of a shelf or the juncture of the floor or ceiling and walls as well as inside plumbing connections.

Sanitation is extremely important for effective long term cockroach management. Food, moisture and harborage must be eliminated.

Non-insecticide options are heat (120 F) or freezing temperatures, traps and biological controls (predators and parasites).

Insecticide applications should be selected in coordination with the other management procedures and according to label instructions. Place Insecticides directly into harborages and along travel routes. Non-residual insecticides must be used in wet or steamy areas.

b. **Stored product pests**

There are several important pests of stored food. They eat large quantities and contaminate the food with feces and silk with which food is webbed. Excessive populations may lead to microorganism problems.

**Stored product insect pest management**

Stored product insects are detected by sifting.

Sanitation should be complete because they are very adaptable and flourish in small amounts of flour, rice, nuts, pasta, dry dog food, spices etc.

Product rotation, first in-first out, is also a critical management procedure. The food facility should be "pest proofed" to deny flying pests’ entrance to the facility.
Non-chemical alternatives: High or freezing temperatures, modified atmospheres (CO2), sticky traps and electrocutors.

Insecticide application should be selected and prescribed in coordination with the other management procedures, and label instructions followed completely.

c. Domestic flies

Some flies suck blood and directly inject disease organisms into the blood stream. The house fly feeds on liquid food and contaminates food by regurgitating. Flies have been known to carry the organisms of tapeworm, hookworm, whipworm, roundworm, pinworm, diarrhea, typhoid and cholera. Flies experience complete metamorphosis with egg, larval, papal and adult stages.

Domestic fly management

Eggs are laid in wet decaying organic material such as garbage and animal excrement.

Sanitation: the washing and drying out of the garbage area and bins and twice weekly pick-ups of garbage. Good drainage in trash area with no puddles.

Screening of windows, roof vents etc. Doors should be self-closing. Freight doors may be protected with air curtains.

Various fly traps can be placed strategically.

Poison fly baits can be used as part of the outside management program. Keep outside the reach of children and pets and consider label directions.

Contact adulticide sprays to be used with great care. It gives no lasting residual killing action.

d. Occasional pests

- Ants
- Bristle Tails (Silverfish-Firebrats)
- Crickets
- Spiders
- Mites
- Centipedes

SUMMARY

An IPM program should be dedicated to removing causes rather than treating symptoms. It requires that the pest manager become a structural ecologist, who recognizes the characteristic habitats of pests and works systematically to correct the causes of continued infestations.
MEAT INSPECTORS MANUAL

PART I
ABATTOIR HYGIENE

MODULE 6
SANITATION
INDEX

Sanitation

1. INTRODUCTION
2. DEFINITIONS
3. REQUIREMENTS FOR CLEANING AND DISINFECTING THE ABATTOIR AND EQUIPMENT
4. PRE-OPERATIONAL CHECKS AND BACTERIAL MONITORING
5. SOURCES OF CONTAMINATION
6. THE PRACTICE OF CLEANING AND DISINFECTION
7. LEGAL ASPECTS REGARDING CLEANING AND DISINFECTION
SANITATION IN THE ABATTOIR

1. INTRODUCTION

During the slaughtering process meat, which is practically sterile, is exposed to contamination with bacteria from the outside surface and intestines of the animal, from equipment such as knives, saws, hooks and so on, and from the air and the hands of the workers. When equipment is not regularly cleaned therefore, there is a building up of bacteria which shortens the shelf-life of the meat and could also cause food poisoning in consumers. Proper sanitation will reduce the amount of bacteria in all work areas and on the equipment, and therefore has a direct effect on the quality of the meat provided to the consumer.

2. DEFINITIONS

The concepts of sanitation, hygiene, cleaning and disinfection are very broad and to a considerable extent overlap with each other, so for the purpose of this chapter we will assume that:

a. **Sanitation** refers to all the processes and principles which are applied to ensure that the micro-organism count is kept at a safe low level in accordance with (official health) regulations.

b. **Hygienic** refers to a condition that includes the concepts of “clean” and “safe” (in other words the absence of harmful organisms or substances).

c. **Cleaning** refers to the ongoing process of cleaning which takes place throughout the day and reaches its peak after the slaughtering process has ended. This process includes the mechanical and chemical methods by which macroscopic, visible dirt is removed. When an object appears to be clean, it is not necessarily free of harmful micro-organisms.

d. **Disinfection** refers to the process of sterilisation by which micro-organisms and their spores are killed or inactivated so that they cannot spread to other objects and contaminate them.

The desired condition can be achieved by the application of heat and/or chemicals.

3. REQUIREMENTS FOR CLEANING AND DISINFECTING THE ABATTOIR AND EQUIPMENT

The aim of food hygiene is to ensure clean, safe and wholesome food.

It is extremely important for the management of an abattoir to be fully informed of their duties in respect of hygiene, which the Act imposes on them. If they are not, a tendency could arise to favour production above hygiene, or even attempt to economise on cleaning and disinfecting materials.

1. All equipment, implements, tables, containers, disposal chutes and so on must be made of a material that can be easily cleaned and sterilised.

2. All parts of an abattoir as well as fixed articles, equipment, tables and implements must be kept clean and in good condition to the satisfaction of the meat inspector.

3. All parts of the abattoir, as well as all partitions, equipment and utensils used in the abattoir and which come into contact with the carcass, meat or animal product, must be thoroughly cleaned and disinfected at the end of the working day, or more frequently should it be required.

4. All machinery and equipment used in an abattoir must be so designed and situated as to be easily accessible for cleaning.
5. All equipment used in an abattoir must always be kept in a clean, protected state when not in use.

6. Equipment such as fillers, boilers, autoclaves, digesters and mixer tanks must, when not in use, be kept at a temperature that inhibits the growth of heat resistant micro-organisms.

7. All equipment that has been in contact with bile, faecal or disease-infected material must be cleaned and sterilized immediately before re-use.

8. Metal brushes or steel wool may not be used, because they damage the surface of the equipment; this makes proper cleaning and disinfection difficult.

9. Cloths may not be used for drying, as this only spreads contamination.

10. No polish or other substance that contains any poison may be used for the cleaning or polishing of equipment. All such substances must be SABS approved.

11. After cleaning all utensils and surfaces of equipment, the abattoir must be thoroughly disinfected, including the floors and walls.

12. The disinfection of an abattoir and its equipment, which is infected by a contagious human or animal disease, must be done in a way and with a disinfectant approved by the National Executive Officer.

13. The holding area must also be thoroughly cleaned and when necessary disinfected.

14. A water supply of at least 900 liters per slaughter unit in the case of red meat abattoirs and 15 liters in the case of a chicken abattoir must be available to protect against contamination, and the quality of this water must meet certain requirements.

15. A satisfactory supply of hot water at a minimum temperature of 40 - 50°C must be available at all times during working hours where necessary for cleaning.

16. It is the responsibility of the abattoir owner to ensure that the premises are kept as free as possible from rodents, birds, cats, dogs, flies and other insects at all times, and that no breeding place or circumstances are permitted on the premises which could encourage the breeding of vermin.

4. PRE-OPERATIONAL CHECKS AND BACTERIAL MONITORING

4.1 Pre-operational check:

In order to check up on the effectiveness of the cleaning and disinfection processes, it is very important to inspect the slaughter floors and equipment first thing in the morning. If there are any problems, there is still time to re-clean properly before slaughtering begins. A pre-slaughter inspection of the abattoir is essential.

A visual inspection of the abattoir and equipment will reveal immediately any traces of meat, fat, blood and other contaminants that have not been removed. These remnants are highly undesirable, as they attract insects and rodents while also serving as an excellent growth medium for bacteria.

During inspection the senses of smell, sight and touch are employed and samples are taken for bacteriological analysis. Odours in an abattoir can give a good indication of whether the cleaning and disinfection processes have been carried out properly.

While bad odours such as rotting meat immediately indicates ineffective cleaning procedures, an excessive smell of chemicals is also undesirable, as it can easily mask bad odours, and meat is also well known for its ability to absorb odours.

Important information can also be obtained from touching surfaces, especially those that are not easy to see. Greasy surfaces, dust, splits and cracks can be traced in this way.
4.2 Bacteriological Monitoring:

Samples for bacteriological culturing must be taken regularly from surfaces which come into contact with meat and edible offal, equipment, protective clothing and so on to give a good indication of how effective the cleaning and disinfection functions in the abattoir are.

If the required level of hygiene is to be maintained in an abattoir, cleaning and disinfection must logically take place on a continuous basis throughout the slaughtering process, because contamination also takes place all the time. If this is not done, the entire slaughtering floor will soon be covered with blood, intestinal contents and trampled bits of fat and meat, and microorganisms will be transferred from "dirty" to "clean" areas. The floor and equipment directly under carcasses should therefore not be sprayed, as water that splashes up can only contaminate the carcasses - squeegees must be used for this purpose.

Effective supervision and regular inspections throughout the day are absolutely essential to ensure the success of the cleaning and disinfection processes.

5. SOURCES OF CONTAMINATION

In order to apply effective sanitation in an abattoir, it is necessary to take all sources of contamination into account and to eliminate them as far as possible or to restrict them to the minimum. Effective cleaning and disinfection of the abattoir and equipment can be nullified by conditions that bring about recontamination of the abattoir and equipment.

Slaughtering facilities and equipment

It is of the utmost importance to keep the micro-organism count in abattoirs as low as possible and to keep contamination of meat and other edible products to the minimum during the slaughtering process. This is why wood and cloths are not allowed in abattoirs. Rusty equipment and grease from the rails are also sources of contamination.

Animals slaughtered

It is obvious that the animals that are slaughtered in an abattoir can be the most important source of contamination if strict precautionary measures are not taken to prevent this. Animals infected with one or more kinds of micro-organisms, in other words sick animals, can spread their contamination to the meat and other edible animals products, as well as to the abattoir workers. This is why ante-mortem inspection is so important.

Slaughtering And Processing Procedures

Poor slaughtering techniques include:

- Poor stunning
- Poor bleeding out
- Damaging intestines when eviscerating

Apart from poor slaughtering techniques, the following factors also contribute to contamination during the slaughter and processing of meat:

- Untrained and careless workers. Satisfactory training and encouragement can largely eliminate this problem.
- Production line and slaughtering speeds that are too fast mean that the hands and equipment cannot be washed and disinfected regularly.
- Not enough working spaces and cramped working conditions. (See Abattoir Layout.)
- Contamination which is washed off instead of being trimmed off.
• Recovering on the slaughter floor itself. This practice can only spread the contamination, and should rather be done in the detention area.

• Overloading the refrigeration facilities, causing carcasses to touch each other and consequently ineffective chilling.

*Abattoir personnel*

Workers can also be a source of contamination of meat. The abattoir supervisor must inspect all the workers every day before they start work to establish whether they have any abnormalities such as skin diseases, visible open wounds or septic sores on the head, neck, arms or hands or unnatural discharges from the eyes, nose ears or skin. If such an abnormality is identified, the worker must be examined by a nursing sister or a doctor to establish whether he/she is fit for work that day or not.

*The Abattoir And Its Environment*

The situation of the abattoir can also be a source of contamination. Large amounts of pollution from smoke, dust or unpleasant smells can make it extremely difficult to maintain a high standard of hygiene.

*Water Quality*

Water is used as the universal cleaning medium. However, pure water does not exist in nature and the quality of water (chemical and microbiological) varies considerably depending on area and time of year. Since, especially the chemical quality of water has a dramatic effect on the performance of detergents it is important to establish water quality and its influence on a sanitation program.

For example: For a chlorinated alkaline cleanser an extra amount (over the recommended concentration) of 1 gram is needed for every 50 ppm hardness over 150 ppm; water hardness in the South African context is often over 150 ppm and even up to 500 ppm.

Water used in food plant sanitation must be of potable quality and should conform to the following specifications:

- Total bacterial count: < 100 viable organisms/ml (30 °C/ 48 hours)
- Coliform count: < 0/100 ml
- Faecal coli: < 0/100 ml

The water supply should be monitored regularly for the presence of psychrotrophic (cold loving) bacterial contamination.

*Protective Clothing*

Protective clothing must be provided every day before work and sometimes during working hours if desired hats, aprons and boots must be cleaned regularly before and during the slaughtering process and replaced when necessary.

*Containers For General Refuse*

Rubbish containers must be made of durable, rust-resistant, non-absorbent materials and must be provided with tight fitting lids to protect the contents against flies and cockroaches and to limit unpleasant smells to the minimum. The containers must also be emptied regularly and then cleaned and disinfected. The use of disposable plastic rubbish bags does not mean that the containers need not be cleaned and disinfected.

6. THE PRACTICE OF CLEANING AND DISINFECTION

6.1 The 7 basic steps of cleaning and disinfection

1. *Removal* of loose bits of rubbish such as meat, fat, skin and bone from equipment walls and floors to facilitate cleaning.
2. **Loosening** pieces of rubbish, blood faecal and other contaminants by means of dry sweeping, and removing them by picking them up. Bits of meat and fat and skin, in particular, must not be washed into the drainage system.

3. **Pre-washing** all equipment, floors and walls with clean hot water (40 - 50°C) to soften and loosen the remaining particles.

4. **Washing and scrubbing** with detergents and hot water under pressure.

5. **Rinsing** with clean hot water (45 °C) under pressure in order to remove the loosened particles and detergents properly.

6. **Disinfecting** with a suitable disinfectant at the proper concentration.

7. **Microbiological survey** of the equipment and walls to establish the effectiveness of the cleaning and disinfecting.

Two other important factors to remember is that condemned material and trimmings must be put into containers and not thrown on the floor, and racks and reels must be provided for brooms and hoses.

According to SABS 049 – 1989, acceptable standards are:

<table>
<thead>
<tr>
<th>QUANTITY OF ORGANISMS</th>
<th>JUDGEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 15 organisms / 10 cm²</td>
<td>satisfactory</td>
</tr>
<tr>
<td>16 - 75 organisms / 10 cm²</td>
<td>fairly satisfactory</td>
</tr>
<tr>
<td>75 + organisms / 10 cm²</td>
<td>unsatisfactory</td>
</tr>
</tbody>
</table>

### 6.2 Guidelines For The Compilation Of A Cleaning And Disinfection Programme

A hygiene specialist in co-operation with the production management, abattoir engineer, and the manufacturers of cleaning and disinfecting agents must lay down procedures for cleaning and disinfection. Standard Operational Procedures (SOP's) must be compiled for cleaning and disinfection of the abattoir equipment and vehicles but also for the equipment which is used for cleaning and disinfection such as brooms, brushes, containers etc. The complete procedure must then be written down in schedule form and made available to both workers and management for regular consultation and reconsideration. Strict supervision on the part of management must ensure that the established procedures are being followed in order to make a success of the cleaning and disinfection programme.

*How to draw up a cleaning and disinfecting programme*

a. Make a list of all the surfaces which have to be cleaned, the material they are made of, and the standard of sanitation required for each.

b. Decide on the method of cleaning and sanitation in each case and the sequence in which each surface must be cleaned. Make sure that when a surface is cleaned, surfaces, which are already clean, do not get soiled again. Disinfecting should preferably take place at the end of the cleaning programme, in the same sequence as the cleaning.

c. Decide in co-operation with the hygiene department what kind of cleaning and disinfecting agents should be used and at what concentrations.

d. Standard operating procedures (SOP's) which set out the instructions based on the above points in which the method of cleaning and disinfecting, the kind and concentration of chemicals and the sequence of cleaning and disinfection are clearly stated should be available to every member of the cleaning team.

e. The cleaning team must be well trained, and strict supervision must then ensure that the above instructions are carried out meticulously.
f. Make use of the **WHO, WHAT, WHERE, WHEN** and **HOW** PRINCIPLES. Each member of the team must know exactly **WHO** must do the work, **WHAT** must be done, **WHERE** it must be done, **WHEN** it must be done and **HOW** it must be done.

g. Arrange for microbiological surveys. Unacceptable results will reveal weaknesses in the cleaning and disinfecting programme as well as problem areas.

### 6.3 Detergents

The purpose of detergents is to render water insoluble dirt soluble or dispersible in water. Because of the variety of pollutants occurring in the meat industry and their different solubility characteristics, there is **NO SINGLE MIRACLE DETERGENT** which will remove all the dirt at all times.

#### 6.3.1 The Following 4 Anionic Detergents Are Most Frequently In Use

a. **Acid Detergents**

These are used to dissolve mineral deposits on the surface of equipment. The pH of the solution is usually 2.5 or lower.

b. **Alkaline detergents**

Alkalis are the main ingredients of the majority of detergents. They react with fats and proteins to make soluble compounds that can easily be dissolved in water.

c. **Chlorinated detergents**

Chlorine reacts strongly with proteins, and is therefore added to alkaline detergents. It also reduces mineral deposits resulting from the detergent. At the high pH at which they are used, however, chlorinated detergents cannot be used as disinfectants. The high pH also reduces the corrosion problems experienced with ordinary chlorine.

d. **Foam detergents with enzymes**

Recently, a new type of cleaner has appeared which is designed primarily for poultry and meat plants. This cleaner, or, actually, cleaning system, consists of two components. The first contains a mixture of surfactants and a mixture of enzymes, and the second is an alkaline solution supplemented with water softeners and conditioners. The two components are mixed with **warm water** (maximum 45º C) just before use and usually applied as foam. These enzyme-based detergents have many advantages. The concentrated foam clings to all surfaces including vertical surfaces, which gives the chemicals enough time to emulsify the dirt. If they are used in chillers the relatively low temperature save energy as well as refrigeration costs.

#### 6.3.2 Detergent Product Selection Guide

a. The product should be economical, the factor to measure this by is price of the solution used, not price per litre or kg of product.
b. It should contain corrosion inhibitors to prevent attacks on soft metals such as aluminum and galvanising.
c. It should display good soil (dirt) penetration through wetting action.
d. It should be able to sequester water hardness of 150 mg/kg or more to prevent deposition of mineral salts.
e. It should have good soil suspending properties to prevent re-deposition of emulsified soils.
f. It should be free-rinsing.
g. It should be readily water soluble.
h. It should be of low toxicity and acceptable effluents (biodegradable).
i. Its foaming characteristics need to be matched to its application.
j. It should adjust the pH of the cleaning solution to the required value (alkaline for the removal of fats, proteins and heavy soils, acid for the removal of alkaline scales and mineral deposits).
6.3.3 Factors Affecting The Effectiveness Of Detergents

Even the best detergent available is only as good as the way in which it is used. There are 4 deciding factors that determine the effectiveness of a detergent:

a. Concentration (Chemical action)

Every product has its optimum concentration. A weaker concentration lowers its effectiveness, and a higher concentration does not give better results; it only increases costs.

b. Mechanical action

This includes such actions as scrubbing, brushing, rinsing and high-pressure spraying which are essential if the detergent is to function properly.

c. Temperature

This is a deciding factor for the effectiveness of any detergent. In general it can be said that the higher the temperature (up to 80°C) of the solution, the more effective the operation, especially in respect of greasy dirt.

d. Contact time

The contact time between the detergent solution and the dirt must be long enough, as most detergents rely on chemical processes and reaction to remove dirt.

The effectiveness of cleaning method depends in every aspect on the interaction of these 4 factors. Generally speaking the reduction of one factor requires the increase of one or more of the others. If cleaning is not thorough, disinfecting will also be ineffective.

6.3.4 Five Fundamental Steps In Cleaning

a. Bringing the detergent solution into intimate contact with the soil by wetting and penetrating.

b. Displacing the soil from the surface by saponifying fat, peptising proteins and dissolving minerals.

c. Dispersing the soil in a solvent by dispersing, de-flocculation and emulsification.

d. Preventing re-deposition of the soil onto the clean surface.

e. Rinsing the soil from the cleaned surface.

GOOD SANITATION IS 90% CLEANING AND 10% DISINFECTION!
6.4 Disinfectants/ Sanitizers

Even the most thorough cleaning will not remove all the micro-organisms from a surface. Disinfection is therefore essential to bring the microbe population of a surface down to levels that will be safe for public health. This can be obtained by using a SABS approved disinfectant.

6.4.1 **For effective disinfection the following requirements must be met:**

- The surfaces must be thoroughly cleaned.
- The contact time between disinfectant and surfaces must be at least 30 minutes, and preferably overnight.
- The concentration of the disinfectant solution must be strictly in accordance with the manufacturer’s instructions. Too little disinfectant can result in ineffective disinfection, and too much increases the danger of contaminating meat with the chemicals.

6.4.2 **The Following 3 Kinds Of Disinfectants Are Most Often Used In The Meat Industry:**

- **a. Chlorine-based disinfectants.**
  
  They have good disinfectant properties against a wide range of bacteria. In properly mixed solutions they are relatively non-toxic, colourless, non-staining and easy to prepare and to use. Chlorine disinfectants are however inactivated to a considerable extent by organic material, and can also cause soft metals to corrode.

- **b. Iodine-based (iodophor) disinfectants**
  
  They have a rapid disinfectant action against a wide variety of gram-positive and gram-negative microorganisms. At working concentration they are relatively non-toxic, non-irritant and stable. The temperature of the working solution must not exceed 45°C. No rinsing is necessary with solutions less than 25 ppm of iodine.

- **c. Quaternary ammonium compounds (QAC)**
  
  These are effective against many gram-positive and some gram-negative bacteria. In working solutions they are colourless, odourless and non-toxic. They are stable when heated, but are also inactivated by organic material. No rinsing is necessary for solution of less than 200 ppm of active ingredients.

- **d. Comparison test between a disinfectant and water at 82 °C**
  
  Disinfection by heat at 82°C is not usually as effective as chemical disinfection, except in the case of equipment small enough to be immersed into a steriliser and kept under water at, 82°C for relatively long periods. In a test at an abattoir the disinfection efficiency of heat at 82°C was compared with that of a chemical disinfectant. Microbiological surveys conducted throughout the test gave the following results (measured in numbers of **colony-forming units/cm²**):

  This pattern has also been observed at other abattoirs where similar tests were performed.

  These results show clearly that:

  - The application of water at 82°C for 2 minutes did not result in sterilisation. After sterilisation there should not be any living organisms present.

  - Chemical agents did not always result in sterilisation even after 30 minutes application. They are therefore not real disinfectants, but rather sanitation agents, because they simply lower the micro-organisms population to a safe, low level.
6.4.3 Disinfectant Product Properties Selection Guide

- Rapid kill in short time (seconds).
- Broad kill and rapid kill time.
- Safe and non-irritating to employees.
- Safe for consumers and acceptable to or approved by regulatory agencies.
- Freely rinsable.
- No adverse effect on food being processed.
- Economical (consider use-dilution).
- Easily tested for use-solution concentration.
- Stable in concentrate and use-solution form.
- Non-corrosive.
- Readily water soluble.
- Compatible with other chemicals and equipment.

6.5 Acceptable Standards In Respect Of Cleaning And Disinfecting

Cleaning and disinfection can be regarded as effective when:

a. no more visible dirt occurs;
b. no chemical residues from the cleaners and/or disinfectants occur on working surfaces;
c. there are no mineral deposits from the water;
d. no unacceptable smells or odours occur;
e. there are no stains;
f. no physical damage such as cracks or splintering is present;
g. acceptable bacteriological counts are obtained.

6.6 Sanitation Chemicals

Detergents and disinfectants should be purchased only from reputable suppliers according to the guidelines supplied in this manual. Close attention should be paid to using disinfectants at the specific concentrations for no-rinse approval.

6.7 Do's And Don'ts With Sanitation Programmes

DO!

a. Remove gross soils such as scraps, fat, meat juices and other organic matter before applying the detergent foam or solution.
b. Always rinse with warm water (40-50 °C).
c. Foam or scrub with detergent solution (60-70º C).
d. Allow a contact time of 10 minutes for foam.
e. Use disinfectants at the recommended concentration only.
f. Drain equipment and store dry where possible.

DON'T!

a. Misuse chemicals - both overuse and under-use is wasteful.
b. Use cold water - it increases your chemical requirements.
c. Mix different chemicals without the manufacturer's instructions they may react dangerously or may neutralise each other.
d. Add chemicals to foodstuffs.
e. Rinse after sanitising - allow to air dry.
f. Use pieces of cloth (rags) anywhere - it facilitates contamination of surfaces and products.

A sanitation program for each work area is important. Cleaning and disinfection is just as important for the production of a safe product of high quality as any other part of the program.
7. LEGAL ASPECTS REGARDING CLEANING AND DISINFECTION

Abattoir design and facilities

1. The design of an abattoir and the equipment used must be such as to facilitate easy cleaning and sterilisation.

2. The following water supply must be available for sanitation purposes during production and sanitation:
   
   (1) Water used for sanitation must be potable;
   (2) Hot water at 82°C in sterilisers for disinfecting hand equipment;
   (3) Water at 40°C at hand wash basins for washing of hands;
   (4) Water at 40°C for general cleaning purposes.

3. The abattoir owner must supply all the necessary equipment needed in the sanitation process.

Sanitation programs

4. A detailed post slaughter sanitation program must be in place detailing the following information:
   
   (1) A list of all areas and rooms to be cleaned;
   (2) The frequency of cleaning;
   (3) Step by step cleaning procedures for each area, room or equipment, including ablution facilities, meat transport vehicles and lairages;
   (4) Technical sheets of the chemicals used must be available with reference to accredited approval for use in meat plants, active ingredients, dilution rates and applications;
   (5) Target results, including microbiological monitoring, to be obtained as the objective of the sanitation program;
   (6) Job descriptions and training program for all cleaners.

5. Programs must be in place for continuous cleaning during:
   
   (1) Production;
   (2) Breaks;
   (3) Shift changes.

6. An effective pre-production monitoring program must be in place to ensure cleanliness of all facilities before production commences.

7. All these above programs must be approved.

8. Slaughter must not commence before all areas, rooms and equipment have been cleaned and disinfected.

9. No sanitation must commence in any area before all edible meat products have been removed to prevent contamination.

Chillers and Freezers

10. Chillers must be sanitised before a fresh load of carcasses or products are loaded.

11. Chillers may not be sanitised if it contains meat.

12. Freezers must be defrosted and thoroughly sanitised at least once a year or more often if required by the authorised person.
MEAT INSPECTORS MANUAL

PART I
ABATTOIR HYGIENE

MODULE 7
QUALITY & SAFETY CONTROL SYSTEMS
QUALITY & SAFETY CONTROL SYSTEMS

1. INTRODUCTION
2. DEFINITIONS
3. THE NEED FOR QUALITY SYSTEMS
4. HACCP AS A FOOD SAFETY MANAGEMENT SYSTEM
5. QUALITY SYSTEMS AS PRE-REQUISITES FOR HACCP
6. HACCP IMPLEMENTATION
7. HYGIENE MANAGEMENT SYSTEMS (HMS)
8. KEEPING OF RECORDS
9. HAS
QUALITY & SAFETY CONTROL SYSTEMS

1. INTRODUCTION

Quality control is becoming an increasingly more important factor in the food industry. The new Meat Safety Act legalises Hygiene Management Systems. The main objective of HACCP is to make provision for a safe product while ISO 9000 is a quality system. The HAS is a system used to monitor the different safety and quality systems. HACCP, HMS and HAS will be discussed shortly.

2. DEFINITIONS

2.1 Quality

Quality means to comply with standards set by the customer/consumer, management or legislation.

2.2 Quality Assurance (QA)

The system used to interpret and formulate the firm’s policy with respect to quality and the setting of parameters against which standards can be measured.

2.3 Good Manufacturing Practice (GMP)/ Good Hygiene Practice (GHP)

GMP means manufacturing procedures and methods that, while taking into account the principles of hygiene, are applied in such a way that food is not spoilt during the manufacturing process.

2.4 Hazard Analysis and Critical Control Point (HACCP)

HACCP is a system that identifies, evaluates and controls hazards that are significant for food safety.

2.5 Critical Control Point (CCP)

It is a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

3. THE NEED FOR QUALITY SYSTEMS

This is not a course on HACCP but only an introductory text to some of the basic facts about quality control systems and HACCP. Considerably more training in these systems than the following text will be required for their successful implementation.

A quality management system allows for planning to prevent things from going wrong during processing; it does not wait for things to have gone wrong before acting. The risk must be managed and must be as small as possible. It is generally accepted that a quality system should be:

- Established – What is the right way/right procedure/right standard?
- Documented – The right way must be written down
- Maintained – You must do what you have written down
- Audited – Checked that you are actually doing what you say you are doing

Various quality systems are available. These include the ISO 9000 series, and in the food industry at present, mostly GMP and HACCP. Having a HACCP system in place is an absolute requirement for exportation of meat to the European Union (EU) and the United States of America (US). While GMP mostly refers to quality systems including hygiene, HACCP deals only with food safety. The standard texts at present are the publications of the international Codex Alimentarius Commission’s guidelines for both HACCP and hygiene.
4. HACCP AS A FOOD SAFETY MANAGEMENT SYSTEM

The Hazard Analysis and Critical Control Point (HACCP) is a system to manage food safety. It is a proactive system because food safety hazards are controlled throughout processing instead of only after production by end-product testing. It gained prominence because the incidence of food borne human illness is increasing thus causing world-wide concern over food safety issues. In recent times food borne disease has been on the increase all over the world and even first world countries experience a worrying increase in outbreaks of food borne disease. In fact, food borne disease has been described by the World Health Organisation as one of the most widespread public health problems of the contemporary world. The international community is now are pinning their hopes on pathogen management systems to help solve the problem.

The HACCP system is science based and systematically identifies specific hazards as well as measures for their control in order to ensure the safety of foods. It includes control of microbiological, chemical and physical hazards.

The HACCP concept is simple:

It is a proactive approach to prevent food safety hazards by focussing resources at those points in food production where food safety hazards can be controlled, instead of placing emphasis on (reactive) end product testing.

5. QUALITY SYSTEMS AS PRE-REQUISITES FOR HACCP

The main prerequisite for implementation of quality systems and HACCP is management commitment. Management must be willing to render visible as well as financial support to the HACCP and prerequisite quality programmes. Do not attempt introducing HACCP without it!

The production of safe food products requires that the HACCP system be built upon a solid foundation of pre-existing programmes. These prerequisite programmes provide the basic environmental and operational conditions that are necessary to produce safe, wholesome food. Common prerequisite programmes may include but not be limited to:

Procedures for:
- Sanitation
- Pest Control
- Maintenance of equipment and facility
  - Slaughtering and dressing
  - Chilling
  - Dispatch
  - Offal processing
- Water supply controls
  - Plant water supply
  - Chlorination

Personnel
- All personnel should receive documented training in:
  - Personal hygiene
  - Good Manufacturing Practices
  - Cleaning and sanitation procedures
  - Personal safety
  - Their specific role in GMP and HACCP programmes
- Training should be updated where necessary. With required updating and new appointments, training almost becomes a continuous task.
- It is most important that all employees (including management) as well as other persons entering the plant, must observe all rules of personal hygiene and behaviour. GMP must become a way of life at the plant.
Pre requisite programs are often confusing in that they can be called different names in the different spheres or organizations where food safety programmes are implemented. To simplify it for the sake of this module in broad terms the following names will in essence describe pre requisite programmes:-

Hygiene management programs
Good Manufacturing programs
Good hygiene programs
Quality management systems
etc.
One or more of the above are often required for an effective pre requisite program for HACCP.

6. HACCP IMPLEMENTATION

Although the HACCP concept is simple and at first glance obvious, its implementation is difficult. It is based on science and scientific fact and not simply on perceptions. HACCP implementation includes control of microbiological, chemical and physical hazards. Successful implementation requires input from a variety of fields such as processing, engineering, maintenance, microbiology and hygiene, food technology etc. It is unlikely that one person can be an expert in all these fields and especially in the smaller plant where multitasking is practised, outside assistance with the HACCP plan may be required.

The 7 principles of HACCP are:

Principle 1: Conduct a hazard analysis
Principle 2: Determine the critical control points (CCP’s)
Principle 3: Establish critical limit(s)
Principle 4: Establish a system to monitor control of a CCP
Principle 5: Establish a corrective action to be taken when monitoring indicates that a particular CCP is not under control.
Principle 6: Establish procedures for verification that the HACCP system is working effectively.
Principle 7: Establish documentation concerning all procedures and records appropriate to these principles and their application.

The 12 stages in HACCP implementation are:

1. Assemble a HACCP team
2. Describe product
3. Identify intended use
4. Construct a flow diagram
5. On-site confirmation of flow diagram
6. List all potential hazards associated with each step, conduct a hazard analysis and consider any measures to control identified hazards (see Principle 1)
7. Determine Critical control points (see Principle 2)
8. Establish critical limits for each CCP (see Principle 3)
9. Establish a monitoring system for each CCP (see Principle 4)

10. Establish corrective actions (see Principle 5)

11. Establish verification procedures (see Principle 6)

12. Establish Documentation and record keeping (see Principle 7)

Since HACCP is a tool to establish control systems that focus on the “prevention rather than cure” approach, the concept can be applied to other aspects of food quality and successfully used to ensure production of a quality product every time.

7. HYGIENE MANAGEMENT SYSTEMS (HMS)

The Meat Safety Act, 2000 (Act 40 of 2000) provides for the implementation of hygiene management systems. The following extract was taken from the regulations in terms of this act.

The owner of an abattoir must –

(a) provide the provincial executive officer with a documented Hygiene Management System containing detailed information on control measures or programmes required to monitor identified control points, including the methods of monitoring or checking these control points, for approval;

(b) provide relevant records of observations, checks, measurements or results;

(c) provide sampling programmes for laboratory analyses, as well as names of laboratories to do the required analyses;

(d) provide written accounts of decisions relating to corrective actions when taken; and

(e) assess the hygiene status of the abattoir by means of the Hygiene Assessment System (HAS) and provide results to the provincial executive officer for verification as frequently as he or she may require.

1. Document management system

A document management system must provide for –

(a) the retrieval of documents relating to an identified slaughter batch;

(b) the recording of each slaughter batch containing information regarding date of slaughter, species slaughtered, mass, quantities, identification and destination for carcasses as well as cut meat; and

(c) a documented product recall procedure approved by the provincial executive officer.

2. Schematic plan of abattoir

The owner must prepare an updated schematic plan of the abattoir to include details of –

(a) all the different areas on each level;

(b) all the different rooms in each area identified, indicating the process or operation including the capacities or rates of operation that take place in such rooms;

(c) the flow of the product;

(d) ancillary structures on the premises;
(e) the required temperature as well as the capacity of each room where temperature is controlled;

(f) the different ablution facilities for workers in clean and dirty areas as well as the personnel entrances to the different areas;

(g) all entrances to rooms, areas and building; and

(h) boundaries, indicating entrances and exits to and from premises.

3. Flow diagram of slaughter process

The owner must prepare a flow diagram of the slaughter process which must include –

(a) all steps involved in the process, including delays during or between steps, from receiving of the animals to placing of the end product on the market; and

(b) details and technical data including equipment layout and characteristics, sequence of all steps, technical parameters of operations, flow of products, segregation of clean and dirty areas, hygienic environment of the abattoir, personnel routes and hygienic practices, product storage and distribution procedures.

4. Potential hazards

The owner must prepare a list of all potential biological, chemical or physical hazards that may occur at each step of the process, including –

(a) unacceptable contamination or recontamination of a biological, chemical or physical nature;

(b) unacceptable survival or multiplication of pathogenic micro-organisms; and

(c) unacceptable production or persistence of toxins or other undesirable products of microbial metabolism.

5. Prevention of hazards

The owner must prepare written hygiene management programmes (HMP) for approval by the provincial executive officer, to prevent, eliminate or reduce hazards mentioned in regulation 53 to acceptable levels and must –

(a) ensure that management programmes for each hazard is implemented;

(b) establish critical limits for control points;

(c) establish a monitoring or checking system for each control point; and

(d) prepare written corrective actions that must be taken without hesitation when a deviation is observed and such corrective action must specify –

(i) the persons responsible to implement the corrective action;

(ii) the means and action required for each hazard;

(iii) the action to be taken with regard to the meat having been processed during the period when the process was out of control; and

(iv) that a written record of measures taken must be kept.
6. The owner of an abattoir must –

(a) a HMP for ante-mortem inspection, including control measures to –

(i) ensure that all animals/birds which for some reason or other cannot be processed into safe meat are identified and handled in accordance with Part VIII;

(ii) identify animals/birds with diseases and conditions of which symptoms may not be visible during post-mortem meat inspections;

(iii) identify animals/birds with zoonotic diseases;

(iv) identify animals/birds with highly contagious diseases or diseases controlled under the Animal Health Act, 2002 (Act No. 7 of 2002); and

(v) identify animals/birds that pose a high contamination risk, such as those with septic conditions or animals that are excessively soiled; and

(vi) ensure that injured animals/birds in obvious pain are presented for emergency slaughter or preferential slaughter without undue delay;

(b) a HMP for slaughter and dressing, including –

(i) control measures (CM) to ensure that no contamination of meat and edible products occur from –

(aa) the external surface of the animal slaughtered;

(bb) wind and dust;

(cc) the contents of hollow organs;

(dd) persons working with edible products; or

(ee) contact with unclean objects;

(ii) slaughter and dressing procedures which must limit any contamination to the absolute minimum;

(iii) training of all workers in correct slaughter techniques including principles of hygiene practices which must be monitored;

(iv) a programme for the daily checking of carcasses for soiling to provide for regular checking of a representative sample of carcasses throughout the day on a random basis and to determine the levels of contamination of carcasses;

(c) a HMP for meat inspection, in terms of which the supervisory registered meat inspector (SMI) assisted by the registered veterinarian must monitor meat inspection by means of implementation of written control measures to ensure –

(i) that meat inspection is done according to Part VI;

(ii) the competency of the meat inspectors and meat examiners;

(iii) the personal hygiene of the meat inspectors and meat examiners;

(iv) that heads, red and rough offal are correlated to the carcasses of origin;
(v) the security of detained carcasses and organs;
(vi) the security of provisionally passed carcasses and organs;
(vii) the security of the stamp of approval;
(viii) the security of condemned material;
(ix) the implementation of standard operational procedures (SOP’s) for –
   (aa) emergency slaughter;
   (bb) preferential slaughter;
   (cc) provisional slaughter;
   (dd) slaughter of cattle which have reacted positively to Brucellosis and Tuberculosis tests done on the farm and branded with the “C” and “T” brand marks;
   (ee) dirty animals; and
   (ff) dropped meat;

(d) a HMP for personal hygiene of workers in terms of which –
   (i) a general code of conduct, approved by a registered inspector, for personnel and in particular for workers who come into direct contact with meat and edible products, must be available;
   (ii) a training programme, as well as registers of attendance, for all personnel to apply the principles of the code of conduct referred to in subparagraph (i) must be available; and
   (iii) records of surveillance and supervision including records of disciplinary action in cases of repetitive misconduct or non-compliance must be available;

(e) a HMP for medical fitness of workers in terms of which –
   (i) records of initial medical certification that workers are fit to work with meat and edible products, prior to employment, must be available; and
   (ii) records of daily fitness checks, including corrective actions applied in cases of illness and injury, must be available;

(f) a HMP for the temperature of water in sterilizers and maintenance of sterilizers in terms of which control measures to ensure the continuous availability and accessibility of sterilizers in good working order at water temperatures of 82 °C, including registers for daily checks indicating frequency of checks as well as corrective action procedures in cases of non-compliance, must be available;

(g) a HMP for the availability of liquid soap and soap dispensers, toilet paper, and disposable towels, in terms of which control measures to ensure the continuous availability and accessibility of liquid soap and soap dispensers for hand-washing purposes, toilet paper and disposable towels at pre-identified points must be available;

(h) a HMP for sanitation and continuous cleaning including a cleaning schedule providing –
   (i) a list of all the areas to be cleaned;
(ii) a list of all the rooms that have to be cleaned within every area;

(iii) the name of the person responsible for the cleaning of each area, section or room;

(iv) for each room within a particular area, a detailed description of the cleaning of each structure, including –

(aa) the frequency of cleaning;

(bb) step by step methods of cleaning;

(cc) data of the chemicals which are used, such as registration data, safeness, dilutions, application prescriptions;

(dd) the correct application of the detergents such as dilution, temperatures and contact times;

(ee) the rinsing off of applied chemicals; and

(ff) the results to be obtained as an objective of the cleaning programme;

(v) an addendum for each room in which the cleaning of each structure must be described in detail including aspects such as method, frequency and target results;

(vi) for the training of cleaning teams in the execution of these programmes;

(vii) for control over the storage of detergents to prevent contamination of edible products;

(viii) a detailed description for continuous cleaning on the processing line during processing, which must include –

(aa) a list of all the actions in this programme including the cleaning of moving equipment and crates; and

(bb) a step by step description of each action;

(ix) for these programmes to be approved by a registered inspector; and

(x) for laboratory checks as control of effectiveness of the cleaning programmes to be instituted and documented;

(i) a HMP for availability and quality of water in terms of which –

(i) the owner of the abattoir must account for the source of water supply and the status of such water;

(ii) the owner must be able to demonstrate the water distribution system within the abattoir and provide an updated schematic plan of the water distribution on the premises;

(iii) a sampling programme must be followed to ensure that all outlets, including water hoses are checked on a repeated consistent basis within an allotted period of time, and the sampling procedure must be described; and

(iv) the owner is responsible to ensure that water used in the abattoir is potable and that records of microbiological and chemical water test results are available;
(j) a HMP for vermin control in terms of which the owner of the abattoir must provide a written control programme for each vermin type for approval by the provincial executive officer, and such programme must include –

(i) schematic drawings indicating the position of bait stations;
(ii) a poison register, including specifications for the use of different poisons; and
(iii) training programmes for persons working with poisons;

(k) a HMP for waste disposal, including condemned material, in terms of which –

(i) the owner of the abattoir must provide a written control programme for the removal of each different category of waste material including general refuse removal for approval by the provincial executive officer; and
(ii) security arrangements to prevent condemned material from entering the food chain must be described;

(l) a HMP for in contact wrapping and packing materials in terms of which –

(i) the owner of the abattoir must provide a written control programme addressing the suitability as well as the storage and handling of all in contact wrapping and packing material;
(ii) control measures to prevent contamination in store rooms must be provided; and
(iii) control measures to prevent contamination of wrapping materials must be provided;

(m) a HMP for maintenance, providing for the owner of the abattoir to provide a document addressing the routine maintenance of all equipment and structures; and

(n) a HMP for thermo control in terms of which –

(i) a plan must be provided that indicates the layout of all the chillers, freezers and processing rooms where temperature control of the rooms is required including –

(aa) each temperature controlled room or area;
(bb) the number of the room or area;
(cc) the temperature requirement of each room; and
(dd) the throughput of each room;

(ii) each room must be equipped with a recording thermograph, or equivalent means of monitoring and recording must be used, that indicates the temperature measurements in the room on a continuous basis;

(iii) the graphs or data must provide the actual time and temperature as well as the correct date;

(iv) annual calibration and certification to this effect must be available;

(v) records in respect of regular testing of digital thermographs and meters against a certified fluid in glass thermometer, done by the owner, must be available;
(vi) placing of the thermo-sensors within a room must be representative of the
temperature in that room;
(vii) if a centralized computer system is used for this purpose all the relevant
temperatures must be recorded on an ongoing basis at least every 30 minutes;
(viii) the temperature status of every room must be checked at least every 12 hours
by the owner to ensure maintenance of temperatures and all deviations must be
accounted for;
(ix) checks by the owner must be recorded on the temperature control records;
(x) any deviations from the required temperature must receive immediate
corrective attention;
(xi) the hygiene manager must be notified immediately in every case where a
temperature breakdown has occurred;
(xii) records must be available for inspection by the national executive officer or
provincial executive officer; and
(xiii) the hygiene manager must indicate daily control checks by way of signature on
the records.

8. KEEPING OF RECORDS

Record keeping is the collection, notation, and filing of relevant information in an organised manner.
The purpose of record keeping is as follows:

1. The information collected has statistical value.
2. The information collected shows tendencies.
3. The information can be demanded by importing countries.
4. The information can be used for reference as needed, i.e. motivation for a Directive.

Examples of forms that can be used for record keeping are attached. These forms can be modified
to comply with specific needs. If necessary, the local Veterinary Public Health officer can be
contacted.

2. Secondary inspections (Measle control/detentions/bruising trimming.
3. Temperature control (Carcasses/chillers/freezers/dispatch/deboning).
4. Lairage inspections (Blood smears/removal of dead animals/shoot and destroy).
5. Changing room and toilet facilities (availability of soap/neatness).

The following examples of forms are commonly used in abattoirs. As a result of personal preference
and specific management systems, different forms are used in different abattoirs. The “Schedule 8”
forms are prescribed by the Abattoir Hygiene Act and serves to report all condemnations to the
Directorate Food Safety and Veterinary Public Health.

9. HAS (HYGIENE ASSESSMENT SYSTEM)

The Hygiene Assessment System is a nationally standardised evaluation system that quantifies
the standard of hygiene management at abattoirs. Different roleplayers need it for different
reasons. The most important is the abattoir owner and more specifically the person in control of
hygiene management at the abattoir (Hygiene Manager - HM/ Quality Controller-QC). This is
usually the most senior meat inspector. This person has the responsibility to frequently monitor
the standard of hygiene. The HAS is ‘a pre-determined standard to which he/she can measure
the hygiene standard at the abattoir, against essential national standards. Progressive
improvement or deterioration can easily be monitored and corrective actions can be documented
according to the marks scored. The periodic auditing by provincial and national inspectors is essential in order to maintain set standards. HM's and QC's must be trained to interpret the guidelines as objectively as possible. Copies of these evaluations must be kept on record at the abattoirs for the different role players.

- Provincial and national inspectors.
- Co-ordinators of inspectors who are in the service of agencies delivering meat inspection services.
- Co-ordinators of meat classification services.
- The abattoir owner may make the results available to clients as part of a marketing strategy.

The next is an example of page 3 of the HAS form that is used at high throughput red meat abattoirs. The complete form has approximately 20 pages. This example illustrates the different aspects covered by the HAS. Only the page used to indicate the marks is included.
ABATTOIR: __________________ ABATTOIR NO: __________ GRADE : ___________ DATE: ____________
DAILY THROUGHPUT: C _______ P _________ S _________ Other____________________________________

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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

Index
ABATTOIR LAYOUT AND CONSTRUCTION

1. INTRODUCTION
2. SPECIFIC ADDITIONAL REQUIREMENTS FOR RED MEAT ABATTOIRS
3. GRADES OF AND REQUIREMENTS FOR RED MEAT ABATTOIRS
4. GRADES OF AND REQUIREMENTS FOR CUTTING AND PROCESSING PLANTS – RED MEAT
5. STANDARD DESIGN DRAWINGS FOR RED MEAT ABATTOIRS
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 workplace.

Regulations have been promulgated to ensure that the layout of the building will enhance the easy handling of carcasses and that acceptable practices 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 measly 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 lairages, 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) lairages 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 lairages 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;
the landing, shackling, bleeding and dressing areas must be separate areas except
where eight or less units are slaughtered per day;

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;

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;

a room where paunches and intestines are emptied, washed and kept must be
provided;

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;

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

where freezing facilities are not provided for treatment of conditionally passed measly
carcasses at the abattoir, such facilities must be arranged elsewhere with the approval
of the provincial executive officer;

a dispatch area equipped to quarter, sort and mark carcasses and red offal as well as a
door for dispatching must be provided;

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;

change room, shower, toilet as well as hand wash facilities must be provided on the
premises for persons working at the abattoir;

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;

a storage facility or room for items needed in the daily slaughter process must be
provided;

if an office is required by the owner, a separate room must be provided;

rooms or facilities must be provided for –

(i) storage of cleaning equipment and materials;
(ii) cleaning and sterilization of movable equipment; and

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-haring, 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 measly 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 if the condemned material is removed on a continuous basis during slaughter or if 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 cartooned 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 lairage 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 lairage 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 lairages 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 lairages.
(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
INDEX
SLAUGHTER AND DRESSING

1. FLOW DIAGRAM OF PROCESS STEPS
2. ANIMAL WELFARE ASPECTS AT ABATTOIRS
3. STUNNING
4. HOISTING
5. CUTTING THE THROAT
6. BLEEDING
7. ELECTRICAL STIMULATION
8. DEHEADERING
9. REMOVAL OF THE HIDE/SKIN
10. EVISCERATION
11. OFFAL HANDLING
12. HALVING THE CARCASSES
13. MARKING CARCASSES
14. FINAL TRIMMING OF CARCASS
15. WASHING THE CARCASS
16. TEMPERATURE CONTROL AND STORAGE OF MEAT
17. CUTTING AND PROCESSING
18. TRANSPORT OF CARCASSES, MEAT AND ANIMAL PRODUCTS
19. SLAUGHTER PROCESS OF LIVESTOCK (RMAA):

1. Slaughter process - cattle
2. Slaughter process - sheep
3. Slaughter process - pigs
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.
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.


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 Liaraging 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 lairaging 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 (i.e 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 the 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

<table>
<thead>
<tr>
<th>Species</th>
<th>Minimum current level during stunning</th>
<th>Maximum stun/stick interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep and goats</td>
<td>1 Amp 200 Volts</td>
<td>15 seconds</td>
</tr>
<tr>
<td>Lambs and Kids</td>
<td>0.6 Amp 160 Volts</td>
<td>15 seconds</td>
</tr>
<tr>
<td>Weaned pigs</td>
<td>1.3 Amps 240 Volts</td>
<td>15 seconds</td>
</tr>
<tr>
<td>Grown out pigs</td>
<td>1.3 Amps 240 volts</td>
<td>15 seconds</td>
</tr>
</tbody>
</table>

**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 Schochet 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 °C 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...
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 eviserator 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) Cartonned offal may not be stored in the same chiller as carcasses or un-cartonned 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:

![Stamps Diagram]

(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/cm$^2$.

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

<table>
<thead>
<tr>
<th>STORAGE TEMPERATURE (°C)</th>
<th>TIME FROM CUTTING (DAYS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>20</td>
<td>2 – 3</td>
</tr>
<tr>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>
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. \(0\text{\(aerobic\) C}\text{O}_2\) (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

<table>
<thead>
<tr>
<th>LENGTH OF TIME</th>
<th>GENERATION TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30 MIN</td>
</tr>
<tr>
<td>0 HOUR</td>
<td>50</td>
</tr>
<tr>
<td>2 HOURS</td>
<td>800</td>
</tr>
<tr>
<td>4 HOURS</td>
<td>12 800</td>
</tr>
<tr>
<td>6 HOURS</td>
<td>204 800</td>
</tr>
<tr>
<td>8 HOURS</td>
<td>3 276 800</td>
</tr>
</tbody>
</table>

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°C, 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 practices 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).
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 cartonned 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.
SLAUGHTER PROCESS OF LIVESTOCK
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

Weasns rodding is done after separating the trachea form 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 severe 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 down 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 is 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 severe 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 ± 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 the 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.

**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 overscaling.

*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.

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(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

VERTEBRAE:
- CERVICALIS
- THORACIC (DORSAL)
- LUMBAR
- SACRAL
- CAUDALES

BONES:
- CRANIUM
- MANDIBLE
- SCAPULA
- HUMERUS
- STERNUM
- RADIUS
- CARPUS
- METACARPUS
- PELVIS
- FEMUR
- PATELLA
- TIBIA
- TARSUS
- METATARSUS
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 glycolitic 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°C, 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:

<table>
<thead>
<tr>
<th>COMPONENTS</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>75.5</td>
</tr>
<tr>
<td>Protein</td>
<td>18.0</td>
</tr>
<tr>
<td>Myofibrillar protein (10%)</td>
<td></td>
</tr>
<tr>
<td>Sacroplasmic protein (6%)</td>
<td></td>
</tr>
<tr>
<td>Other protein (2%)</td>
<td></td>
</tr>
<tr>
<td>Fat</td>
<td>3</td>
</tr>
<tr>
<td>Soluble no protein substances</td>
<td>3.5</td>
</tr>
<tr>
<td>Traces of minerals, vitamins, etc</td>
<td>0.10</td>
</tr>
</tbody>
</table>

### 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.
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 mistral 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 -

- SUP. VENA CAVA
- R. ATRIUM
- R. VENTRICLE
- INF. VENA CAVA

AORTA
PULMONARY ARTERY
ENDOCARDIUM
EPICARDIUM
PULMONARY VEIN
L. ATRIUM
PERICARDIUM
L. VENTRICLE
MYOCARDIUM
SEPTUM

EXTERIOR OF THE HEART -

- AORTA
- CORONARY ARTERY
- CROWN GROOVE
  KROON GROEF
- VET
- FAT
- APEX
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:

<table>
<thead>
<tr>
<th>LEFT LUNG</th>
<th>RIGHT LUNG</th>
<th>BRONCHI</th>
<th>APPEARANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bovine</td>
<td>3 lobes</td>
<td>4 lobes</td>
<td>3 accessory bronchi to right lung</td>
</tr>
<tr>
<td>Sheep</td>
<td>3 lobes</td>
<td>4 lobes</td>
<td>3 accessory bronchi to right lung</td>
</tr>
<tr>
<td>Pigs</td>
<td>3 lobes</td>
<td>3 lobes</td>
<td>3 accessory bronchi to right lung</td>
</tr>
<tr>
<td>Horses</td>
<td>2 lobes</td>
<td>3 lobes</td>
<td>2</td>
</tr>
</tbody>
</table>
COMPARATIVE ANATOMY OF THE LUNGS
VERGELYKENDE ANATOMIE VAN DIE LONGE

SHEEP -

- BOVINE

ACCESSORY BRONCHUS

LOBUS CRANIALES
(APICAL)

LOBUS MEDIUS
(CARDIAC)

LOBUS ACCESSORIUS

LOBUS CAUDALIS
(DIAPHRAGMATIC)

PIG

HORSE

ACCESSORY BRONCHUS
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

<table>
<thead>
<tr>
<th>BOVINE</th>
<th>SHEEP</th>
<th>PIGS</th>
<th>HORSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corneous papillae</td>
<td>Corneous papillae</td>
<td>Smooth surface</td>
<td>Smooth surface</td>
</tr>
<tr>
<td>Sharp tip</td>
<td>Rounded tip</td>
<td>Sharp tip</td>
<td>Spatulate</td>
</tr>
<tr>
<td>Dorsal groove on top</td>
<td>Mid groove</td>
<td>No dorsal groove, Thin</td>
<td>No dorsal groove</td>
</tr>
</tbody>
</table>

(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).
**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.

**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.

**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.

**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.

**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 gall bladder lies more or less centrally on the vertical surface. Near the gall-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:

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

**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
- POSTERIOR VENA CAVA
- CAUDATE LOBE
- PORTAL VEIN
- Ln. HEPATICUS
- BILE DUCTS GALBUISE
- GALL BLADDER GALBLAAS

BOVINE LIVER

PIG LIVER
- CAUDATE LOBE
- PORTAL VEIN
- BILE DUCT (NO GALL BLADDER)
- GALL BLADDER

HORSE LIVER
SCHEMATIC OUTLAY OF THE INTESTINES OF SLAUGHTER ANIMALS

RUMINANTS - SHEEP

NON RUMINANTS - PIG
COMPARATIVE ANATOMY OF THE STOMACH

STOMACH OF HORSE (NON RUMINANT)

OESOPHAGUS
SLUKDERM

DUODENUM
PYLORUS

STOMACH OF BOVINE (RUMINANT)

Rumen
OESOPHOGUS
OMASUM
RETICULUM
ABOMASUM
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 debri 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 abnoral 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 toxaemia when toxines are not secreted from the blood.

Comparison of the kidneys of the different animal species:

<table>
<thead>
<tr>
<th></th>
<th>Number of lobes</th>
<th>Special characteristics</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bovine</td>
<td>15-25 lobes</td>
<td>Left kidney hangs loose. The right kidney is fixed.</td>
<td>Reddish brown</td>
</tr>
<tr>
<td>Sheep/goats</td>
<td>Not lobed</td>
<td>Bean-shaped.</td>
<td>Dark brown.</td>
</tr>
<tr>
<td>Horses</td>
<td>Not lobed</td>
<td>Left kidney is bean-shaped. Right kidney is heart-shaped.</td>
<td>Reddish brown</td>
</tr>
<tr>
<td>Pigs</td>
<td>Not lobed</td>
<td>Thinner and flatter than other animals. Enlongated bean-shaped.</td>
<td>Reddish brown</td>
</tr>
</tbody>
</table>
COMPARATIVE ANATOMY OF THE KIDNEY

SHEEP KIDNEYS

INTERNAL VIEW

- CORTEX
- MEDULLA
- PELVIS RENALIS
- CAPSULE - KAPSEL
- URETER

LEFT KIDNEY OF BOVINE

RIGHT KIDNEY OF BOVINE

- RENAL ARTERY
- URETER
- RENAL VEIN
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

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow</td>
<td>Yellow</td>
<td>Quite firm</td>
</tr>
<tr>
<td>Bull / heifer</td>
<td>White / Yellowish white</td>
<td>Firm</td>
</tr>
<tr>
<td>Calf</td>
<td>White / greyish white</td>
<td>Soft and gelatinous</td>
</tr>
<tr>
<td>Sheep / Goat</td>
<td>Very white</td>
<td>Very firm and brittle</td>
</tr>
<tr>
<td>Pig</td>
<td>Yellowish white</td>
<td>Quite firm and oily</td>
</tr>
<tr>
<td>Horse</td>
<td>Yellow</td>
<td>Soft and oily never marbling</td>
</tr>
</tbody>
</table>

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)

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

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 costocondral 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 medi. 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:

a. lumbar
b. celiacum
c. mesentericum cranialis
d. 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 lumber 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, lumber 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, collonic 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 jejenum and last turn of the spiral. In sheep the 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 Cisterna 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. iliaca 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. iliaca 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. retropharyngi.

(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
BOVINE - INTERNAL LYMPHATIC SYSTEM

LN. POPLITEUS
LN. INGUINALIS SUPERFICIALIS
LN. SUBILIACUS
LNN. ILIACI MEDIALES ET LATERALIS
LN. RENALIS
LNN. STERNALIS CRANIALES ET CAUDALES
LNN. CERVICALIS PROFUNDI CAUDALES
LN. CERVICALES SUPERFICIALES
LNN. CERVICALIS PROFUNDI
LN. ISCHIATICI
LNN. SACRALS
LNN. LUMBALES AORTICI
LNN. INTERCOSTALIS
LN. COSTOCERVICALIS
BOVINE - SUPERFICIAL LYMPHATIC SYSTEM

LN. RETROPHARANGEUS

LN. PAROTIDEUS

LN. MANDIBULARIS

LN. CERVICALIS SUPERFICIALIS (PRESCAPULAR)

LN. GLUTEAL

LN. TUBERAL

LN. SUBILIACI (PREFEMORAL)

LN. POPLITEUS

LN. INGUINALIS SUPERFICIALIS
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 an 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:**

- Muscle development is more pronounced
- Meat is darker
- Fat is yellow and oily
- Neck is longer
- Horses have 18 ribs and cattle 13
- Ribs, thinner and more curved
- Legs are longer
- Withers longer and more upright
- Ulna extends to middle of radius – in cattle it forms part of the carpal joint
- Fibula extends to two thirds of the tibia. In cattle they are very rudimentary
- Kidneys are smooth. In cattle lobulated
- 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)
(iv) 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**

<table>
<thead>
<tr>
<th>Term</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSCESS</td>
<td>MEAT ODOURS</td>
</tr>
<tr>
<td>ANAEMIA</td>
<td>MEAT OF UNBORN ANIMALS</td>
</tr>
<tr>
<td>ARTHRITIS / ARTHROSIS</td>
<td>MELANOSIS</td>
</tr>
<tr>
<td>BACTERAEMIA</td>
<td>METRITIS</td>
</tr>
<tr>
<td>BRUISING</td>
<td>MYOPATHY</td>
</tr>
<tr>
<td>CACHEXIA / EMACIATION</td>
<td>NECROSIS</td>
</tr>
<tr>
<td>CALCIFICATION</td>
<td>NEPHRITIS</td>
</tr>
<tr>
<td>CASEATION</td>
<td>NEPHROSIS</td>
</tr>
<tr>
<td>CASEATION</td>
<td>NEOPLASM (TUMOUR)</td>
</tr>
<tr>
<td>DEGENERATION</td>
<td>OEDEMA</td>
</tr>
<tr>
<td>EMPHYSEMA</td>
<td>OMPHALOPHLEBITIS</td>
</tr>
<tr>
<td>ENTERITIS</td>
<td>OVERSTICKING</td>
</tr>
<tr>
<td>FATTY DEGENERATION</td>
<td>PERICARDITIS</td>
</tr>
<tr>
<td>FATTY INFILTRATION</td>
<td>PERITONITIS</td>
</tr>
<tr>
<td>GANGRENE</td>
<td>PETECHIA, ECHINOSIS, SUGGILATIONS</td>
</tr>
<tr>
<td>HEPATITIS</td>
<td>PLEURITIS</td>
</tr>
<tr>
<td>HYDRONEPHROSIS</td>
<td>POORNESS</td>
</tr>
<tr>
<td>HYPOSTATIC STAINING (Hypostasis)</td>
<td>PURULENT</td>
</tr>
<tr>
<td>ICTERUS</td>
<td>PYAEMIA</td>
</tr>
<tr>
<td>INCOMPLETE BLEEDING</td>
<td>RIGOR MORTIS</td>
</tr>
<tr>
<td>IMMATURETITY</td>
<td>SEPTICAEMIA (BLOOD POISONING)</td>
</tr>
<tr>
<td>INFARCTS</td>
<td>TELANGIECTASIS</td>
</tr>
<tr>
<td>INFLAMMATION</td>
<td>TOXAEMIA</td>
</tr>
<tr>
<td>MASTITIS</td>
<td>URAEMIA</td>
</tr>
<tr>
<td>METASTASIS</td>
<td>VALVULAR ENDOCARDITIS</td>
</tr>
</tbody>
</table>
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 steam 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 INFLTRATION

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-mortes 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 toxaemia 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

Haemolitic - 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 to long or short, the stun to bleeding time to 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
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 toxaemia. In chronic cases where no toxaemic 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, hypotension, 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

POORENESS

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 a accumulation of neutrophilic polymorphonuclear / granulocytes.

Causes

Bacteria – Psuedomonas, 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 pus 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 – Psuedomonas, 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 5
DISEASES & CONDITIONS
Index

DISEASES AND CONDITIONS

1. DISEASES CAUSED BY VIRUSES AND RICKETTSIAE
2. DISEASES CAUSED BY BACTERIA
3. DISEASES CAUSED BY PROTOZOA
4. DISEASES CAUSED BY FUNGI
5. PARASITES
6. METABOLIC DISEASES
7. DIVERSE CONDITIONS
8. POST MORTEM LESIONS/CONDITIONS
9. FOOD POISONING
10. ZOONOSIS
11. MOST COMMON CONDITIONS
DISEASES AND CONDITIONS

1. DISEASES CAUSED BY VIRUSES AND RICKETTSIAE

INTRODUCTION

A virus is not a true cell, since it has no autonomous metabolism or life; it needs a living cell to reproduce and is therefore an obligate intracellular parasite.

Viruses are much smaller than bacteria and cannot be seen under even the highest magnification of a normal light microscope; a special microscope called an electron microscope that is able to use very high magnifications, is used to obtain images of viruses.

The diagram below illustrates the shapes and relative sizes of animal viruses:
AFRICAN SWINE FEVER

A peracute highly fatal, highly contagious disease of domesticated pigs (transmitted by urine and manure). The disease poses a considerable threat to pig-producing countries. The only effective method of control is by destroying all animals that are possibly infected. Transmission by Ornithodoros sp (“Tampans”) or infected carcass / offal.

Cause : Unclassified virus  
Species : Pigs  
Ante-mortem : Marked purple blotching of the skin: weakness (especially hind legs); fever  
Post-mortem : Septicaemia  
Decision : Condemn (Controlled disease)

CLASSICAL SWINE FEVER (HOG CHOLERA)(EUROPEAN SWINE FEVER)

A peracute, acute or chronic, highly contagious disease of domesticated pigs (transmitted by urine and manure). The disease poses a considerable threat to pig-producing countries. The only effective method of control is by destroying all animals that are possibly infected. Transmission mainly by contact or by infected carcass / offal or swill. This disease may spread to the wild pig population in S.A. that will result that the wild pig may become a carrier of the disease.

Cause : Pestivirus  
Species : Pigs  
Ante-mortem : Peracute: Sudden death  
Acute: High fever, weakness, conjunctivitis, anorexia, constipation followed by diarrhoea or vomiting. Purple discoloration of abdominal skin. Necrosis of tips of extremities and nervous signs of circling, tremors or convulsions may occur  
Chronic: Occur in vaccinated herds. Weight loss, hair loss, dermatitis and skin discoloration may occur  
Post-mortem : Haemorrhagic lesions on kidney capsule, lymph nodes, ileo-caecal valve, bladder and larynx  
Decision : Condemn

CONTROLLED DISEASE

LUMPY SKIN DISEASE

Highly infectious skin disease of cattle characterised by the sudden appearance of nodules on all parts of the skin

Cause : Severe form - Neethling pox virus  
        Mild form - Allerton herpes virus (United Kingdom)  
        Dermatropic bovine herpes virus (USA)  
Species : Cattle  
Ante-mortem : Fever, multiple nodules on skin (5–7 cm diameter)  
Post-mortem : Nodules in subcutaneous tissue (can also be present in respiratory and genital tract and stomach)  
Decision : Remove affected parts. Condemn if fever present (Notifiable disease)

FOOT AND MOUTH DISEASE (F-BRAND)

An extremely contagious, acute disease of all cloven hoofed animals, characterised by fever and vesicular eruption in the mouth and on the feet

Cause : Aptho virus  
Species : All cloven hoofed animals  
Ante-mortem : Fever, lameness, vesicular eruption in the mouth (including tongue) and on the feet (and sometimes on the teats), surface of the cheeks, lips and also
the feet just above the clefts. Vesicles erupt and leave raw, red sores. The animal may shed its hooves. After 7–10 days the lesion can only be identified as a greyish-brown patch and after three weeks all that remains is a light coloured patch on the tongue.

**Post-mortem:** Vesicles

**Decision:** Total condemnation (controlled disease)

**AFRICAN HORSE SICKNESS**

Highly fatal, infectious disease spread by insect vectors. Present a potential threat to the horse industry in countries of the Western world.

**Cause:** Orbi virus

**Species:** Horse, mule and donkey

**Ante-mortem:**
- Dunkop syndrome of the disease: fever, laboured breathing, coughing, nasal discharge, recumbent, die
- Dikkop syndrome of the disease: Swelling of head, eyes bulge, tongue, lips and legs swell

**Post-mortem:**
- Dunkop syndrome of the disease: Hydrothorax, lung oedema, ascites
- Dikkop syndrome of the disease: Hydropericardium, endocardial haemorrhage, anasarca (subcutaneous oedema)

**Decision:** Condemn (Controlled disease)

**RABIES**

Highly fatal infection of the central nervous system, which occurs in all warm blooded animals.

**Cause:** Lyssa virus

**Species:** Man and all species slaughtered can be affected

**Ante-mortem:** Nervous symptoms e.g. nature of animal changes, fearless, eyes stormy, salivation, very thirsty but can’t drink, aggressive, tenesmus

**Post-mortem:** No lesions

**Decision:** Total condemnation based on diagnosis by veterinarian (Controlled disease—fatal disease in humans)

**BLUE TONGUE**

Disease of sheep and occasionally cattle, transmitted by insect vectors.

**Cause:** Orbi virus

**Species:** Sheep

**Ante-mortem:** Lameness, fever, inflammation of lips, nose, tongue and hooves

**Post-mortem:** Inflammation of lips, tongue (can turn blue) and hooves. Areas of bleeding in muscles

**Decision:** Condemn if acute (fever), if chronic partial or total condemnation

**RIFT VALLEY FEVER**

Acute disease transmitted by biting insects, chiefly mosquitoes.

**Cause:** Phlebo virus

**Species:** Man, cattle and sheep

**Ante-mortem:** Fever, in co-ordination, collapse and sudden death, abortion

**Post-mortem:** Necrosis of liver, widespread areas of bleeding

**Decision:** Condemn (notifiable disease). Man is susceptible

**WESSELSBRON DISEASE**

Similar to Rift Valley Fever. Can occur on same farm but no cross-immunity.
BOVINE MALIGNANT CATARRH

An acute, highly fatal infectious disease of cattle

Cause : Alcelaphine Herpesvirus - 1
Species : Cattle
Ante-mortem : Fever, nasal discharge, inflammation and necrosis of nose and mouth with salivation inflammation of gastro-intestinal tract
Post-mortem : Inflammation and necrosis of nasal cavity, mouth and intestines
Decision : Condemn (notifiable disease)

THREE DAY STIFF SICKNESS

Infectious disease of cattle characterised by stiffness, lameness and enlargement of lymph nodes (Transmitted by insects)

Cause : Unnamed rhabdovirus
Species : Cattle
Ante-mortem : Fever, stiffness, lameness
Post-mortem : Enlarged lymph nodes; increase in synovial fluids. Sometimes emphysema of lungs
Decision : Carcasses that show signs of fever – Condemn. If only joints / lungs are affected - partially condemn

RICKETTSIAE

HEART WATER

Regarded as the most important tick borne disease in Southern Africa

Cause : Cowdria ruminantium
Species : Cattle, sheep and goats
Ante-mortem : Fever, nervous signs or diarrhoea
Post-mortem : Fluids in body cavities. Enlarged spleen and lymph nodes. Confirm with brain smear
Decision : Condemn carcasses, which have signs of fever
Partially condemn / pass if only signs of diarrhoea

2. DISEASES CAUSED BY BACTERIA

INTRODUCTION

At the end of this Section you should know the condition caused, the bacterial species causing the condition, the animal species involved, the organ involved, the carcass or organ judgement with reasons, and the lesions (Pathology) of the organs. You should also be able to answer the questions at the end of this section.

Bacteria are very small, microscopic, single celled organisms and vary in size and shape. There are three basic shapes of bacteria (They can only be seen under the oil immersion lens of a microscope):

- Cocci (spheres) which include:
  Streptococci - long chains of coci
  Diplococci - pairs of coci
  Staphylococci - masses or clumps of coci
- Bacilli, which are rod-shaped bacteria
- Vibrios, which are curved bacteria.

Bacteria multiply or reproduce by direct splitting of the cells under favourable conditions of temperature, moisture and food supply.

Under adverse conditions, some bacteria (usually bacilli) can form spores that can exist for a long time.
Some bacteria can only grow in the presence of oxygen (aerobic bacteria); others only grow in the absence of oxygen (anaerobic bacteria); while some can grow either in the absence or presence of oxygen (facultatively anaerobic). Toxins are the poisonous products of bacteria. They are called endotoxins if they are released when the bacterium disintegrates or dies, and are called exotoxins when secreted by a living bacterial cell.

**DISEASES**

**ACTINOMYCOSIS (LUMPY JAW)**

This bacteria chiefly causes disease in cattle, but can also occur in horses and pigs. It causes ‘fistulous withers’ in horses and is the main cause of chronic mastitis in pigs.

**Cause**: *Actinomyces bovis* - a facultative anaerobic rod-shaped or slender, branching filamentous bacterium, found normally in the mouth of cattle or in feed contaminated with saliva.

**Lesions**: Infection in cattle is through damaged oral mucosa (abrasions to the tissue lining the mouth cavity). It forms a dense, hard lump on the jawbone, which may break open and discharge pus from time to time. The associated lymph nodes are not involved but may be enlarged. Other organs such as the tongue can be affected, or the organism can spread to the lungs. It affects mainly the bone.

**Judgement**: Where the carcass is not emaciated or where the disease is not generalised, only the affected parts are removed and condemned.

**ACTINOBACILLOSIS (WOODEN TONGUE)**

A disease of cattle, sheep and goats.

**Cause**: *Actinobacillus lignieresi*, rod and cocci shaped bacteria found normally in the mouth of cattle. These bacteria enter the system in the same way that Actinomycosis does - through sores, cuts and abrasions in the mouth.

**Lesions**: Initially ulceration at the site of the wounds, especially on the sides of the tongue or in front of the dorsal eminence of the tongue. The tongue eventually becomes hardened due to the body’s reaction to the infection. Lesions can also occur in the fore-stomach, the lungs or in the liver where they resemble tuberculosis. The lymph nodes are involved and are enlarged and hardened. It affects mainly the soft tissues.

**Judgement**: The disease is rarely generalised. The affected organ eg. Head, stomach or liver is removed and condemned.

Compare with Actinomycosis.

**BOTRIOMYCOSIS**

This is chiefly a disease of horses.

**Cause**: *Staphylococcus aureus*.

**Lesions**: Large fibrous tumours with yellowish-brown centers that project above the cut surface and which contain ‘sand grain’ granules. Predilection sites are the spermatic cord after castration, and the chest or pectoral region where ill-fitting harnesses cause erosion of the underlying skins with subsequent infection. The bacteria may spread to the lungs or other organs by metastasis.

**Judgement**: Remove and condemn all affected parts.

**ANTHRAX (NOTIFIABLE DISEASE)**

Anthrax is a highly contagious disease of domestic and wild animals as well as humans. In most species of animal the disease is characterised by a terminal septicaemia with rapid death, and the presence of bacteria in the blood and body fluids at death.

**Cause**: *Bacillus anthracis*, an aerobic, spore forming, brick shaped bacteria. These bacteria
occur in extremely large numbers in the blood (septicaemia) and excrete a powerful
toxin, which disappears soon after death. If the organisms come into contact with air
they will form extremely resistant spores which can survive for up to one hundred
years. For this reason, and to protect abattoir workers from infection, it is imperative
that all animals that die in an abattoir have a blood smear examination performed on
the carcass, and that infected carcasses are not opened for post mortem
examinations as this will cause the bacteria to sporulate and spread the infection.

Signs : The disease causes septicaemia - ruminants die very quickly (cattle die so quickly
that they may not be seen to be sick), while horses and pigs are more resistant. Birds
and wild animals can be very resistant. Infected animals have a high temperature and
usually have bloody diarrhoea. (Blood from all body openings)

Lesions : On Post mortem examination the blood is very dark, there is bloody fluid in the chest
and abdominal cavities, lymph nodes are swollen and have small haemorrhages and
the spleen is very large and tarry.

Zoonosis : Anthrax can manifest as one of three forms of disease in humans; a skin form, where
infection occurs through wounds in the skin (called malignant pustular disease), a
lung form, where infection occurs through the lungs (called "woolsorter’s disease),
and an intestinal form caused by eating infected meat. All of these forms can cause
septicaemia, brain infections and death.

Judgement : The carcass and all manure, hay etc. in the pens must be burnt. The floor must also
be disinfected with flame or steam. (heat)

If the animal has been slaughtered, all carcasses that have been in contact must also be destroyed. Infected clothing must be burnt and knives and instruments must be boiled for 30 minutes.

BLACK QUARTER (QUARTER ILL, SPONSSIEKTE)

This disease is called Black Quarter in cattle, and Malignant Edema or Gas Gangrene in other
animals.

Cause : Clostridium chauvoei, anaerobic rod-shaped bacteria. Young animals often in rime
condition up to 3 years of age become infected through wounds or through ingesting
(entry per mouth) spores.

Lesions : The large muscle groups of the front or hind legs are usually affected. Mortality is
high and decomposition is rapid. The affected leg usually sticks out, and the affected
area usually feels spongy (due to gas). If the area is cut open it is red and jelly-like
with the smell of rancid butter. Small haemorrhages may be seen on the heart,
kidneys or liver.

Judgement : Total condemnation.

BOTULISM (LAMSIKTE)

This disease is a highly fatal intoxication affecting cattle, sheep, goats, horses and rarely pigs,
characterised by paralysis. Humans are susceptible.

Cause : Clostridium botulinum multiplies in rotten meat and forms toxins. Animals (rabbits,
tortoises, birds, dogs, cats, etc.) can die in the field and the bacteria can multiply in
the carcasses and form toxins. If susceptible animals eat parts of these animals, they
will develop botulism. Young-growing animals, cows in calf and lactating cows can
use up phosphorus reserves in their bones due to growth or production, and if they
are in a phosphorus deficient area this phosphorus will not be replaced by their diet.
Such animals may show signs of swollen sore joints, and they may also exhibit pica
(an abnormal appetite for bones, stones and pieces of metal) to try and supplement
their phosphorous intake. Due to pica pieces of bone or meat containing botulism
toxin may be eaten resulting in clinical botulism.

Signs : The toxin paralyses the muscles, so there is stiffness, difficulty in swallowing, the
tongue may hang out, the neck may be limp. Pneumonia may also develop.

Judgement : Total condemnation irrespective of carcass condition. Compare to 3 Day Stiff
Sickness (a viral disease with fever).
BRUCELLOSIS (CONTAGIOUS ABORTION, MALTA FEVER)

This is a notifiable disease and an important zoonosis. It causes contagious abortion in cows, and Malta or undulating fever in humans.

**Cause** : *Brucella abortus* causes contagious abortion in cattle and undulating fever “Malta fever” in humans. (*Brucella melitensis* rarely occurs in South Africa and affects goats and humans - it causes Malta fever “Undulant fever” in humans which is a more severe disease than undulating fever). Cattle contract the disease ‘through the mouth e.g. They eat pasture, grass, fodder or water, which has been contaminated by a cow which has aborted.

**Signs** : It causes abortion “storms” in a newly infected herd. The abortions are characteristically mid- to late-term.

**Lesions** : Lesions may be seen in the placenta following abortion. The bacteria develop in the placenta and cause inflammation of the cotyledons. This interferes with the blood supply and the calf dies, resulting in the abortion. Bacteria can also develop in the udder thereby infecting the milk. Brucellosis can cause infertility in bulls due to inflammation of the testes. The disease is not easily seen at slaughter.

**Zoonosis** : People become infected by drinking the milk of infected animals or by coming into contact with body fluids (e.g. placenta, uterine fluid of cow during calving) of infected animals, therefore slaughtermen are at great risk of contracting the disease when an infected animal is slaughtered if no protective measures are taken. Touching aborted calves or placentas also exposes people to infection. Malta fever is a lingering disease whose symptoms resemble influenza, but the fever present fluctuates. The disease may recur time and again for many years.

**Prevention** : There is a national scheme to eradicate brucellosis being conducted by the Directorate of Veterinary Services. This involves testing the blood of herds and slaughtering all positive animals. These positive animals are branded with a ‘C’ on the right hand side of the neck. They then travel to certain abattoirs by prior arrangement with a red-cross permit. These permits must be collected and returned to the State Veterinarian of the district from which the animal came. Slaughter personnel can recognise positive animals from the ‘C’ brand mark and take the necessary steps to avoid exposure to the disease - wearing gloves, face masks, protective glasses and protective clothing during slaughter. Such animals are usually slaughtered last on the line and kept in quarantine pens prior to slaughter.

**Judgement** : The meat is safe for consumption after bleeding out and is therefore unconditionally passed. It is advisable to remove all the major lymph nodes, as well as the uterus and udder unopened. Care must be taken not to cut into the udder tissue. Compare with metritis.

CALF DIPHTHERIA

This disease usually occurs in young calves, but may occur in older cattle.

**Cause** : *Fusobacterium necrophorum*

**Lesions** : Sores in the mouth and throat, which may later develop into ulcers.

**Judgement** : If not fevered then condemn only affected parts.

CASEOUS LYMPHADENITIS (PSEUDOTUBERCULOSIS)

This is a chronic disease of sheep and goats characterised by abscessation of one or more lymph nodes.

**Cause** : *Corynebacterium Pseudotuberculosis* “Pseudotuberculosis” (*C. ovis* - old name), a facultatively anaerobic rod to coccus shaped bacteria.

**Lesions** : Bacteria enter through wounds such as shearing wounds and form abscesses that can be localised or can spread to the lymph nodes. Abscesses can occur anywhere in the body, but most often occur in the lungs. Here they can cause pneumonia. The abscesses resemble tuberculosis, but the pus is usually greenish in colour. When cut
through, the pus is in concentric layers and resembles a cut onion. There is a thick capsule present.

Judgement: The organism does not affect humans, so in mild cases the affected parts may be removed and condemned. When widespread or when the carcass has been soiled with pus, condemn the entire carcass.

GLANDERS (FARCY) – NOTIFIABLE

This is a notifiable disease of horses, especially undernourished animals kept in poor conditions, characterised by nodules, ulcers and scars in the lungs, upper airways and skin.

Cause: *Actino-bacillus mallei* (Pseudomonas mallei/ Pfeifferella mallei - old name), an aerobic rod shaped organism.

Lesions: Pox-like lesions and nodules or ulcers are seen on the skin. The lymph vessels are enlarged and stand out. Ulcers that form in the nasal cavity may heal into star-shaped scars.

Judgement: Condemn the entire carcass because it is a zoonosis that can affect humans. Compare with strangles (*Streptococcus equi*) - a purulent inflammation of the nasal mucous membrane with abscesses in the submaxillary lymph node.

JOHNE’S DISEASE (PARATUBERCULOSIS)

This is a disease of cattle, sheep and goats. It is a notifiable disease and a survey is presently (1997) being conducted to determine the incidence of the disease in sheep in South Africa.

Cause: *Mycobacterium paratuberculosis*, a rod shaped organism.

Lesions: The disease is very slow growing and has an incubation period from six month to fifteen years, but most animals show lesions at three to five years of age. The small intestine becomes thickened and corrugated (resembles a brain). The animal develops severe diarrhea and wastes away. Samples need to be taken from the intestines for histopathological examination to confirm a diagnosis. It is therefore important to retain any suspected case until a veterinarian can take the necessary samples. Detain

Judgement: Condemn the intestines. If the animal is emaciated then the entire carcass must be condemned.

OMPHALOPHLEBITUS

This is also called ‘navel ill.’

Cause: Numerous pus-forming bacteria can cause this condition.

Lesions: Pus-forming bacteria infect the navel. From here they may spread to the liver, other organs, or even to the joints to form abscesses (called ‘joint ill’ when the joints are affected).

Judgement: If localised then condemn only the affected portions or organs. If generalised then condemn the entire carcass.

PARATYPHOID

This is a disease that generally affects calves younger than three months of age or stressed animals. If animals recover they may become “carriers” and infect other animals.

Cause: Various *Salmonella* species and types may cause the disease.

Lesions: On post mortem severe enteritis (inflammation of the intestines) is usually seen. The mesenteric lymph nodes are swollen. In less acute cases there are small white spots (the size of a pinhead) seen on the liver. These are areas of necrosis.

Judgement: Condemn entire carcass because *Salmonella sp.* cause food poisoning in humans.
Compare with several other bacterial or viral diarrheas and/or pneumonia’s in young animals. In these cases the entire carcass is also condemned unless the illness is very mild.

**SPIROCHAETOSIS**

This is a disease of pigs frequently associated with poor hygiene.

- **Cause**: Small organisms called Spirochaetes.
- **Lesions**: The organisms penetrate the skin through superficial wounds and form abscesses or ulcers. These lesions are usually localised e.g. one foot.
- **Judgement**: Condemn only the affected parts.

**SWINE ERYSIPELAS “Erysipelas” (NOTIFIABLE)**

This disease is often referred to as ‘Diamond Skin Disease’. It affects mainly pigs, but can also affect humans and chickens.

- **Cause**: *Erysipelothrix rhusiopathiae*, a facultatively anaerobic rod shaped bacterium. The organism can live in the soil and can also occur in the digestive system of healthy animals. Pigs become infected when they eat contaminated food, faeces or soil, or through wounds in the skin.
- **Lesions**: There are several forms of the disease. In the acute form a septicaemia develops leading to rapid death. It is thought that the bacteria produce an enzyme, which affects the blood vessels leading to small haemorrhages in the kidneys, lungs and mucous membranes. The lymph nodes and spleen are enlarged and red, and there are usually red patches on the skin. In the subacute form typical ‘Diamond skin disease’ develops. Large, red, slightly raised diamond shaped lesions is seen in the skin. Scabs form at a later stage. Pigs that are chronically affected are usually unthrifty and suffer from infections of the heart valves and/or chronic arthritis.
- **Zoonosis**: The disease in humans is usually an infection of the skin with painful sores. It occurs due to contact with infected pigs or chickens.
- **Judgement**: In cases where a specific diagnosis of Erysipelas are made the entire carcass is condemned. These are usually the sub-acute or “diamond skin” form. In the case of arthritis a specific diagnosis cannot be made and the carcass is evaluated as an arthritis case. In the case of negative endocarditis the whole carcass is condemned.

**TAIL BITE NECROSIS**

This is a condition affecting mainly pigs.

- **Cause**: When pigs are kept in close confinement, they may bite each other’s tails. These bite wounds can then become infected with various bacterial species and this infection may spread up the spinal cord and affect the rest of the body (pyaemia).
- **Lesions**: Vary from mild infection in the tail to generalised pyaemia with numerous organs involved.
- **Judgement**: Condemn affected parts if localised. Condemn entire carcass if generalised.

**TETANUS (LOCK JAW)**

Tetanus is an intoxication of the nervous system, which is almost invariably fatal. Horses are the most susceptible of the domestic animals.

- **Cause**: A toxin produced by *Clostridium tetani*, which attacks the nervous system. These bacteria can form spores which can survive in the soil for many years. It occurs in warm areas especially in well-cultivated, well-manured soil. In some countries it is a common inhabitant of intestines of humans and animals. Infection takes place
through deep penetrating wounds like cuts or puncture wounds. If these then heal over the conditions are ideal for the organism to multiply, as it is anaerobic. Therefore deep puncture wounds e.g. by nails etc. are the most dangerous. A toxin is secreted which attacks the nervous system to produce the typical muscular cramps, but it also damages the red blood cells. The toxin is easily destroyed by heat, but the spores are very resistant and need to be exposed to steam at 115°C for 60 minutes. Horses are the most susceptible. They can be infected through nail holes in the soles of their feet, or other deep wounds such as castration wounds.

**Signs** : The first symptom is excitability - the animal is easily frightened, sweats, walks stiffly and swallows with difficulty. The 3rd eyelid closes over and the muscles of the legs and neck become very hard. Mortality is high because the respiratory muscles become paralysed.

**Judgement**: Condemn the entire carcass.

**TUBERCULOSIS (NOTIFIABLE)**

This disease is an important **zoonosis**. It is a controlled animal disease and therefore the nearest State Veterinarian must be notified of any suspicious case.

**Cause** : *Mycobacterium bovis*, *Mycobacterium tuberculosis* or *Mycobacterium avium*. *M. bovis* is the main cause of tuberculosis in cattle, *M. tuberculosis* is the main cause of the disease in people (but can also affect cattle), and *M. avium* affects birds.

**Lesions** : The organism is either inhaled or ingested by susceptible animals that have contact with infected animals or people. Infection therefore develops mainly in the lungs or intestines, with spread to the lymph nodes draining these regions. The lesions that develop at first appear as little nodules, which are grayish, and these later become yellow-white and cheesy (resemble chunky cottage cheese). The body tries to isolate the infection by surrounding it with a capsule. Later the nodules calcify. In cattle these nodules calcify quickly and when the blade of the knife is pulled over the cut surfaces it resembles gritty sand granules. If the animal has enough resistance, the disease will remain localised, but when resistance is lowered the disease spreads in a number of ways. A septicaemia may develop with the organism being present in the blood and lymph system. This may occur so quickly that multiple small lesions are seen in the organs e.g. liver, kidneys, spleen etc. This form is known as acute miliary tuberculosis. Re-infection can lead to a spread of the infection in the organs—so-called chronic organ tuberculosis. These lesions are cheesy masses with small haemorrhages and indistinct borders. This form usually spreads to the lymph nodes.

**Zoonosis** : Humans can become infected if they drink raw (unpasteurised) milk from infected animals, or if they eat meat infected with the organisms. Infection through wounds in the skin may also occur if the wounds are directly contaminated with the bacteria e.g. during slaughter.

**Prevention** : There is a national scheme being performed by the Directorate of Veterinary Services to eradicate tuberculosis form South Africa. It involves testing herds by injecting tuberculin into the skins of the animals and measuring the skin reaction before and after intra-dermal injection. Positive reactors to the skin test are branded with a “T” on the left side of the neck. These animals may then only travel with a red-cross permit to an abattoir by prior arrangement. These permits are also collected and returned to the State Veterinarian in the district of origin. (Compare with Brucellosis).

**Judgement** : According to the standing regulations under Act 121 of 1992:

a. **Cattle** :

1. i) TB with emaciation - total condemnation.
   ii) Generalised TB - total condemnation. This refers to:
      - Miliary TB of both lungs
      - TB lesions on both pleura and peritoneum.
      - TB lesions in muscle and in lymph nodes.
      - TB lesions in the muscles of the pharynx, trachea, diaphragm, intestines and hilus of the liver.
2. When the carcass is otherwise healthy only the affected parts need to be condemned if:
   i) Lesions are localised and confined to the lungs and lymph nodes in the chest.
   ii) If lesions are confined to the liver
   iii) Lesions are confined to the head and throat
   iv) Lesions confined to any combination of these, but limited

b. Pigs

1. Lesions in the lymph nodes in the jaw and in any other part of the body - total condemnation.
2. If TB is only found in the head, and nowhere else, then condemn only the head.

The additional examination to be carried out in the case where evidence of tuberculosis is found, or a pyaemic condition is suspected is set out in Schedule 2, Section II of Standing Regulations GN No R3505 of 9 October 1969.

3. **PROTOZOAL DISEASES**

Protozoa mostly of microscopical size and the most primitive organisms. Single celled and multiply by division.

Of most importance in meat inspection are:

**COCCIDIA**

Affect certain food animals and being specific cross-infection do not occur. It affects the digestive tract and cause red dysentery.

Condemn intestines if localised. Condemn carcass if generalised effect has been caused which is very rare. More serious in rabbits

**SARCOSPORIDIA** (Zoönosis)

1. *Sarcocystis miescheriana*

Found in the muscle of pigs and cattle. It appears as light gray oblong dots. Can be confused with calcified cysticercus (measles).

Condemn carcass.

2. *Sarcocystis tenella* (*Balbiana gigantea*)

Found chiefly on the oesophagus of the sheep and goat. Also on tongue, pharynx, diaphragm and skeletal muscles. Cigar shaped and the size of a grain of cooked rice or bigger. Can be mistaken for a mass of fat or small abscess.

Only affected parts are condemned.

**REDWATER** (Babesiosis)

Caused by *Babesia bovis* or *Babesia bigemina* carried by the Blue tick. Develops in red blood cells and cause anaemia - haemaglobinuria = redwater. All organs pale and watery, liver yellow spleen very enlarged. Bladder may be filled with red urine. Condemn.

**BILIARY FEVER IN HORSES**

Also carried by ticks, affects red blood cells and causes icterus.

**GALL SICKNESS** (Anaplasmosis)

Caused by Anaplasma marginale. Carried by Blue tick. Also lives in red blood cells but break down
the red blood cells so fast, as redwater and liver can convert haemoglobin to bile pigments, so icterus develops. Condemn for icterus.

**EAST COAST FEVER (Theileriosis)**

Caused by Theileria parva carried by Brown tick. Lives in red blood cells and on white cells (Kochs bodies - bluish balls with darker dots. Practically eradicated. (Notifiable). Lymph glands very enlarged, like tennis balls.

Condemn carcass.

**NAGANA (Trypanosomiasis)**


**DOURINE (Controlled disease)**

Also Trypanosome but venereal disease of horses transmitted when mating. Causes swelling of sex organs and emaciation. One or more legs can become paralysed.

Condemn carcass.

**BESNOITIOSIS (Elephant skin disease)**

Mostly in warmer areas of Northern Province. Probably carried by biting insects (can be transmitted by infected blood).

Parasites circulate - fever - inflammation of skin e.g. scrotum and neck skin. Skin thickens, becomes wrinkled, hard and cracks open. Hair falls out. Looks like an elephant.

At post mortem, in subcutaneous tissue, little white cysts the size of pins head. Feels like grains of sugar or sand. White cysts in eye, then palpate carcass. If superficial trim, if deep condemn carcass.

4. **FUNGAL INFECTION OF MEAT**

Fungi do not play a major role in food poisoning or spoilage under modern conditions. The one essential requirement for their development is moisture, and fungi thus become important when meat is stored or transported under moist conditions. Although most fungi are retarded by cold some species may thrive under refrigeration, which once again emphasises the importance of free air circulation during chilling as these organisms cannot survive dehydration (drying out).

Fungi develop essentially on the surface of meat, especially that with no fat covering. They are mostly non-poisonous but they often impart an undesirable colour and odour to meat. Most fungi form spores which frequently contaminate the walls and equipment of slaughterhouses and chillers and thus the carcasses. The more important types of fungi which are encountered by the meat inspector are fairly easy to identify by their colour, growing habit, etc. and include:

**CLADOSPORIUM spp:**

Usually occurs in carcasses held near freezing point and is seen as black spots about 1 cm in diameter and penetrating only some 5 mm into the meat. The spots cannot be wiped off and affected areas have to be cut away.

**SPOROTRICHON spp:**

This is probably the most common fungus infection encountered and takes the form of small, white, woolly and superficial spots which can usually be scraped off.
MUCOR AND THAMODIUM spp:

Usually occurs in carcasses held near freezing point and cause a heavy outgrowth of whitish whiskers up to 2,5 cm long.

PENICILLIUM spp:

Cause blue- green areas of various sizes and frequently seen on "mouldy" bread, etc.

Many mouldy areas may be simultaneously contaminated by bacteria which give the areas a slimy look.

When such contamination is of recent origin and not too advanced, trim the meat to a variable depth, or strip any serious membranes. In old cases with deep penetration it may be necessary to condemn on aesthetic grounds.

5. PARASITES

A parasite is an organism that lives on another organism known as the host, deprives the host of its nutrients, resulting in the loss of the host's condition and retarding growth.

CLASSIFICATION

INTERNAL PARASITES

Cestodes: Tapeworms
Nematodes: Roundworms
Trematodes: Flukes

TAPEWORMS

These are segmented, flat worms, which live mainly in the intestines to which they attach by means of hooks or suckers on their heads.

Life cycle

When the posterior segments are ripe and full of eggs, they break off and pass out with the faeces. These eggs are eaten by the intermediate host, where they hatch in the intestines and the larvae, which develop, migrate to a suitable part of the body for further development, forming a cyst or bladder worm, which is the immature form of the tapeworm. When the final host eats the cyst, the infective head everts and once in the intestine attaches itself to the intestinal wall where it lives on the semi-digested food and grows into the adult form.

The following tapeworms are of importance in meat inspection:

1. *Taenia solium*

Final host: man
Intermediate host: pig
Cyst name: Cysticercus cellulosae

This is a 5m worm. The lower ripe segments are not mobile. They are passed out with human faeces and when ingested by pigs, they migrate through the intestinal wall into the blood stream, which carries them to different muscles. They have a predilection for the most active muscles of the body: skeletal muscles, heart, tongue, diaphragm and shoulder. In the muscles they grow into cysts and at about 10 weeks they are seen as 2,5-cm fluid filled cysts with a clearly visible head (white spot).

Judgement: If only a few cysts are present, the carcasses may be treated by freezing at -10°C for 10 days or -18°C for 72h. When there is one or more cysts on the majority of cut surfaces, the carcass must be condemned
2. *Taenia saginata*

Final host: man
Intermediate host: beef
Cyst name: Cysticercus bovis

This worm can become 9 meter long. The life cycle is very similar to that of *Taenia solium*. The lower ripe segments are mobile and can leave the host spontaneously and can therefore be transmitted from infected humans to pasture and infest cattle despite the provision of adequate toilet facilities.

The following incisions during meat inspection for cysticercosis should be made in the following muscles and organs:

(a) *Masticatory muscles*

1. Two incisions parallel to each other in the masseter muscles on the outside of each jaw.
2. One incision in the pterygoideus muscle on the inside of the jaw.

(b) *Heart*

1. One incision in the left ventricle from the basis to the apex of the heart.
2. Two incisions obliquely cut through the septum, parallel to each other and ± 1 cm apart.

(c) *Shoulder muscles*

One deep incision in the triceps brachii muscles about 10cm proximal of the bone process (olecranon) or the “elbow” of each front leg.

(d) Two parallel incisions cut in the diaphragm and the strip pleura or peritoneum between the two cuts, must be stripped off for inspection of the exposed muscle.

When during the routine inspection one or more cysts are found, two additional incisions should be made in the shoulder muscle, parallel to each other, ± 2 cm apart proximal of the primary cut.

Judgement: Having made the four additional incisions in the shoulder muscles for secondary inspection and on the majority of cuts surfaces (i.e. 19+) one or more cysts are found, the level of infestation is excessive and the carcass must be condemned.

The most common way of treatment of a measly carcass is to freeze it for 72 hours in a freezer at -18°C or for 10 days at a temperature of -10°C. The deepest muscle must reach –6°C for effective treatment.

3. *Taenia multiceps*

Final host: dog
Intermediate host: sheep
Cyst name: Coenurus cerebralis

A tapeworm of dogs and the cyst is found in the brain of sheep, causing pressure.

Judgement: condemn the head.

4. *Taenia hydatigena*

Final host: dog
Intermediate host: sheep, beef, and pig
Cyst name: Cysticercus tenuicollis

A tapeworm of dogs. The cysts are found in the abdominal cavity, they are about 5 cm in diameter and have a long neck.

Judgement: removal and condemnation of the cysts.
5. *Taenia ovis*

Final host: dog  
Intermediate host: sheep  
Cyst name: Cysticercus ovis  
The cysts are very similar to the measles of cattle and they are usually found in the heart, diaphragm and skeletal muscles.

Judgement: carcasses condemn

6. *Echinococcus granulosus*

Final host: dog  
Intermediate host: ruminants, pig and man  
Cyst name: Hydatid cyst  
This is a small tapeworm of dogs. Most animals, including man act as intermediate host. The cysts develop mainly in the lungs and liver and can grow to a large size. Can cause pressure necrosis and be fatal in cases of brain involvement.

Judgement: the affected organs must be condemned.

7. *Stilesia hepatica*

Final host: sheep  
Intermediate host: unknown  
A very thin tapeworm found in sheep livers, sometimes in large numbers blocking the bile duct and causing icterus.

Judgement: affected livers are condemned. Stilesia can be removed from the bile ducts with a suction pump or trimming and in this case, livers can be passed after secondary inspection.

**ROUND WORMS**

These worms are round, long, with pointed ends, the females lay eggs and their life cycle is direct, without an intermediate host.

1. *Ascaris suum*

Host: pigs  
Life cycle: adults live in the pig small intestines. When eggs are ingested by the pig, the larvae hatch in the intestine and migrate to the liver and then via the blood to the lungs. Once in the lungs they get coughed up and swallowed to grow to maturity. During this migration through the liver they cause damage with in the formation of spots (milk spot liver) and in the lungs they may cause pneumonia.

Judgement: If the liver is badly affected, it must be condemned on aesthetic grounds, otherwise the spots must be cut out. Affected lungs must be condemned.

2. *Parafilaria*

Host: cattle  
The life cycle of the parasite requires a final host (cattle) and an intermediate host (fly). The female parasite is 6 mm in length, burrows her way to the subcutaneous tissue through the hide to deposit her eggs in superficial blood. The fly (Musca species) ingests the eggs, which hatch into larvae. Larvae are transmitted via the saliva of the fly to other cattle. These larvae grow into the adult worm and after fertilisation the female continues the cycle.
The subcutaneous lesions are jelly-like, greenish in colour with a typical copper smell. The condition is known as false bruising.

Judgement: Affected areas can be trimmed off. When the condition is generalised the carcasses must be condemned.

**FLUKES**

1. Liver fluke

*Fasciola hepatica*

Host: cattle

These are flat, leaf shaped parasites about 3 cm long, brownish in colour and live in the bile ducts of the liver of cattle.

Life cycle: The eggs pass out with the faeces and after hatching the larvae penetrate the water snail which acts as intermediate host. After leaving the water snail they swim to the nearest grass blade where they are ingested by the final host (cattle). Once in the final host they burrow through the intestine wall and migrate to the liver where they penetrate through to the bile ducts and grow to maturity. The parasites cause marked irritation and hardening of the bile ducts.

Judgement: Severely affected livers must be condemned. Slight affection confined to the bile ducts may be excised and the remainder passed.

**IMPORTANT TAPEWORMS FOR MEAT INSPECTIONS**

<table>
<thead>
<tr>
<th>WORM</th>
<th>FINAL HOST</th>
<th>LARVA</th>
<th>INTERMEDIATE HOST</th>
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<tr>
<td><em>Taenia solium</em></td>
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<td>Cysticercus cellulosae</td>
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<td><em>Taenia multiceps</em></td>
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<td>Coenurus cerebralis</td>
<td>Sheep</td>
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<tr>
<td><em>Taenia hydatigena</em></td>
<td>Dog</td>
<td>Cysticercus tenuicollis</td>
<td>Sheep, cattle and pig</td>
<td>Abdominal cavity</td>
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<tr>
<td><em>Taenia ovis</em></td>
<td>Dog</td>
<td>Cysticercus ovis</td>
<td>Sheep</td>
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<tr>
<td><em>Echinococcus granulosus</em></td>
<td>Dog</td>
<td>Hydatid cyst</td>
<td>Ruminants, man, pig</td>
<td>Liver, lungs, eye and brain of man</td>
</tr>
</tbody>
</table>

**Meat Hygiene**

Life cycle of *E. granulosus*. (Courtesy of Center for Disease Control, Atlanta, Georgia, USA, and Oxford University Press)
Life cycle of Taenia saginata. (By kind permission of the Center for Disease Control, Atlanta, Georgia, USA, and Oxford University Press)
6. METABOLIC DISEASES

Most of the diseases in this category leave very little, if any post mortem lesion’s.

Therefore information obtained from the ante-mortem inspection as well as Veterinary certificates, if available, is of utmost importance in the final evaluation and judgement of these cases.

pH measurements after overnight chilling will in most cases be the deciding factor, whether meat from these animals suffering from Metabolic diseases is fit for human consumption or not.

pH values higher than 6.3 in case of cattle or sheep, 6.4 in pigs and 6.1 in horse meat warrants total condemnation due to poor shelf-life and reduced nutritional value of the meat

CATTLE

*Hypocalcemia (Milk fever)*

*Cause* : Calcium deficiency

*Transport disease*

*Cause* : Complex multi factorial metabolic disturbances.
*Ante mortem* : Often in pregnant cows. Symptoms manifest during transport or shortly after arrival. Restless, stagger, posterior paresis, anorexia. Can be comatose.
*Post mortem* : As for Hypocalcemia.

*Ketosis*

*Cause* : Hypoglycaemia
*Ante mortem* : More often in pregnant cows. Symptoms as above.
*Post mortem* : As for above.

SHEEP

*Pregnancy toxaemia*

*Cause* : Hypoglycaemia in pregnant ewes.
*Ante mortem* : Nervous, stagger, ataxia anorexia.
*Post mortem* : Yellow fatty liver. Fat necrosis. Empty rumen and gut. Sometimes constipation.
*Judgement* : Total condemnation based on high pH.

*Transport tetanus*

*Cause* : Complex combination of metabolic disturbances.
*Ante mortem* : Very similar to above. Sometimes acute death. Symptoms may manifest 12 - 72 hours after transport
*Judgement* : Total condemnation based on high pH values.
PIGS

**Pale soft exudative (PSE) pork. Porcine Stress Syndrome (PSS)**

*Transport Miopathy*

Cause : Stress associated shock syndrome especially in Landrace breeds. (Genetically heritable)
Post mortem : Quick onset of rigor mortis. Initial very low pH of 5, recovering quickly to normal. Muscle pale and exudative.
Judgement : Normally not condemned, depending on the extent of the lesions meat from PSE pork may not be smoked or pickled.

7. **DIVERSE CONDITIONS**

**Traumatic reticulitis in cattle/sheep**

Cause : Foreign object (mostly wire). Penetration of the reticulum.
Ante mortem : Acute cases: arched back, high temperature and signs of septicaemia.
Chronic cases : Show very little if any signs.
Post mortem : Necrotic lesions, adhesions and abscessation. Peritonitis and sometimes pleuritis.

**Tail bite necrosis in pigs**

Cause : Tail biting.
Ante mortem : Necrotic lesion on tail.
Post mortem : Expose spinal cord. Metastatic abscesses in the spinal cord /vertebrae and in the lungs.
Judgement : In cases with metastatic abscesses total condemnation due to pyemia and Septicaemia.

**Scrotal Sepsis**

Cause : Castration lesion sepsis.
Ante mortem : Necrotic/Septic lesions of the scrotum with/without septicaemia.
Post mortem : Acute: Lesion and associated septicaemia.
Judgement : Total condemnation due to septicaemia.

**Telangiectasis in cattle liver**

Cause : Degenerative condition of the liver. Often seen in 6-24 month old feedlot cattle.
Ante mortem: None.
Post mortem : Single or multiple dark red foci (1 - 5mm) in liver. Lesions are blood coagulations in the sinusoids of the liver. Older lesions seen as grey foci
Judgement : Liver condemned on aesthetic grounds.
Footrot

Cause: Fusobacterium necrofrum infection of the hooves of cattle, sheep and pigs.
Ante mortem: Lameness, poor condition.
Post mortem: Necrotic swollen hooves.
Judgement: Acute cases with associated septicaemia - total condemnation. Chronic localised lesion can be removed.

Uterine prolaps (mostly cattle)

Cause: Thin or over stretching of uterine ligaments during oestrus or after birth.
Post mortem: As above.
Judgement: Remove affected area. Total condemnation if signs of septicaemia are present.

Rectal prolaps (mostly pigs)

As for uterine prolaps.

Tick toxicoses (Sweating sickness)

Cause: Allergic reaction to Hyalomma tick bite.
Ante mortem: Loss of hair, high body temperatures, salivation and sweat in calves.
Post mortem: Fever, carcass, dehydration, emaciation and necrosis of mucous membranes in the mouth.
Judgement: Total condemnation? fever and toxaemia.

White muscle disease

Cause: Vitamin E/Selenium deficiency.
Ante mortem: A disease more often seen in sheep. Muscle weakness.
Post mortem: Pale striped appearance of muscles in especially the hind quarters.
Judgement: Condemn on aesthetic grounds.

Wounds/bruising/fractures/haematomas

Cause: Often seen at abattoir are injuries during transportation.
Ante mortem: Lesions with/without bleeding, lameness, swelling, often no superficial signs.
Chronic: Wounds that are secondarily infected can became necrotic. Scar tissue formation. Septicaemia, fever, abscess formation.
Post mortem: Lesions with/without systemic involvement.
Judgement: Total condemnation with septicaemia and fever. If localised trim affected areas. In all cases detain for 24 hours and determine pH.
8. POST MORTEM LESIONS/CONDITIONS

Contamination

**Faeces/Gut content/Bile**

Cause : Bad slaughter techniques. In pigs the gut may burst during mechanical dehairing.

**Pus**

Cause : Abscess accidentally cut open.

**Grease and oil**

Cause : Poor maintenance of overhead rails and equipment.

Judgement : If localized affected areas may be trimmed. If generalised - total condemnation

"Bone Taint"

Cause : Post mortem growth of especially Fusobacterium necroforum organisms in deep laying joints e.g. hip and shoulder. More common in very large carcasses in cold rooms with inadequate chilling.

Post mortem : Green foul smelling bone joint and meat near the bone. (Deep seated meat)

Judgement : Remove affected bone, joint and meat. If infection penetrated the meat extensively – total condemnation.

Erythema (reddening)

Cause : Often seen in pigs that were transported for long periods and laid in urine and faeces.

Anti mortem : Animals very dirty.

Post mortem : Red blotches appear on the skin (ventral surfaces and sides) after scalding.

Judgement : Trim affected areas

Mechanical damage

Cause : Poor slaughter techniques often seen in pigs that were dehaired mechanically.

Post mortem : Obvious lesions.

Judgement : Trim affected areas.

Blood splashing

Cause : Often seen in sheep (but also other species) after delay between stunning and bleeding.

Post mortem : Wide spread haemorrhages of varying size.

Judgement : Involves no health risks but may be aesthetically unacceptable.
9. ZOONOSES

Viroses

(a) Rabies (Hondsdoelheid)
   Rift Valley Fever (Slenkdalkoors)
(b) Avian Chlamydiosis (Papegaaisiekte)
   Q–Fever (Q–Koors)

Bacterioses

Actinomycosis
Animal Erysipelas and Human Erysipeloid (Wondoos)
Anthrax
Botulism
Brucellosis
Campylobacteriosis (Campylobacteriose)
Salmonellosis (Voedselvergiftiging)
Staphylococcal Food Poisoning (Voedselvergiftiging)
Zoonotic Tuberculosis

Parasitic Diseases

Sarcocystosis

Mycoses

Aspergillosis (Sistemese mikose)

Helminthiases

Hydatidosis
Taeniasis and Cysticercosis (Lintwurmbesmetting en sistiserkose)

Acanthocephaliasis and Nematodiases

Cutaneous Larva Migrants (Velmol of Sandwurm)
Trichinosis (Triginose)
Visceral Larva Migrants and Toxocariasis (Viserale of ingewandslarwemigrasie)
10. MOST COMMON CONDITIONS

PIGS

A. CARCASS

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<td>ERYSIPELAS</td>
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<td>ICTERUS</td>
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B. HEADS

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C. SKIN

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<td>INSECT BITES</td>
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<td>MELANOMA</td>
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D. LIMBS

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E. **LUNGS**
1. ABSCESS
2. PNEUMONIA
3. PLEURITIS
4. BLOOD ASPIRATION
5. TUBERCULOSIS
6. SOILING SCALDING TANK
7. (WATER ASPIRATION)

F. **HEART**
1. PERICARDITIS
2. EPICARDITIS
3. MEASLES
4. BLOOD SPLASHING

G. **TONGUE**
1. MEASLES

H. **LIVER**
1. MILK SPOTS
2. ABSCESS
3. SOILING / PATHOLOGICAL / MECHANICAL
4. BLOOD
5. CIRRHOSIS
6. CIRRHOSIS
7. FATTY DEGENERATION

I. **KIDNEYS**
1. NEPHRITIS
2. HYDRONEPHROSIS
3. PETECHIA
4. PETECHIA
5. PETECHIA
6. PETECHIA

J. **SPLEEN**
1. INFARCTS
2. SPLENOMEGALY
3. TORSION
4. ABSCESS

K. **STOMACH**
1. GASTRITIS
2. PERITONITIS

L. **INTESTINES**
1. TUBERCULOSIS
2. ENTERITIS
3. PERITONITIS
4. ASCARIS SUUM
5. TENUICOLLIS CYSTS

M. **REPRODUCTIVE ORGANS**
1. METRITIS
2. SCROTAL SEPSIS
3. MASTITIS
# Cattle / Calves

## A. Carcasses

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## B. Heads

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## C. Limbs

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## D. Lungs

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<td>Ruminal contents aspiration</td>
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## E. Heart

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<tr>
<td>4</td>
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## F. Tongue

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## G. Liver

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<td>Telangiectasis</td>
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<td>Cirrhosis</td>
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H. **KIDNEYS**
1. NEPHRITIS
2. HYDRONEPHROSIS
3. PETECHIA

I. **SPLNEEN**
1. INFARCTS
2. SPLENOMEGALY
3. TORSION

J. **STOMACH**
1. PERITONITIS

K. **INTESTINES**
1. TUBERCULOSIS
2. ENTERITIS
3. PERITONITIS

L. **REPRODUCTIVE ORGANS**
1. METRITIS
2. MASTITIS

**SHEEP**

A. **CARCASS**
1. ABNORMAL ODOUR
2. ICTERUS
3. ABSCESSES
4. GRASS SEED PENETRATION
5. BLOOD SPLASHING
6. BRUISING
7. EMACIATION
8. WET CARCASS SYNDROME
9. PYEMIA
10. SEPTICAEMIA
11. OEDEMA
12. SOILING
13. FEVER
14. CHEESY LYMPHADENITIS
15. PLEURITIS + PERITONITIS

B. **LIMBS**
1. ABSCESSES
2. BRUISING (FRACTURES)

C. **LUNGS**
1. ABSCESSES
2. PNEUMONIA
3. PLEURITIS
4. BLOOD ASPIRATION
5. ECHINOCOCCUS
6. RUMEN CONTENTS ASPIRATION
D. **HEART**
1. PERICARDITIS
2. EPICARDITIS
3. BLOOD SPLASHING

E. **LIVER**
1. ECHINOCOCCUS
2. ABSCESSES
3. STILESIA
4. SOILING MECHANICAL
5. SOILING PATHOLOGICAL
6. CIRRHOSIS
7. FATTY INFILTRATION

F. **KIDNEYS**
1. NEPHRITIS
2. PETECHIA

G. **SPLEEN**
1. INFARCTS
2. SPLENOMEGALY
3. ABSCESSES

H. **STOMACH**
1. PERITONITIS

K. **INTESTINE**
1. PIMPLY GUT
2. TENUICOLLIS
3. ENTERITIS
4. PERITONITIS

L. **REPRODUCTIVE ORGANS**
1. METRITIS

**HORSES**
1. BRUISING
2. EMACIATION
3. PERITONITIS
4. STRONGYLUS
5. MELANOSIS
6. RHINOTRACHEITIS
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.
2.3. 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. pterygoideus 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.
When inspecting the hindquarter, the registered inspector must inspect bilaterally –

(a) the parietal peritoneum, by observation;
(b) the *Lnn iliaca 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.

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.

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.

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(l)(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(l)(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

\[
\text{Ruminants all 6.3}
\]

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 ONDERSTEPOORT 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.