NATIONAL OPEN UNIVERSITY OF NIGERIA

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL HEALTH SCIENCES

COURSE CODE: EHS 401

COURSE TITLE: MEAT INSPECTION, ABATTOIR/SLAUGHTER SLAB MANAGEMENT

COURSE GUIDE

EHS 401: MEAT INSPECTION, ABATTOIR/SLAUGHTER SLAB MANAGEMENT

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CONTENTS

INTRODUCTION

EHS 401 Meat Inspection, Abattoir/Slaughter Slab Management is a two-credit unit course. Meat inspection is commonly defined as the sanitary control of slaughter animals and meat, with the aim of providing safe and wholesome meat for human consumption. The responsibility for achieving this lies primarily with the relevant public health authorities who are represented by veterinarians and meat inspectors at the abattoir or slaughter slab stage. These experts and some others working at different levels of livestock derived foods value chainare interested in regulating the products production processes in order to ensure that such products are not compromiseddue to poor industry practices.

The oldest recordsof meat inspection are the food laws or edicts of the ancient Egyptians. The Mosaic Lawalso identified which animals were suitable (ruminant and domestic fowls) and unsuitable (camel, rabbit, pork etc). These food laws found for instance in Leviticus 11 and Deuteronomy 14 that forbid the consumption of pork and many other types of meat are still strictly adhered to by the Jews. Islamic food regulation even in modern terms are similar to the Egyptians and Mosaic food laws. Quran 5 forbids the faithful to eat that which had died of itself, blood, pain strangled, flesh of animals torn by wild beast and pork. These regulations point to an early recognition of meat as a possible source of disease to man. Indeed, several Greek and Roman writers including Aristotle, Hippocrates and Virgile noted the similarities between the disease of man and animals.

In more modern time, especially in the USA, meat inspection was carried out in rudimentary manner prior to the passage of the meat inspection act of 1906. As a rule, the local butchers were prominent members of the community and usually scrutinized all slaughtered animals in an attempt to eliminate disease bearing ones. However, because of the general lack of training and expertise in detecting disease condition, unwholesome meat was inevitably processed and passed for human consumption. As human population increased and the transportation system developed, livestock and industries expanded from a local to a national enterprise in many countries of the world. More animals were thus being slaughtered and processed by few large slaughter houses and fewer animals by the local butchers with the concentration of livestock marketing and slaughtering at central locations.This generated the need for improved sanitation and better inspection procedures in order to safeguard the consumers from unwholesome meat and meat products.

Veterinarians were specifically mentioned for the first time in meat control regulation in Germany in 1761. However, when large epidemics of trichinosis occurred in Germany in 1860s, no active veterinary meat inspection occurred. This epidemic however gave rise to not only the spread of an animal disease public health importance in slaughter houses but also resulted in the establishment of veterinary meat inspection services in that country. In the light of current knowledge, the basic purpose of meat hygiene is to avert spoilage and prevent meat borne infections by reducing to a minimum microbial loads particularly, pathogenic microorganisms. However, in many developing countries such as Nigeria, and in particular in rural abattoirs/ slaughter slabs, meat inspection remains a neglected or poorly approached issue due to lack of trained personnel, resources and guidelines to assess the sanitary status of

carcasses, meat and organs from slaughter animals. Development and adoption of integrated meat inspection system, where information from the farm level is included, has been suggested for abattoir services improvement.

Above all, it is important to note that in countries where livestock derived foods inspection is prioritized,the citizens are better protected from the disease hazards arising from the consumption of such products and this contributes to food security and public health. This course focuses on meat inspection activities that will ensure protection from health hazardsarising from the processing, handling and consumption of livestock derived foods.

WHAT YOU WILL LEARN IN THIS COURSE

This course deals with an aspect of food quality assurance that applies to everyday life and living in the society. The issues at stake are therefore of interest to all individuals in the society. The information delivered in the course is of great importance to not only public health experts and students but also to consumers who would apply it in their daily dealings with various livestock derived foods. Its contents are not abstract but practical and depicts actual scenarios in a particular segment of the food industry. Indeed, there is no food item that does not constitute some form of health hazards to its consumers as well as processors. The knowledge gained may therefore be applied to the quality control and assurances of safety of other food items. There is the need for the student to approach the course content with an open mind and an expectation to learn something new that could be applied in one's daily life. The knowledge gained could also be applied in the establishment of a meat or other livestock derived food processing enterprises. In the same vein, the knowledge and skill gained from this course would empower the student to discharge his/her functions as a food safety personnel and as a member of the public health team.

COURSE AIM

The overall aim of this course is to transfer functional knowledge, develop positive attitudes and horn-intheskillsyou need to effectively function in the team that ensures the delivery of wholesome meat products to the consumers.

COURSE OBJECTIVES

It is expected that at the end of this course, students should be able to:

- Understand the basic anatomy and physiology of food animals such as ruminants, pig and poultry
- Describe important slaughter animal diseases, especially zoonoses
- Know the agencies involved in meat inspection, slaughter management and food animal husbandry and management
- Describe the principles of good practice in an abattoir
- Describe the standard regulations and guidelines for abattoir planning, construction and management
- Understand the requirements and needs for animal husbandry
- Apply the principles of risk assessment to meat inspection and slaughter management

- Carry out actual meat inspection at the abattoir
- Identify abattoir practices and legislations that determine hygienic and quality meat production
- Perform, recognize and describe the regulatory procedures and hygienic practices involved in food animal slaughter

Working through this Course

The organization of this course takes cognizance of the fact that this might be the first time the student is being exposed to this specialized area. The subject is therefore simplified and aided with many illustrations to enable the student understand the important concept and terminologies in the course. Efforts have been made to avoid unnecessary details, especially those meant for veterinary professionals who have been grounded in veterinary clinical sciences in order to confusion the students. The distinct contents of the course would help deliver the knowledge and skills needed by the student to function effectively either in individual tasks or as a member of a public health teamduring meat inspection and abattoir management activities.

Although the course has been designed to support independent study, attending tutorial sessions and participating in the practical activities included in this course will greatly enhance understanding of concepts discussed, as it will avail the student the opportunity to seek clarifications on poorly understood sections. Studying the course resources and attending tutorial sessions and practical aretherefore vital to enhancing not only student'sgrade but also their understanding and usability of the knowledge garnered from the course.

COURSE MATERIALS

The course materials are as listed below:

- The Study Guide
- Study Units
- Reference / Further Reading
- Assignments
- Presentation Schedule

STUDY UNITS

The study units in this course are outlined below:

MODULE 1 ANATOMY, PHYSIOLOGY AND DISEASES OF FOOD ANIMALS

Unit 1 Anatomy and products from food animals
Unit 2 Diseases of food animals
Unit 3 Food animals' husbandry and welfare

Module 2 PRINCIPLES OF ABATTOIR PRACTICE

Unit 1 Abattoir planning, construction and management
Unit 2 Sanitation in the abattoir
Unit 3 Quality and Safety control systems

Module 3 MEAT INSPECTION AT THE ABATTOIR

Unit 1 Meat hygiene and quality control
Unit 2 Ante mortem inspection, slaughtering and dressing methods
Unit 3 Post mortem inspection methods and procedures

There are activities related to the lecture in each unit which will helpyour progress and comprehension of the unit. You are required to work on these exercises together with the TMAs to enable you achieve the objectives of each unit.

ASSIGNMENT FILE

There are two types of assessments in this course. First are the Tutor-Marked Assessments (TMAs); second is the written examination. Insolving the questions in the assignments, you are expected to apply theinformation, knowledge and experience acquired during the course. Theassignments must be submitted to your facilitator for formal assessmentin accordance with prescribed deadlines stated in the assignment file.

The work you submit to your facilitator for assessment accounts for 30percent of your total course mark. At the end of the course, you will berequired to sit for a final examination of 1½ hours duration at your study center. This final examination will account for 70 % of your total course mark.

PRESENTATION SCHEDULE

There is a time-table prepared for the early and timely completion and submissions of your TMAs as well as attending the tutorial classes. You are required to submit all your assignments by the stipulated time and date. Avoid falling behind the schedule time.

ASSESSMENT

There are three aspects to the assessment of this course. The first one is the self-assessment exercises. The second is the tutor marked assignments and the third is the written examination or the examination to be taken at the end of the course. Do the exercises or activities in the unit by applying the information and knowledge you acquired during the course. The tutor-marked assignments must be submitted to your facilitator for formal

assessment in accordance with the deadlines stated in the presentation schedule and the assignment file.The work submitted to your tutor for assessment will count for 30% ofyour total course work. At the end of this course, you have to sit for afinal or end of course examination of about a three-hour duration which
will count for 70% of your total course mark.

TUTOR-MARKED ASSIGNMENTS

This is the continuous assessment component of this course and itaccounts for 30% of the total score. You will be given four (4) TMAs byyour facilitator to answer. Three of which must be answered before youare allowed to sit for the end of course examination.
These answered assignments be returned to your facilitator. You'reexpected to complete the assignments by using the information andmaterial in your readings references and study units. Reading andresearching into your references will give you a wider via point and giveyou a deeper understanding of the subject.

1. Make sure that each assignment reaches your facilitator on or beforethe deadline given in the presentation schedule and assignment file. Iffor any reason you are not able to complete your assignment, make sureyou contact your facilitator before the assignment is due to discuss thepossibility of an extension. Request for extension will not be grantedafter the due date unless there in exceptional circumstances.

2. Make sure you revise the whole course content before sitting or theexamination. The self-assessment activities and TMAs will be useful forthis purposes and if you have any comment please do before theexamination. The end of course examination covers information from allparts of the course.

COURSE MARKING SCHEME

Assignments	**Marks**
Assignments 1 - 4	Four assignments, best three marks of the four count at 10% each = 30% of course marks
End of course examination	70% of overall course marks
Total	**100% of course materials**

Table 2: Course Organization

Unit	Title of Work	Weeks Activity	Assessment (End of Unit)
	Course Guide	**Week**	
1	Anatomy and products from food animals	Week 1	Assignment 1
2	Diseases of food animals	Week 2	Assignment 2
3	Food animals' husbandry and welfare	Week 3	Assignment 3
4	Abattoir planning, construction and management	Week 4	Assignment 4
5	Sanitation in the abattoir	Week 5	Assignment 5
6	Quality and Safety control systems	Week 6	Assignment 6
7	Meat hygiene and quality control	Week 7	Assignment 7
8	Ante mortem inspection, slaughtering and dressing methods	Week 8	Assignment 8
9	Post mortem inspection methods and procedures	Week 9	Assignment 9

HOW TO GET THE MOST OUT OF THIS COURSE

In distance learning, the study units replace the university lecturer. This is one of the huge advantages of distance learning mode; you can read and work through specially designed study materials at your own pace and at a time and place that suit you best. Think of it as reading from the teacher, the study guide tells you what to read, when to read and the relevant texts to consult. You are provided exercises at appropriate points, just as a lecturer might give you an in-class exercise.

Each of the study units follows a common format. The first item is an introduction to the subject matter of the unit and how a particular unit is integrated with the other units and the course as a whole. Next to this is a set of learning objectives. These learning objectives are meant to guide your studies. The moment a unit is finished, you must go back and check whether you have achieved the objectives. If this is made a habit, then you will significantly improve your chances of passing the course.

The main body of the units also guides you through the requiredreadings from other sources. This will usually be either from a set bookor from other sources.

Self-assessment exercises are provided throughout the unit, to aidpersonal studies and answers are provided at the end of the unit.Working through these self-tests will help you to achieve the objectivesof the unit and also prepare you for tutor marked assignments andexaminations. You should attempt each self-test as you encounter them
in the units.

The following are practical strategies for working through thiscourse

1. Read the Course Guide thoroughly.

2. Organize a study schedule. Refer to the course overview for moredetails. Note the time you are expected to spend on each unit and howthe assignment relates to the units. Important

details, e.g. details of yourtutorials and the date of the first day of the semester are available. Youneed to gather together all this information in one place such as adiary, a wall chart calendar or an organizer. Whatever method youchoose, you should decide on and write in your own dates for workingon each unit.

3. Once you have created your own study schedule, do everything youcan to stick to it. The major reason that students fail is that they getbehind with their course works. If you get into difficulties with yourschedule, please let your tutor know before it is too late for help.

4. Turn to Unit 1 and read the introduction and the objectives for theunit.

5. Assemble the study materials. Information about what you need for aunit is given in the table of contents at the beginning of each unit. Youwill almost always need both the study unit you are working on and oneof the materials recommended for further readings, on your desk at thesame time.

6. Work through the unit, the content of the unit itself has been arrangedto provide a sequence for you to follow. As you work through the unit,you will be encouraged to read from your set books.

7. Keep in mind that you will learn a lot by doing all your assignmentscarefully. They have been designed to help you meet the objectives ofthe course and will help you pass the examination.

8. Review the objectives of each study unit to confirm that you haveachieved them. If you are not certain about any of the objectives, reviewthe study material and consult your tutor.

9. When you are confident that you have achieved a unit's objectives,you can start on the next unit. Proceed unit by unit through the courseand try to pace your study so that you can keep yourself on schedule.

10. When you have submitted an assignment to your tutor for marking,do not wait for its return before starting on the next unit. Keep to yourschedule. When the assignment is returned, pay particular attention toyour tutor's comments, both on the tutor-marked assignment form andalso that written on the assignment. Consult you tutor as soon as possible if you have any questions or problems.

11. After completing the last unit, review the course and prepareyourself for the final examination. Check that you have achieved theunit objectives (listed at the beginning of each unit) and the courseobjectives (listed in this course guide).

FACILITATORS/TUTORS AND TUTORIALS

Sixteen (16) hours are provided for tutorials for this course. You will benotified of the dates, times and location for these tutorial classes. Assoon as you are allocated a tutorial group, the name and phone numberof your facilitator will be given to you.

These are the duties of your facilitator: He or she will mark andcomment on your assignment. He will monitor your progress andprovide any necessary assistance you need. He or she will mark yourTMAs and return to you as soon as possible. You are expected to mailyour tutored assignment to your facilitator at least two days before the
schedule date.
Do not delay to contact your facilitator by telephone or e-mail fornecessary assistance if you do not understand any part of the study in thecourse material. You have difficulty with the self-assessment activities.You have a problem or question with an assignment or with the gradingof the assignment.

It is important and necessary you acted the tutorial classes because this is the only chance to have face to face content with your facilitator and to ask questions which will be answered instantly. It is also period where you can say any problem encountered in the course of your study.

FINAL EXAMINATION AND GRADING

The final examination for EHS 401: Meat Inspection, Abattoir/Slaughter Slab Management will be of 1½ hours duration. This accounts for70 % of the total course grade. The examination will consist of questionswhich reflect the practice, exercises and the tutor-marked assignmentsyou have already attempted in the past. Note that all areas of the coursewill be assessed. To revise the entire course, you must start from the firstunit to the twelfth unit in order to get prepared for the examination. Itmay be useful to go over your TMAs and probably discuss with yourcourse mates or group if need be. This will make you to be moreprepared, since the examination covers information from all aspects ofthe course.

SUMMARY

This course has been designed to help you function effectively in the public health team charged with the responsibility of ensuring that apparently healthy, physiologically normal animals are slaughtered for human consumption and that abnormal animals are separated and dealt with accordingly. You will also learn how to ensure that meat from animals is free from disease, wholesome and of no risk to human health. The course is therefore designed to impact functional knowledge of meat inspection, abattoir/slaughter slab management to you. We wish you success in this course and hope that you will translate the knowledge gained to solutionsto relevant public health problems.

Review Questions

Define meat inspection?
On which authorities do the responsibilities for meat inspection lie primarily?
Outline the historical evolution of modern meat inspection practice
Why is meat inspection still relatively neglected in many developing countries?

C**ONTENTS** **PAGE**

UNIT 1 ANATOMY AND PRODUCTS FROM FOOD ANIMALS

CONTENTS

1.0 INTRODUCTION

This unit on anatomy and physiology of food animals tells you about the different types of animals used by humans as food and the different types of products made from them. The word **animals** includes all species in the biological kingdom*Animalia*. For example, insects, fish, and cattle are animals. You will be introduced to the anatomy (structures) and physiology (functions) of the different parts and organs of the domesticated food animals which are also generally called livestock.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- Know the different animals use as food
- Understandthe basic anatomy and physiology of livestock and chicken
- Understand the animal products made from livestock and chicken

3.0 MAIN CONTENT

3.1 Food Animals and their Products

Billions of animals are slaughtered or killed for food every year for food. Some of these animals have been domesticatedand raised in captivity for consumption and other purposes, while others are obtained from the wild and water bodies. The following list of animals (mammals and non-mammals) and probably more consumed as food are given below.

1. Mammals

Bovines: American bison, carabao, cattle, water buffalo, domesticated yak, springbok, greater kudu; gemsbok, impalaetc
Camelids: Alpaca, llama and camel
Canids: Dog, Kurī (extinct), Poi dog (extinct), Nureongi, Xoloitzcuintle, fox etc
Caprae(goats): Domestic goat, antelope, duiker etc
Deer (Cervidae): Moose (rarely tamed), reindeer, red deer, fallow deer and elk
Felidae: Domestic cat
Equines: Donkey, horse, zebra etc
Lagomorphs: Rabbit, hare
Marsupials: Kangaroo
Oves (sheep): Domestic sheep
Rodents: Guinea pig, edible dormouse, coypu (nutria), capybara, rats (cane rate, African giant rat etc)
Suidae(swine): Domestic pig, warthog

2. Non-mammals
Amphibians: Frogs
Birds: Chicken, domestic duck, domestic goose, domestic turkey, domesticated quail, domestic pigeon, guinea fowl, ostrich, emuetc
Fish: Carp, catfish, flounder, trout, salmon, striped bass, sturgeon, tilapia, sardine etc
Insects: Chapulines, maguey worm, mopane worm, silkworm, locust, grasshopper, palm grub, crickets, termites, caterpillars, cockroaches etc
Crustaceans: Crayfish, crab, lobster, shrimp, prawnsetc
Mollusks: Oysters, mussels, land snails, abaloneetc
Reptiles: Alligator, crocodile, turtles, snakes, lizards etc

On a global scale, the top ten animals slaughtered for food and other products are marine animals (fish, shrimps etc), chicken, ducks, pigs, rabbits, turkey, sheep, goats and cattle. Among these, cattle sheep, goat and pig represent the livestock animals and with poultry, especially chickens, turkey and ducks form important part of animal agriculture throughout the world. In Nigeria, the veterinary public health decree of 1992 identified the following as food animals;cattle, sheep, goat, carmel, fish, rabbits, poultry, etc. People depend on animal production and processing for their livelihood, for food (particularly high-quality protein), and for leather and wool. Meat vary from a country to country depending on the respective meat culture, regulations or legislations.

According to the Food and Agriculture Organization (FAO), the average per person consumption of animal products in the world is meat (based on carcass weight), 84 lb (38 kg) per year; milk, 101 lb (46 kg) per year; eggs, 18 lb (8 kg) per year; and fish, 44 lb (20 kg) per year. Consumption of meat in the developed countries is higher, with meat consumption (based on carcass weight) being over 264 lb per capita per year, and much lower in Sub-Saharan Africa, where it is frequently lower than 22 lb per capita per year. The top three countries for meat production are the United States, People’s Republic of China, and Brazil.

Generally, people like animal products, regardless of where they live in the world. Not only have the number of people increased, but also as the global economy has grown, people have had much greater ability to afford to buy food and, particularly, animal products. There is a strong correlation between per capita income (per capita gross domestic product) in a country and the consumption of meat, milk, and eggs. Again, there are good nutritional reasons to eat animal products, including high quality protein, with optimal or close-to-optimal amino acid balance; iron; zinc; calcium; and vitamins such as niacin and vitamin B12.

An animal product is any material derived from the body of an animal. Examples are fat, flesh, blood, milk, eggs, and other lesser known products. Animal by-products, as defined by the USDA, are products harvested or manufactured from livestock other than muscle meat.

3.2 Introduction to Anatomy and Physiology Livestock and Chicken

The term anatomy has come to refer to the science that deals with the form and structure of all organisms. Literally, the word means to cut apart. In contrast to anatomy, which deals primarily with structure, physiology is the study of the integrated functions of the body and the functions of all its parts (systems, organs, tissues, cells, and cell components), including biophysical and biochemical processes. Figures 1 to 10 show the pictures of the major livestock and chicken and their annotated external anatomies.

Fig. 1: A cattle showing the characteristic hump (*Bosindicus*)super. Courtesy of the USDA

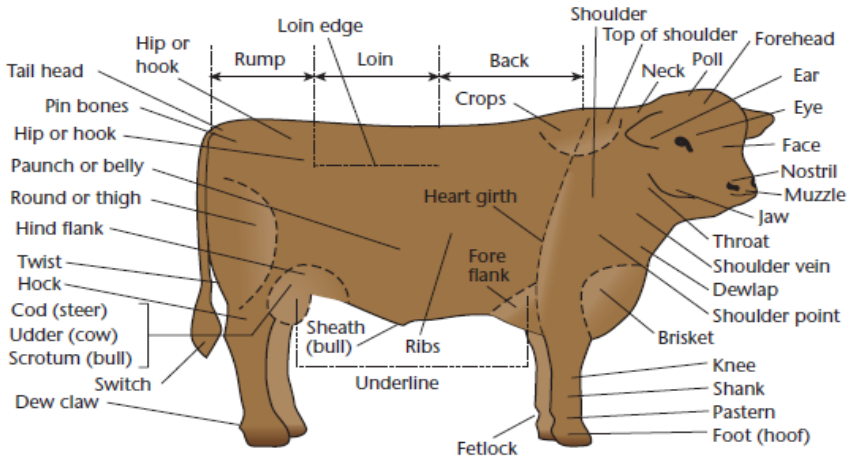

Fig. 2: External anatomy of cattle showing musculature. (Source: Delmar/Cengage Learning)

Fig. 3: Yorkshire pig. (Courtesy of Mapes livestock photos).

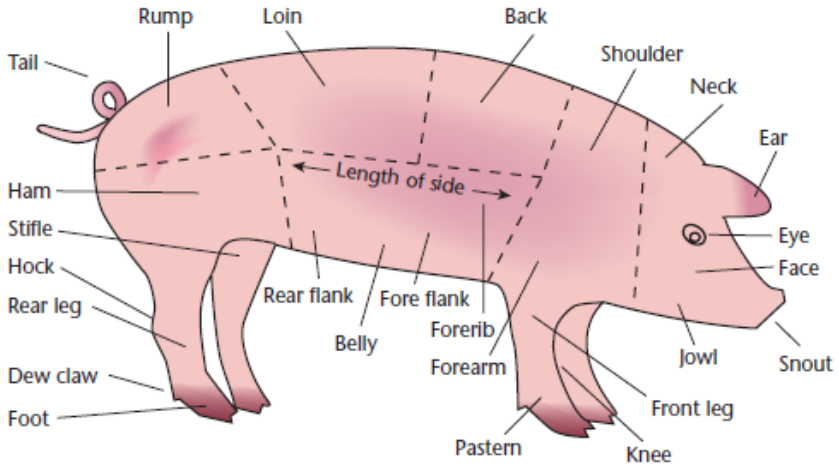

Fig. 4: External anatomy of pig (Source: Delmar/Cengage Learning)

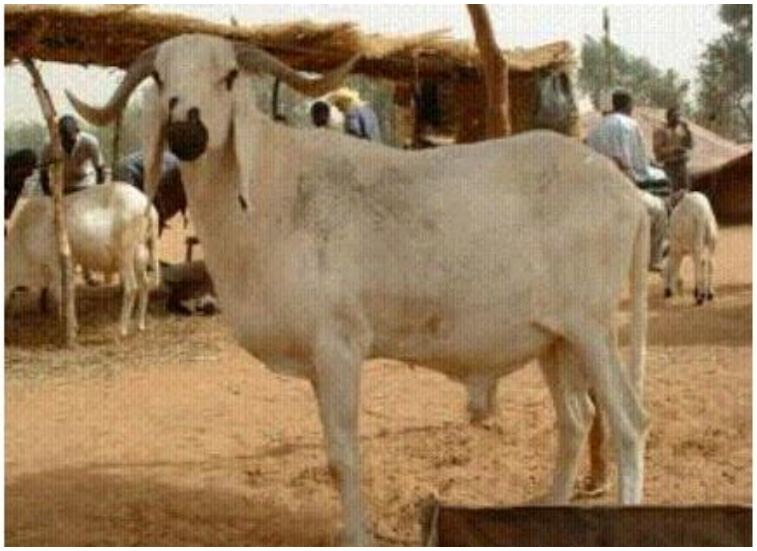

Fig. 5: Balami ram. (Source: Akinbobola, 2019)

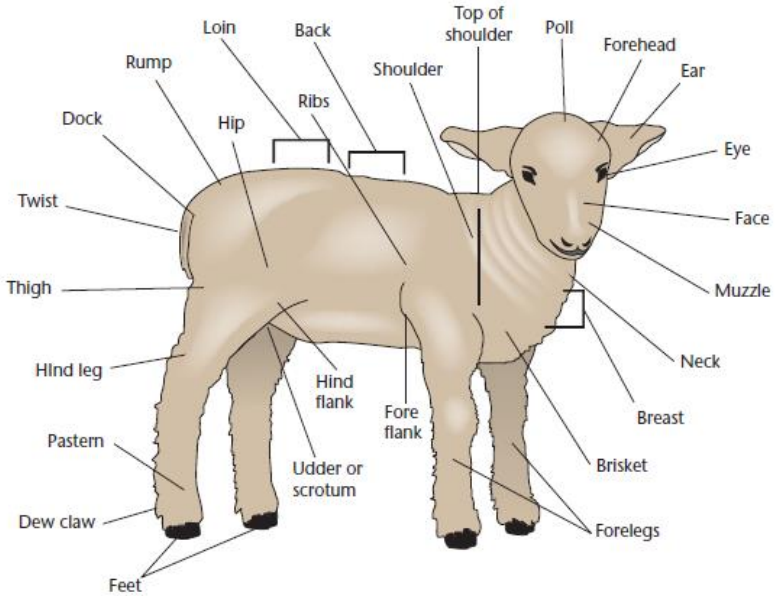

Fig: 6: Eternal anatomy of sheep. (Source: Delmar/Cengage Learning)

Fig. 7: West African Dwarf goats. (Source: Achonwa 2017).

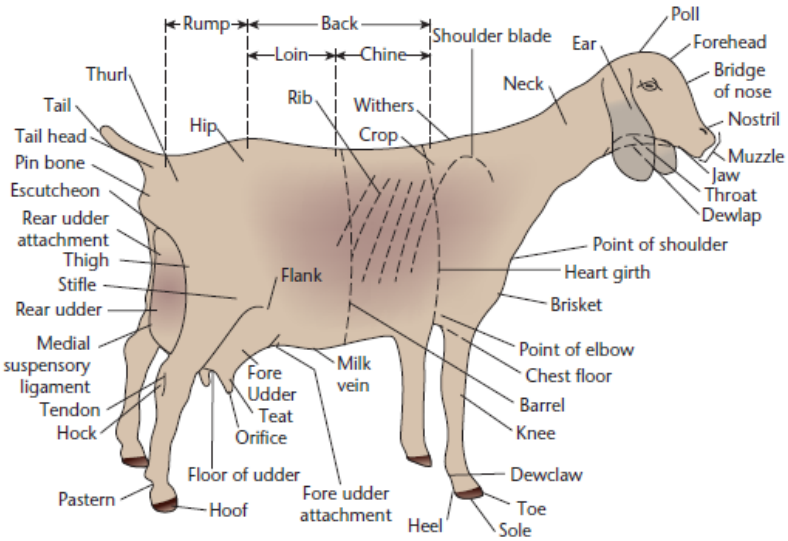

Fig: 8: External anatomy of goat (Source: American Dairy Goat Association, NC)

Fig. 9: Adult white leghorn rooster (Source: USDA)

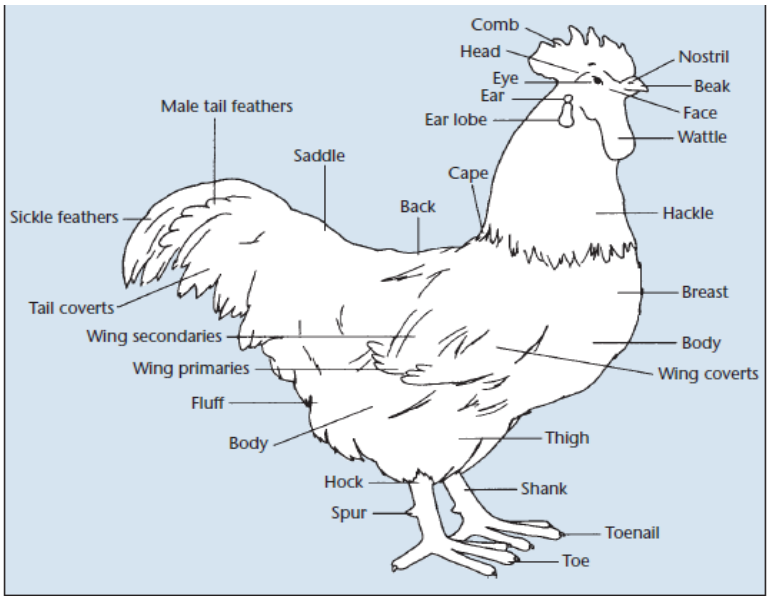

Fig. 10: External anatomy of male chicken (Source: Delmar/Cengage Learning)

Major Organ Systems

Major organ systems include the gastrointestinal tract (gut), cardiovascular system, respiratory organs, muscle, skeleton, adipose tissue, nervous system and brain, and endocrine organs.

GI Tract (Digestion and absorption): It is important to understand the structure and functioning of the GI tract or gut of domestic animals because without it, nutrients will be neither digested nor absorbed. Both the overall size of the gut and its organs varies with whether the animal is herbivorous (large gut) or carnivorous (small gut), with omnivores between the other categories. The relative importance of fermentation varies with species, with it being essential in ruminants and other plant-eating species. Fermentation also occurs in the hindgut, and this is particularly important in horses and rabbits.

The structure of the GI tract: The GI tract (or gut) has the same overall structure with a multilayer structure. The layers are the following from inside (lumen) to outside: epithelium, glandular, circular and longitudinal muscle, and external connective tissue layer. There is the same basic pattern for the organs within the GI tract across species:

1. The mouth (with teeth except in birds). Here, food is chewed, and saliva from the salivary glands is added. The latter lubricates the ingesta by addition of water and mucus, and the presence of the enzyme, amylase starts digestion of starch.
2. The esophagus links the mouth with the stomach and, therefore, carries ingesta to the stomach. There is an outgrowth of the esophagus in many birds called the crop. It is relatively small (<10% of the gut), with lactic acid being a major product of fermentation of the ingesta stored there.
3. The stomach is the site of the muscular mixing (and grinding in some species) of the ingesta. There is the addition of gastric secretions (or juices) containing hydrochloric acid and

pepsinogen. This is converted into the active enzyme, pepsin by the acid conditions. Pepsin starts protein digestion. The rumen is a four-chambered structure formed within the stomach. The avian stomach has two parts: the gizzard that grinds ingesta and the proventriculus where gastric secretions are added.

4. The small intestine is made up of three parts, from front (anterior) to back (posterior): duodenum, jejunum, and ileum. It is 30% of the gut, and the site of carbohydrates, protein, and fat digestion and absorption of products, together with vitamins and minerals. Digestion occurs at the anterior end, and absorption increases along the small intestine. Digestive enzymes are added to the ingesta. These are produced by the glands in the small intestine and pancreas. The proteases, such as trypsin and chymotrypsin, digest proteins.Structures of GI tract of different animals are shown in figure 11, while that of chicken is shown in figure 12.

The functions of the gut are as follows

1. Digest the food, first by mechanical grinding of the food and then breakingdown complex chemical compounds to simple chemicals by enzymes.
2. Absorb nutrients, including water.
3. Protect against pathogenic organisms.
4. Ferment the feed to provide nutrients.
5. Move ingesta through the GI tract.

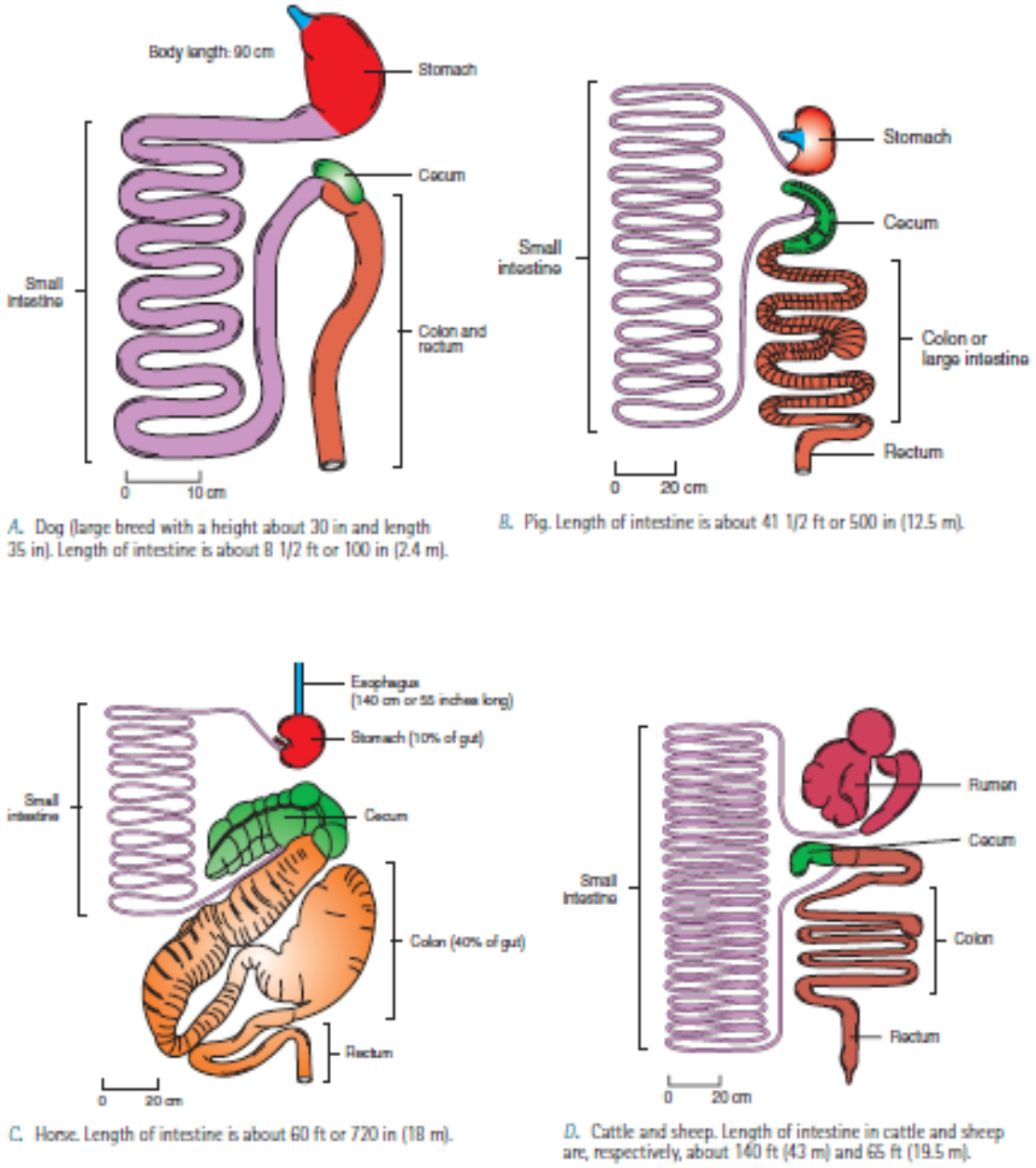

Fig 11: Structure of GI tract of different animals

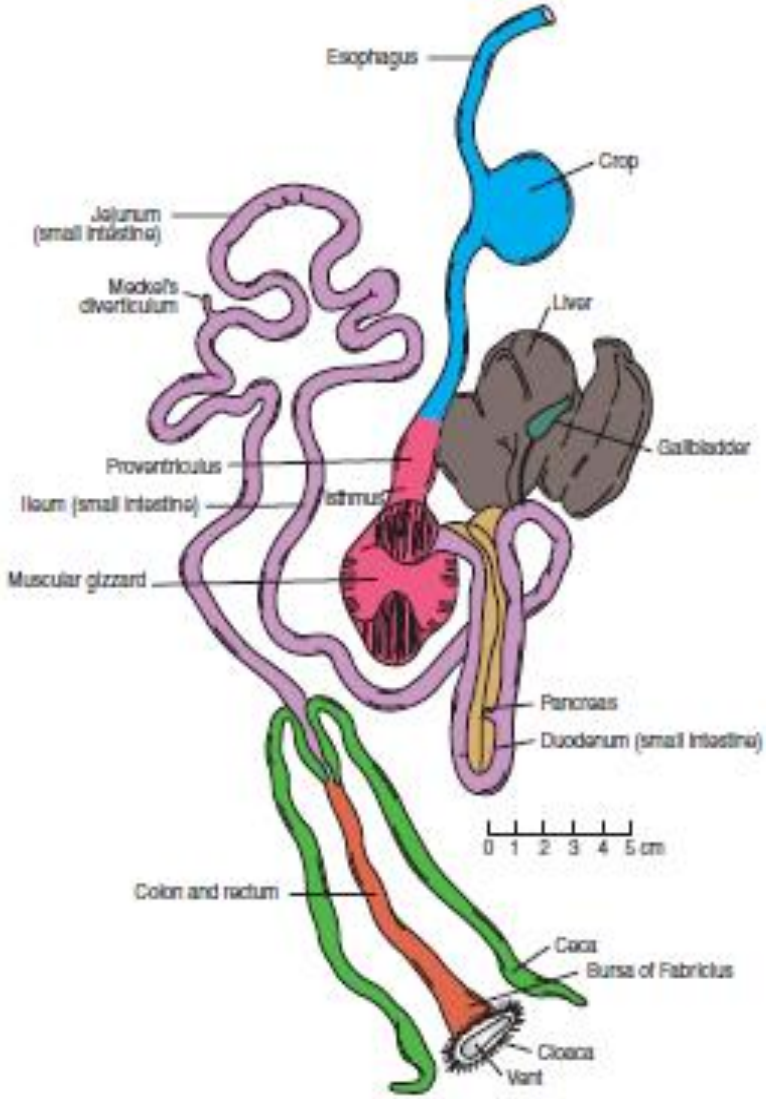

Fig. 12: Structure of GT tract of domestic chicken

Cardiovascular system: The cardiovascular system is made up of three elements:
1. *The four-chambered heart.* This consists of the right atrium, right ventricle, left atrium, and left ventricle. The right atrium pumps blood to the right ventricle, and this in turn pumps the blood through the lungs to oxygenate the blood. The left atrium pumps blood to the left ventricle, which in turn pumps blood around the body.
2. *The blood vessels*, which are arteries taking blood from the heart, veins bringing blood back to the heart, and capillaries bringing nutrients, oxygen, and hormones to cells, removing wastes from cells, and connecting arteries and veins.
3. *The blood made up of plasma*, which is the watery component containing minerals, nutrients, and proteins such as antibodies and the clotting proteins, and the formed elements, including the red blood cells, which are responsible for transportation of oxygen and carbon dioxide; white blood cells, which are responsible for immune defense and platelets, which are responsible for blood clotting. The composition of blood is illustrated in figure 13.

Respiratory organs: There are both similarities and major differences between the respiratory system of mammals and birds. There is a trachea bringing air into the lungs and providing an

exit for the air and there are two lungs where gaseous exchange occurs, that is, hemoglobin in the blood becomes oxygenated, and carbon dioxide is lost; carbon dioxide is transported in the blood as bicarbonate. In mammals, air is moved in and out of the lungs by contractions of the diaphragmand the intercostal muscles between the ribs. In birds, there is neither a diaphragm nor ribs. Instead, air is moved by the abdominal and other muscles through the lungs into air sacs. These are blind-ending sacs in the abdominal cavity and in bones. Not only are they essential for respiration, but they also reduce the weight of birds, facilitating flight.

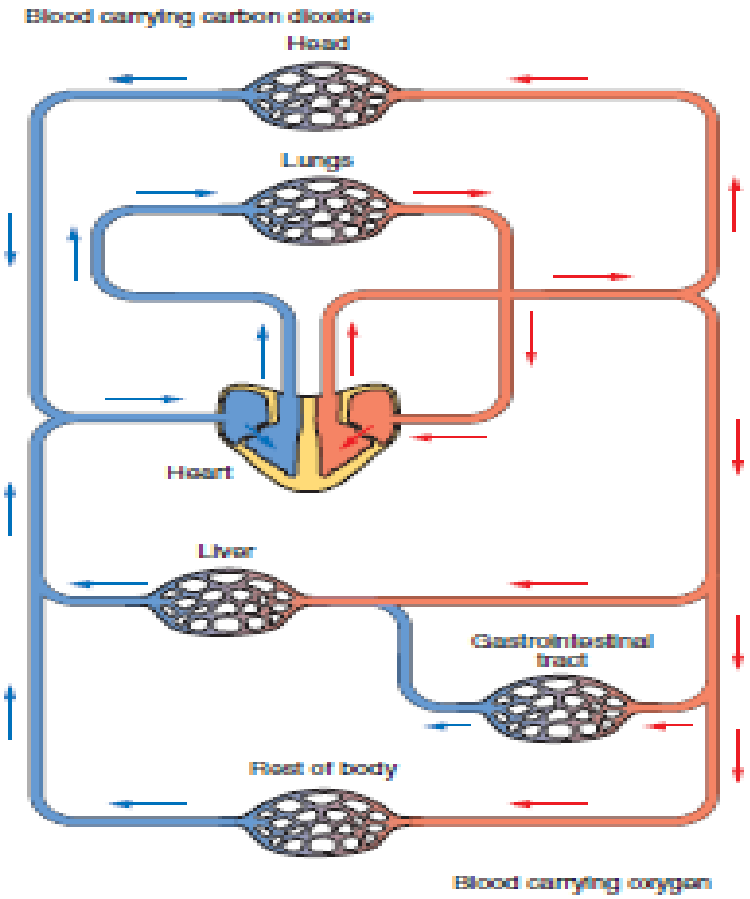

Fig. 13: Schematic diagram of the circulatory system of domestic animals.Arteries leadfrom the heart to organs and carry oxygenated blood (red), except from the heart to the lungs. Veins carry blood back to the heart. The blood is deoxygenated, except from the lungs (Source,Scanes 2011).

Musculoskeletal system: There are three types of muscle:

1. *Skeletal or striated muscle,* which are under voluntary control and used for meat.
2. *Smooth muscle,* which are found around the intestines, uterus, and blood vessels, and are under autonomic or involuntary control
3. *Cardiac muscle,* which contract rhythmically and spontaneously, but are synchronized to contract at the same time by the cardiac pacemaker or sinoatrial node. The rate and strength of contraction of heart muscles are influenced by the autonomic nervous system.

With the exception of their water content, muscles are predominantly protein. There are three types of protein in muscle:
a. *Myofibrillar proteins*, which are intimately involved in muscle contraction;
b. *Sarcoplasmic proteins*, which are soluble proteins;
c. *Stromal proteins*, which make up the extracellular matrix that holds the muscle together.

Muscle is composed of cells or fibers, which are sometimes several inches in length. These fibers are arranged in parallel. There are multiple nuclei (up to 100) per cell. The overall structure of muscle is summarized in Figure 14.

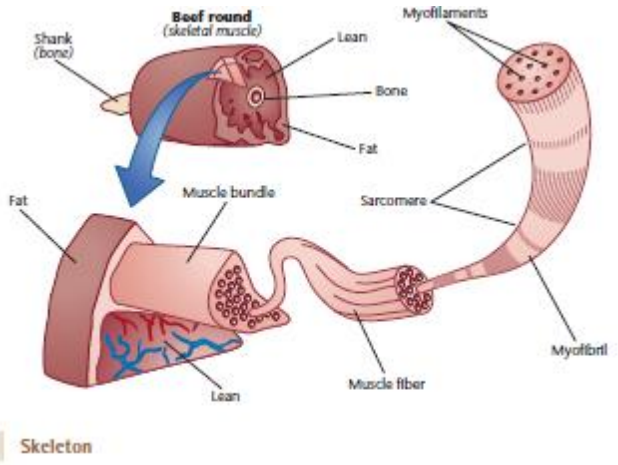

Fig 14: Structure of muscle. (Source: Delmar/Cengage Learning)

• Muscle is composed of multinucleated cells or fibers.
• Muscle fibers are composed of myofibrils.
• Myofibrils are composed of a series of sarcomeres along their length.
• Sarcomeres are composed of the contractile elements of muscle: actin andmyosin. Myosin molecules slide across the myofilaments made of actin.

Skeleton

There are two principal types of tissue in the skeleton: cartilage (at joints) and bone. The bone contains bone cells (osteoblasts, osteoclasts, and osteocytes) together with a collagen matrix with calcium phosphate deposited. There are two types of bone tissue: compact or cortical bone, and trabecular or spongy bone in the interior of some bones. In the embryo, bones of the skeleton are initially composed of cartilage. Later, bone tissue takes over. Growth of the long bones is at the epiphyseal plates or cartilage plates. At puberty, these plates fuse so that growth does not continue. The anatomy of the skeleton is illustrated in Figure 15.

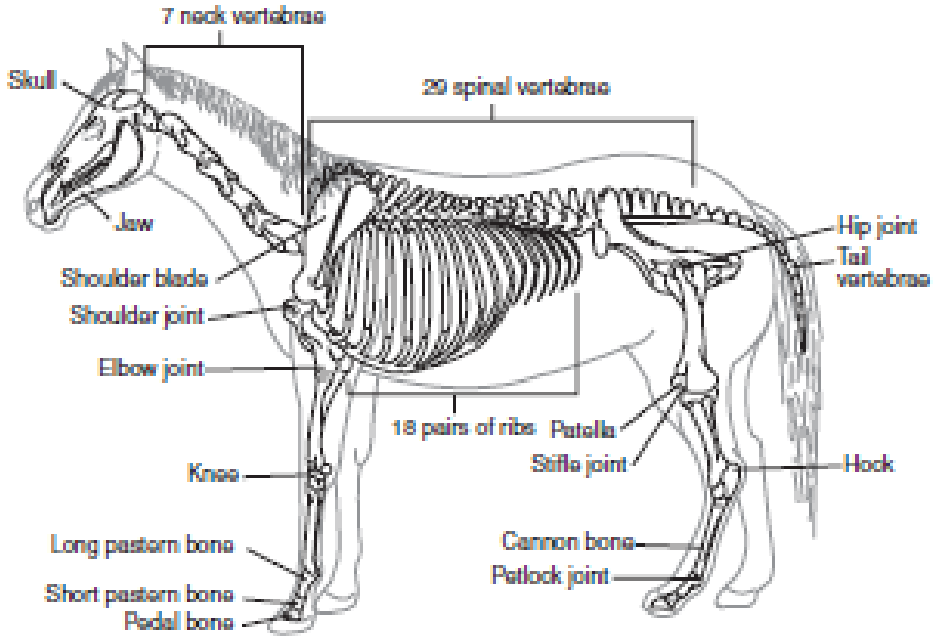

Fig.15: Skeleton of horse(Source: Delmar/Cengage Learning).

The skeleton has the following functions;
• A framework for the body
• Points of attachment for muscles and, therefore, allowing movement
• Protection of vital organs, for example, the cranium around the brain, and ribs around the heart and lungs
• Storage of calcium and phosphorus if there are needs for these that are not met from the diet.

Adipose tissue: Although people usually think of body fat as a "bad thing," it is essential to the survival of an animal or person. There are two types of adipose tissue:
a. White adipose tissue, which is the common adipose tissue
b. Brown adipose tissue, which is found at the time of birth and responsible for the production of heat.

The function of white adipose cells is to store energy as triglyceride. To store energy, the adipose tissue will either take up fatty acids from the blood or synthesize them from glucose. The fatty acid is then combined with glycerol—in fact, glycerol-3-phosphate that is produced from glucose—to form triglyceride. Three fatty acids plus plusglycerol-3-phosphate equals triglyceride. At times of inadequate nutrition, the triglyceride is broken down in a manner similar to digestion to form fatty acids that the body can use as an energy source and glycerol that can be converted back into glucose in the liver.

Adipose tissue is found in three anatomic locations:
1. Subcutaneous, which is under the skin
2. Intermuscular and intramuscular, which are responsible for the marbling in meat
3. Abdominal, which is around the intestines in the abdominal cavity and around the kidneys
The largest cellular organelle in an adipose cell is a fat vacuole filled with triglyceride. The major chemical constituent of adipose cells is triglyceride.

Nervous system and brain: The nervous system is divided into three functionally distinct systems:
a. The central nervous system, including the brain and spinal cord
b. The peripheral nervous system
c. The autonomic nervous system, where there is little conscious control of such functions as reflex responses, breathing, gut function, temperature control, feeding control, and reproduction.

The nervous system is essential for many life processes, including motion or movement (voluntary and reflex), ensuring homeostasis (constant conditions in the body), and playing vital roles in both reproduction and growth.

Endocrine organs: Hormones are chemical messengers that work closely with the autonomic nervous system to maintain homeostasis and control key functions such as metabolism, growth, reproduction, and lactation. Hormones are produced by endocrine glands or tissues.

The major endocrine tissues are the following:
• Hypothalamus
• Pituitary gland
• Thyroid glands producing thyroxine
• Adrenal glands composed of the medulla (Chromaffin cells), producing epinephrine and norepinephrine at times of fight or flight, and the cortex, producing cortisol (corticosterone in birds) to combat stress and aldosterone to increase sodium retention.
• Islets of Langerhans in the pancreas (also known as the *endocrine pancreas*)
• A or-cells producing glucagon (increases blood glucose)
• B or -cells producing insulin (decreases blood glucose)
• Gonads producing estrogens and progesterone (females) and testosterone (males)
• Gut
• Liver producing insulin-like growth factor 1 and converting thyroxine to its active form, triiodothyronine
• Adipose tissue producing a hormone, leptin, that reduces food intake
• Pineal gland producing melatonin that affects seasonal breeding and sleep patterns

The hypothalamo-pituitary-endocrine organ axis is summarized in Figure 16.The hormone from the target endocrine gland exerts a negative feedback on the hypothalamus and/or pituitary gland and thereby suppresses, respectively, the release of hormone. Examples of this system are the following:
1. Hypothalamo-pituitary adrenocorticotropic hormone stimulates the adrenal cortex to produce cortisol release.
2. Hypothalamo-pituitary thyroid-stimulating hormone stimulates thyroid release of thyroxine.
3. Hypothalamo-pituitary growth hormone (GH) increases production of (insulin-like growth factor 1) (growth axis)
4. Hypothalamo-pituitary luteinizing hormone stimulates ovary/corpus luteum (progesterone axis).
5. Hypothalamo-pituitary luteinizing hormone stimulates testis/Leydig cells (testosterone axis).

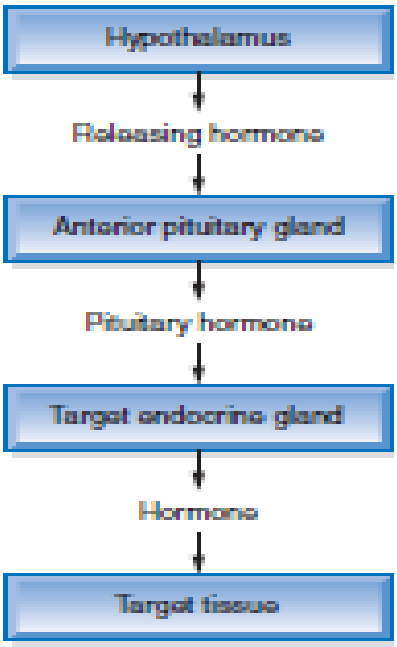

Fig. 16: schematic representation of hypothalamic control of anterior pituitary

The advantages of the hypothalamo-pituitary-endocrine organ axis are that a small amount of a hypothalamic-releasing hormone can lead to a very large change, and there are multiple points of control. This is analogous to why we need both a brake and accelerator in a car.

Reproductive organs: In both males and females, the primary reproductive organs are the gonads, thatis, the ovaries in females and testes in males. There must also be accessory organsthat allow the spermatozoa and ova to meet and to provide the environment necessaryfor the development of the conceptus. In addition, there are behaviors thatlead to mating and that increase the chances of the mating leading to a successfulnext generation.
*Male reproductive organs:*The reproductive systems of mammals show strong similarities. The bull, boar,and rooster reproductive systems are shown in Figures 17 and18 respectively.
The testes are the primary reproductive organs, with spermatozoa producedin very large numbers in the seminiferous tubules. In addition, thetestes have specific cells in the interstitium between the seminiferous tubules, numbers of spermatozoa together with secretions from the accessory glands,namely, the epididymis, ampulla (not present in pigs), seminal vesicles (very
large in pigs), the prostate gland, and bulbourethral (or Cowper's gland). The secretions protect the spermatozoa. The reproductive ducts arethe vas deferens, including two, with one from each testis/epididymis, and the urethra.

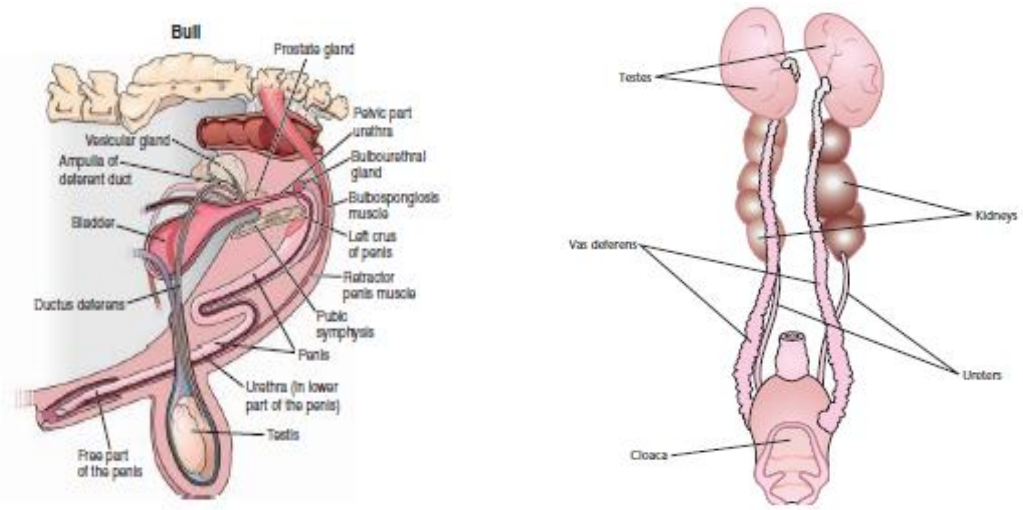

Fig. 17: Male reproductive tract of bull and cock(Source: Delmar/Cengage Learning)

Poultry have testes within the body cavity but lack a penis, epididymis, andaccessory organs such as prostate, Cowper's glands, and seminal vesicles. Chicken semen has low concentrations of nutrients. Afterejaculation, some of the spermatozoa are stored in glands in the vaginal wall.

*Female reproductive organ:*The reproductive system of the female functions to produce ova; to provide sitesfor insemination, fertilization, and embryonic/fetal development; to give a routefrom the site of insemination to that of fertilization; to produce female sex hormonesand the overlapping group of hormones associated with maintenance ofpregnancy; and to cause parturition or birth. The female reproductive systemsof the cow and hen are summarized in figures 18.

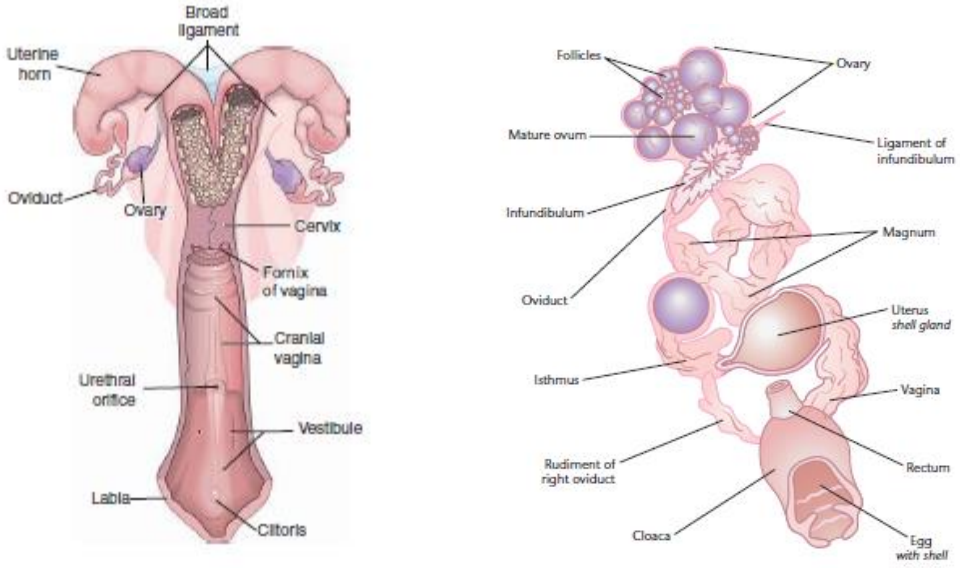

Fig. 18: Female reproductive tract of cow and hen (Source: Delmar/Cengage Learning)

In poultry, there is a single ovary and reproductive tract, known confusinglyas the *oviduct*. The left ovary and left oviduct develop, whereas theright ovary and oviduct regress. In the mature hen, the ovary is large with largeyellow or yolk-filled follicles with the largest, the F1

follicle, up to 1 in (2.5 cm)in diameter. There are also small yellow and even smaller white follicles togetherwith post- ovulatory follicle(s). There is no CL because poultry do not become
pregnant. During follicular development, the ovum takes up yolk precursors thatare synthesized by the liver under estrogen stimulation. The oviduct is made upof five regions, infundibulum, magnum, isthmus, uterus and vagina (Figure 18).

Ovulation occurs about 45 minutes after oviposition of the previous egg, leavingtime for the spermatozoa to migrate to the infundibulum. The oviduct completesits development during sexual maturation, largely under the influence of the ovarianhormone estradiol. Poultry can be molted by a variety of techniques, includingchanges in day length and diet. This results in the ovary and oviduct undergoingregression. After molting, the ovary and oviduct regenerate, and subsequent eggproduction is much higher than before the molt.

3.3 Animal Products from Livestock and Chicken

An **animal product** is any material derived from the body of an animal. Examples are fat, flesh, blood, milk, eggs, and lesser known products, such as isinglass and rennet. Animal by-products, as defined by the USDA, are products harvested or manufactured from livestock other than muscle meat. In the EU, animal by-products (ABPs) are defined somewhat more broadly, as materials from animals that people do not consume. Thus, chicken eggs for human consumption are considered by-products in the US but not France; whereas eggs destined for animal feed are classified as animal by-products in both countries. This does not in itself reflect on the condition, safety, or "wholesomeness" of the product.

Animal by-products are carcasses and parts of carcasses from slaughterhouses, animal shelters, zoos and products of animal origin not intended for human consumption, including catering wastes. These products may go through a process known as "rendering" to be made into human and non-human foodstuffs, fats, and other material that can be sold to make commercial products such as cosmetics, paint, cleaners, polishes, glue, soap and ink. The sale of animal by-products allows the meat industry to compete economically with industries selling sources of vegetable protein.

Animal products have both positive and negative effects on the consumer. It is well established that animal products are a very important part of the human diet. Animal products provide an excellent source of protein, and both vitamins and minerals. Some of the important nutrients in animal products are the following:

- Protein, which when digested, provides an excellent balance of essential amino acids for growth, muscles, and replacing lost cells.
- Vitamins, particularly vitamin B12, which is only found naturally in animal products, and vitamins A and D in milk.
- Vitamins in eggs such as choline (125 mg per egg), B vitamins, folate (essential for development), and lutein, which is important to functioning of the eye and particularly the macula.
- Key minerals:

- Calcium, which is essential for bone development and potassium, lowering blood pressure; it is available from milk and dairy products.
- Iron essential for hemoglobin, oxygen transportation, and, therefore, red blood cell formation together with mortar skill development; it is available from meat.
- Zinc is a critical cofactor, with meat and eggs as excellent sources.
- Copper is another critical cofactor, with meat as an excellent source.
- Iodine is essential for thyroid hormone products and, therefore, normal metabolism, growth, and mental development, and is available from seafood.

Milk provides an excellent source of calcium. For instance, in the UnitedStates, women consume 64% of their calcium intake from milk and dairy products.Despite this, many women in the United States are not consuming the dailyrequirement of calcium as established by the National Academy of Science. There are also issues of iron deficiency. The Centers for Disease Control estimates the following levels of iron deficiency in the United States: 5% of American children,16% of adolescent girls, 2% of men, and 12% of women.

Animal products from cattle may be considered as functional foods because theycontain conjugated linoleic acid (CLA). This component has health- promoting effects. Moreover, consumption of fish and fish oils provides an excellent sourceof two of the essential fatty acids.
Animal products also contain saturated fat. The federal Food and Drug Administration(FDA) has concluded that saturated fat increases the blood concentration oflow-density lipoprotein (LDL), which is the so-called bad cholesterol, and, therefore,elevates the risk of coronary heart disease. The major negative aspect of virtuallyany food is that when consumed in excess, it leads to obesity and consequentadverse effects of longevity and overall health.

Location of high- and low-value wholesale cuts of beef are shown in figure 19. Figure 20 shows the retail cuts of a chicken.Lamb carcasses are graded according to USDA standards from top to bottom as prime, choice, good, and utility, while the wholesale cuts of lamb are shown in Figure 21.

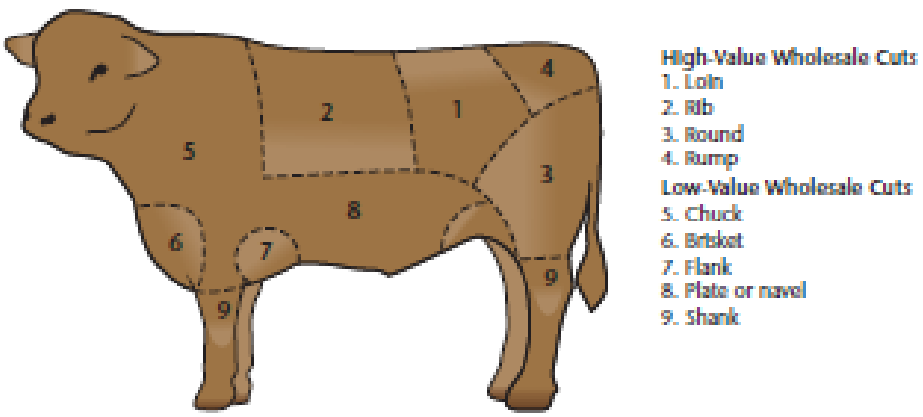

Fig. 18: Locations of wholesale cuts of beef (Source: Delmar/Cengage Learning)

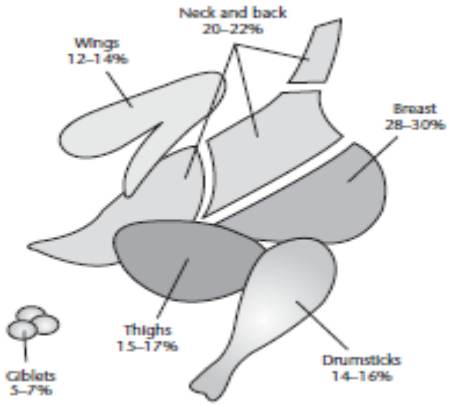

Fig. 20: Retail cuts of chicken (Source: TomoJesencnik, 2010)

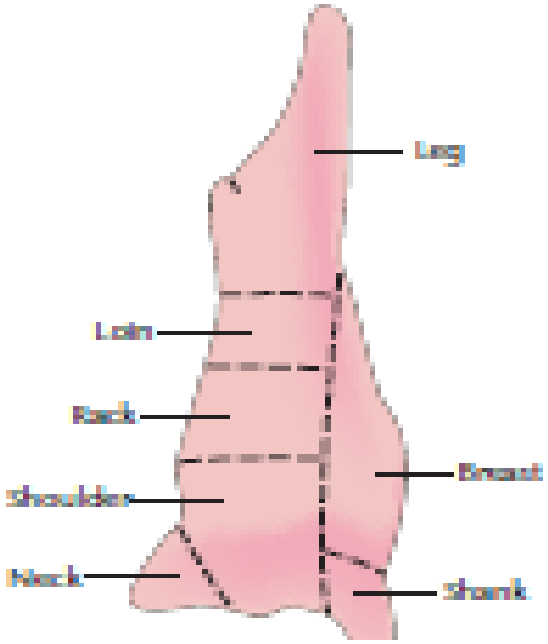

Fig. 21: Whole sale cut of lamb (Source: Delmar/Cengage Learning)

Slaughterhouse waste

Slaughterhouse waste is defined as animal body parts cut off in the preparation of carcasses for use as food. This waste can come from several sources, including slaughterhouses, restaurants, stores and farms. In the Nigeria and many African countries, what is usually classified as slaughter house waste elsewhere are consumed, with the exception of condemned meat.

Animal by-product in pet food

The leftover pieces that comes from the process of stripping meat from animals tends to get used for different purposes. One of them is to put these parts into pet food. Many large, well-known pet food brands use animal by-products as protein sources in their recipes. This can include animal feet, livers, lungs, heads, spleens, etc.

Edible animal products

- Blood, especially in the form of blood sausage
- Bone, including bone char, bone meal, etc.
- Broths and stocks are often created with animal fat, bone, and connective tissue
- Carmine also known as cochineal (food dye)
- Caviar
- Casein (found in milk and cheese)
- Civet oil (food flavoring additive)
- Dairy products (e.g., milk, cheese, yogurt, etc.)
- Eggs and Egg products (e.g., mayonnaise, eggnog, custard, etc.)
- Escargot Pearls
- Gelatin
- Hard Roe (as food is used as a raw or cooked ingredient in various dishes)
- Honey
- Honeydew (secretion)
- Isinglass (used in clarification of beer and wine)
- Insects (some edible insects are consumed whole or made into a powder, like cricket flour. The flours are then used to make products like insect fitness bars or burger patties.)
- L-cysteine from human hair and pig bristles (used in the production of biscuits and bread)
- Lard
- Kopi luwak&Black Ivory Coffee
- Meat (which includes fish, shellfish, sauces made from them, and poultry in addition to livestock, game, and "exotic dishes" made from amphibians or reptiles)
- Offal
- Rennet (commonly used in the production of cheese)
- Shellac
- Soft Roe also known as “White Roe” (is commonly fried, used as an ingredient in a larger dish, or used as a condiment in some European and Asian countries)
- Swiftlet's nest (made of saliva)
- Whey (found in cheese and added to many other products)

Non-food animal products

- Animal fiber
- Ambergris
- Beeswax
- Blood and some blood substitutes (blood used for transfusions is always human in origin, though some blood substitutes are made from animal sources. Many diagnostic laboratory tests use animal or human sourced reagents)
- Casein (used in plastics, clothing, cosmetics, adhesives and paint)
- Castoreum (secretion of the beaver used in perfumes and possibly in food flavoring)
- Coral rock
- Donkey milk

- Egg Oil (used in skin care products as a preservative and as skin conditioning agent)
- Emu oil (serves as a "natural" emollient in cosmetic preparations, especially in products that claim it has the ability enhance and maintain beauty.)
- Ejaculate (used in artificial insemination)
- Feathers
- Fur
- Gallstones (from livestock for Traditional Chinese Medicine)
- Horse Oil (used in East Asian skincare masks and creams for similar purposes as emu oil]].)
- Horn, including antlers etc.
- Ivory
- Lanolin
- Limulus amebocyte lysate (a chemical in horseshoe crab blood used to detect bacterial endotoxin)
- Leather
- Manure
- Mink oil
- Musk
- Ovine Placenta
- Pearl or mother of pearl
- Royal Jelly (used as a dietary supplement)
- Scales
- Silk
- Sponges
- Snail Mucin (used in topical medications and skincare products as a treatment for lesions and acne or as an antioxidant to brighten, hydrate, and the skin)
- Tallow, may be used in food and soap
- Tortoiseshell
- Urine
- Venom (used to produce human and veterinaryantivenin)
- Whale oil
- Wool

4.0 CONCLUSION

You have learned thatthere are different types of animals(mammals and non-mammals) used by humans as food and that different types of products are made from them. However, on a global scale, mostly ten ofthese animals are slaughtered for food and other products, especially marine animals, chicken, ducks, pigs, rabbits, turkey, sheep, goats and cattle.People of all cultures cherish animal products and there is a strong correlation between per capita incomeof a country and the consumption of animal products. In order to effectively monitor the quality of animal products there is the need to have a working knowledge of the anatomy and physiology of the major organ systems include the gastrointestinal tract (gut), cardiovascular system, respiratory organs, muscle, skeleton, adipose tissue, nervous system

and brain, and endocrine organs.It is now well established that animal products are a very important part of the human diet.

5.0 SUMMARY

In this unit, you have been informed that cattle sheep, goat and pig represent the livestock animals and with poultry, especially chickens, turkey and ducks form the major food animal throughout the world. The term anatomy, deals primarily withform and structure of the animal, while physiology is the study of the integrated functions of the body and the functions of all its parts.Major organ systems include the gastrointestinal tract (gut), cardiovascular system, respiratory organs, muscle, skeleton, adipose tissue, nervous system and brain, and endocrine organs.An animal product is any material derived from the body of an animal. Examples are fat, flesh, blood, milk, eggs, and lesser known products, such as isinglass and rennet, while animal by-products are products harvested or manufactured from livestock other than muscle meat.Animal products provide an excellent source of protein, and both vitamins and minerals.

6.0 TUTOR-MARKED ASSIGNMENT

1. Draw and label the external anatomies of cattle, pig, goat and sheep
2. Discuss the terms animal products and animal by-products
3. Write short notes on gastro intestinal tract and musculoskeletal system

7.0 REFERENCES/FURTHER READING

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UNIT 2 DISEASES OF FOOD ANIMALS

CONTENTS

1.0 INTRODUCTION

This unit on diseases of food animals will introduce you to general concepts of animal diseases occurrence, infectious and non-infectious diseases and the diseases transmitted from animals to humans through different sources including foods of animal origin. Definitions of important terms will also be given help you as a non-veterinary student to make sense of the subject.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- Have an overview of animal diseases
- Understand the effects of infectious and non-infectious diseases
- Understand the importance of zoonosis in animal production

3.0 MAIN CONTENT

3.1 Overview of animal diseases

Definitions

Infectious diseases are those caused by infectious agent orpathogens, eg tuberculosis.
Non-infectious diseases are those caused by non-infectious agents, eg wounds and trauma.
Contagious diseases are those easily spread from one animal/person to another, eg bird flu.
Pathogens are organisms that cause infectious disease, eg viruses, bacteria, orprotozoa.
Vector is an organism thatfacilitates movement ofa pathogen or a parasitefrom one host to another. Examples include, fleas withthe dog tapeworm, pork with*Trichinellaspiralis*, mosquitos with malaria, blood-suckingbugs with *Trypanosomacruzi*causing Chagas' disease, and tsetse flies with *Trypanosomabrucei*causing sleepingsickness in people and naganain cattle.
Parasites live in close proximityto an animal and receive theirnutrition from the host.
Zoonosis (plural *zoonoses*) isan infectious disease spreadfrom animals to people.
Epidemic (or *epidemicdisease*) is an infectiousdisease that spreads rapidlycausing many people (oranimals) to become sick orill; showing obvious clinicalsymptoms of the disease(such as fever).

Epidemiology is the scienceof the causes, spread andcontrol of diseases.
A *pandemic* is an epidemiceffecting a very large number(or proportion) of people and occurring across the world.
Morbidity is the number ofsick animals (overt clinicalinfections).
Mortality is the number ofanimal deaths.
Prophylactic treatments areadministered to prevent adisease rather than to treatthe disease. Examples include drugs and vaccines.
Subclinical infection is when an animal is infected, but there is no overt sickness/symptom. Subclinical infections can reduce production efficiency.
Therapeutic drugs are used to fight an active disease.

Impact of animal diseases on livestock
Animal diseases are serious threats to humans' well-being, especially in developing countries like Nigeria where animal health care are poorly developed. Infectious animal diseasescan cross species barriers and cause serious diseases in people. Such animal diseasesare called zoonotic diseases. Animal diseases reduce productivity of livestockproduction through animal mortalities because a dead animal will definitely not produce any more products. Animal illnesses also reduce their productivity, through depressed growth rates, lower reproductive efficiency, and increased spontaneous abortion. Animal diseases killor incapacitate valuable and/or much-loved horses and companion animals.Animal diseases are caused by infectious agents such as viruses and bacteria, ortransmissible agents and may be non-infectious agents. In addition, parasites such as protozoa, flukes, roundworms, tapeworms, and externalparasites reduce productivity of livestock, impair performance of horses, and ingeneral reduce the health of animals, rendering them susceptible to other infections.

There is still a tremendous impact of animal diseases in developed and developing countries, especially in Africa, Asia, and Latin America. This is despite an armory of mechanisms used in combating animal diseases in modern times, including good management, sanitation, biosecurity, veterinarycare, monitoring and depopulation in the event of an outbreak, vaccines,prophylactic drugs, and therapeutic drugs.

Examples of the economic impact of animal diseases based on government estimates include the following:
• Annual cost of treatment, prevention and control of animal diseases are enormous in many countries
• The last major foot-and-mouth disease outbreaks costing the British economy about $17 billion and the outbreak in Taiwan costing $1.3 billion.
• Mastitis impacting dairy production by an average of over $100 per cow in the United States.
• Because of tsetse flies and trypanosomes, cattle production is severely impacted, in Sub-Saharan Africa.
• Newcastle disease in non-vaccinated poultry has wiped out poultry in whole villages in parts of Africa.

• Animal diseases impact commerce and the price of animal products with the exporting of livestock or animal products restricted when there is a disease outbreak. For instance, the persistence occurrence of foot and mouth disease (FMD) in African cattle populations limits the exports of beef products to major global markets.

3.2 Effects of infectious and non-infectious diseases

Infectious diseases

Infectious diseases will be introduced under the types of organisms thatcause them from viruses to bacteria and parasites.

Viruses:Viruses can have either DNA or ribonucleic acid (RNA) as the genetic material.Under the Baltimore system of classification of viruses, they are assigned to one ofseven groups based on the form of the DNA or RNA and not based on the diseases they cause. Viroids are smaller than viruses and are known to be plant pathogens.

*Rabies:*Rabies is a viral disease of many mammalian species, including bats, dogs, cats,foxes, raccoons, skunks, and people. It is spread chiefly by animal bites. Rabiesis almost always fatal in people and most animals. Rabies vaccination is requiredlegally for dogs and cats in Nigeria and mostcountries of the world. People who have a highrisk of animal bites, such as veterinarians, receive prophylactic vaccination againstrabies. If someone is bitten by an animal suspected of having rabies (being rabid),a series of vaccinations are used. Orally active vaccines at baiting stations are usedto control rabies in wildlife.

Foot-and-Mouth Disease: Foot-and-mouth disease, also known as hoof-and-mouth, is a highly contagiousviral disease of cattle, pigs, and sheep. The disease is caused by a RNA virus, thefoot-and-mouth disease virus. North America has been foot-and-mouth diseasefree since 1954, with the last reported case in the United States in 1929, while Africa and many tropical countries remain endemic. There was a significant outbreak in the United Kingdom in 2001, with 7 million animals culled.This spread to Western Europe. Vaccines against foot-and-mouth disease virus areonly used in countries where foot-and-mouth disease is found because vaccinationprevents exports and does not allow surveillance for the presence of the disease.

Avian Influenza: Avian influenza is caused by one of a series of viruses. The disease not only affects poultry but also can infect both game and wild birds. The latter is particularly a problem because they fly around and can spread the disease locally or, forthose that migrate, spread the disease into different regions and countries. Avian influenza viruses are classified on two bases:

1. The degree of pathogenicity, that is, the ability of the virus to cause disease.The virus can have low pathogenicity or high pathogenicity. Infection with a low-pathogenicity avian influenza virus will cause little overt signs of disease.However, the low-pathogenicity avian influenza virus can mutate into ahigh-pathogenicity virus, with serious consequences.
2. The presence of two glycoproteins on the surface of the virus:

a. Hemagglutinin proteins (H). There are 16 (H1–H16).

b. Neuraminidase proteins (N). There are nine (N1–N9).

A particularly serious form of the avian influenza virus is the H5N1 virus becauseit is highly contagious among birds, and the disease is frequently fatal to them. Moreover,there are reports of infection by people with the H5N1 virus. In people, pathogenic viruses cause influenza. It is thought that avian influenzaviruses mutate into forms that are pathogenic to people and/or domestic animals.

Avian influenza type A virus may be transmitted from animals to humans in twomain ways: directly from birds (live or dressed) from avian virus–contaminatedenvironments to people, or through an intermediate host, such as a pig. Transferof the virus to pigs and horses may be from people to domestic animals. The human influenza viruses can be categorized as A, B, and C types. The type A viruses are further classified by subtype based on surface proteins—hemagglutinin(H) and neuraminidase (N). Subtypes of the virus that have caused influenzain mammals include H3N2, H2N2, H1N1, and H1N2 in humans; H1N1 andH3N2 in pigs; H7N7 and H3N8 in horses; and H3N8 in dogs.

Bacteria:Bacteria are a simple microscopic form of life. They can produce all the proteinsneeded for life. They use DNA as their genetic material. They are called *prokaryotes*because they do not contain a nucleus and membrane-bound organelles. Incontrast, eukaryotes (animals, plants, fungi, and protozoa) do contain a nucleusor cellular organelles.The classification ofbacteria is domain,Bacteria; and otherdomains, Eukarya(containing the Animalia,Fungi, Plantae, andProtista kingdoms) andArchaea.

Bacterial diseases include mastitis, the secondary infection of shipping fever incattle, *Borreliaburgdorferi*, causing Lyme disease in dogs, cats, and people, andbubonic plague. Many food-borne diseases are caused by bacteria such as *Campylobacterjejuni*and *Campylobacter coli*, *Escherichia coli*, salmonellosis caused by *Salmonella* bacteria,*Listeria*and tuberculosis

*Mastitis:*Mastitis is the number one disease of dairy cattle. It resultsin much-reduced milk production, the loss of milk not saleable with a high concentrationof somatic cells (leukocytes), and long-term damage to the mammarygland. It is caused by the invasion of the mammary gland by pathogens, includingvarious species of *Streptococcus*, *Staphylococcus*, and *Mycoplasma* bacteria.The innate immune response plays a significant rolein how the mammary gland deals with pathogenic bacteria. The teat canal is a barrierpreventing pathogens from entering the mammary gland. Between milkingand during the dry period, the teat canal is sealed by keratin, which is a plug. This is derived from the stratified epithelial lining of the canal. Inflammation is part ofthe innate immune, and mastitis is inflammation of the mammary gland.Mastitis can be either of the following: clinical or overt (readily seen by observation),or subclinical.

Tuberculosis: Tuberculosis is a chronic disease of many animal species and poultry caused by bacteria of the genus*Mycobacterium*. It is characterized by development of tubercles in the

organs of most species. Bovinetuberculosis is caused by *Mycobacterium bovis*. It is a significant zoonotic disease.An infected animal is the main source of transmission. The organisms are excreted in theexhaled air and in all secretions and excretions. Inhalation is the chief mode of entry and for calvesinfected milk is an important source of infection. When infection has occurred tuberculosis may spread:

a) By primary complex (lesion at point of entry and the local lymph node)
b) By dissemination fromprimary complex.

In sick animals the condition manifests as;

1. Low grade fever
2. Chronic intermittent hacking cough and associated pneumonia
3. Difficult breathing
4. Weakness and loss of appetite
5. Emaciation
6. Swollen superficial body lymph nodes

Mycobacteria invade cattle by respiratory (90 – 95 %) and oral routes (5–10 %). Congenitalinfection in the bovine fetus occurs from an infected dam. Tuberculosis lesions can be classified as acute miliary, nodular lesions and chronic organ tuberculosis. Young calves are infected by ingestion of contaminated milk. The incidence of human tuberculosis caused by *Mycobacterium bovis* has markedly dropped with the pasteurization of milk. It also has dropped in areas where programs of tuberculosis eradication are in place. Man is however susceptible to the bovine type. In cattle, lesions of tuberculosis caused by the avian type are commonly found in the mesenteric lymph nodes. Tuberculosis in small ruminants is rare. In pigs the disease may be caused by the bovine and avian types.

Salmonellosis: Salmonellosis is a disease which occurs in all animals and humans. In animals, salmonellosis ischaracterized clinically by one of three syndromes:

a) *Peracute septicemic form:*
b) *Acute enteritis*
c) *Chronic enteritis*.

The young, old, debilitated and stressed animals are at greater risk. More than 200 antigenically differentserotypes of Salmonella have been identified and all of these possess pathogenic potential. The mostfrequently identified serotypes of the organisms which cause the disease in cattle are *S. typhimurium, S.dublin, S. muenster* and *S. newport*. Salmonellosis in stressed animals is frequently associated withinadequate diet, irregular feeding, water deprivation, overcrowding, parasitism, weather extremes,pregnancy, parturition, inter-current diseases etc. The calving complications which may predispose thedisease include abortion or early termination of pregnancy, retained placenta, endometritis and post-parturient metabolic condition

It is transmitted through the ingestion of feed that have been contaminated by the faeces of infected animals, bydrinking water in stagnant ponds and by the carrier animals. In housed

animals, transmission is viacontaminated feedstuff containing improperly sterilized animal by-products such as bone and meat mealand fish meal. Casual workers, infected clothing and utensils, transportation trucks and birds may transmitthe disease to the farm. Active carrier animals shed Salmonella organisms intermittently and withoutobvious stress factors. Latent carriers with stress factors are also identified in the transmission ofsalmonellosis.Human infection is transmitted via contaminated water, raw milk and meat. Compared to bovines, pigs and poultry are more significant sources of infection in humans.

Leptospirosis: This is the disease caused by clinical infectionwith any one of the many serovars of the bacterium*Leptospirainterrogans*. Each serovar of the bacterium ismaintained in nature by non-clinical persistent infection ofone or more wild or domestic mammals. These mammals
are the maintenance hosts.Leptospirosis as a clinical disease occurs when mammals ofother susceptible species, such as humans, becomeinfected. The disease is associated with septicemia,hemolytic anemia, hepatitis, nephritis, jaundice,abortion and still births. The bacteria persist in the kidneysof the maintenance hosts, are shed (excreted) in the urine,and can survive for some time in aquatic and moistenvironments. Infection can occur through the followingways:
– ingestion of contaminated water
– handling or ingesting infected milk or tissues
– transplacental invasion
– sexual contact
– social grooming.

In humans, farm and abattoir workers, hunters andtrappers, wildlife handlers and zoo-keepers havetraditionally been the high-risk groups. Epidemicoutbreaks may be associated with periods of high rainfall, particularly in habitats with poor drainage and a high density of carrier animals. Thus, while leptospirosis has been an acknowledgedzoonosis for many ears, recently it appears to be gainingnew importance as a public health threat.

*Brucellosis:*Several species of *Brucella*infect animals. Infection oflivestock by any of these species, whether or not theinfection results in disease, may cause the animals to test‘positive’ in standard screening tests used to identify andeliminate infected domestic animals or herds.*Brucellaabortus*and *B. melitensis*are the species mostregularly transmitted between wild and domesticungulates, and are most frequently associated with theconflicting needs of agriculture, and the risk ofhuman disease. Each species can cause significant diseasein livestock (*B. abortus*in cattle and *B. melitensis*in sheepand goats), and both can cause serious disease in humans.Human health risks are generally associated with thehandling or consumption of infected animals or products.

These *Brucella*species also pose potential health risks topeople who handle or consume infected animal products.Indeed, at least 91 species of wild mammals, from ninedifferent orders, demonstrate some evidence of infectionwith one or more species of

Brucella.Infections can result in abortion,lameness and sterility on the individual level, but manyinfections appear to be sub-clinical.

Parasites and disease: A parasite is an organism that lives in close proximity to an animal and completelydepends on it. Parasites receive their nutrition from the host, using thehost's blood or absorbing nutrients in the host's intestine. Although the parasitesrarely kill the host, they do inflict significant harm. Parasites adversely affect thequality of life for companion animals and livestock; they also reduce production efficiency of livestock and may result in the death of an animal.Internal parasites include protozoa, roundworms or nematodes, flatworms ortrematodes, cestodes or tapeworms, and some flies such as a botfly.Ecto-parasites can be either insects or arachnids (ticks and mites, bugs, fleas, flies,lice, or mosquitos).

Protozoa: Protozoa are single-celled eukaryotes with a nucleus and intracellular organelles. They impact the livestock and companion animals as parasites, as zoonotic diseases, and by symbiotic ciliates participating in the fermentation in the rumen.For example, trypanosomes are protozoa with flagella that can cause serious diseases in animals and people. Examples include the following:

• The trypanosome *T. brucei*causes African trypanosomiasis (or sleeping sickness) in humans and nagana in cattle in Africa. The vector is the tsetse fly. The presence of the tsetse belt effectively closes some 10 million km^2 in Africa to efficient cattle production.

• *T. cruzi*causes Chagas' disease in Central and South America. Its vector is the blood-sucking bug *Rhodniusprolixus*.

• *Trypanosomaequiperdum*are sexually transmitted in horses.

Coccidia are intracellular parasites of the intestinal cells. The following are examples of coccidian and coccidial diseases:

• *Cryptosporidium* is a widespread zoonosis.

• Coccidiosis in dogs and cats is due to coccidia of the genus *Isospora.*

• Toxoplasmosis is due to ingestion of protozoan parasites, *Toxoplasma gondii*, in raw or undercooked meat, or through contact with an infected cat.

• Bovine coccidiosis.

• Coccidiosis in poultry due to *Eimeriatenella*. Without coccidiostats, production of poultry would be severely impacted with significant mortality (deaths), morbidity (sickness), and reduced growth and poorer feed conversion efficiency. A number of coccidiostat are available commercially.

*Giardia intestinalis*is a common parasite of cats. It also infects dogs, cattle, sheep, and people. Protozoan parasites *Theileriaannulata*and *Theileriaparva*infect cattle in sub-Saharan Africa. This greatly impacts the potential development of theindustry. Ticks are the vector. Another protozoan parasite is *Histomonasmeleagridis*,which causes a disease called *blackhead* in chickens and turkeys.

Roundworms or nematodes: Roundworms are from the phylum Nematoda, and include both parasitic and free-living species. Examples of roundworm parasites are the following:
• Intestinal roundworms (ascarids):
• Dogs, with two species of roundworms (*Toxocaracanis*and *Toxascarisleonina*)
• Cats, with two species of roundworms (*Toxocaracati*and *T. leonina*)
• Pigs, with the large roundworm (*Ascarissuum*)
• Horses, with the large roundworm in horses (*Parascarisequorum*)
• Chickens and turkeys (*Ascaridiagalli*)
• Strongyles; for example, in horses, there are large strongyles (also known as red worms or bloodworms) and small strongyles.
• Pinworms found in, for instance, horses and people.
• Heartworm (*Dirofilariaimmitis*), which is found in dogs and cats.
• *Trichinella. spiralis* which ispresent in pig muscle causes trichinosis in people who eat pork.
• Hookworms, which are small nematodes that attach to the gastric mucosa.There are hookworm species that infect cats, dogs, and people, with the potential for anemia

Flatworms: An example of a flatworm is the sheep liver fluke *Fasciola hepatica*. Tapeworms live in the intestines of their primary host. The scolex or head of the tapeworm embeds itself in the upper small intestine using hooks and suckers. From the head emerges a chain of proglottids or independent segments, each about the size of a grain of rice. Additional proglottids are being continuallyproduced, and, therefore, with time, they move down the gastrointestinal tractto be eliminated with the feces. The tapeworm has no digestive system. The proglottidsjust absorb nutrients that otherwise would go to the host. When mature,each proglottids will have both a male and female reproductive system, and whena terminal proglottid(s) breaks off the chain, each will contain about 20 eggs.

The common tapeworm of dogs and cats (*Dipylidiumcaninum)* is up to 25 inches (62 cm) long. The intermediary host is the flea, with dogs and cats eating the fleasduring grooming. The eggs hatch in the fleas and develop into infectious larvae.Signs that a dog or cat has a tapeworm infestation include the presence of proglottids,white large seed-like structures with a squirming motion, in the fecesor around the anus. In addition, a dog may exhibit a scooting behavior if the anusis irritated.

The most important pathogenic tapeworms to humans are the porktapeworm *(Tenia solium*) and beef tapeworm *(Tenia saginata*). In these cases, peopleare the primary host, and pigs and cattle are, respectively, the intermediary hosts (Figure 22).

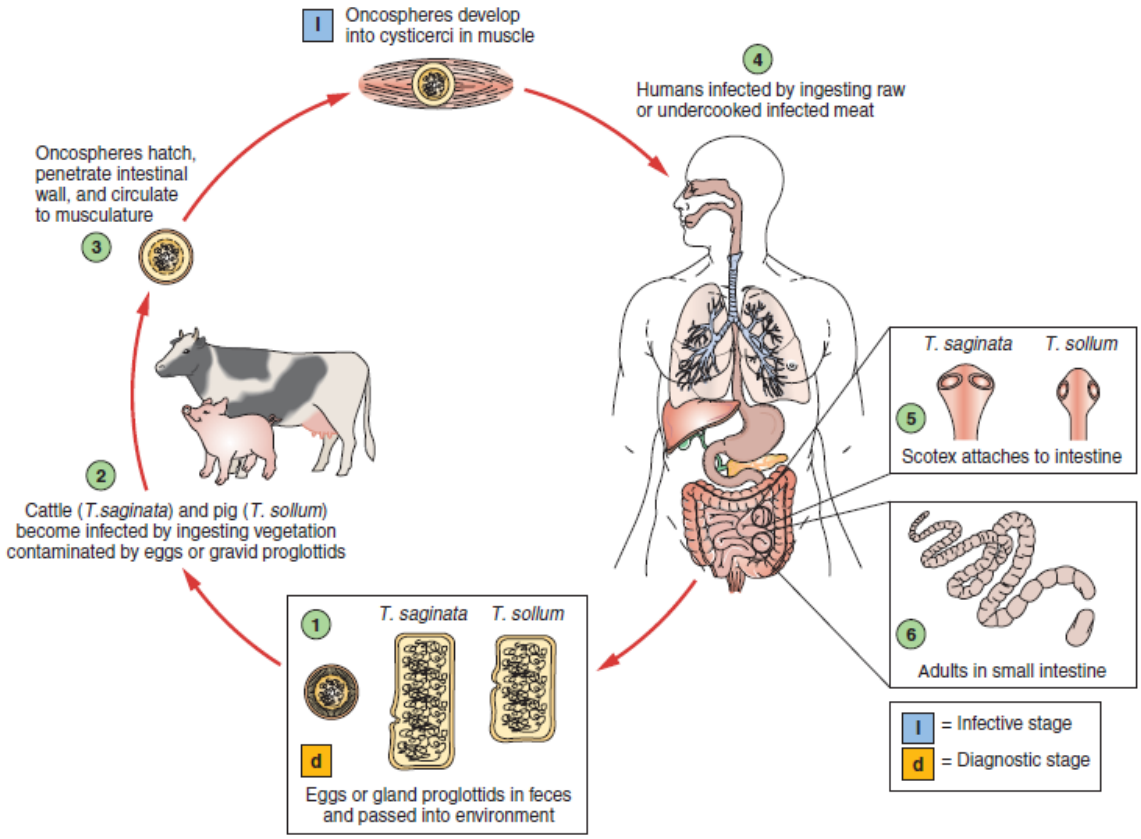

Fig. 22: Life cycle of the beef and pork tape worms

The beef tapeworm causes cysticercosis in cattle. Three species of tapeworms infect the horse: *Anoplocephalaperfoliata*, which isthe most common tapeworm; *Anoplocephala magna*; and *Paranoplocephalamamillana*.Horses with infections are not at their healthiest. Diagnosis is difficult, withsubclinical infections causing damage to the gastrointestinal tract and reducingnutrient absorption, but not causing visible disease.

*External parasites (Ecto-parasites):*Ecto-parasites can be either insects or arachnids (ticks and mites, bugs, fleas, flies, lice, or mosquitos).Ticks and mites live on the skin of animals and exist by sucking blood, but some use dead skin. Like spiders, these are arachnids. Other examples of ticks and mites include the following:

• Dog tick (*Dermacentorvariabilis*).

• Deer tick (*Ixodesscapularis*), which is the vector for Lyme disease caused by some spirochetal bacteria.

• Lone Star tick (*Amblyommaamericanum*).

• The mite, *Sarcoptesscabiei*, infecting dogs, cats, pigs, and people. In dogs, this sarcoptic mite causes mange, also known as sarcoptic mange or canine scabies. Another mite that infects dogs is *Demodexcanis*. This may result in skin disease.

• Poultry mites – the Northern Fowl Mite (*Ornithonyssussylviarum*) and the chicken mite (or Red Roost Mite).

Examples of parasitic insects include the following:

• Lice (order, Phthiraptera) (nomenclature, singular louse; a louse egg is a nit).

Lice can be either blood sucking or chewers on the skin. An example is poultry lice, *Menacanthusstramineus*.

• Fleas (order, Siphonaptera), such as the cat flea (*Ctenocephalidesfelis*) and dog flea (*Ctenocephalidescanis*).

• Blood-sucking bugs (order, Hemiptera), e.g., *R. prolixus.*

• Blood-sucking true flies, e.g., mosquitoes and tsetse flies.

Non-infectious diseases

Non-infectious diseases include diseases in which there are nutritional, metabolic,stress-related, and genetic causes. Examples of such diseases are milk fever;founder or laminitis (inflammation and edema of the laminae of the hoof) in horses,which is associated with dietary carbohydrate; ascites (accumulation of fluid in thebody cavity) in meat-type chickens; and leg weakness/tibial dyschondroplasia inmeat-type poultry. Stress diseases include heat stress. In cats and dogs, obesity,leading for instance to diabetes mellitus, is a growing problem. In addition tononinfectious diseases, there are also bone fractures and other injuries.

Milk fever: Milk fever is a metabolic disease in cattle occurring at the transition between late pregnancy and early lactation. In milk fever, cattle have hypocalcemia or reducedconcentrations of calcium in the blood. This can be either subclinical, in whichthere is hypocalcemia (calcium <2 mmol/L) but with no obvious clinical signsof the disease (but reduced muscle function and depressed milk production), or clinical, in which the hypocalcemia is so severe (calcium <1.4 mmol/L)that nerve and muscle functioning is greatly perturbed and the cow collapses(a "downer" cow). The mortality with milk fever is about 5%, and there is a3.5-year reduction in the life of affected cattle.

Ascites:Ascites is a metabolic disease in poultry, with fluid accumulation in the body cavity, an inability to supply tissues with sufficient oxygen, and a flaccid but enlarged heart.It is estimated that 8% of the mortality of meat-type chickens is due to ascites.

Edema:Edema is the accumulation of excess fluid in the intercellular (interstitial) tissue compartments, includingbody cavities.There are two types of edema: inflammatory (exudate) and non-inflammatory (transudate) edema. *Inflammatory edema* shows yellow, white or greenish clear or cloudy fluid in the area of inflammation. *Non-inflammatoryedema* is an accumulation of fluid in subcutaneous tissue, submucosae, lungs and brain.

Localized edema is noted after:

a. The swelling of a leg of a cow in prolonged decubitus. This swelling is caused by obstruction of thevenous outflow

b. Interference with the lymph circulation of an organ or area by proliferation of tumours in or aroundbile ducts.

c. Inflammation or an allergic reaction

Systemic or generalized edema may occur secondary to congestive heart failure or is caused by lowprotein levels in the blood. The latter may be associated with: severe malnutrition, severe amyloidosis of the kidney, gastrointestinal parasitic infestation, chronic liver disease,

damage to the vascular endothelium by toxins and infectious agents. Anasarca is a form of edema of the subcutaneous tissues. Ascites is an accumulation of fluid in theperitoneal cavity. Hydrothorax is an accumulation of fluid in the pleural cavity.

Bruises:Bruises are frequently found on food producing animals andpoultry. In cattle bruises caused by transportation or handling are commonly found in the hip, chest andshoulder areas; in pigs within the ham and in sheep in the hind leg. Bruises and hemorrhages in the hipjoint are caused by rough handling of animals during shackling. Bruises in poultry can be localized orgeneralized and are frequently associated with bone fractures or ruptured ligament tendons.

Tumours: A tumour is an abnormal mass of tissue which grows without control and uncoordinated with the tissue ororgans of origin or those nearby. Its presence if often cumbersome to the tissue or organ it arose either bypressure or by replacement of normal functional tissue. Tumour cells resemble healthy cells howeverserve no useful purpose. The term *tumour* in current medical lexicon is presently limited to neoplasticgrowths.Tumours are usually divided according to tissue of origin i.e. epithelial, mesenchymal (connective tissue), haemopoietic, nervous etc. Tumour behavioral classification include their mode of growth and the degreeof invasiveness. Slow growing non-invasive circumscribed tumours are considered *benign* and fastgrowing, infiltrative and frequently metastatic are *malignant* tumours. The spread of neoplasm is by directexpansion and infiltration, via lymphatics and blood circulation and by implantation.

3.3 Animal Diseases Transmitted to Humans (Zoonoses)

A zoonosis is an infectious disease spread from animals to people directly through abite, by aerosol, in food, or through a vector such as a mosquito. The most appropriate definition of zoonosisseems to be the one suggested by Teufel: “zoonotic agents are infectious (transmissible) agents whichare not only confined to one host but which can cause an infection (infestation) (with orwithout clinical disease) in several hosts including humans. On the other hand, all diseasesaffecting animals and humans are not strictlyzoonotic but could be qualified as common:both animals and humans generally contract theinfection from the same sources (soil, water,invertebrate animals and plants); however, animalsdo not play an essential role in the life cycle of theetiologic agent, but may contribute in varyingdegrees to the distribution and actual transmission of infections (Figure 23).

According to the WorldOrganization for Animal Health (OIE), 75% of theemerging diseases originate from domestic or wildanimals, which prompts for a close collaborationbetween animal and public health authorities. Toachieve such a goal, the One Health strategy wasrecently developed to expand interdisciplinarycollaborations and communications on all aspectsof health care for humans, animals and theenvironment. Such collaborations are particularlyevident when considering zoonoses.

It has been reported recently that 1415 pathogens infecting humans and theirdomestic mammals and identified 56.5% as being zoonotic. A previous studyfocusing on recorded events of EIDs highlighted that60.3% of these diseases were indeed zoonoses.In the group of

zoonotic pathogens, it isof major importance to consider both emergingagents – e.g. Severe acute respiratory syndrome(SARS) associated coronavirus (-CoV), Nipahvirus, Hantaviruses, prion protein, avian influenza– and re-emerging diseases, e.g. rabies, bovinebrucellosis, yellow fever and bovine tuberculosis.

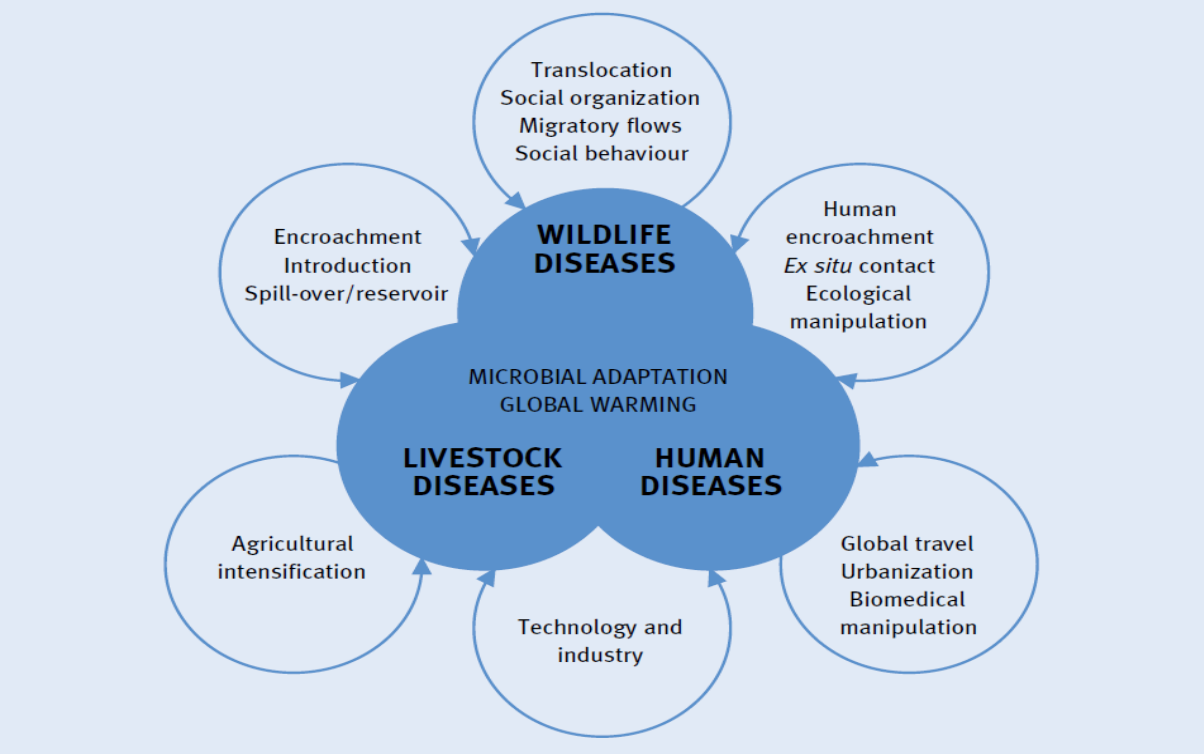

Fig. 23: The host-parasite ecological continuum (here parasites include viruses and parasitic bacteria). (Source: Saegerman*et al.*, 2012).

Examples of zoonosesare the following:
• Viral diseases:
• Avian influenza
• Equine encephalitis virus
• Bacterial diseases:
• Psittacosis (parrot fever) caused by *Chlamydophilapsittaci*and spread from birds.
• Salmonellosis caused by salmonella bacteria that infect many species of animals.
• Anthrax caused by *Bacillus anthracis*, infecting, for instance, cattle.
• The prion-based disease variant Creutzfeldt-Jakob disease (vCJD),
• Trichinosis caused by the larval stage of the roundworm—*T. spiralis*.
• Cryptosporidiosis is an emerging zoonotic protozoan disease.

4.0 CONCLUSION

You have learned the definitions of different veterinary terms especially that infectious, non-infectious, contagious diseases and zoonotic disease which was specifically defined as an infectious disease spread from animals to people.These diseases are important because they reduce productivity of livestockproduction through animal mortalities, through depressed growth rates, lower reproductive efficiency, and increased spontaneous abortion. It has been

reported recently that 1415 pathogens infecting humans and theirdomestic mammals and identified 56.5% as being zoonotic and that 75% of theemerging diseases originate from domestic or wild animals. This has prompted the recent close collaborationbetween animal and public health authorities.On economic scale, animal diseases impact commerce and the price of animal products with the exporting of livestock or animal products restricted when there is a disease outbreak. For instance, the persistence occurrence of foot and mouth disease (FMD) in African cattle populations limits the exports of beef products to major global markets.

5.0 SUMMARY

In this unit, you have been informed thatanimal diseases are serious threats to humans' well-being, especially in developing countries like Nigeria where animal health care are poorly developed.The infectious diseases wereintroduced under the types of organisms thatcause them from viruses to bacteria and parasites.Mastitis was specifically introduced as a disease dairy cattlethat resultsin much-reduced milk production, the loss of milk not saleable with a high concentrationof somatic cells (leukocytes), and long-term damage to the mammarygland.Tuberculosis was also introduced as a chronic disease of many animal species and poultry caused by bacteria of the genus*Mycobacterium* and characterized by development of tubercles in the organs of most species, with bovine tuberculosis being of special importance in meat inspection.The most important pathogenic tapeworms to humans are the porktapeworm *(Tenia solium*), beef tapeworm *(Tenia saginata*) and also the beef tapeworm causes cysticercosis in cattle.Interestingly, the group of emerging zoonotic pathogens such as Severe acute respiratory syndrome(SARS) Nipahvirus, Hantaviruses, prion protein, avian influenza and re-emerging diseases, such rabies, bovinebrucellosis, yellow fever and bovine tuberculosis are most endemic in tropical developing countries where there is urgent need to improve animal protein intake.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss the impact of animal diseases on livestock production
2. List three each of the viral, bacterial parasitic and non-infectious diseases. Draw an annotated diagram of the beef and pork tape worms
3. Discussanimal diseases transmitted to humans. What are the impacts of tuberculosis on meat?

7.0 REFERENCES/FURTHER READING

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UNIT 3 FOOD ANIMALS' HUSBANDRY AND WELFARE

CONTENTS

1.0 Introduction

This unit on food animals' husbandry and welfarewill highlight genesis of animal husbandry, starting with the domestication of livestock and poultry and pouting out the animal husbandry and welfare situations in major producing countries of the world. The environmental concerns about animal husbandry will also be introduced to highlighted the cooperate responsibilities and extant guidelines that regulate production activities.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- To know history of livestock domestication
- Understand the current global animal husbandry and welfare situations
- Understand the importance environmental concerns about animal agriculture

3.0 MAIN CONTENT

3.1 Domestication of Livestock and Poultry

Around 9000 BC, sheep were domesticated by some of the new Neolithic agriculturalcommunities in the Fertile Crescent. This was followed by the domesticationof the goat in about 8000 BC and cattle in about 5800 BC in the Fertile Crescent.Independently, Asian cattle were domesticated in the Indian subcontinent in about2500 BC. Sheep, goats, and cattle provided meat and milk, converting indigestibleplant materials to high-quality protein foods for the burgeoning Neolithicagricultural communities. Sheep, goats, and cattle were raised not
only by farmers, but also by nomadic people.

Livestock, including cattle, sheep, goats, pigs, buffalo, and chickens, is raised today in the developing world under different systems, including pastoral, with nomadic groups on the native rangeand grasslands; mixed crop and livestock, with small-scale family or village farms,tenant farmers, and sharecroppers; mixed crop and livestock (small-scale family or

village farms); landless peasants; and industrial, with large-scale confinementsystems used in the United States for poultry and pig production.

Pigs were domesticated independently in both present-day China and theFertile Crescent around 7000 BC. Chickens were domesticatedby 5500 BC in what is now Northeast China. It is thought that captive junglefowl (*Gallus gallus*) from Southeast Asia provide the ancestral stock. Both pigs andchickens are excellent scavengers and provide an excellent source of meat withchickens also providing eggs.

3.2Animal husbandry and animal welfare

Animal husbandry in different countries

The top three countries for meat production are the United States, People'sRepublic of China, and Brazil. Production is increasing inall three, but the rate of increase is far greater in China and Brazil. This is due to theavailability of grain and capital for intensive animal production. Meat productionas a percentage of global production is declining in Western European countries such as Germany, France, Italy, and the United Kingdom, together with the Asianadvanced-industrial country of Japan. The basis of the decline is the higher costsof production, including high labor, and land and feed costs, together with theexpense of addressing stringent government regulations.

Animal agriculture is increasing because production ofmeat, eggs, milk, and aquaculture products (finfish and shellfish) is increasing tomeet consumer demand.By and large, people like animal products, regardless of where they live in theworld. Not only have the number of people increased, but also as the global economyhas grown, they have had much greater ability to afford to buy food and, particularly,animal products. There is a strong correlation between per capita income (per capitagross domestic product) in a country and the consumption of meat, milk, and eggs. There are good nutritional reasons to eat animal products, including high-qualityprotein, with optimal or close-to-optimal amino acid balance; iron; zinc; calcium; and vitamins such as niacin and vitamin B12.

Livestock also provides power for plowing. They also provide manure for fertilizingthe soil. Moreover, dried cattle dung can be used as a fuel in Asia and Africa. Livestock contributes significantly to the economic vitality in rural communitiesin the developed countries by being a value-added productfrom plant agriculture, and by generating income and jobs by production andfurther processing.

Production of major animal products

This section will cover the global production of products from cattle, pigs, and poultry.Today beef, pork, and poultry meat each represent almost a thirdof meat produced and consumed globally.

Beef and dairy production:There has been a major increase in global production of meat from cattle (beeftogether with veal) and milk. This reflects increasesin all production systems. Extensive production systems are range- or grass-fedcattle and the pastoral systems of developing countries. The land available forexpansion of production in extensive systems is limited. Intensive systems usecereals being fed and/or supplements. Mixed-crop systems are less intensive systems,including cattle eating the residue after the harvesting of cereals.

Beef production is growing, with global production up 11% between 1990and 2005. This increase is marked but is less than thatobserved with either pork or poultry meat. Perhaps surprisingly, China is exhibitinga very major increase in the production of beef (89%).India is now the world's leading milk-producing nation. Productionof milk in India showed a modest increase between 1950 (17 million metrictons) and 1970 (21 million metric tons). Between

1970 and 2005, production of milk from both water buffalo and cattle has increased by 4.6-fold. This is dueat least in part to the successes of a series of cooperatives that market the milk. Milk production is also rapidly increasing in China (3.1-fold in 10 years), Pakistan(56% in 10 years), and Brazil (49% in 10 years). However, production is static ordeclining in Western Europe and the Russian Federation. Nigeria host about 55% of the cattle population in West Africa.

Cattle aretremendously important acrossthe world, providing milk, meat,hides, manure (fertilizing soiland used for heat or cooking insome societies), and traditionallylocomotive power pullingplows and other equipment.Production is typified by very small herds of two or three stalled animals fed cropresidue such as wheat straw, rice straw, and corn stalks, together with grass andother vegetation collected from along roadsides. The feed is supplemented using
a nitrogen source such as urea. The increase in milk production and availabilityhas enabled per-person consumption to double to more than a cup per day. Thisis critically important to children and infants, together with pregnant and lactatingwomen in whom needs for protein are high, and protein deficiencies are notuncommon.

Pork Production: There have been major increases in pork production across the world. This reflects increases in all production systems, including pastoral systemsof developing countries, mixed-crop systems, and an intensive industrial model ofcereals or other high-energy components such as sweet potatoes in Vietnam beingfed together with protein sources. With the shift toward the intensive system, fewer farmers are producing pigs,regardless of whether in the developed or developing world.

Traditionally, pigs were scavengers in villages and farmsteads. This is still the patternin some developing countries. In Western countries, pigs became more concentratedin many farms, particularly in the corn belt. The situationtoday shows a strong trend toward large highly efficient pig-producing operationswith integration with breeders and/or meat processors. Economists refer to thisas the “industrialized model.” Again, there are large increases occurring in pig production,particularly in China and Southeast Asia. There are also increases in two ofthe major corn-producing countries, the United States and Brazil. In contrast,production is relatively static in Europe.

The development of pig and poultry production in developing countries is frequentlyoccurring in densely populated areas near cities. This enables ready accessto market and little transportation costs. However, there are adverse effects suchas pollutants and pathogens released into populated areas, and the destruction offragile ecosystems such as wetlands.

Poultry and egg production: Globally, the production of the primary poultry products (meat and eggs) has been increasing rapidly. Among thelargest increases in the production of chicken were those in Vietnam (136%),with production increasing from 0.14 million metric

tons in 1995 to 0.32 millionmetric tons in 2005; India (217%); China (67%); and Brazil (112%). The
increase in chicken production in the United States was 38% over the 10-year period. This reflects consumption based, in turn, on consumer preferencefor these high-quality products and the relatively low price that has beena consequence of the efficiency of production. Over a 10-year period between1995 and 2005, there were the following percent increases (based on carcass. Globally, total egg production is 78% by weight that of poultry meat production,with China by far the major producing nation. Nigeria is the second largest poultry meat producer in Africa, after South Africa.

Egg productionis growing rapidly (39% over 10 years), with Asian countries (e.g., China and India) having high rates of increase of, respectively, 42% and 67%. Despite theincreased concerns of welfare, the aggregate production of chicken eggs in theEuropean Union has increased by 6% from 9.4 million metric tons in 1995 to10.0 million metric tons in 2005. Nigeria is currently the leading egg producer in Africa

Animal welfare

In different parts of the world, producers are increasingly holding themselves accountable to consumers. Examples in many western countries, pork quality assurance plus assuring pork safety, swine welfare,and good production practices, and the poultry welfarestandards are being rigorously pursued. Third-party welfare assurance has also been developed to audit productionfacilities to ensure animal welfare. This focus on animal welfare follows campaigns
by activists and standards enunciated by major users of animal products, such as big corporations and food outlets who are increasinglydemanding cage-free eggs and stall-free pork. Inaddition, these corporations are giving preference to processors that use controlled atmosphere stunning. For example, Kentucky Fried Chicken Corporation, with more than 5,000 restaurants inthe United States, has committed to humanely raised poultry, and it audits to ensurethat the standards are being met. The new standards include education and trainingof poultry personnel, hatchery operation conditions, nutrition and feeding, healthcare, adequate space, routine inspections, and catching and transportation are being set.

3.3 Animal agriculture and the environment

US Environmental Protection Agency (EPA) defines an animal feeding operation(AFO) as an agriculturaloperation in which animals are raised in confinedsituations., while aconcentrated animalfeeding operation(CAFO) isan agricultural operation inwhich animals are raised in confined situations. CAFOstend to be larger than AFOs.CAFOs are regulated by the USEPA as point sources of pollution and must therefore must meetof the following environmental criteria:

• Animals are confined for at least 45 days in a 12-month period.

• There is no grass or other vegetation in the confinement area during the normal growing season.

Animal waste

Animal waste comprises both urine and feces. Urine consists of water together withnitrogenous waste from the animal (urea in mammals and uric acid in birds) andother soluble compounds that pass through the kidney. Also present may be antibioticsand other drugs such as growth stimulants. Feces are the undigested and/or unabsorbed materials that are voided by the animal. In livestock, the feces arecalled manure. The composition of manure depends on the animal species and thecomposition of animal feed (e.g., protein content). Feces also contain the following:

• Microorganisms, including pathogens, that live in the gut.

• Any unabsorbed minerals, such as phosphorus as phytate phosphorus and metalssuch as calcium chelated by the phytate or minerals such as copper and zinc presentin the diet of pigs at levels that exceed the capacity of the body to absorb.

• Products of bacterial fermentation in the intestine. These are frequentlyodorous/volatile (smelly) and can create problems for a producer withneighbors. An example of a chemical found in animal waste with anextremely bad smell is skatole. This gives feces its characteristic smell.

Animal waste can be used as a source of plant nutrients, particularly nitrogenand phosphorus. This has been used traditionally in agriculture, with the manurebeing applied to the land. Manure is used by organic producers often as the principalsource of plant nutrients to fertilize. There is the potential for the constituents of the animal waste to run offthe land, for instance during heavy rains or with the thawing of snow cover.Moreover, manure is usually applied either before planting or after harvestingin, respectively, the spring or fall. Thus, the animal waste needs to be storedbefore application, with the potential, again, for losses into the watershed.Approaches have been developed whereby manure can be applied most of the year.

Animal waste also contains pathogens, including the following six humanpathogens: *Campylobacter* spp. (bacteria), *Salmonella* spp. (non-typhoid), *Listeria monocytogenes*, *Escherichia coli*O157:H7, *Cryptosporidium parvum*(protozoan), and *Giardia lamblia*(protozoan). These organisms account for over 90% of food borne and waterbornediseases in people, and frequently also affect dogs and cats. The use of manure to fertilize fruitsand vegetables (such as salad) that are not cooked can be a problem for humanhealth.

Animal waste can be considered as “non-point pollution” with animals on pastureor ranch, or when there is land application of the animal waste. The animalwaste can wash into rivers, creeks, and streams, for example, during a rainstorm. Asimilar situation exists for synthetic fertilizer when land applied.

Atmosphere

Agriculture contributes to the shifts in the composition of Earth’s atmosphere,including ammonia (NH_3); greenhouse gases, which are carbon dioxide (CO_2),nitrous oxide (N_2O), and methane (CH_4); and odiferous compounds affecting theneighbors of animal units.

Ammonia: It is estimated that over half of the global emissions of ammonia come fromagriculture and about a third of the total from livestock. Ammoniain animal facilities can adversely affect the health of both the workers and the animals.Of the 21 million metric tons of ammonia being added to the atmosphereevery year, the vast majority are returned to the surface, predominantly in rain.This ammonia comes from cattle (12.9 million metric tons), sheep and goats(1.5 million metric tons), pigs (3.4 million metric tons), poultry (1.9 millionmetric tons), and other animals such as buffalo (1.9 million metric tons).Ammonia is oxidized to nitric oxide and, therefore, nitrate or to N_2O by nitrification in the soil as part of the nitrogen cycle. Nitric oxide and nitrates can beconverted in the soil to N_2O and nitrogen gas by nitrification in the soil.

Greenhouse gases: With increasing human and livestock populations and industrialization, there arechanges in the composition of Earth's atmosphere. There is a scientific consensus that changes in the composition of the atmosphereare the result of human activities. Some scientists
and policy makers disagree with the prevailing viewpoint.In the past 100 years, average surface temperatures in the world have increasedby about 0.8°C. However, the real (measured) and projected changesin the average temperature vary in different geographic regions of the world. The changes in greenhouse gases in the atmosphere are thought by a scientificconsensus to be playing a significant role in global warming, as is exemplified bya United Nations scientific review in 2007, the Kyoto treaty, and the U.S. EPA.

There are many scientists and political leaders who consider that the linkbetween man's activities and climate change has been fully demonstrated. Some large agribusinesses have announced that they will reduce greenhouse gas emissions by 6% in years to come. Different gases that are released into the atmosphere have a different size of effect onglobal warming: CO_2 has a global warming potential of one, CH_4 of 21, and N_2O of 310.

Mitigation of the effects of agriculture on greenhouse gases: There are numerous approaches whereby agriculture can reduce its effect ongreenhouse gas emissions:
• Changes in agronomic practice, such as shifts to reduce tillage and increasecarbon sequestration.
• Improvements in the efficiency of animal production. This entails reducingthe amount of greenhouse gases produced per unit of meat, milk, or eggs.For instance, the use of bovine somatotropin to increase the efficiency of milkproduction reduces CH_4 emission per unit of milk produced.
• Manure management to reduce CH4 and N2O.

It should be noted that ethanol production does not greatly affect the agricultural"footprint" on greenhouse gas emissions but will reduce that of petroleumsomewhat.

4.0 CONCLUSION

You have learnedthat the first animal to be domesticated was the sheep, followed by the cattle and other livestock and poultry.Animal agriculture has remained important and indeed is increasing because production ofmeat, eggs, milk, and aquaculture products (finfish and

shellfish) is increasing tomeet consumer demand.Cattle aretremendously important acrossthe world, providing milk, meat,hides, manure (fertilizing soiland used for heat or cooking insome societies), and traditionallylocomotive power pullingplows and other equipment.The development of pig and poultry production in many developing countries is frequentlyoccurring in densely populated areas near cities to ready accessto market and little transportation costs.Nigeria is the leading egg producer and second largest poultry meat producer in Africa, after South Africa.Although animal wastes have many valuable applications, there is the potential for the constituents of the animal waste to run offthe land, for instance during heavy rains or with the thawing of snow cover.Similarly, animal wastes contribute to the shifts in the composition of earth's atmosphere,including ammonia (NH_3); greenhouse gases, which are carbon dioxide (CO_2),nitrous oxide (N_2O), and methane (CH_4); and odiferous compounds affecting theneighbors of animal units.

5.0 SUMMARY

In this unit, you have been informed thatthe top three countries for meat production are the United States, People'sRepublic of China, and Brazil, while India is now the world's leading milk-producing nation, while China and Southeast Asia, United States and Brazil are the major pock producers.Globally, the production of the primary poultry products (meat and eggs) has been increasing rapidly, withVietnam, India, China and Brazil recording the highest increases.In different parts of the world, producers are increasingly holding themselves accountable to consumers for the animals they produce.The new standards include education and trainingof poultry personnel, hatchery operation conditions, nutrition and feeding, healthcare, adequate space, routine inspections, and catching and transportation are being set.In addition to the food products they produce animal also produce wastes which contains pathogens, including, human pathogens,that account for over 90% of food borne and waterbornediseases in people. Again, there is scientific consensus that with increasing human and livestock populations and industrialization, there arechanges in the composition of Earth's atmosphere and thatammonia comes from livestock operations contribute to this.

6.0 TUTOR-MARKED ASSIGNMENT

1. What is the current global picture of beef, pork and egg production?
2. Discussthe importance of animal waste and its contribution to shifts in the composition of Earth's atmosphere
3. What do you understand by the terms animal welfare and greenhouse gasses?

7.0 REFERENCES/FURTHER READING

C. Scanes (2011). Fundamentals of animal science. Delmar/Cengage Learning, New York, USA.

MODULE 2 PRINCIPLES OF ABATTOIR PRACTICE

Unit 1 Abattoir planning, construction and management
Unit 2 Sanitation in the abattoir
Unit 3 Quality and Safety control systems

UNIT 1 ABATTOIR PLANNING, CONSTRUCTION AND MANAGEMENT

CONTENTS

1.0 INTRODUCTION

This unit on abattoir planning, construction and management will introduce you into principles behind meat inspection policies, as well as different types of abattoirs and slaughter slabs and how they are generally managed. Regulations for hygiene and biosecurity at the abattoir will also be discussed.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- Know how to plan and construct an abattoir
- Have a basic understanding anatomy and physiology of food animals
- Develop a basic hygiene and biosecurity program for the abattoir

3.0 MAIN CONTENT

3.1 Abattoir planning and construction

In most developing countries like Nigeria, most animal slaughter points are constructed as slaughter houses and slabs due the inability of the relevant agencies to fund the construction of standard modern abattoirs. In this section therefore, emphasis will be laid on the planning and construction of such slaughter houses.Anyone intending to erect an abattoir must contact the Directorate of Veterinary Services in the state for guidelines and approval.

Reasons for building slaughter houses: These may include; to convert a beast to a well valued meat, to prevent cruelty to beast so that the meat is valuable, wholesome and marketable and to convert animal by-products, both edible, and inedible into useful products after processing for example, blood to blood meal, intestine to catgut, bone to buttons etc.

Locating of slaughter houses:The trend is to locate slaughter houses in producing and consuming area. The advantages of locating them at the producing area are;

1. It is cheaper to transport meat than live animals to consumers
2. The cost of slaughtering is lower in the producing areas
3. The cost of land is cheaper
4. There is more regular supply of slaughter animals

The disadvantages may include;

1. Live animals when transported tend to lose weight
2. The custom or prejudices or vested interest may hamper slaughtering
3. Some butchers fear that meat transported may deteriorate

Siting of slaughter houses: The size of the planned slaughter house should be in accordance to the number of animals to be received bearing in mind the possibility of expansion. When siting a slaughter house, the following points should be considered;

1. It should be sighted in industrial designated areas and if possible, at the free hinges of cities capable of expansion
2. It should be sited in areas not subjected to regular and frequent flooding. Equally, the siting should be reasonably far from objectionable dust odour, smoke and other contaminants
3. It should allow the digging of sufficient number of pits for condemned carcasses, meat, flocks and toilets as well as manure compost making
4. The premises should be separated from any building used for residential, industrial or any other purposes
5. There should be abundant supply of portable water with convenient outlets
6. The area surrounding the premises must be suitable for receiving effluent but must not contaminate the ground water
7. It should be sited close to cattle market
8. It should be sited on the high ground, open air and fenced off to prevent access by non-slaughtered animals or unwanted persons
9. Electricity is important and must be uninterrupted

The choice of a suitable site for an abattoir is most important and should therefore also take into account the following environmental factors;

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

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

(c) Water supply – An adequate supply of potable water must be available. Consideration should alsobe given to the storage (storage tanks, chlorination tanks and pressure tanks)

which must be on theclean 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 abattoirshould 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 (lairage).
(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 shouldbe 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 andoriented. Provide also for future extensions.

Principles of abattoir design
A well-designed and constructed structure is needed to systematically process the animal that isslaughtered. 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.Abattoir design consist of four basic units, namely, lairage, slaughter and dressing unit, facilities for handling meat and edible offal which may or may not be refrigerated and department for reception and processing of by-product

Features common to the layout of abattoir irrespective of the size and design
Pre-slaughter accommodation (Lairage): This is necessary so that animals may rest and recover from the stress of journey. The accommodation may allow for easy inspection of the animals and should include provisions for isolation of disease or suspected animals. The floor of the lairage must be impermeable but non-slippery. There should be space in the lairage for threedays supply of cattle and two days' supply of sheep, goats and pigs. It must have water and feeding troughs and adequately drained. There must be a roof cover to shield the animal from excessive sun and rain

Humane slaughtering: There should be a direct unobstructed entrance from the lairage from the stunning or killing room.

Slaughter halls: this should be opened, well ventilated and lighted. The floor must be non-slip material and must slope towards gullies to enhance drainage. Blood must not drain into gullies so as not to congest or block the drainage system. The wall must be smooth, impervious up to 6ft from the floor.

Division between clean and dirty operations: Live animals should enter at one end of the building, dressed and inspected. Fresh or chilled carcass should leave out at the opposite end. The arrangement should be that carcasses move in at one direction and the offal in another direction without any risk of contaminating the processed meat.

Meat inspection: Line or rail system of slaughtering is widely recommended. An overhead rail enables an inspector to make the necessary examination without holding up other operations. Provisions of hooks on which the body hangs, especially the dresses carcasses assist identification. Meat inspection office must be provided with facilities for recordkeeping and laboratory examination.

Separation of @passed" from "detained" and condemned carcasses: There should be a special overhead rail so that unfit carcasses for human consumption may be separated from passed carcasses.

Separation of pigs from other livestock: Pigs should be dealt with in a separate hall in order to ensure hygiene and also for religious reasons.

Cold or chilled rooms: This is very essential in the tropics. Carcasses should be treated immediately after dressing by rapid cooling in dry atmosphere. The chilling room should be adequate for two days. Chilling temperature should be between 30-40F (freezing temperature is between 15-18F). In Nigeria, meat is generally sold "hot".

Guttery and trippery room: It is necessary to provide large tripperies to deal with offal meant for human consumption.N.B: contamination increases with cleaning of the stomach, intestine, etc

By-product plants: For hygienic and economic reasons, all condemned carcasses and inedible carcasses should be converted into livestock feed or fertilizers. By-product plants should therefore be provided where possible.
Supplies of steam and hot water: The size of the boiler will depend on whether by-productsprocessing is planned.

Staff welfare room: For maintenance of satisfactory hygiene among the staff, toilets and lavatories, washing and shower facilities should be provided for employees of both sexes. "Mess room" and lockers should be included according to number of employees. Others include offices, administrative block, small labs, first aid room to treat cuts, injuries, etc.

Facilities for disposal of condemned meat, offal or carcasses: The most convenient and hygienic method is by

a. Incineration but this is very expensive.
b. Chemical treatment
c. Deep burial

B and C can be combined. Condemned meat must not be fed to birds, dogs or carnivorous birds. This could be dangerous (infection).

Types of slaughter house
Slaughter slab (Primitive slaughter house): This should be built whenever the number of animals to be slaughtered is small so that field or backyard slaughtering could be eliminated.

It must be considered as a temporary structure until such a time that better public slaughtering facilities can be provided. It must not be privately owned except in exceptional cases.

Adequate slaughter house: This should be provided by the local government or the state government authorities. Such slaughter houses may be operated and managed in two ways:
a. The butchers slaughter their livestock and pay certain fees to the slaughter house authority. The butcher or its paid staff do all the slaughtering operations and collect the dressed carcasses and all the offal. It may be therefore necessary in this system to divide the slaughter house into several halls of cubicles or compartment, each to be used by different butchers or group of butchers but the maintenance of hygiene and the provision of meat inspection services remain the duty of slaughter house authorities.
b. When large number of animals are slaughtered and where the objections of the butchers can be overcome, the authority which owns the slaughter house employs the necessary personnel and slaughtering is carried out as line dressing by fully equipped, well-disciplined staff. The butcher merely delivers its livestock into the lairage and collect the dressed carcass and offal. Neither he nor his staff touches the animals or any part of it until it emerges as dressed carcass. In this system, the identification of individual animal is very important. This method automatically excludes owners, butchers, stripe washers (Gut), cleaners and many others who contributes to the contamination and pilfering in the slaughter house and those whose presence nullifies all attempts to carry out meat inspection and maintaining satisfactory hygiene.

Central factory abattoir: This stage is reached when large numbers of animals or livestock are slaughtered for distribution in a large consuming area or for export. This system is operated on the principle that the purchasing of livestock, slaughtering operations, utilization of by-products and sales of dressed carcasses to the butchers remain the responsibility of one body (Abattoir body). It also provides uniform meat which has been slaughtered and inspected under ideal conditions.

Centralization of the slaughter houses: At times, a survey may reveal that too many slaughter houses are operating with a radius of few kilometres. These slaughter houses may only cater for a small number of consumers and may be a burden rather than an asset to a local government.They may have been built on the fringes of towns and cities but gradually surrounded by new buildings. They may be obsolete and dilapidated and making sanitary operations and hygienic maintenance impossible.They may also lack proper facilities for slaughtering and meat inspection. They may not lend themselves to improvement/modernization.
The best situation in these circumstances is to centralize the slaughter in one properly equipped abattoir which is provided with adequate facilities such as cold room and by-product processing plant.

Advantages of centralization: These include;

1. Slaughtering is carried out under strong supervision by skilled and experienced operators

2. There is improved hygiene and adequate meat inspection resulting in more wholesome meat for consumers
3. By providing cold rooms, the butchers would be able to store meat until required. This will ensure an increase in the tenderness and palatability of the meat.
4. By-product plant will ensure the utilization of offal, resulting in additional income and stock feeds and fertilizers will become more available in the country.

3.2 Abattoir and management and factors affecting it

Meat vary from country to country depending on the respective meat regulations or legislations. In Nigeria, the veterinary public health decree of 1992 identified the following as food animals;cattle, sheep, goat, camel, fish, rabbits, poultry, etc.

Transportation:Food animals intended for slaughters are moved to abattoir through the following ways;

1. On hoof driving: The cheapest and more practical way of moving animals over short distances. However, in long distances and especially in bad weather condition, this method of transportation causes the animals to lose flesh and weight.
2. Road transport: Lorries and trucks are rapid means of conveying animals in this type of transportation.
3. Rail road transport: Rail wagons are better than trucks and lorries for transporting animals in long distances.
4. Air transport: It is an expensive means of transport. Thus, it is limited to small animals including poultry and rabbits.
5. Sea transport.

Effect of transportation of animals: The movement of animals from where they are produced to the abattoir causes some degree of changes in the physical condition of animals. These include:

1. Rough handling such as bruises, fracture or even death.
2. Inadequate ventilation/overcrowding which may result in suffocation, crushing and even death.
3. Fatigue and hunger may result in weight and flesh loss.
4. The stress caused by fatigue, hunger, stress and excitement may deplete glycogen reserve resulting in a high pH and therefore keeping quality of the meat.

Minimum requirement for transportation of food animals: The adverse effect of transportation listed above could be minimized if the following guidelines are carefully examined.

1. Loading must be done not more than one hour before departure time.
2. Provision of adequately sloppy board (ramp) to facilitate loading and unloading, thereby preventing fractures and bruising. The ramp must incline at an angle not more than 45^{O} and must be fended with cross bars.

3. Wagons or lorries should be properly ventilated and provided with roofing to protect the animals from rain and the heat of sun. The floors and the side of the truck must be undamaged and there must be no nail or sharp object projecting from the side or floor.
4. Adequate bedding of sand, saw dust must be provided.
5. Avoid overcrowding by providing adequate spacing for each animal.
6. Water must be provided during the journey and rest for the animals after 26 hours.
7. Separate horned or ferocious animals
8. Disinfect all vehicles and keep them clean regularly with the following:
    a. Steam or hot water if available
    b. Quick lime
    c. 2.5% Lysol
    d. 3% Phenol
    e. Formalin
    f. Dettol, Izaal, etc
9. Lairage the animal on arrival to the abattoir

Lairage

This serves two general purposes, which are to provide rest for the animals while preparing for slaughter for at least 24hours and not more than 24 hours and to provide space and facilities to inspect animals prior to slaughter.

Importance of rest

1. A minimum of 12-24 hours' period of rest in the lairage allow the animals to recover from stress of transportation and with adequate feed and water will restore its lost weight and glycogen reserve.
2. Ample drinking water intake also serves to lower the bacteria load of animals and facilitates the removal of hides and skin during dressing operation.
3. Withholding feed from cattle for a period of 12hours prior to slaughter minimizes emigration of bacteria from the intestinal tract to occur during digestion.
4. Detaining animals too long in the lairage often result in salmonella cross-infection.
5. Young animals, for example calves, may not be rested for too long but slaughtered on arrival at the abattoir to prevent cross infection of salmonella infection.

Services provision at the abattoir

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

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

(c) Transport – There must be sufficient facilities for the reception of animals as well as for the removalof 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 materialand refuse are restricted to the "dirty" area and may not enter areas where meat vehicles and staffwho handle meat are to be found.

Requirements for premises
(a) Must be fenced with lockable gates in order to control the unauthorized entry of vehicles, personsand animals.
(b) The layout of the site should be such that a linear flow pattern can be maintained with live animalreception 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 asurface that is dust and mud free, readily cleanable and well drained. The traffic zones of largerabattoirs must have a permanent surface. The planting of grass and shrubs creates a pleasantenvironment 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 ismaintained, the easier it is for the workers to accept and adjust to the high standards of hygieneexpected 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
curbstones and be drained so that they can be cleaned every day. Dirt that is washed onto grass isimpossible 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 paunchcontents to be removed, must also be paved, drained and provided with curbstones.

3.3 Hygiene and Biosecurity at the Abattoir
Progressive procedures to prevent the contamination of meat by organisms and other contaminantsduring the slaughter process must be taken.This aim can be achieved by correct internal abattoir design. The layout must eliminate cross-flowpatterns of people and products.In designing the abattoir, it is important to refer once again to the principle of a linear flow pattern.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.

Cycle of operation: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. This is

summarized as follows; Entry of livestock →lairage (ante-mortem inspection) → washing → stunning→ bleeding/killing→ dressing (head, legs, hides and skin) → evisceration of offal→ meat inspection (post-mortem) →cold room (refrigeration) → exit to the market

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 weighing.
• 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 cartooned.
• 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 andtallow
• Cloakrooms, toilets, showers, washing facilities and dining room where only workers of the dirtyareas have access.
• Store rooms for dirty area.
• Maintenance workshops.

"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 their fitness forhuman 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 lifeensured.
• 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 areahave access.
• Store rooms.

Clean and dirty products

Clean products: Dressed carcass (includes head and feet in pigs and skin in poultry); Red offal may be the following, depending on the species:Lungs pancreas, kidneys if removed, clean fat (omentum), heart, diaphragm if removed, tongues, heifer udders if removed, liver, sweetbreads (Thymus), tail, testes, spleen.

*Dirty products:*Edible: rough offal, paunch and esophagus, 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 withlegislation), crop in case of chickens, rectum/cloaca in chickens.

Facilities for staff

(a) Change rooms, toilets, showers and canteen facilities sufficient for the number of workers on thepremises must be provided in terms of the Occupational Health and Safety laws of the country.

• 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 inthe "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 separate storeroom for cleaning agents, soap and chemicals must be provided.

(h) Lockers must be provided. The basket system, as used at swimming baths, is highlyrecommended 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 thebaskets, e.g. food, empty bottles etc. which might be stored together with the overalls.

Personal hygiene

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

Health requirements of workers

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 animal – in other words a sick animal, or onethat is a carrier of the organisms – or from other sources. These sources include food handlers(people who work with food) at the abattoir,

wholesalers or retailers – even the housewife inher kitchen. This discussion however focuses on people employed at an abattoir. The principles canhowever also be applied elsewhere. Where we refer to meat handlers the same can be saidof any food handler.

Legal requirements regarding the health and hygiene of workers

a. Visitors entering an abattoir: All persons entering an abattoir including management, visitors and maintenance personnelmust be issued, by the owner, with clean suitable protective clothing complying to abattoir regulation.

b. 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 not a carrier of, or sufferer 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.

a. Health checks: The owner must ensure that all personnel –

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

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

(3). Protective clothing

(i) Protective clothing must be light coloured, clean, in good repair and must include safetyhats, hair nets, beard nets, head and shoulder capes, white gumboots and safetyboots compliant with hygiene requirements and waterproof aprons as required by thework situation.

(ii) At the start of each working day or shift, the owner must provide personnel withprotective clothing.

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

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

(v) Protective clothing must be changed or cleaned when it becomes contaminated byobnoxious matter or becomes dirty.

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

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

(vii) Personnel may change into protective clothing only in appropriate change rooms anditems of protective clothing left in the abattoir working areas may only be placed orhung in areas designated for these items.

(ix) 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.

(x) 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.

(4) Injuries
(i) All cuts and minor injuries must be covered with a durable waterproof dressing, surgical gloves or rubber finger guards.
(ii) Personnel must immediately report any injury to the owner.

(5) Showering and washing of hands
Personnel who handle foodstuffs must –
(i) shower before assuming duties; and
(ii) 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.

(6) Prohibitions
(i) Jewelry, including traditional objects, may not be worn in an area where edible products are handled.
(ii) Fingernails must be short, clean and free of nail varnish.
(iii) Eating, drinking or using or handling tobacco are not allowed in any area where meat is handled.
(iv) Drugs, liquor or any intoxicating substance may not be brought into any part of thepremises and a drugged or intoxicated person may not be allowed to enter any part ofa meat handling plant.
(v) Personnel must refrain from any actions that could contaminated the product.

(7) Training: All personnel must be trained in hygiene procedures and personal hygiene matters by theowner, and training records must be kept.

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 emphasized.
• 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.

Realities of Nigerian meat processing and handing business in pictures

What can you say about hygiene and biosecurity at these sites as captured in these pictures?

Fig. 24:Courtesy of Departments of Animal Science and Technology, and Public Health students, Federal University of Technology Owerri, Nigeria.

4.0 CONCLUSION

You have learned that in most developing countries like Nigeria, most animal slaughter points are constructed as slaughter houses and slabs due the inability of the relevant agencies to fund the construction of standard modern abattoirs. However, there is the need to ensure that abattoir planning, construction and management especially hygiene and biosecurity at these abattoirs meat standard specifications outlined in extant laws of the country. Personal hygiene and health of food abattoir workers is also of the utmost importance with medicallyexamined and physically being recommended to perform the work. Field evidences of the actual meat processing and handling situations at local slaughter points in Nigeria is however currently below expected standards and requires urgent intervention to save consumers of meat products from imminent epidemic of food borne diseases.

5.0 SUMMARY

In this unit, you have been informedthat the reasons for building slaughter houses include; to convert a beast to a well valued meat, to prevent cruelty to beast so that the meat is valuable, wholesome and marketable and to convert animal by-products, both edible, and inedible into useful products after processing.A lairage is need at slaughter facilities to two general purposes, which are to provide rest for the animals while preparing for slaughter for at least 24hours and not more than 24 hours and to provide space and facilities to inspect animals prior to slaughter.Progressive procedures to prevent the contamination of meat by organisms and other contaminantsduring the slaughter process must be taken.This aim can be achieved

by correct internal abattoir design in order to eliminate cross-flowpatterns of people and products.Personal hygiene and health of food handlers is of the utmost importance when an effort ismade to deliver a safe product of high quality to the consumer.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss the different types of slaughter houses and features common to the layout of abattoirs
2. Discussthe health and personal hygiene requirements for abattoir workers
3. Discuss the concept of fixed status in terms of “Clean” or “Dirty” areas in the slaughter process

7.0 REFERENCES/FURTHER READING

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UNIT 2 SANITATION IN THE ABATTOIR

CONTENTS

1.0 INTRODUCTION

This unit on sanitation in the abattoir will teach you the requirements for cleaning and disinfecting, pre-operational checks for bacteria and sources of contamination as well as the practice of cleaning and disinfection in the abattoir. 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,other equipment, 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 providedto the consumer.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- Know the requirements for cleaning and disinfecting in the abattoir
- Knowthe pre-operational checks for bacteria and sources of contamination
- Understand the basisfor the practice of cleaning and disinfection in the abattoir

3.0 MAIN CONTENT

3.1 Requirements for Cleaning and Disinfecting in the Abattoir

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 course we will assume that:

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

b. *Hygiene* refers to a condition that includes the concepts of “clean” and “safe” (in other words theabsence 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 and visible dirt are removed. When an object appears tobe clean, it is not necessarily free of harmful micro-organisms.

d. *Disinfection* refers to the process of sterilization by which micro-organisms and their spores arekilled 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.

Requirements for cleaning and disinfection

The aim of food hygiene is to ensure clean, safe and wholesome food. Therefore, it is extremely important for the management of an abattoir to be fully informed of their duties inrespect of hygiene, which the public health law imposes on them. If they are not, a tendency could arise to favorproduction above hygiene, or even attempt to economize on cleaning and disinfecting materials. These requirements include;

1. All equipment, implements, tables, containers, disposal chutes and so on must be made of a material that can be easily cleaned and sterilized.
2. All parts of an abattoir as well as fixed articles, equipment, tables and implements must be keptclean 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 andwhich come into contact with the carcass, meat or animal product, must be thoroughly cleanedand 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 easilyaccessible 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, fecal 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 theequipment; 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 polishingof equipment. All such substances must be NAFDAC 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 oranimal disease, must be done in a way and with a disinfectant approved by the Department of Veterinary Services.
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 15liters in the case of a chicken abattoir must be available to protect against contamination, and thequality of this water must meet the Department of Public Health requirements.
15. A satisfactory supply of hot water at a minimum temperature of 40 - 50°C must be available at alltimes 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.

3.2 Pre-operational Checks for Bacteria and Sources of Contamination

Pre-operational checks

In order to ascertain the effectiveness of the cleaning and disinfection processes, it is veryimportant to inspect the slaughter floors and equipment first thing in the morning. If there are anyproblems, there is still time to re-clean properly before slaughtering begins. A pre-slaughterinspection of the abattoir is therefore essential.A visual inspection of the abattoir and equipment will reveal immediately any traces of meat, fat, bloodand other contaminants that have not been removed. These remnants are highly undesirable, as theyattract 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 anddisinfection processes have been carried out properly.While bad odours such as rotting meat immediately indicates ineffective cleaning procedures, anexcessive smell of chemicals is also undesirable, as it can easily mask bad odours, and meat is alsowell known for its ability to absorb odours.Important information can also be obtained from touching surfaces, especially those that are not easyto see. Greasy surfaces, dust, splits and cracks can be traced in this way.

Bacteriological monitoring

Samples for bacteriological culturing must be taken regularly from surfaces which come into contactwith meat and edible offal, equipment, protective clothing and so on to give a good indication of howeffective 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 mustlogically take place on a continuous basis throughout the slaughtering process, becausecontamination also takes place all the time. If this is not done, the entire slaughtering floor will soonbe covered with blood, intestinal contents and trampled bits of fat and meat, and microorganisms willbe transferred from “dirty” to “clean” areas. The floor and equipment directly under carcasses shouldtherefore not be sprayed, as water that splashes up can only contaminate the carcasses.Overall, effective supervision and regular inspections throughout the day are absolutely essential to ensurethe success of the cleaning and disinfection processes.

Sources of contamination

In order to apply effective sanitation in an abattoir, it is necessary to take all sources of contaminationinto account and to eliminate them as far as possible or to restrict them to the minimum. Effectivecleaning and disinfection of the abattoir and equipment can be nullified by conditions that bring aboutrecontamination 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 tokeep contamination of meat and other edible products to the minimum during the slaughteringprocess. This is why wood and cloths

are not allowed in abattoirs. Rusty equipment and grease fromthe 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 ofcontamination if strict precautionary measures are not taken to prevent this. Animals infected with oneor more kinds of micro-organisms, in other words sick animals, can spread their contamination to the meat and other edible animal products, as well as to the abattoir workers. This is why ante-morteminspection 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 duringthe slaughter and processing of meat:
• Untrained and careless workers. Satisfactory training and encouragement can largely eliminatethis 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.
• 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 consequentlyineffective chilling.

Abattoir personnel:Workers can also be a source of contamination of meat. The abattoir supervisor must inspect all theworkers every day before they start work to establish whether they have any abnormalities such asskin diseases, visible open wounds or septic sores on the head, neck, arms or hands or unnaturaldischarges from the eyes, nose ears or skin. If such an abnormality is identified, the worker must beexamined by a medical personnel 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 fromsmoke, dust or unpleasant smells can make it extremely difficult to maintain a high standard ofhygiene.

Water quality:Water is used as the universal cleaning medium. However, pure water does not exist in nature andthe quality of water (chemical and microbiological) varies considerably depending on area and time ofyear. Since, especially the chemical quality of water has a dramatic effect on the performance ofdetergents, 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 one gram is needed for every 50 ppm hardness over 150 ppm.

Water used in food plant sanitation must be of potable quality and should conform to the followingspecifications:
Total bacterial count: < 100 viable organisms/ml (30 °C/ 48 hours)
Coliform count: < 0/ 100 ml
Fecal 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 ifdesired hats, aprons and boots must be cleaned regularly before and during the slaughtering processand replaced when necessary.

Containers for general refuse:Rubbish containers must be made of durable, rust-resistant, non-absorbent materials and must beprovided with tight fitting lids to protect the contents against flies and cockroaches and to limitunpleasant smells to the minimum. The containers must also be emptied regularly and then cleanedand disinfected. The use of disposable plastic rubbish bags does not mean that the containers neednot be cleaned and disinfected.

3.3 The Practice of Cleaning and Disinfection in the Abattoir
The seven 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 fecal 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 bewashed into the drainage system.
3. Pre-washing all equipment, floors and walls with clean hot water (40 - 50°C) to soften and loosenthe 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 cleaningand disinfecting.

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

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 thestandard 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 cleaningprogramme, in the same sequence as the cleaning.

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

d. Standard operating procedures (SOPs) which set out the instructions based on the above pointsin which the method of cleaning and disinfecting, the kind and concentration of chemicals and thesequence of cleaning and disinfection are clearly stated should be available to every member ofthe cleaning team.

e. The cleaning team must be well trained, and strict supervision must then ensure that the aboveinstructions are carried out meticulously.

f. Make use of the **who, what, where,when** and **how** principles. Each member of theteam 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 cleaningand disinfecting programme as well as problem areas.

Detergents

The purpose of detergents is to render water insoluble dirt soluble or dispersible in water. Because ofthe 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.

The following four anionic detergents are most frequently in use in the abattoir.

a. Acid detergents:These are used to dissolve mineral deposits on the surface of equipment. The pH of the solution isusually 2,5 or lower.

b. Alkaline detergents: Alkalis are the main ingredients of the majority of detergents. They react with fats and proteins tomake 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 reducesmineral 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 corrosionproblems 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 ofsurfactants and a mixture of

enzymes, and the second is an alkaline solution supplemented with watersofteners and conditioners. The two components are mixed with warm water (maximum 45ºC) justbefore 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 energyas well as refrigeration costs

Detergent product selection guide

a. The product should be economical, the factor to measure this by, is price of the solution used, notprice per liter or kg of product.
b. It should contain corrosion inhibitors to prevent attacks on soft metals such as aluminum and
galvanizing.
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 offats, proteins and heavy soils, acid for the removal of alkaline scales and mineral deposits).

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 four 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 ahigher 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 areessential 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 thehigher the temperature (up to 80°C) of the solution, the more effective the operation, especially inrespect of greasy dirt.
d. Contact time: The contact time between the detergent solution and the dirt must be long enough, as mostdetergents 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. Ifcleaning is not thorough, disinfecting will also be ineffective.

Disinfectants/ Sanitizers

Even the most thorough cleaning will not remove all the micro-organisms from a surface. Disinfectionis therefore essential to bring the microbe population of a surface down to levels that will be safe forpublic health. This can be obtained by using a NAFDAC approved disinfectant. 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 themanufacturer's instructions. Too little disinfectant can result in ineffective disinfection, and toomuch increases the danger of contaminating meat with the chemicals.

Types of disinfectants used in the meat industry: The following three 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 solutionsthey are relatively non-toxic, colorless, non-staining and easy to prepare and to use. Chlorinedisinfectants are however inactivated to a considerable extent by organic material, and can alsocause soft metals to corrode.

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

c. Quaternary ammonium compounds (QAC): These are effective against many gram-positive and some gram-negative bacteria. In workingsolutions they are colorless, odorless and non-toxic. They are stable when heated, but are alsoinactivated by organic material. No rinsing is necessary for solution of less than 200 ppm of activeingredients.

d. Comparison test between a disinfectant and water at 82 0C: Disinfection by heat at 82°C is not usually as effective as chemical disinfection, except in the case ofequipment small enough to be immersed into a sterilizer and kept under water at, 82°C for relativelylong periods. In a test at an abattoir the disinfection efficiency of heat at 82°C was compared with thatof a chemical disinfectant. These results show clearly that:

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

• Chemical agents did not always result in sterilization even after 30 minutes application. They aretherefore not real disinfectants, but rather sanitation agents, because they simply lower the microorganismspopulation to a safe, low level.

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.

4.0 CONCLUSION

You have learnedthe seven basic steps of cleaning and disinfection fromremoval of loose bits of rubbish throughpre-washing all equipment,washing and scrubbing with detergents to disinfection and microbiological survey.Drawing up an effective cleaning and disinfecting programme is important and this should usuallymake use of the who, what, where, when and how principles; where 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. Different types of detergents are available in the market, howeverthere is no single miracle detergent which will remove all the dirt at all times. Again, even the most thorough cleaning will not remove all the micro-organisms from a surface. Disinfectionis therefore essential to bring the microbe population down to levels that will be safe forpublic health.Cleaning and disinfection can be regarded as effective when no more visible dirt occurs; no chemical residues from the disinfectants occur on working surfaces;there are no mineral deposits from the water;no unacceptable smells or odours occur;there are no stains;no physical damage such as cracks or splintering is present; and acceptable bacteriological counts are obtained.

5.0 SUMMARY

In this unit, you have been taught thepractical aspects of cleaning and disinfection in the abattoir. There is a need to understand the basic steps in the process, which will enable you to draw up an effective program of cleaning and disinfection. The available detergents such as Acid detergents, alkaline detergents, chlorinated detergents and foam detergents with enzymes have their advantages and disadvantages which should be taken into consideration before making the choice of the product to use.Essentially, the factors affecting the effectiveness of detergents include the concentration, mechanical action, temperature and contact time of the product. Again, the effectiveness of the disinfection process can only be met if the surfaces if thoroughly cleaned, if the contact time between disinfectant and surfaces is enough, preferably overnight and if the concentration of the disinfectant solution is strictly in accordance with themanufacturer’s instructions.Cleaning and disinfection can be regarded as effective when, no more visible dirt occurs; no chemical residues from the cleaners and/or disinfectants occur on working surfaces;there are no mineral deposits from the water;no unacceptable smells or odours occur;there are no stains;no physical damage such as cracks or splintering is present; and acceptable bacteriological counts are obtained.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss the requirements for cleaning and disinfection in the abattoir
2. Discuss the general sources of contamination in the abattoir
3. Outline the sevenbasic steps of cleaning and disinfection and discuss the different types of disinfectants used in the meat industry

7.0 REFERENCES/FURTHER READING

T. Bergh (2007). Meat inspector's manual abattoir hygiene. Directorate: Veterinary Services, Veterinary Public Health, National Department of Agriculture, Republic of South Africa.

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UNIT 3 QUALITY AND SAFETY CONTROL SYSTEMS

CONTENTS

1.0 INTRODUCTION

In this unit you will be introduced to quality and control systems in the abattoir. The unit will cover definitions and the need for quality systems; Hazard Analysis and Critical Control Point (HACCP) implementation as meat safety management system,as well as hygiene management systems (HMS) and records keeping. Quality control is becoming an increasingly more important factor in the food industry. In Nigeria, the meat inspection laws legalize Hygiene Management Systems. The main objective of HACCP is to make provision for safe products, while Nigerian Standard Organization (SON) standards are quality systems.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- Define basic terms and appreciate the need for quality systems in the abattoir
- Understand HACCP implementation as a meat safety management system
- Understand hygiene management systems (HMS) and keeping of records

3.0 MAIN CONTENT

3.1 Definitions and the need for Quality Systems

Definitions

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

*Quality Assurance (QA):*The system used to interpret and formulate the firm's policy with respect to quality and the setting ofparameters against which standards can be measured.

*Good Manufacturing Practice (GMP)/Good Hygiene Practice (GHP):*GMP means manufacturing procedures and methods that, while taking into account the principlesof hygiene, are applied in such a way that food is not spoilt during the manufacturing process.

*Hazard Analysis and Critical Control Point (HACCP):*HACCP is a system that identifies, evaluates and controls hazards that are significant for foodsafety.

*Critical Control Point (CCP):*It is a step at which control can be applied and is essential to prevent or eliminate a food safetyhazard or reduce it to an acceptable level.

The need for quality systems

This is not a course on HACCP but only an introductory text to some of the basic facts about qualitycontrol systems and HACCP. Considerably more training in these systems than the following textwill be required for their successful implementation.A quality management system allows for planning to prevent things from going wrong duringprocessing; it does not wait for things to have gone wrong before acting. The risk must bemanaged and must be as small as possible. It is generally accepted that a quality system shouldbe:

_ 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, SON standards, and in the food industryat present, mostly GMP and HACCP. Having a HACCP system in place is an absolute requirementfor exportation of meat to the European Union (EU) and the United States of America (USA). WhileGMP mostly refers to quality systems including hygiene, HACCP deals only with food safety. Thestandard texts at present are the publications of the international Codex Alimentarius Commission'sguidelines for both HACCP and hygiene.

HACCP as a food safety management system

The Hazard Analysis and Critical Control Point (HACCP) is a system to manage food safety. It is aproactive system because food safety hazards are controlled throughout processing instead of onlyafter production by end-product testing. It gained prominence because the incidence of food bornehuman illness is increasing, thus, causing world-wide concern over food safety issues. In recenttimes food borne disease has been on the increase all over the world and even first world countriesexperience a worrying increase in outbreaks of food borne disease. In fact, food borne disease hasbeen described by the World Health Organization as one of the most widespread public healthproblems of the contemporary world. The international community is now pinning their hopeson 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 ofmicrobiological, chemical and physical hazards.The HACCP concept is simple:It is a proactive approach to prevent food safety hazards by focusing resources at those points infood production where food safety hazards can be controlled, instead of placing emphasis on(reactive) end product testing.

3.2 HACCP Implementation as Meat Safety Management System

Quality systems as pre-requisites for HACCP

The main prerequisite for implementation of quality systems and HACCP is managementcommitment. Management must be willing to render visible as well as financial support to the
HACCP and prerequisite quality programmes. The production of safe food products requires that the HACCP system be built upon a solidfoundation of pre-existing programmes. These prerequisite programmes provide the basicenvironmental 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 newappointments, training almost becomes a continuous task.
_ It is most important that all employees (including management) as well as other personsentering the plant, must observe all rules of personal hygiene and behavior. GMP mustbecome a way of life at the plant.
_ Recall procedures for faulty products
_ Supplier quality assurance
_ Etc.

Prerequisite programs are often confusing in that they can be called different names in thedifferent spheres or organizations where food safety programmes are implemented. To simplify itfor the sake of this module in broad terms the following names will in essence describe prerequisite 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 prerequisite program for HACCP.

HACCP implementation

Although the HACCP concept is simple and at first glance obvious, its implementation is difficult.It is based on science and scientific facts and not simply on perceptions. HACCP implementationincludes control of microbiological, chemical and physical hazards. Successful implementationrequires 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 inall these fields, and especially in the smaller plant where multitasking is practiced, outsideassistance 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 aparticular 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 tothese 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 andconsider 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 thancure" approach, the concept can be applied to other aspects of food quality and successfullyused to ensure production of a quality product every time.

3.3 Hygiene Management Systems (HMS) and Keeping of Records

Hygiene management systems (HMS)

The Nigerian Meat Inspection laws, provide for the implementation of hygiene managementsystems. However, these laws are hardly obeyed or enforced in the numerous slaughter slabs and houses scattered all over the country (see the pictures in unit 2). The following extract was taken from the regulations in terms of theglobal acts and laws. Specifically, the owner of an abattoir must meet the following requirements: –

(a) Provide the veterinary officer with a documented hygiene management systemcontaining detailed information on control measures or programmes required to monitoridentified control points, including the methods of monitoring or checking these controlpoints, 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
(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.

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
(c) A documented product recall procedure approved by the Department Veterinary Services.

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

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

(b) Details and technical data including equipment layout and characteristics, sequence of allsteps, technical parameters of operations, flow of products, segregation of clean anddirty areas, hygienic environment of the abattoir, personnel routes and hygienicpractices, product storage and distribution procedures.

Potential hazards: The owner must prepare a list of all potential biological, chemical or physical hazards that mayoccur 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

(c) Unacceptable production or persistence of toxins or other undesirable products of microbial

metabolism.

Prevention of hazards: The owner must prepare written hygiene management programmes (HMP) for approval by theprovincial executive officer, to prevent, eliminate or reduce hazards.

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

(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 duringthe period when the process was out of control

(iv) that a written record of measures taken must be kept.

Keeping of records

Record keeping is the collection, notation, and filing of relevant information in an organized 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 can be found in literature. These forms can be modified tocomply with specific needs. If necessary, the local Veterinary Public Health officer can be contacted.

1. Vehicle inspections (Transport of livestock/Dispatch of carcasses).
2. Secondary inspections (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).

4.0 CONCLUSION

You have learnedthata quality management system allows for planning to prevent things from going wrong during processing rather than wait for things to go wrong before acting. The Nigerian Meat Inspection laws, provide for the implementation of hygiene managementsystems; however, these laws are hardly obeyed or enforced in the numerous slaughter slabs and houses scattered all over the country. Ideally, Hazard Analysis and Critical Control Point (HACCP) is the proactive system of food safety manage employed in standard abattoirs, because it is required that food safety hazards be controlled throughout processing, instead of onlyafter production by end-product testing.The main prerequisite for implementation of quality systems and HACCP is management commitment since the HACCP system has to be built upon a solidfoundation of pre-existing programmes.Since prerequisite programs are often confusing a simplifiedcategorization of such programs should capture hygiene management, good manufacturing and good hygiene programs and quality management systems.Record keeping is invaluable to abattoir operations and requires the collection, notation, and filing of relevant information in an organized manner.

5.0 SUMMARY

In this unit, you have been taught the importance of quality systems in abattoir operations and this is ideally predicated on the institution and implementation of sound HACCP system, which is a science based and systematically identifies specific hazards as well asmeasures for their control in order to ensure the safety of foods.The seven principles of HACCP include: Conduct a hazard analysis; determine the critical control points (CCP's); establish critical limit(s); establish a system to monitor control of a CCP; establish a corrective action to be taken when monitoring indicates that aparticular CCP is not under control; establish procedures for verification that the HACCP system is working effectively; establish documentation concerning all procedures and records appropriate tothese principles and their application.

6.0 TUTOR-MARKED ASSIGNMENT

1. What are the seven principles of HACCP and what are the stages in HACCP implementation?
2. Discussthe abattoir owner's responsibilities toward hygiene management systems (HMS) in the abattoir

3. What are the purpose and examples of record keeping in the abattoir? Why should quality systems be set up at abattoirs?

7.0 References/Further Reading

T. Bergh (2007). Meat inspector's manual abattoir hygiene. Directorate: Veterinary Services, Veterinary Public Health, National Department of Agriculture, Republic of South Africa.

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MODULE 3 MEAT INSPECTION AT THE ABATTOIR

Unit 1Meat hygiene and quality control
Unit 2 Ante mortem inspection, slaughtering and dressing methods
Unit 3 Post mortem inspection methods and procedures

UNIT 1 MEAT HYGIENE AND QUALITY CONTROL

CONTENTS

CONTENTS

1.0 INTRODUCTION

In this unit on meat hygiene and quality control you will be introduced to basic veterinary public health and food hygiene; biological and chemical bases of meat hygiene as well as the microbiology of meat products. The ultimate goal of meat inspection is to ensure public health; which is the total practice of human community medicine resulting inextending life expectancy and delaying the inevitability of deaththrough the promotion of healthful conditions and habits; theprevention of illnesses and the co-ordination of communityapproaches to medical care.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- Understand the veterinary functionsin public health, especially food hygiene
- Understand biological and chemical bases of meat hygiene
- Develop a working knowledge of the microbiology of meat products

3.0 MAIN CONTENT

3.1Veterinary Public Health and Food Hygiene
Veterinary public health

Veterinary public health is a component of public health devoted tothe application of veterinary skills, knowledge and resources to theprotection and improvement of human health. It includes:

i. The zoonoses: These deal with diseases that can betransmitted from animals to man and from man to animals. Itincludes surveillance, prevention and control of suchdiseases.

ii. Hygiene of food of animal origin: This involves the safeprocessing and handling of foods of animal origin in mannersfit for human consumption and these include meat, milk,eggs and fish products.

iii. Environmental hazards and protection: Including wastedisposal and management and pest control.

iv. Occupational hazards, trauma, allergies and control ofanimal population which may serve as disease reservoirs.

Human health problems become public health problems when they affect more than an individual in a community and cannot be solved by the unaided effort of the individual. Measures taken to control such disease or conditions will not completely eliminate the problems but will substantially reduce the effect of the disease on the population. Veterinary public health can thus be seen as the bridge between human medicine and the practice of veterinary medicine. Efforts in veterinary public health are geared towards the production of safe and wholesome foods of animal origin for the purposesafeguarding the health of the consuming populace.

Meat hygiene: This is the scientific concepts and procedures applicable to theprocessing of food animals in such a way that the meat and meatproducts derived thereof are safe and wholesome for human andanimal use.

General principles of food hygiene

Food hygiene is the efforts made to safeguard food from becominghealth hazard and to prevent early spoilage and contaminationcaused by handling of the foods. It is the procedures applicable to theprocessing of food in such a way that the products derived thereofare safe and wholesome for human use. The general principle of foodhygiene is to ensure that food products are safe, wholesome and fitfor human consumption.

Fit for human consumption: Food which has been passed andappropriately branded by an inspector and in which no subsequentchanges have been found due to disease, decomposition orcontamination.It is important to note that there are three key elements in the abovedefinition. In order for food to be classed as fit for humanconsumption, it must be safe, wholesome and processed in ahygienic manner.

a) *Safe*: Food products must be free from any substance which maybe harmful to man. Such include both infectious agents and toxic substances of either endogenous or exogenous origin.

b) Wholesome: Food products must be free from defects which maybe either endogenous diseases or exogenous non-microbialcontamination and adulterations.Whereas the primary aim in a safe food product is to exclude harmfulmicrobes from the food chain,

wholesomeness is much broader inthat it implies that the food products must be generally free from bothmicrobial organisms, non-microbial contaminants and even religiouslyand aesthetically acceptable to the consumer.

The criteria governing the wholesomeness of food products can begrouped as follows:
i) Such food products must be free from obvious defectsincluding contamination with seemingly harmless extraneousmaterials.
ii) Microbial contamination of such food products must notexceed levels which could adversely affect the shelf-life ofthe products. The effect of microbial contamination on thekeeping quality of food will depend on the type of productsand the storage methods.
iii) The attributes of such food products must conform toexpected standards such as colour, taste and smell.

c) Hygienic processing: Food products processed in the manner toensure compliance with the above requirements and to protect thoseinvolved in the process from occupational hazards such astuberculosis, brucellosis, salmonellosis, leptospirosis among others.Hygienic processing also implies that a production system is in placewhich does not create environmental hazards to the public.

There are a number of other terms used in meat hygiene and many ofthese are defined in the legislation:
Edible products are defined as products that are fit for humanconsumption. This would include meat, certain offal, casings, etc.from animals which have been examined and passed by an inspector.
Inedible products are defined as "meat products which are not fit forhuman consumption" and would include such products as hoofs, horn, hair, bone, bristle, blood, dew claws, hide and skin.
Condemned meat is defined as "meat and meat products which havebeen found be an inspector not to be fit for human consumption". Alldiseased and defective carcasses or part of carcasses will be declaredcondemned material by the inspector and severely contaminatedproducts may also be included in this category.

Purposes of food inspection
Meat inspection is the sanitary control of slaughter animals and meat.The aim of meat inspection is to provide safe and wholesome meatfor human consumption. The responsibility for achieving this objectivelies primarily with the relevant public health authorities who arerepresented by veterinarians and meat inspectors at the abattoirstage. The objectives of meat inspection programme can be broadlyclassified into two:
i) To ensure that only apparently healthy, physiologicallynormal animals are slaughtered for human consumption andthat abnormal animals are separated and dealt withaccordingly.
ii) To ensure that meat from animals is free from disease,wholesome and of no risk to human health. Specifically, the purposes include:
a) To prevent unsanitary meat (i.e. self-dead animals, diseasedmeat, fetus etc.) from being released for humanconsumption.

b) To prevent post-mortem contamination of meat throughunhygienic dressing of carcass, contamination duringwashing with polluted water, contamination from humancarriers of infectious diseases etc.
c) To prevent the addition of dangerous drugs and chemicals tomeat e.g. in canning.
d) To prevent false or fraudulent practices with meat e.g.soaking of meat and rubbing of pale carcasses with blood bybutchers.
e) To detect outbreaks of infectious diseases among foodanimals.
f) To fulfil national and international regulations and laws on themeat trade i.e. meat edicts and decrees and other internationalregulations. E.g. Codex Alimentarius Commission on theacceptable levels of chemical residues in food animals EU(96/446/EU) requirements for the imports from third worldcountries of bone and bone products, horn and horn products,hoof and hoof products.

Fig. 25:In what ways have the activities in these pictures fallen short of the purposes of food inspection? (Source, Students of the Department of Animal Science and Technology, FUTO)

3.2 Biological and Chemical Bases of Meat Hygiene

The basic need for meat hygiene stems from the need toproduce wholesome products that will nourish and benefit theconsumers rather than make them sick. The general belief is thatin the developing countries (Nigeria inclusive) the consumption ofanimal protein is far below the FAO recommended levels, premised onlow production of livestock and poultry for the teeming populace. Itis then important that the "little" available animal protein is fit forhuman consumption.Several factors are responsible for the unwholesomeness ofanimal products amongst which are microbial and chemicalcontaminants.

Microbial contamination: Bacteria are everywhere and can be regarded as commoncontaminants. The most common ways by which bacteria andother micro-organisms contaminate meat and milk are usually fromprocessing (slaughtering and processing of meat and milkcollection and processing) and post-abattoir handling of theproducts. This includes transportation and storage of meat prior toand during sale.Efforts must then be put in place for proper slaughtering andprocessing of food animals to limit the spread of micro-organisms to the edible parts of the carcass (care must be taken to separateclean operations from dirty operations) and also to avoid crosscontaminationof the carcass (water, slaughtering surface, meathandlers, containers, vehicles etc).Assurance of microbiological quality of foods relies on control ofthe fate of organisms in the food and its environment.

Bacteria are by far the most important group of microorganisms encountered in red meat and poultry productions and are of great concern from the standpoint of both food spoilage and foodborne diseases. 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, especially those bacteria that arecapable 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).

Food borne disease mechanisms

i) *Infection:* The food acts as a vehicle to transport the infectious agent into the gastrointestinal tract wherethe micro-organisms colonize and produce illness. For example: Salmonella, and Shigella.

ii) *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.*

iii) *In vivo intoxication:*The food acts as a vehicle for organisms that form toxin *in vivo*. For example:*Clostridium perfringens* and some *Escherichia coli.*

Chemical contamination

Residues of drugs in food animals refer to the presence of drugs asresidual deposits in meat, milk, eggs and other foods of animal originat levels higher than the maximum permitted in

the food product.Such can be antibiotics, anthelminths, anti-protozoans, hormones,organophosphates and biologicals such as vaccines.

In most livestock production systems, drugs such as antimicrobialsare used for the prevention and treatment of animal diseases and toimprove the efficiency of animal production. These agents usually findtheir way into animal tissues by direct routes through injections orindirectly via the feed.Antibiotics used for the treatment of food animals do not pose ahealth hazard to the consumer, provided they are properly used inaccordance with the recommendations for their use: proper dose,proper route of administration, proper species of animal andadequate withdrawal period before slaughter.
Residues of drugs in meat, milk or eggs and processed foods mayresult from intentional or accidental exposure of animals or animalproducts to drugs. Intentional exposure is a result of drug usage forthe purposes of prevention and treatment of diseases, growthpromotion and as feed preservatives. Accidental exposure, which isalso referred to as unintentional exposure however occurs as a resultof circumstances not intended to protect the feed or the foodproducinganimals. This includes the contamination of food and waterby industrial chemicals.
Residues which may consist of parent compound, metabolites ordecomposition products may accumulate and be deposited or storedwithin cells, tissues or organs of food producing animals, and mayproduce deleterious effects on the health of the consumers.

Thepublic health concern is because of the potential carcinogenicity,mutagenicity, teratogenicity and long term toxic effects of theresidues of these drugs on human. The concern about antibioticresidues in meat however is mainly on hypersensitivity reactions andthe possibility of the development of micro-organisms resistant toantibiotics in human.

Antibiotic residues in animal tissues may lead to the emergence ofresistant strains of bacteria in animals and the passage of these viathe food chain of animals to man.Apart from the safety aspect, the presence of antibiotics in milk caninterfere with micro-organisms essential for the maturation of cheeseand yoghurt and their presence in meat can also cause fermentationfailure in sausage production.

Control of antibiotic residues in meat
• There is a need for legislative control over the licensing and supply of veterinary drugs. Legislative control of veterinarydrugs involves making laws governing the use of veterinary drugs.
• There is a programme of advice and education about the use of veterinary drugs by farmers/food animal producers.
• There is the monitoring for residues in the meat and meatproducts available for human consumption.

Methods of detection of drug residues in meat: The main analytical methods used for the analysis of residues of veterinary drugs in animal tissues are
• Microbiological assay

• Immunoassays
• Chromatographic methods.

3.3 Microbiology of Meat Products

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 microorganismsas are their gastro-intestinal tracts. From the moment of slaughter, each processing step subjectsthe carcass to opportunities for contamination with micro-organisms from the exterior surfaces, utensils andequipment and, most importantly, from the gastro-intestinal tract.Cutting of carcasses also involves the use of utensils and equipment and transfers micro-organisms to thecut surfaces. Theoretically removal of the skin should expose the sterile surface of the muscle but in practicethe extra handling seems to contribute significantly to the bacterial load on the surfaces. This happens withmeat 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-organismsfrom:
• 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 102-104 organisms per cm^2. To put the numbers of organisms associated withsome 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 astudy of live cattle, 107 organisms were found per cm^2 of hide. The soil (ground) is also a major source ofmicro-organisms and has comparable numbers (107) of bacteria per gram of soil. Faeces are about 100x more contaminated and have coli forms of about 108 per gram of faeces.

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 orfleece 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 significantnumbers of organisms to the meat surface. Likewise, hands and equipment that touch the outside of thehide can serve to transfer organisms to the meat and should not come into contact with the underlyingcarcass meat before thorough cleansing.

Since it is extremely difficult to obtain clean meat from dirty animals or birds, it is important that only relativelyclean animals are presented for slaughtering. The cleanliness of livestock depends on husbandry, weatherand climate (rainy, dry), methods of transport (stress causes defecation and urination) and holdingconditions at the abattoir. Cattle from feedlots may carry more faecal bacteria and less soil organisms thanthose from pastures. The modern trend is that excessively dirty animals should not be slaughtered untilaction has been taken to clean them. Also, strategies should be developed to reduce the number of suchanimals presented for slaughtering. From the figures quoted above, it is clear that under normal conditions, the heaviest and potentially the mostdangerous load of bacteria is in the animal's digestive tract.

Already a small volume of material from theintestinal tract can contaminate the carcass with sufficiently high numbers of "coli forms'" to cause problemsso that rupturing of the intestines or spillage of the intestinal content would cause severe contamination ofthe 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 ofworkers, processing equipment, (e.g. saws, hooks, boning tables, conveyers) and water used to washcarcasses, hands and equipment. Airborne spread of particles and aerosols will also occur in the abattoir. Allof these factors can lead to the transmission of potentially hazardous organisms and contamination ofcarcasses. To minimize 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 stationsas 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 wellunderstood but it appears to become irreversible with time – the longer organisms remain on the meat themore difficult it becomes to remove them. In poultry processing, the contact period between the meatsurface and contaminating organisms is reduced by washing carcasses at intermediate points duringprocessing before attachment occurs. The principle should not be applied to larger carcasses because toomuch wetting spreads rather than removes contamination. In fact, when small volumes of faeces,

intestinalcontents, mud or soil are spread over the carcass by rinsing, the clean areas of the carcass can becomequite heavily contaminated.

This is the reason why carcasses should not be rinsed. Wet carcasses also tendto spoil more rapidly - especially if wet and warm. Un-split carcasses should never be washed and splitcarcasses should only be partially washed under lowest pressure possible.With any delay between consumption or further processing, it is essential to cool the carcass. As far as themicrobiological 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. Withthese 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, bysplashing if cleaning is carried out in a loaded chiller and from the air, especially if the filters are not regularlycleaned.

Cutting of carcasses also involves the use of utensils and equipment that transfer micro-organisms to the cutsurfaces. 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, skinnedchicken portions).The main challenge to the meat industry in relation to hygiene is to minimize external contamination of meatwith micro-organisms during all stages of the production chain.

Food microflora and spoilage

Bacteria are everywhere, the most common ways in which bacteriaand other micro-organisms spread are in the air, by contact and viainsects and other creatures. In meat processing, the common way ofspread of micro-organisms to meat is through cross contaminationfrom dirty equipment, personal gear, hands and hides and skins,fleece and feathers or the digestive tract.
Food microbiology is important in meat hygiene for the purposes ofprotection of the consumer against food-borne microbial diseasesand the prevention of meat spoilage due to microbial activities.

Food micro-flora are basically moulds, and bacteria.
Moulds: Mouldsare multicellular, filamentous fungi that grow on foods. They have cottony appearance and may sometimes becoloured. While some are useful (e.g. in the production of cheese), others cause spoilage of food, thus making such food unfit forhuman consumption. Some in addition to spoilage produce various toxicmetabolites such as *mycotoxin* that is toxic.

Bacteria: Bacteria growth in and on foods is often extensive, this cancause food spoilage and makes food unattractive inappearance. Pigmented bacteria cause discoloration on the surfaces offoods. Films may cover the surface of foods and cause it to beslimy. Bacteria growth in liquid such as milk may result incloudiness or sedimentation.The following are the bacteria commonly associated with foodspoilage and are important in meat hygiene:
Pseudomonas, Vibrio, Escherichia, Salmonella, Enterobacter,Shigella, Klebsiella, Yersinia, Streptococcus, Staphyllococcus andLactobacilli.

Contamination of food: Food contamination is the physical presence of impuritiesand micro-organisms in food. This can lead to food poisoning, intoxication and spoilage.Food contaminating flora originates from three main sources
o Soil,
o Water
o Human –animal reservoir.

Prevention of food contamination by food microflora: Food can be prevented from contamination with microflora by:
a) Inspection of meat and other meat products beforereleasing such for human consumption
b) Keeping edible meat from offal

Food spoilage: This meansdisagreeable change in food's normal state. Such changes can be detected by smell, taste, touch or sight. Food decays or spoils are usually due to the metabolic activities of microorganismsthat are present in the food therein. The micro-organisms use the food as substrate or medium ofgrowth and sustenance.

Conditions for spoilage
• Availability of oxygen
• Moisture
• Water activity
• Temperature
• pH

Decomposition: This is the process of breaking up of organic matter of food (meat) bythe action of bacteria. Gram negative organisms that can grow at lowtemperature and low humidity (such as *Pseudomonas*) mainly causethe surface spoilage of meat, while spoilage of deep tissues is mainlydue to anaerobes (such as *Clostridia).* The organisms excretecoagulase, which hydrolyses the connective tissues leading to tissueliquefaction, gas and acid production. The acids produced are thecause of bad flavour and foul smell of spoilt meat.

The signs of decomposition include changes in colour; grey, yellow orgreen, softening of meat, production of slime and the production ofrepulsive odour.The rate of decomposition of meat is determined by the factorsaffecting bacteria growth (temp. moisture, pH). Other factors includethe type of bacteria present and its initial load, and the condition ofthe animal prior to slaughter. Delay in evisceration of the carcasses canlead to invasion of bacteria from the gut to the tissues and causespoilage of the meat. The presence of greenish hue on the kidney fat
and peritoneal is a strong indication that evisceration has beendelayed.

Bacterial food poisoning and intoxication: Bacterial food poisoning results from ingestion of food containinglarge numbers of living organisms or their toxins. There are threecategories of food poisoning bacteria:

(a) Those that grow and produce toxins in foods before they areeaten. E.g. *Staphylococcus aureus* and *Clostridium botulinum*
(b) Those that multiply in the intestinal tract and cause disease byinfection of the host. E.g. *Salmonella typhi, S. typhimurium, S.enteritidis, Shigellae*
(c) Those that apparently act through a dual mechanism. E.g.*Clostridium perfringes, Bacillus cereus, Vibrio parahaemolyticus*andenteropathogenic*E. coli.*

Some important food-borne infections
• *Staphylococcal food poisoning*
• *Botulism*
• *Vibriosis*
• *Salmonellosis*

4.0 CONCLUSION

You have learnedthatmeat hygiene is the scientific concepts and procedures applicable to theprocessing of food animals in such a way that the meat and meatproducts derived thereof are safe and wholesome for human andanimal use. The basic need for meat hygiene therefore stems from the need toproduce wholesome products that will nourish and benefit theconsumers rather than make them sick. In order for meat to be classed as fit for humanconsumption, it must be safe, wholesome and processed in ahygienic manner.The responsibility for achieving this objectivelies primarily with the relevant public health authorities who arerepresented by veterinarians and meat inspectors at the abattoirstage.

5.0 SUMMARY

In this unit, you have been taught the importance of meat hygiene. The meat under the skin of a healthy animal is sterile. The slaughtering process must beaimed at keeping the bacterial load on the newly exposed meat surface as low as possible and all effortsshould be made to prevent bacteria from being deposited on the carcass. It is necessary to ensure thatnothing that touches the exposed meat is contaminated with micro-organisms. By using the correctslaughtering techniques with this aim in mind, a high degree of sterility is indeed possible under commercialconditions.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain what you understand by the terms (a) meat that issafe, wholesome and processed in ahygienic manner and (b)Edible, inedible and condemned meat?
2. Detail what you understand by the terms microbial and chemical contamination of meat
3. Discuss the term, meat spoilage

7.0 REFERENCES/FURTHER READING

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UNIT 2 ANTE-MORTEM INSPECTION, SLAUGHTERING AND DRESSING METHODS

CONTENTS

1.0 INTRODUCTION

This unit will introduce you toante-mortem inspection methods, slaughtering and carcass dressing methods**.** The objectives of meat inspection programme are twofold; to ensure that only apparently healthy, physiologically normal animals are slaughtered for humanconsumption and that abnormal animals are separated and dealt with accordingly. It also ensures that meat from animals is free from disease, wholesome and of no risk to human health.

These objectives are achieved by ante mortem and postmortem inspection procedures and by hygienicdressing with minimum contamination. Whenever appropriate the HACCP principles is be applied. The inspection procedures should be appropriate to the spectrum andprevalence of diseases and defects present in the particular class of livestock being inspected using theprinciples of risk assessment.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- Understand the principles of ante-mortem inspection
- Know all the relevant slaughtering methods
- Know the prevailing carcass dressing methods

3.0 MAIN CONTENT

Meat inspectionis defined as “Expert supervision of the whole process of producing meat products with the object of providing wholesome meat for human consumption and preventing danger to public health”. There are 3 steps in meat inspection:

Ante-mortem inspection:This is the examination of animals prior to slaughter to assess their suitability as a source of products fit for human consumption (animals may be passed as being fit for slaughter for human consumption).

Post-mortem inspection:This is the examination of carcasses and organs after slaughter to assess whether these products are fit for human consumption.

Hygiene and sanitation inspection: This is the inspection of facilities, equipment and processes to assess whether the production system is hygienic as discussed in module 2 of this course.

Meat inspection may be performed by various groups of people including veterinarians, trained inspectors and company qualitycontrol personnel.The methods of meat inspection and the extent to which it is pursuedin different countries depend on a number of factors.

3.1 Ante-Mortem Inspection

This is the comprehensive examination of food animals destined toslaughter prior to slaughter. Ante-mortem examination of meatanimals for slaughter is very necessary in order to produce
wholesome meat and safeguard the health of the consumers.This aspect of meat inspection should be conducted in the lairagewithin 24 hours of slaughter and repeated if slaughter has beendelayed over a day.

Objectives of ante-mortem inspection

Some of the *major objectives* of ante mortem inspection are as follows:

- To screen all animals destined to slaughter.
- To ensure that animals are properly rested and that proper clinical information, which will assist in the disease diagnosis and judgement, is obtained.
- To reduce contamination on the killing floor by separating the dirty animals and condemning the diseased animals if required by regulation.
- To ensure that injured animals or those with pain and suffering receive emergency slaughter and that animals are treated humanely.
- To identify reportable animal diseases to prevent killing floor contamination.
- To identify sick animals and those treated with antibiotics, chemotherapeutic agents, insecticides and pesticides.
- To require and ensure the cleaning and disinfection of trucks used to transport livestock.

Both sides of an animal should be examined at rest and in motion. Ante-mortem examination should bedone within 24 hours of slaughter and repeated if slaughter has been delayed over a day.Spread hogs and animals affected with extensive bruising or fractures require emergency slaughter.Animals showing clinical signs of disease should be held for veterinary examination and judgement. Theyare treated as “suspects” and should be segregated from the healthy animals. The disease andmanagement history should be recorded and reported on an A/Minspection card. Other information should include:

1. Owner's name
2. The number of animals in the lot and arrival time
3. Species and sex of the animal
4. The time and date of ante mortem inspection
5. Clinical signs and body temperature if relevant
6. Reason why the animal was held
7. Signature of inspector

Ante-mortem inspectionprocedure: Routine ante-mortem inspection procedure varies in different situations but as a general rule, inspection should be carried out daily and the final examination should take place on the day of slaughter. Animals are observed for clinical signs of disease or pathological conditions. This should be carried out in adequate lighting where the animals can be observed bothcollectively and individually at rest and motion. The general behavior of animals should be observed, aswell as their nutritional status, cleanliness,

signs of diseases and abnormalities. Some of the abnormalitieswhich are checked on ante mortem examination include:

1. Abnormalities in respiration
2. Abnormalities in behavior
3. Abnormalities in gait
4. Abnormalities in posture
5. Abnormalities in structure and conformation
6. Abnormal discharges or protrusions from body openings
7. Abnormal color
8. Abnormal odor

*Abnormalities in respiration*commonly refer to frequency of respiration. If the breathing pattern is differentfrom normal the animal should be segregated as a suspect.

Abnormalities in behavior are manifested by one or more of the following signs:
The animal may be:

a. walking in circles or show an abnormal gait or posture
b. pushing its head against a wall
c. charging at various objects and acting aggressively
d. showing a dull and anxious expression in the eyes

An *abnormal gait* in an animal is associated with pain in the legs, chest or abdomen or is an indication ofnervous disease.

Abnormal posture in an animal is observed as tucked up abdomen or the animal may stand with anextended head and stretched out feet. The animal may also be laying and have its head turned along itsside. When it is unable to rise, it is often called a “downer”. Downer animals should be handled withcaution in order to prevent further suffering.

Abnormalities in structure (conformation) are manifested by:

a. swellings (abscesses) seen commonly in swine
b. enlarged joints
c. umbilical swelling (hernia or omphalophlebitis)
d. enlarged sensitive udder indicative of mastitis
e. enlarged jaw (“lumpy jaw”)
f. bloated abdomen

Some examples of *abnormal discharges* or protrusions from the body are:

a. discharges from the nose, excessive saliva from the mouth, afterbirth
b. protruding from the vulva, intestine
c. protruding from the rectum (prolapsed rectum) or uterus
d. protruding from the vagina (prolapsed uterus)
e. growths on the eye and bloody diarrhea

Abnormal color such as black areas on horses and swine, red areas on light colored skin(inflammation), dark blue areas on the skin or udder (gangrene).
An *abnormal odour*is difficult to detect on routine A/M examination. The odour of an abscess, a medicinalodour, stinkweed odour or an acetone odour of ketosis may be observed.

Principles of judgement in ante-mortem examination
a) *Fit for slaughter*. Animals which are normal and free from anyclinical signs of disease should be sent for slaughter.
b) *Unfit for slaughter*. Highly emaciated, skin bound animals andthose affected with tetanus or communicable diseases likerabies etc. or diseases which cannot be treated should bedeclared unfit for slaughter.
c) *Suspects*. All suspected animals need further attention. Someanimals with localized condition and recovered cases should bepassed for slaughter as suspect with instructions for carefulpost-mortem examination.
i. *Detained animals*. Some animals need to be detainedfor specified period of time for treatment of disease orexcretion of known toxic residues.
ii. *Emergency slaughter*. It is recommended in caseswhere the animal is in acute pain or is suffering from acondition where any delay in slaughter would becontrary to the welfare of animal. It is done under strictsupervision so that there is no hazard to the consumerhealth. Such condition could be recent injuries, recentfractures, tympany (bloat), prolapse of uterus etc.

In summary, animals with the following conditions should not be slaughtered; rabies, anthrax, black leg, tetanus, rinderpest, etc. Animals suffering from emaciation and other signs which render them suspicious of having pathological conditions are detained so that detailed post-mortem examination and bacteriology can be conducted before releasing them to the market.Crippled immature animals and those in advanced stages of pregnancy are detained.Animals found dead or in dying condition from known or unknown causes are dangerous and should not be processed for human consumption.Since many abattoirs in developing countries usually have no accommodation station or yards for animals, Inspector's ante-mortem judgement must be performed at the admission of slaughter animals.

Advantages of ante-mortem inspection

1. Probably, the most important procedure in meat hygiene. Without ante-mortem inspection, adequate inspection and rational judgement as to the fitness of food animals slaughtered for food cannot be possible.
2. Specific diseases such as rabies, tetanus, enterotoxaemia (*E. Coli*), septic metritis, listeriosis, etc in which post mortem lesions are difficult to find, if not totally absent, the clinical symptoms of this disease could be recognised readily at ante-mortem inspection.
3. Animals suffering from infectious diseases are detected in time to prevent their infection to man and animals by contaminating slaughter houses, personnel, carcasses and other animals

4. It aids in the control of animal diseases by detecting such diseases and making it possible to trace the diseases to their sources and thereby control measures as in Chronic Bovine Pleuropneumonia (CBPP).
5. Without ante-mortem inspection, obviously ill animals will be slaughtered and passed for human consumption resulting in food poisoning.

3.2 Slaughter Methods

Slaughtering means putting the food animals to death and thereafterpreparing the carcasses for human consumption. The essentials inthe slaughter of food animals are that it should not cause
unnecessary suffering to the animals and bleeding should be asefficient as possible. Besides, it should be safe for the handlers also.

Slaughter types

Home slaughter: In developing countries animals are often slaughtered at home, andthis practice is likely to continue for many years to come. Domesticslaughter of animals is however not recommended. Instead, animals should betaken for slaughter at an approved slaughter slab.The assurance of clean, wholesome meat; the elimination ofcontamination of the premises of the owner with blood or intestinalcontents and the danger of diseases spreading to animals and manare the factors in favor of using a slaughter slab. In slaughtering, ahole of about 50cm deep should be dug under the bleeding animal.Dogs must be kept away from the slaughter place.During all operations, utensils, hands and clothes should be as cleanas possible. Only the slaughterer should be allowed to touch themeat, while other people may only handle hides and intestinalcontents.

Emergency slaughter: Immediate killing may sometimes be necessary where an animal is so injured that death is inevitable. It is important therefore that such an animal is slaughtered at the earliest possible time to save the meat for human consumption.Some common causes of emergency slaughter are;

1. Fracture of limb/pelvis
2. Extensive bruising or injury e.g accidents and trampling during transit.
3. Respiratory distress e.g as seen in choke or suffocation.
4. Prolonged decumbency as seen in milk fever
5. Difficult parturition
6. Partial asphyxiation for example in pigs during transit
7. Heat stroke e.g in hot weather/ transit
8. Pregnancy toxaemia in ewes
9. Potential danger to life and property

The carcass and offal in any case of emergency slaughter should receive thorough inspection and if there is any doubt, samples should be sent for bacteriological examination.

Dry slaughtering: This occurs when all the operations such as flaying, evisceration, splittingand dispatching are done without the carcass coming into contactwith water, either

directly or through wet walls, floors or equipment. Itmust not however be understood to mean that the premises are dirtyor unwashed, on the contrary, strict pre-slaughter hygiene andthorough cleaning and washing of the premises and equipment mustbe carried out after each slaughter operation so that the nextslaughter takes place in clean, dry premises. Care must be taken thatmeat does not come in contact with intestinal contents, floors, hides and skin and unsafe water.In dry slaughtering, all operations are performed on the rail from thepoint of entry to exit. This however does not interfere with strict meatinspection.

Slaughter without previous stunning

1. Halal method
2. Jewish method
3. Decapitation

Both halal and Jewish method of slaughter employ one stroke to cut the throat, severing all together the skin, muscle, esophagus, carotid artery, jugular vein except the cervical vertebra, vertebra arteries and the spinal cord within the hollow of the vertebra column. In the halal method of slaughter, the animal is cast in such a way that it faces the east. An Imam or its representative is solely responsible for killing the animal. This is not essential in the Jewish method of slaughter in which case the animal can face any direction.

Advantages of the Jewish and halal method

1. Some people in this method render the animals unconscious immediately upon severing the carotid arteries and veins. Hence, these methods are humane.
2. Since breathing and actions of the heart are not reduced seriously, bleeding is thought to be enhanced

Disadvantages of the Jewish and halal method

1. Unconsciousness may not be immediate as thought because of the possible blood supply to the brain through vertebral arteries which remain contact.
2. Stomach contents may be regurgitated and this contaminates tissues of the neck or may be aspirated into the lung and mix with blood rendering it useless for meat consumption.
3. The preliminary operation of casting and forcing the animal head to a position for the cut are difficult, painful and objectionable from humanitarian point of view.

Decapitation: This method employs one stroke behind the neck with a sword. The method entails great strength and skill to decapitate particularly large animals such as bulls and buffaloes.
Disadvantages: A miss or mistake could result in pain and excitement from that animal.
Stomach contents may also contaminate blood and tissues.

Humane slaughter

This is also known as scientific slaughter. Such a slaughter method avoidsunnecessary pain and cruelty to food animals and ensures ascomplete bleeding as possible. It also ensures

speed of operationand safety of the personnel.Stunning is a process employed to create a state of immobility orunconsciousness at the time of slaughter, immediately, the animal ishoisted and blood vessels on the neck are severed (sticking) to bleedthe animal to death. It is important to note that in stunning the animalis not killed but only made unconscious.This requires more than the use of stunning equipment such as captive bold pestle or hammer, etc and it requires that;

a. From the moment the animal enters the lairage until the moment it is bled, it does not suffer, fatigue, excitement or breathing.
b. It does not see any dressed carcass/meat, running blood or other animals being slaughtered.
c. Ideally, death should come instantaneously without any visible preparation and while the animal is still unconscious.
d. Quiet, relaxed animals bleed more satisfactorily and the carcass set better

Stunning before slaughter

Mechanical method

a) *Stunning with the use of an axe or Maul* to smash the roof of the skull. The blow is aimed at the point of intersection of an imaginary line draw from the base of the horns to the inner corner of the eyes on both sides. If this is properly executed, the blow produces immediate unconsciousness immediately but missing the right spot causing pain and excitement.

b) *Stunning with captive bold pistle:* There are at least three types that are used but generally, this is becoming out of fashion. The bolt destroys the brain and unconsciousness is attained instantly. The shot is made at the thinnest portion of the skull. Stunning with the use of pistle discharging free bullet is dangerous through misdirected shot and jumping and rebounding bullets can also be a problem. This method is not acceptable to Jews and Muslims because of the destruction of the brain which connotes apparent death of the animal.

Electrical stunning

It is conveniently employed in stunningof small ruminants, pigs and poultry. The instrument carrieselectrodes by which alternating current is passed throughthe brain. Bleeding is very efficient and the powerconsumption is extremely low. If the current remains low,*missed shock* may occur resulting in paralysis of the animal,although it remains fully conscious. It affects the quality ofmeat besides compromising the safety of the handler. On the other hand, too high a current may cause *splash*. Itrefers to the appearance of pin pointhaemorrhagesthroughout the subcutaneous tissue in pigs. The capillariesget ruptured due to excessive increase in blood pressure.

Therefore, the requirement of efficient electric stunning includes;

1. Sufficient electric magnitude of 250mA, 75V applied for at least 10 seconds
2. The electrodes must be positioned correctly so that the current passes through the sensory centre of the brain.
3. The skin or hide should be cleaned and moist.
4. Bleeding should be done immediately after the removal of electrodes at most 5 seconds after stunning to avoid blood splashing.

NOTE: It is important that bleeding be done as soon as possible after electric stunning to minimize blood flow to tissues (extravasation) organs. Blood pressure increases rapidly during electrical stunning and unless the pressure is relieved immediately by bleeding, the rush of blood by tissues and organs causes blood and splashing especially at the muscular portion of the diaphragm.

Signs of efficient electrical stunning include
(a) hind-legsstretched out violently
(b) fore legs stiff
(c) head and neck
bent backward
(d) cessation of respiration.

Advantages of this system include the following:
(i) saves manual labor and permits speedy operation
(ii) humane because unconsciousness is immediatelyproduced and the electrode is painless on application
(iii) no mutilation of any part of the animal, hence may beacceptable by certain religions.

Disadvantages include:
(i) blood splashing may occur
(ii) needs steady electricity

Chemical stunning.
Carbon dioxide gas stunning is most suitable for pigs. Carbon dioxide is heavier than air and can be contained in a tunnel. The gas blocks the nerve endings. On exposure to gas, pigs become anaesthetized that are then shackled and bled. 65-70% of CO_2 is used to knock down the animal in chambers e.g. pigs. Unconsciousness lasts for only 1-1.5 minutes.

Advantages

a. Respiratory and circulatory centres in the brain are not affected. Hence, bleeding is efficient.
b. No blood splashing occurs because the blood pressure is not altered.
c. It is less dangerous than electrical/mechanical method

Disadvantages

a. Animals have different sensitivity to CO_2
b. It is not predictable for large animals
c. It is expensive due to high cost of installation and the method requires careful handling.

Sticking or bleeding of the animal: It is important that bleeding should be done as soon as possible after stunning so as to minimize the extravasation of blood into the organs and musculature. Blood pressure is markedly increased during the period of stunning and unless

the pressure is relieved immediately by bleeding the rush of the blood to the tissues (splashing) occurs.

Bleeding can be done by any of the two methods:
1. After hoisting on the overhead rail, carotid arteries and jugular veins of both sides are severed across the throat region, caudal to the larynx.
2. On the floor, skin is incised along the jugular furrow and carotid artery and jugular vein of one side are severed. The knife is then passed to the chest severing the anterior aorta and anterior vena cava. Sometimes, knife reaches too far in the chest puncturing the pleura and the blood may be aspirated into the thoracic cavity. This blood adheres to the parietal pleura especially the posterior edges of the ribs. This contamination of lungs is called *back bleeding or over sticking*. It requires to be washed immediately.

3.3 Carcass dressing methods

Dressing techniques and sequence of dressing operations vary fromplace to place and are very much influenced by the equipment andfacilities available in the abattoir. The present trend in organizedabattoirs is towards line dressing whereby once the animal has beenhoisted to the bleeding rail, it is not lowered to the floor till the entiredressing operation is completed. The carcass is conveyed by gravityor power driven along an overhead rail. Equipment such as brisketsaw, hock cutter, hide puller, bone cutter etc. facilitate the dressing.

The process includes the opening of the carcass, flaying,evisceration, splitting, inspection and dispatch.
1. *Flaying*: This is the removal of the hide and skin of cattle(buffalo), sheep and goat.
2. *Dehairing*: The removal of hair and bristles of pigs. This canbe done by hand or by dehairing machine. Plucking orDefeathering is the removal of feathers of poultry.
This canbe done by 2 methods
(a) Dry method whereby the feathersare plucked after destroying the nerve centre behind thebrain with a knife.
(b) Wet method: here, scalding tank withwater is heated to 1300F is used to loosen the feather andfacilitate plucking.
3. *Evisceration*: Removal of the viscera from the carcass.

Dressing of cattle

1. After stunning, the animal is hoisted by one leg to theoverhead rail. It is brought above bleeding trough or gullyand an incision is made just in front of sternum cutting themain blood vessels.
2. Bleeding is done into a specially built bleeding trough whichcarries the blood into a blood-collecting tank. Completebleeding is essential as blood is an excellent medium formultiplication of bacteria throughout the carcass.
3. A cut is made across the larynx, the esophagus is tied offand the head is skinned and detached at the atlas joint.
4. Now the forelegs (shanks) are removed.
5. The hind legs are skinned and removed while the carcass ishung by tendons on the spreader.

6. Deskinning (flaying) is carried forward from hind andforequarters and hide is now pulled with the help of a hidepuller.
7. Brisket is now opened along with the midline and the pelviccavity is opened along the abdominal cavity. Eviscerationcommences and plucks as well as viscera and removed. A careful cut releases the viscera which are separated into“thoracic viscera”: lungs, heart, liver, spleen and the pouchwhich includes stomach and intestines. The thoracic visceraare hung on hooks over the viscera inspection table or onspecial edible offal carries attached to overhead rails. This isdone without delay. The intestinal contents should not beallowed to spill over the carcass and the floor of theslaughter hall. The testicles, penis and tail should beremoved and not allowed to contaminate the carcass. Themammary gland should also be removed without it beingpunctured.
8. Now the carcass is sawn into two halves along the vertebralcolumn.
9. Spray washing of the carcass. The carcass is then inspectedand from the inspection line the carcass is transferred to thechilling room.

Dressing of sheep and goat

1. Every effort should be made to ensure that dirt is not carriedon the hair/wool into the slaughter place.
2. After stunning, the animal is hoisted to overhead rail and anincision is given in the jugular furrow near the head severingboth carotid arteries.
3. The forelegs are knuckled and a cut is made to the front, theforelegs are removed at knee.
4. The neck and cheeks are skinned along with the shoulder.The throat is opened up and esophagus is tied.
5. The hind legs are knuckled and a cut is made to the root ofthe tail. The legs are skinned.
6. The skin is incised in the middle of the bell and skinningproceeds towards the flank. Now skin is pulled down overthe backbone and base of the head.
7. The head and hind legs are removed. Treatment and the useof the head depend on different customs in variouscountries.
8. A small cut in the abdomen is extended to the brisket andthe breast bone is also split.
9. The pluck and viscera are removed. Kidney and its fat areleft in the carcass. Under conditions where a sheep/goatgantry hoist does not exist, all processes should be carriedout on a skinning cradle.
10. Spray washing of the carcass is done followed by transferto the chilling room.

Dressing of pig

1. Sticking (Killing). After stunning, the pig is hoisted to theoverhead rail. An incision of 5 to 10cm is made at the mid -point of neck facing breast bone. The knife is inserted in thisincision at an angle of 450 and is forced down and back atleast 12 – 15 cm to a point below the front of the breastbone. The knife is given a slight twist before it is withdrawn.Care should be taken not to insert the knife into the chest
cavity.
2. Bleeding.
3. Scalding; the animal is dropped in the scalding tankmaintained at a temperature of 60 - 620C for about 6 minutes.

4. Scrapping or Dehairing. Raise the animals on the overheadrail and pull off the dew claws and toes while hot. Scrap theloosened hair with the help of a hog scrapper or dull knife hindquarter downwards. Then rinse the carcass with warmwater.
5. Singeing. It is done with the help of a blow lamp in which ahigh temperature is achieved and all the remaining hair isburnt. Besides, singeing sterilizes the cuticle and firms uprind giving it a better appearance and keeping quality.
6. Removal of head. Done at atlas joint before the carcass isopened.
7. Evisceration. Viscera is removed and examined.
8. Splitting of the carcass
9. Final inspection of head and carcass.
10. Spray washing of carcass and transfer to the chillingroom.

4.0 CONCLUSION

You have learnedthatante-mortem examination of meat animals is of prime importancefrom public health point of view. It is the initial step in detection ofany sign of disease, distress, injury etc. which helps in takingappropriate decision before slaughter of animal. It should be done properly and systematically by veterinarians, which will in turn help inmaintaining high standards of meat quality.Therefore, domesticslaughter of animals as practiced in many developing countries is however not recommended.

5.0 SUMMARY

In this unit, you have been taught that the objectives of meat hygiene are achieved by ante mortem and postmortem inspection procedures and by hygienicdressing with minimum contamination.Ante-mortem examination of meatanimals for slaughter is very necessary in order to producewholesome meat and safeguard the health of the consumers.Humane slaughter alsoknown as scientific slaughtermethod has become the ideal since it avoidsunnecessary pain and cruelty to food animals and ensures ascomplete bleeding as possible, while also ensuring speed of operationand safety of the personnel. While dressing techniquesvary fromplace to place and are very much influenced by the equipment andfacilities available in the abattoir, the present trend in organizedabattoirs is towards line dressing whereby once the animal has beenhoisted to the bleeding rail, it is not lowered to the floor till the entiredressing operation is completed.

6.0 TUTOR-MARKED ASSIGNMENT

1. Define the three steps in meat inspection. What are the objectives of ante-mortem inspection?
2. Discuss the different slaughter methods
3. Discuss carcass dressing method as it applies to cattle

7.0 REFERENCES/FURTHER READING

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UNIT 3 POST MORTEM INSPECTION METHODS AND PROCEDURES

CONTENTS

1.0 INTRODUCTION

This unit on post mortem inspection methods and procedureswill introduce you to the definitions of important terms in the subject area, generalizedcarcass conditions and detailed post morteminspection procedures as well as post abattoir meat and products handling practices. Routine postmortem examination of a carcass should be carried out as soon as possible after the completion of dressing in order to detect any abnormalities, so that products only conditionally fit for humanconsumption are not passed as food. All organs and carcass portions should be kept together andcorrelated for inspection before they are removed from the slaughter floor.

2.0 OBJECTIVES

By the end of this unit, you will be able to:

- Define the important terms and generalized carcass conditions
- Understand theprocedures for detailed carcassinspection
- Understand the important post abattoir meat and products handling practices

3.0 MAIN CONTENT

3.1 Definitions and Generalized Carcass Conditions

Definitions

Post mortem inspection is the examination of carcasses and organsafter slaughter to assess whether these products are fit for humanconsumption.

Edible products are products that are fit for human consumption. Thiswould include meat, certain offal, casing etc. from animals whichhave been examined and passed by an inspector.

Inedible products are meat products which are not fit for humanconsumption and would include such products as horn, hair, bone,bristle, blood.

Condemned meat is meat and meat products which have been foundby an instructor not to be fit for human consumption. All diseased anddefective carcasses or part of carcasses will be declared condemnedmaterial by the inspector and severely contaminated products mayalso be included in this category.

Post mortem inspection should provide necessary information for thescientific evaluation of pathological lesions pertinent to thewholesomeness of meat.Professional and technical knowledge must be fully utilized by:

1. Viewing, incision, palpation and olfaction techniques.
2. Classifying the lesions into one of two major categories – acuteor chronic
3. Establishing whether the condition is localized or generalized,and the extent of systemic changes in other organs or tissues.
4. Determining the significance of primary and systemicpathological lesions and their relevance to major organs andsystems, particularly the liver, kidney, heart, spleen andlymphatic system.
5. Coordinating all the components of ante mortem and postmortem findings to make a final diagnosis.
6. Submitting the samples to the laboratory for diagnostic support,if abattoir has holding and refrigeration facilities for carcassesunder detention.

Generalized carcassconditions

Carcass judgement:Trimming or condemnation may involve:

1. Any portion of a carcass or a carcass that is abnormal or diseased.
2. Any portion of a carcass or a carcass affected with a condition that may present a hazard to human health.
3. Any portion of a carcass or a carcass that may be repulsive to the consumer.

Localized versus generalized conditions:It is important to differentiate between a localized or a generalized condition in the judgement of an animalcarcass. In a localizedcondition, a lesion is restricted by the animal defense mechanisms to a certain areaor organ. Systemic changes associated with a localized condition may also occur. Example: jaundicecaused by liver infection or toxaemia following pyometra (abscess in the uterus).

In a generalizedcondition, the animal's defense mechanisms are unable to stop the spread of the diseaseprocess by way of the circulatory or lymphatic systems. The lymph nodes of the carcass should beexamined if pathological lesions are generalized. Some of the signs of a generalized disease are:

1. Generalized inflammation of lymph nodes including the lymph nodes of the head, viscera and/or thelymph nodes of the carcass
2. Inflammation of joints
3. Lesions in different organs including liver, spleen kidneys and heart
4. The presence of multiple abscesses in different portions of the carcass including the spine of

ruminants

Generalized lesions usually require more severe judgement than localized lesions.

Acute versus chronic conditions

Acute conditions: An acute condition implies that a lesion has developed over a period of some days, whereas a chroniccondition implies the development of lesions over a period of some weeks, months or years. A subacutecondition refers to a time period between an acute and chronic condition.The acute stage is manifested by inflammation of different organs or tissues, enlarged haemorrhagiclymph nodes and often by pin pointhaemorrhage of the mucosal and serous membranes and differentorgans such as heart, kidney and liver. An acute stage parallels with the generalized disease complex,when an acute infection tends to overcome the animal's immune system and becomes generalized.Each case showing systemic lesions should be assessed individually taking into account the significancethat these lesions have towards major organ systems, especially the liver, kidneys, heart, spleen andlymphatic system as well as the general condition of the carcass.

Chronic conditions: In a chronic condition, inflammation associated with congestion is replaced by adhesions, necrotic andfibrotic tissue or abscesses. The judgement in the chronic stage is less severe and frequently the removalof affected portions is required without the condemnation of the carcass. However, judgement on theanimal or carcass judgement tends to be more complicated in sub-chronic and sometimes in per-acutestages. If generalized necrotic tissue is associated with previous infection, carcass must be condemned.

3.2 DetailedPost Mortem Inspection Procedures

The primary procedures of post-mortem inspection of carcasses and organs can be classified into;

a. Viewing the carcass and organ
b. Palpating
c. Incise into the carcass and organs

Inspection of heads

After the heads have been stunned and washed and the base of it has been detached, the inspector should;

a. View the head, oral and nasal cavities, muzzle, lips, gums and teeth for lesions such as ulcers, vesicle, erosion of foot and Mouth Disease, rinderpest, vesicular exanthema (pigs), etc
b. View, palpate and incise the thumb without mutilating the blade for lesions of *Cysticercus bovis*(cattle), *Cysticercus cellulose* (Pig), Actinobacillosis caused by *Actinobacillusspp* and blue tongue. Mutilation of blade reduces the market value.
c. Examine in detail by first viewing, palpating and incising the parotid, retropharyngeal and sub-maxillary lymph node for evidence of congestion, caseation (in T.B) and calcification.
d. View and incise the muscle of mastication by making 1 or 2 incision parallel to the jaw on the external masseter and 1 incision only on the internal muscle for evidence of cysticercus.
e. Remove the tonsil as it may harbour pathogenic bacteria and debris.

Inspection of the visceral organs

1. View the stomach, intestine and palpate. if necessary, incise the mesenteric lymph node for evidence of tuberculosis. Observe for pimply gut.
2. View, palpate and incise if necessary the spleen for hydatid cyst
3. View the entire liver, palpate the parietal surface to detect cyst and abscesses. Incise the hepatic lymph node, open up the bile duct and liver tissues for *Fasciola spp.*
4. View and palpate with both hands the lungs for CBPP. Incise the epical, mediasternal and bronchial lymph nodes
5. View the organ, make 1 or 2 incision from the apex to the base of the heart. Inspect the epicardium for haemorrhages. Examine the ventricles for endocarditis and cysticercus cyst
6. Evidence of coronary fat for evidence of emaciation
7. Kidney; view, enucleate (pumping out from the capsule), palpate and incise the hydatid cyst.

Inspection of the carcass

a. View the carcass for evidence of bruising, bleeding efficiency and other injuries as well as the nutritional status and conformation
b. Inspect the thoracic and abdominal cavity for evidence of inflammation, abscesses or tuberculosis lesions.
c. Incise the iliac, prescapular, prefemoral, superficial inguinal or supramammarylymphnode as a routine (Note: Cows have no superficial inguinal lymph node but supramammary lymph node)
d. Examine the cut surfaces of bones for evidence of tuberculosis

Judgement: This is the most difficult part of meat inspection. It is easy to reject meat but not easy to know what to pass for human consumption. This is because diseases vary in their severity, extent and spread within the animal body. Acute stages of diseases are always associated with inflammation because the disease is active and progressive but the disease may also be mild or chronic. So, all the stages are encountered in meat inspection i.e from very slight to very severe with all the possible graduates between them.

The meat inspection regulation lists certain diseases and conditions which render the whole carcass and offal unfit for human consumption. In the case of Anthrax, there is obviously no room for doubt but we may have grazing which may be extensive and severe. The question is "What is extensive?" and "what is severe?". As "extensive and severe" cannot be stated precisely, i words, in judgment becomes very important. The same applies to liver. There may be a single, very small encapsulated abscess in the liver which has not spread to other parts. An experienced meat inspector may trim and reject the affected portion. However, there may be multiple abscesses or very large ones affecting the whole liver. In this case, the entire liver is rejected but between these two extremes (single and multiple abscesses), there can be all sizes, numbers, types, activities of abscesses. The question arises "How much to pass or reject". Judgement can only be learnt by a complete knowledge of all the factors involved and by practical experience.

Actions and judgement

A. *Immaturity:* This is usually encountered in veal carcasses. The flesh looks water soaked, loose, flabby and tears easily and can be perforated with the finger. The tissues around the kidney are jelly-like and there is complete lack of muscular development. The muscles and fats are in poor stage of development and therefore lack the essential requirement of meat.

Judgement:

a. Immature carcasses are unfit for human consumption and therefore must be totally condemned
b. It may be a good avenue for spread of certain infections e.g salmonella

B. *Emaciation:* This is the severe loss of flesh due to disease in food animals especially in sheep. It is always due to chronic infection or parasitic infections of the intestine or lungs. In cattle, this may be due to tuberculosis or Joanne's disease. It is characterized by atrophy and flabby musculature, loss of intramuscular and internal fats which become jelly-like. There is also reduction in the sizes of the organs.

Judgement: The fat of emaciated carcasses is Jelly-like and in some feed for food and are therefore totally condemned.

C. *Pimply gut (caused by Oesophagostomumspp):* This is a greyish white nodule on the walls of the small intestine.

*Judgement:*Remove the nodules if filled and partially condemn the intestine.

D. *Milk spot of pig liver:*this is due to migration of ascarid larvae

Judgement: If filled, trim off but if accompanied with emaciation, condemn.

E. *Cysticercus cellulose:* This is the intermediate stage of *Taeniasolium* of man. The predilection site includes masseter muscle, biceps and triceps muscle, gluteal, intercostal, diaphragm, heart, tongue, neck, shoulder and the flank muscle. The cyst may be observed at ante-mortem inspection on the tongue in pigs.

*Judgement:*Total condemnation because it is dangerous to man.

F. *Cysticercus bovis:* This is an intermediate stage of *Taeniasaginata* formed in the predilection site above.

Judgement: If generalised, total condemnation. If few cysts are found in one part only, partially condemn the affected part. if many cysts are in one part, condemn the part and freeze the rest of the carcass at 21F in 20 days or 15F for 10days.

F= 32 + (C C= (F-32)

Alternatively, you can CAN the milk (CANNING). Cyst may degenerate and become calcified.

G. *Calcified cysticercus bovis of a bovine heart*: Examine and incise the masseter muscle and the tongue. Open the ventricles of the heart and incise the interventricular muscle. Examine the diaphragm and intercostal muscle.

Judgement: If no cyst elsewhere, trim and pass the heart for consumption. If only one cyst is found on the carcass, trim and pass the carcass. If 2 or more cysts are found on the carcass, trim and freeze the carcass at a temperature

Note: cysts in heart muscle degenerate faster while those in the jaw muscles live longer.This therefore serves as an indication that if jaw cysts are found dead, it is likely that those in the heart are non-permeable. To test for viability of cyst, place cyst in normal saline and add few drops of pig bile at body temperature or in unhemolysed bovine serum with 10% bile. The cyst will evaginate within.

H. *Echnicoccusgranulosus (hydatid cyst):* It is a small tapeworm of dogs. Intermediate stage is called hydatid cyst which is found in the liver, lungs, sometimes in kidney of goat, sheep, dog, cattle, camel, pigs and horses. The cyst varying size and have double walls and may contain many scolexes. The public health risk is for human consuming the tape worm segments from dog.

*Judgement:*Condemn affected organs and make sure they are properly disposed. There should be no dog around slaughter house and dog should be treated regularly.

I. *Tuberculosis:* The entire carcass is condemned if there is tuberculosis with emaciation, if there is milliary tuberculosis of both lungs and tuberculosis lesions elsewhere.

*Judgement:*Split the carcass and examine the vertebrae, sternum, spinal cord and all the lymphnodes. Observe the body conformation and also, examine the activity of the body and the extent of the disease, then and only, can total condemnation be recommended.

J. *Icterus carcass:* This is generally caused by blood parasites

Action:Keep the carcass in cold room for at least 44 hours and examine at the end of the period to confirm Icterus. You may also confirm with boiling point.

*Judgement:*If icterus is confirmed, recommend total condemnation. If negative, release the carcass for consumption.

K. *Bovine Fetus (7 month old):* No examination is required but the fetus may be skinned and the skin used for leather industries in making shoes, etc

L. *Foot and Mouth Disease:* It is a notifying disease.

Judgement: If the lesions are seen on the tongue and lips, head and nose, condemn these parts. If foot and mouth disease is accompanied with emaciation, recommend total condemnation.

M. *Anthrax:* In the lairage, if the cattle is alive, separate it from other animals and dispose of it by burying. Check the temperature of the animals in contact with the infected animal. If the temperature is normal, slaughter the animal immediately but if the temperature is high, take blood smear and if positive for anthrax, condemn totally.If negative, isolate and treat. Disinfect the lairage properly with strong disinfectant.If anthrax is found in the main slaughter hall, stop killing immediately and detain all carcasses which may have been splashed even though the butcher may have started dressing or processing.

*Judgement:*Remove and destroy carcass. All splashed carcass must also be destroyed. Spray the hall with a disinfectant e.g 5% phenol. Clean with hot 4% solution of washing soda.Apply more disinfectant and shut the slaughter house for up to a week.If anthrax is found in dressed carcass, there would be dark coloured blood which does not clot. The carcass is red like fire. The spleen is grossly enlarged, petechial haemorrhages on the serosal surfaces.

*Judgement:*Total condemnation.

Men and Equipment; Sterilize all equipment such as cloth, leather belts, ropes can be destroyed by boiling.Finally, all exposed workers should be sent to the hospital.

N.*Septicaemia:*

Judgement: Total condemnation

3.3 Post Abattoir Meat and Products HandlingPractices

Transportation of meat from the slaughter place to the butchers'shop

The aim of hygienic procurement, slaughter and dressing is to ensurethat inspected meat derived from healthy, properly slaughteredanimals reaches the consumer clean, unspoiled and in a wholesomestate, free from danger of infection or intoxication.Great care should be exercised in the method used for transportingmeat from the place of slaughter to the place of sale. Unhygienictransport, exposing the meat to heat, dust and bacterialcontamination can nullify all the measures taken at the most hygienicslaughter facility and properly constructed and operated butcher'sshop. Where the output is large, special meat-carrying vehiclesinsulated, metal lined and if possible, equipped with hooks forhanging the meat is recommended. Care should be taken to ensurethat carcass meat is not mixed with tripe or other offal.

Fig. 26: Inspected meat transportation in Owerri, southeast Nigeria. What do you think is wrong with this method of meat transportation?(Source, Students of the Department of Animal Science and Technology, FUTO)

Refrigeration of carcasses

The carcasses with identification numbers after complete washingand inspection are brought to the chilling room where they are keptfor about 24hrs to bring the pH below 6. The carcasses should be asdry as possible. The aim of chilling is to retard the bacterial growthduring the post-mortem changes to extend the shelf-life of the meat.The temperature of the chilling room should be between 2^{o}C and 4^{o}C.The chilling room should always be kept clean and the carcasseshung on the rails. The chillers should not be overloaded and spacesshould be left between carcasses for the cold air to circulate,otherwise cooling will be insufficient and carcass surface will remainwet for rapid bacterial growth.

Meat Preservation

- The basis for meat preservation is to prevent the meat from microbial attack and prolong the storage life of the meat.
- Basically, preservation methods are designed to make conditions unfavourable for these organisms to grow.
- This is achieved by extreme heat or cold, deprivation of water and oxygen, excess of saltiness and increased acidity of the substrate.
- The methods are based on these principles include;

o dehydration,
o salt curing,
o chemicals,
o irradiation,
o chilling and freezing
o heat processing

Physical changes in stored meat

Meat undergoes the following superficial changes as a result ofstorage;

i. *Shrinkage:*Shrinkage means loss of weight as a result ofevaporation of water from meat surface.

*ii. Swelling:*This means condensation of water vapour onmeat brought from a cold store into ordinary roomtemperature.

*iii. Loss of bloom:*Bloom is defined as colour, texture andgeneral appearance of carcass surface. This is caused byexcessive intake of water, dehydration or undue oxidation.

Methods of meat preservation

Dehydration: This is an old method of food preservation which is still popular inNigeria today. To achieve best results, meat should be pre-cooked attemperatures below 70^{o}C. Low fat meats dry more rapidly and theyare more easily rehydrated. Dehydration does not affect the grosschemical composition of meat. However, dehydrated meat reabsorbswater only to about 60% of the original moisture content. Some of thedisadvantages of drying include:

1. Flavor loss due to conversion of water soluble compounds toinsoluble compounds
2. Loss of some nutritive components especially thiamine andpantothenic acid which are components of the Vitamin Bcomplex

Salt curing: This is a method of preserving meat with the use of brine solution.Brine solution contains the following:
Water 4.50 Litres
Salt 1.02 kg
NaNO3 or KNO3 21.25g
Sugar (optional) 56.75g
The action of salt curing on meat can be preservative orbacteriostatic.
a) Preservative action
b) Bacteriostatic action

Smoking: Smoke is produced as a result of anaerobic distillation of woodfollowed by partial oxidation. If the oxidation is complete, there will beproduction of water and oxygen and not smoke, since wood's maincomponents are cellulose (50%), hemicellulose (25%) and lignin(25%) which all contains carbon, oxygen and hydrogen.Smoke contains well over 200 compounds of which are aldehyde,phenols, acetate and resins. These compounds prevent oxidativeactivities, provide flavour for the meat and have germicidal effect.Smoking is the process of allowing smoke produced from naturalwood, twigs, heather or the fruits of trees to act on the surface ofmeat and meat products. During smoking the smoke is transferred tothe product through the process of absorption, adhesion,condensation, diffusion, dissolution and deposition.

There are many methods of producing smoke which include;smouldering of wood, by friction, steam, gas pyrolysis, vibratoryfeeder and liquid smoke production.
Action of smoke on texture, flavour and colour of meat;
Texture: The effect of smoke on texture meat depends on the relativehumidity and the smoke temperature. At relative humidity of 65 –70%, the surface of the meat will be dry. During smoking, astemperature increases from 49^{o}C to 82^{o}C, the meat proteincoagulates and the meat is toughened.
Color: The surface colour of well-smoked meat is light golden yellowto dark brown shades. The colour varies with the type of wood burnt,the density of smoke and the temperature of the smoke.
Flavor: The smoky taste in smoked meat product is as a result of thephenolic fraction of smoke. The type of wood can also affect theflavor; for example, soft woods give acrid flavors.

Chemical preservatives:
Antibiotics: these have been used to preserve and improve thekeeping quality of beef carcasses, poultry and fish. These antibioticsare added to water in a proportion of 5 to 40ppm and the meat isdropped into the treated water. Alternatively, the antibiotic is added toice in

amounts of 2 – 5ppm and the fish (or meat) is transported in thetreated ice. The storage life of such treated meat, poultry and fish isconsiderably increased.

Disadvantages of this method include;
1. Antibiotics are not effective against yeasts and molds
2. These antibiotics may occur as residues in the meat whichwhen consumed may be hazardous to the health of theconsuming populace.
3. The widespread use of antibiotics in food encourages theappearance of antibiotic-resistant strains among pathogenicbacteria present.
4. There is the danger that producers may tend to depend moreon drugs than good hygienic practices.

Cold storage
*Chilling:*Chilling involves refrigerating meat to temperature just above freezingpoint. This temperature must be maintained throughout the meat untilit is delivered to the consumer. Meat will not keep for a long timeunless it is proper chilled. In chilling, care should be taken to preventmeat from being frozen as meat upon thawing developscharacteristics which are considered not so desirable than thosepossessed by chilling. Quick chilling of carcasses is necessary in orderto prevent the growth of spoilage organisms. This process isachieved by rapid circulation of air at low temperature (1 to 2^oC or aslow as -7^oC) and controlled humidity. Chilling of some of the thickermuscles is sometimes accelerated by the injection of liquid carbondioxide into the muscle.

*Freezing:*Meat has no definite freezing point because of its complex structure.Freezing meat at very low temperature, the quality of the meat isretained better.In freezing meat, the internal temperature of the meat should bereduced to -18^oC. To store already frozen meat, the air temperaturemust be equal to or less than -14^oC and this will keep the meat for9months and above. Pork should be stored at -18oC and will keepwell for 6months. There should be proper spacing of boxed meat ormeat products as they are placed in the freezer between layer boxes and between boxes in the individual layers.To transport frozen meat and prevent thawing during transportation,the vehicle and cargo space should be capable of a maximum airtemperature of -10^oC.

Food irradiation:Food irradiation is a physical means of food treatment by exposingfood either pre-packed or bulk to gamma rays, x-rays or electrons, ina special room and for a specific duration of time to achieve a desiredaim.Technically, gamma rays can be produced from radioisotope sourcese.g. 60Colbat or 37Cesium. Foods treated with ionizing radiation aresafe for human consumption. It has been shown that it is not possibleto activate or induce radioactivity in any food material passed throughirradiator regardless of the length of time of radiation exposure, hencetoxicological testing of foods so treated is no longer required.

Gammarays kill micro-organisms in meat without a significant rise in thetemperature of the product. However, the resultant chemical changesin the irradiated product have been found to change the aroma andodour of such product.

Utilization of animal by-products

Animal by-products refer to the parts of the food animal not used forfood by man. In liberal terms, animal by-products include every partof a slaughtered animal except the dressed carcass.

A. Classification of animal by-products

Animal by-products can be classified as follows:

(i) Edible by-products.

(ii) Inedible by-products.

This classification is not rigid the basic criterion of division betweenedible and inedible by-products is governed by a number of factorssuch as;

• Purchasing power of the consumer,

• The custom and traditions of the people,

• The food habits, religious belief etc.

By-products can also be classified according to ultimate use asfollows:

a) Agricultural by-products: meat meal, bone meal andfertilizer

b) Industrial by-products: gelatine, glue and casings

c) Pharmaceutical by-products: insulin, pepsin, biochemicalsand hormones

B. Classification according to origin (Table 4)

• *principal by-products*,

• *secondary by-products*

Utilization of hides and skin: Hides and skins are one of the most important by-products of theanimals, and serve as raw materials for leather industries. Hides andskins can be classified into:

(a) Those which are processed with the external covering (fur andwool) intact processed for use as articles of clothing. These are gotmainly from animals living in the wild e.g. Fox, milk etc.

(b) Those from which the external covering is removed beforeprocessing into leather. These are got from ox, sheep, goats, pigs,horses and aquatic animals like seal.

Processing of hides and skin;

• *Flaying and Trimming*

• *Preservation*

• *Hide Curing*

• *Tanning of Hides and Skin*

Table 3: Principal and secondary animal by-products

Item No.	Principal by-product	Secondary by-products and Uses
1.	Hides and skin	Leather products such as shoes, gloves, belts, bags etc
2.	Hair, bristles and wool	Brush, fabrics and yarn, blanket, carpet, pillow, lanolin and fertilizer
3.	Blood	Blood pudding, sausage mix, serum and plasma, albumen, fibrin, haemoglobin, glue, textile, coagulated blood products, dye setting, stock feed, fertilizer, liquid blood products
4.	Bones	Bone meal, fat, gelatine, glue, mineral supplement, buttons, cutlery handles and bone articles, osteocalcium tablets from bones
5.	Hoof and horns	Buttons, combs, hair pins, toys, hoof and horn meal, fertilizer, pith used for gelatine and glue etc.
6.	Intestines	Casings, catgut (suturing material), tennis strips, musical instrument strings, tallow etc.
7.	Condemned meat, inedible offal and trimmings	Tallow for soap, machine oil, leather dressing, candles, meat and bone meal
8.	Glands and tissues	Gall bladder – Bile salts Liver – liver extract Lungs – heparin, peptone Pineal gland – melatonin hormone Pituitary gland – Anterior (GH, LH, FSH, prolactin) and post-pituitary lobe hormone (oxytocin, vasopressin) Thyroid gland – Thyroxine Stomach – pepsin, rennin, heparin Parathyroid – parathormone Suprarenal gland – cortex and medullary hormones Trypsin – insulin, pancreatin, glucagons Testes – testosterone, hyaluronidase
9.	Ruminal and intestinal ingesta	Recycling as stock feed, compost manure, production of methane for light, heat and power

Source:OOKehinde.VCH 501, Meat, milk and fish hygiene, Faculty of Veterinary Medicine, University of Agriculture, Abeokuta, Nigeria.

Utilization of blood: Animal blood is used in several ways and its collection method also depends on the specific end use. Some of the uses of blood are asfollows:

1. Industrial
2. Livestock feed
3. Fertilizer
4. Biochemical and Pharmaceuticals
5. Laboratory and Bacteriological Media – blood agar, tissueculture media, albumin and globulin, sphingomyelin, catalase.

Utilization of horn and hoof

- raw material for the production of gelatin
- bone meal production.
- used for the manufacture of buttons, comb and decorativepieces.

• fertilizer

Utilization of organic waste: Wastes from the animal include dung, droppings, urine etc. These
can be subjected to rendering processes and utilized as productssuch as biogas and compost manure.

Utilization of intestines
• food containers such as casings.
• production of surgical ligatures (catgut),
• production of strings for tennis rackets and musical instrumentsetc.

Utilization of bones
• Bones can be processed as a source of gelatin and glue;
• Bone meal and fertilizer

4.0 CONCLUSION

You have learnedthatpost mortem inspection is the examination of carcasses and organsafter slaughter to assess whether these products are fit for human consumption and that the exercise should provide necessary information for thescientific evaluation of pathological lesions pertinent to thewholesomeness of meat. It is usually not easy for the meat inspector to decide whether to reject meat or pass it for human consumption because diseases vary in their severity, extent and spread within the animal body.The meat inspection regulation lists certain diseases and conditions which render the whole carcass and offal unfit for human consumption.Finally, the aim of hygienic procurement, slaughter and dressing is to ensurethat inspected meat derived from healthy, properly slaughteredanimals reaches the consumer clean, unspoiled and in a wholesomestate, free from danger of infection or intoxication.

5.0 SUMMARY

In this unit, you have been taughtthat the primary procedures of post-mortem inspection of carcasses and organs can be classified into viewing the carcass and organ, palpating and incisions into the carcass and organs. The organs inspected include, the head, visceral organs, carcass and other parts. The judgement on to “pass or reject” any part of the meat can only be learnt by a complete knowledge of all the factors involved and by practical experience.After passing the meat for consumption, great care should be exercised in the method used for transportingmeat from the place of slaughter to the place of sale. This is because unhygienictransport, exposing the meat to heat, dust and bacterialcontamination can nullify all the measures taken at the most hygienicslaughter facility and properly constructed and operated butcher’sshop. Different methods such as dehydration, salt curing, smoking, chemical preservation, cold storage and irradiation are used to extent the shelf life and prevent the spoilage of meat.

6.0 TUTOR-MARKED ASSIGNMENT

1. Discuss your action and judgements on major disease conditions encountered during post mortem inspection
2. Describe the different methods of meat preservation
3. Describe the primary and secondary by-products of meat processing and their uses

7.0 REFERENCES/FURTHER READING

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