COURSE CODE:	VCH 501
COURSE TITLE:	MEAT, MILK AND FISH HYGIENE
NUMBER OF UNITS:	2 Units
COURSE DURATION:	Two hours per week

COURSE DETAILS:

Course Coordinator:	**Dr. O. O. Kehinde** DVM, MVPH
Email:	ookehinde@yahoo.com
Office Location:	COLVET, UNAAB
Other Lecturers:	**Prof. M.A. Dipeolu** DVM, MVPH, PhD; **Dr.O.O. Adebowale** DVM, MVPH; **Dr. O.J. Awoyomi** DVM, MVPM

COURSE CONTENT:

Importance of Meat, Milk and Fish Hygiene

Ante-mortem Inspection of Food Animal

Slaughtering and Handling of Meat

Post-mortem Inspection of Food Animals

Ante-mortem and Post-mortem Inspection of Poultry

Fish Hygiene

Basic Principles for the Construction of a Functional Abattoir

Utilization of Animal by-products

Disposal and Treatment of Abattoir Effluents

Milk Hygiene

Food Microflora and Spoilage

Methods of Meat Preservation

Detection of Drug and Chemical Residues in Meat

Safety Issues in Meat and Milk Production

COURSE REQUIREMENTS:

This is a compulsory course for all 500 level students in the college of Veterinary Medicine. In view of this, students are expected to participate in all course activities and have minimum of 70% attendance to be able to write the final examination.

READING LIST:

Alonge, D. O. (2005). Meat and Milk Hygiene . Farmcoe, Nigeria. 218pp

Bunic S. (2006). Integrated Food Safety and Veterinary Public Health. CAB International, USA. 386pp

Vijender Singh (2007). Universal Meat Hygiene in Public Health Care. International Book Distributing Co. New Delhi. 320pp.

LECTURE NOTES

IMPORTANCE OF MEAT, MILK AND FISH HYGIENE

Definition of Meat Hygiene Terms

Public Health

This is the total practice of human community medicine resulting in extending life expectancy and delaying the inevitability of death through the promotion of healthful conditions and habits; the prevention of illnesses and the co-ordination of community approaches to medical care.

Veterinary Public Health

Veterinary Public Health is a component of Public Health devoted to the application of Veterinary skills, knowledge and resources to the protection and improvement of human health. It includes:

i. The Zoonoses. These deal with diseases that can be transmitted from animals to man and from man to animals. It includes surveillance, prevention and control of such diseases.

ii. Hygiene of food of animal origin. This involves the safe processing and handling of foods of animal origin in manners fit for human consumption and these include meat, milk, eggs and fish products.

iii. Environmental hazards and protection. Including waste disposal and management and pest control.

iv. Occupational hazards, trauma, allergies and control of animal 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 purpose safeguarding the health of the consuming populace.

Meat Hygiene

This is the scientific concepts and procedures applicable to the processing of food animals in such a way that the meat and meat products derived thereof are safe and wholesome for human and animal use.

General Principles of Food Hygiene

Food Hygiene is the efforts made to safeguard food from becoming health hazard and to prevent early spoilage and contamination caused by handling of the foods. It is the procedures applicable to the processing of food in such a way that the products derived thereof are safe and wholesome for human use. The general principle of food hygiene is to ensure that food products are safe, wholesome and fit for human consumption.

Fit for Human Consumption: Food which has been passed and appropriately branded by an inspector and in which no subsequent changes have been found due to disease, decomposition or contamination.

It is important to note that there are three key elements in the above definition. In order for food to be classed as fit for human consumption, it must be safe, wholesome and processed in a hygienic manner.

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

b) Wholesome: Food products must be free from defects which may be either endogenous diseases or exogenous non-microbial contamination and adulterations.

Whereas the primary aim in a safe food product is to exclude harmful microbes from the food chain, wholesomeness is much broader in that it implies that the food products must be generally free from both microbial organisms, non-microbial contaminants and even religiously and aesthetically acceptable to the consumer.

The criteria governing the wholesomeness of food products can be grouped as follows:

i) Such food products must be free from obvious defects including contamination with seemingly harmless extraneous materials.

ii) Microbial contamination of such food products must not exceed levels which could adversely affect the shelf-life of the products. The effect of microbial contamination on the keeping quality of food will depend on the type of products and the storage methods.

iii) The attributes of such food products must conform to expected standards such as colour, taste and smell.

c) Hygienic processing: Food products processed in the manner to ensure compliance with the above requirements and to protect those involved in the process from occupational hazards such as tuberculosis, brucellosis, salmonellosis, leptospirosis among others.

Hygienic processing also implies that a production system is in place which does not create environmental hazards to the public.

There are a number of other terms used in meat hygiene and many of these are defined in the legislation:

Edible products are defined as products that are fit for human consumption. 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 for human 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 have been found be an inspector not to be fit for human consumption”. All diseased and defective carcases or part of carcasses will be declared condemned material by the inspector and severely contaminated products 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 meat for human consumption. The responsibility for achieving this objective lies primarily with the relevant public health authorities who are represented by veterinarians and meat inspectors at the abattoir stage.

The Objectives of meat inspection programme can be broadly classified into two:

i) To ensure that only apparently healthy, physiologically normal animals are slaughtered for human consumption and that abnormal animals are separated and dealt with accordingly.

ii) To ensure that meat from animals is free from disease, wholesome and of no risk to human health

Specifically, the purposes include:

i) To prevent unsanitary meat (i.e. self-dead animals, diseased meat, foetus etc.) from being released for human consumption.

ii) To prevent post-mortem contamination of meat through unhygienic dressing of carcass, contamination during washing with polluted water, contamination from human carriers of infectious diseases etc.

iii) To prevent the addition of dangerous drugs and chemicals to meat e.g. in canning.

iv) To prevent false or fraudulent practices with meat e.g. soaking of meat and rubbing of pale carcasses with blood by butchers.

v) To detect outbreaks of infectious diseases among food animals.

To fulfil National and International regulations and laws on the meat trade i.e. meat edicts and decrees and other international regulations. E.g. Codex Alimentarius Commission on the acceptable levels of chemical residues in food animals EU (96/446/EU) requirements for the imports from Third World Countries of bone and bone products, horn and horn products, hoof and hoof products.

Biological and Chemical Bases of Meat and Milk Hygiene

The basic need for meat and milk hygiene stems from the need to produce wholesome products that will nourish and benefit the consumers rather than make them sick. The general belief is that in the developing countries (Nigeria inclusive) the consumption of animal protein is far below the FAO recommended, premised on

low production of livestock and poultry for the teeming populace. It is then important that the “little” available animal protein is fit for human consumption.

Several factors are responsible for the unwholesomeness of animal products amongst which are microbial and chemical contaminants.

Microbial contamination

Bacteria are everywhere and can be regarded as common contaminants. The most common ways by which bacteria and other micro-organisms contaminate meat and milk are usually from processing (slaughtering and processing of meat and milk collection and processing) and post-abattoir handling of the products. This includes transportation and storage of meat prior to and during sale.

Efforts must then be put in place for proper slaughtering and processing of food animals to limit the spread of micro-organisms to the edible parts of the carcase (care must be taken to separate clean operations from dirty operations) and also to avoid cross-contamination of the carcase (water, slaughtering surface, meat handlers, containers, vehicles etc).

Assurance of microbiological quality of foods relies on control of the fate of organisms in the food and its environment.

Chemical Contamination

Drugs are the major chemical contaminants of meat and milk. In Nigeria as in some other developing countries, veterinary drugs can be easily purchased over the counter

thereby subjecting them to abuse. These drugs may ultimately end up in the food chain for human consumption as residues at undesirable levels constituting health risks to the consumers.

Ante-mortem Inspection of Food Animals

Meat Inspection

This is “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 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 is the examination of carcasses and organs after slaughter to assess whether these products are fit for human consumption.

Hygiene and Sanitation Inspection is the inspection of facilities, equipment and processes to assess whether the production system is hygienic.

Meat inspection may be performed by various groups of people including Veterinarians, trained inspectors and company quality control personnel.

The methods of meat inspection and the extent to which it is pursued in different countries depend on a number of factors.

Meat Quality: can be defined as “A combination of traits that provides for an edible product that loses a minimum of constituent, is free of spoilage and other abnormalities after processing and storage, is attractive and appetising, nutritious and palatable after cooking”.

PURPOSES OF MEAT INSPECTION

i) To prevent unsanitary meat from being released for human consumption i.e. self-dead animals, diseased meat, foetus, etc.

ii) To prevent post-mortem contamination of meat through unhygienic dressing of carcass, contamination during washing with polluted water, contamination from human carriers of infectious diseases etc.

iii) To prevent the addition of dangerous drugs and chemicals to meat e.g. in canning, Sodium nitrate is now prohibited while Sodium nitrite is recommended as the correct non-toxic level can determined.

iv) To prevent false or fraudulent practices with meat e.g. soaking of meat and rubbing of pale carcasses with blood by butchers.

v) To detect outbreaks of infectious Diseases among food animals. The number of a certain disease detected passing through the abattoir can indicate the incidence of the disease on the field. High incidence of a scheduled disease must be reported to the Animal Health Division.

vi) To fulfil National and International regulations and laws on the meat trade. i.e. Meat edicts and decrees; Meat for the USA and EEC markets have acceptable limits of chemical residues and nil tolerance for antibiotics and cortisones.

The Objectives of Meat Inspection Procedure

a. To ensure that only apparently healthy, physiologically normal animas are slaughtered for human consumption and that abnormal animals are separated and dealt with accordingly.

b. To ensure that meat from animals is free from disease, wholesome and of no risk to human health.

The objectives are achieved by ante-mortem and post-mortem inspection procedures and by hygienic dressing with minimum contamination.

Pre-slaughter care, Handling and Transport of Meat Animals

It is not enough to produce healthy meat animals, it is equally important to ensure that these animals reach the point of slaughter in sound condition. Pre-slaughter care and handling can markedly influence the quality and quantity of meat. Ways of loading and unloading, means of transportation and average distance covered by the animals from the point of product to the point of slaughter has a definite bearing on the keeping quality of meat. Excited, stressed, fatigued, suffocated, bruised and injured animals are not expected to yield wholesome meat. The underlying principles for pre-slaughter care, handling and transport of meat animals re:

i. To avoid unnecessary suffering of animals during transport
ii. To ensure minimum hygienic standards
iii. To prevent spread of diseases.

Handling of animals should conform to human standards at every stage. It will safeguard the animal welfare as well as meat quality. Rough handling of animals before slaughter can result in several physiological stress. Loading and unloading operations have to be prompt. It is particularly important in hot weather when heat builds up in stationary trucks.

Transport of slaughter animals

Transport of animals by rail, truck or on the hoof must be carried out carefully to ensure the quality of the meat. Prevention of damage during transport, ante-mortem inspection and rest before slaughter are therefore essential. The main requirements are that:

i. The owner should be in possession of a movement permit
ii. During transportation care must be taken to guard the animals against fractures, bruises, lacerations, lack of water and food.

Driving on Hoof

Cattle in developing countries are often driven over 800km, of about 48km per day, to reach consumer area. In these circumstance, holding grounds are essential, to provide a daily intake of water, rest and fodder for the animals in transit.

Road transport

Single-decked lorries are used for large animals, whilst sheep, goat and pigs can be transported in double-deckers. Use of the same vehicles for large and small animals is not recommended. The lorries should have non-slip floors. The landing platform should be fitted with batons to prevent slippage. Where animals are transported on winding roads, it is essential to round off the corners inside the vehicle as very often animals suffocate due to persistent pressure from other animals. For long distance transport under tropical conditions, it is essential that the lorry have a roof or a tarpaulin.

Rail transport

The floors of the rail wagons should be fitted with baton to prevent slippage and should have a roof. Adequate ventilation is essential. The division of the wagon into several compartments is advisable. Entrance should be by a loaded ramp or collapsible door.

Air transport

Expensive, hence limited to small animals like pigs and possible poultry

Sea transport

This means of transportation is very useful in international cattle trade preferably within a limited geographical area.

Minimum Requirements of Transporting Food Animals

The adverse effects of transport could be minimised with the following amenities and practices:

a) Loading must be done not more than one hour before departure time
b) Provision of adequate ramp to facilitate loading and unloading and prevent fractures and bruising.
c) The wagon or lorry should be properly ventilated and provided with roofing to protect animals from rain and heat of the sun. The floor and sides must not be damaged, there should be no nail or sharp obstructions projecting from the floor or wall.
d) Adequate bedding must be provided.
e) Avoid overcrowding by providing adequate space for each animal. The floor space for each animal depends on size.
f) Provide adequate food and water when journey involves extremely long periods
g) Provide rest during journey, at least every 24hrs for cattle.
h) The vehicle must be kept clean and disinfected with any of steam or hot water, freshly prepared

quicklime, Lysol (2.5%), phenol (3%) formalin (1%).

Lairaging of Animals

Lairage serves as a resting ground for the tired and stressed animals. Resting period depends on the length and mode of journey, animal species, age, condition. Undue holding is also not advised.

Lairages are pens for animals for immediate slaughter and should have direct access to the slaughter hall. They serve the purposes of providing rest for animals while waiting for slaughter for at least 24hrs and not exceeding 72hrs, and also to provide place and facility to inspect the animals prior to slaughter.

Lairage should have adequate space to contain 3days supply of cattle and 2days supply of sheep, goats and pigs. Provided with litter and drainage, provided with watering and feeding troughs, the feed of animals should be however be withheld for 12-18 hours before slaughter, but ample supply of drinking water should be made available during this period. This lowers the bacteria load in the intestine and facilitates easy removal of the hide or skin during dressing of carcass. Stunning is made more effective and brightness of the carcass is also improved. The lairage should also have facilities whereby diseased animals could be isolated. Between the lairage and slaughterhouse, there should be facility to wash dirty animals before slaughter.

Effect of Transport on Meat Animals

a) *Stress and Fatigue*: These conditions are inevitable sequel to transportation and do have a bearing on meat quality. These conditions may at times lead to shipping fever (pasturella) and transient tetany.

b) *Loss of weight or shrinkage*: Shrinkage takes place due to dehydration and depletion of muscle glycogen during the period of journey. In general, it ranges from 3 to 10 percent depending on the conditions and duration of transport.

c) *Bruises, torn skin and broken bones*: Bruises are noticed in most of the species due to transportation. Muscular bleeding may occur especially in pigs.

d) *Death*: This may occur during long transportation especially where animals are not properly packed and provided for.

Rest prior to slaughter

Animals transported by rail, road or hoof should not be slaughtered on the day of arrival but should be allowed to rest in the lairage. The transporting vehicle, whether lorry or rail wagon should be subjected to thorough cleaning with disinfectant immediately after discharging the animals.

The quality and condition of the carcass and its storage depend greatly on the care taken prior to slaughter. Nervous, tired and excited animals could have a raised temperature causing imperfect bleeding. Muscular fatigue reduces glycogen content in the blood, which after slaughter changes into lactic acid, thus causing favourable conditions for the growth of spoilage and food-borne bacteria. Tiredness and excitement also cause penetration of bacteria from the intestinal tract to the meat.

The beating of animals, or brutal pulling and dragging prior to slaughter must be eliminated since in addition to being cruel, it has and adverse effect on the muscle and hence economic value of the animal.

Ante-mortem Inspection of Food Animals

Definition

This is the comprehensive examination of food animals destined to slaughter prior to slaughter. Ante-mortem examination of meat animals 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 Lairage within 24 hours of slaughter and repeated if slaughter has been delayed over a day.

Objectives

a) To ensure that animals are properly rested and that proper clinical information, which will assist in the disease diagnosis and judgement, is obtained.
b) To detect animals suffering from scheduled infectious diseases which are communicable to man.
c) To detect certain diseases which are toxic or contagious and whose identification is either difficult or impossible during post-mortem, e.g. tetanus, rabies, listeriosis etc.
d) To make post-mortem examination more efficient, accurate and less laborious
e) To ensure that injured animals and those with pain and suffering receive emergency slaughter and that animals are treated humanely.
f) To prevent unnecessary contamination of building and equipment of the abattoir.
g) To require and ensure the cleaning and disinfection of trucks used to transport vehicles

Ante-mortem Inspection

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

i) to screen all animals destined to slaughter

ii) 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.

iii) to ensure that injured animals or those with pain and suffering receive emergency slaughter and that animals are treated humanely.

iv) To identify sick animals and those treated with antibiotics, chemotherapeutic agents, insecticides and pesticides.

v) 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 be done within 24 hours of slaughter and repeated if slaughter has been delayed over a day.

Animals affected with extensive bruising or fractures require emergency slaughter. Animals showing clinical signs of disease should be held for Veterinary examination and judgement. They are treated as “suspects” and should be segregated from the healthy animals. The disease and management history should be recorded and reported on an ante-mortem inspection 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 inspection should be carried out in adequate lighting where the animals can be observed both collectively and individually at rest and motion. The general behaviour of animals should be observed, as well as their nutritional status, cleanliness, signs of diseases and abnormalities. Some of the abnormalities which are checked on ante-mortem examination include:

1. Abnormalities in respiration
2. Abnormalities in behaviour
3. Abnormalities in gait
4. Abnormalities in posture
5. Abnormalities in structure and conformation
6. Abnormalities discharges or protrusions from body openings
7. Abnormalities colour
8. Abnormalities odour

Abnormalities in respiration commonly refer to frequency of respiration. If the breathing pattern is different from normal the animal should be segregated as a suspect. Abnormalities in behaviour 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 of nervous disease.

Abnormal posture in an animal is observed as tucked up abdomen or the animal may stand with an extended head and stretched out feet. The animal may also be laying and have turned along its side. When it s unable to rise, it is often called a “downer”.

Downer animals should be handled with caution 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 omphalo-phlebitis)
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, after birth
b. protruding from the vulva, intestine
c. protruding from the rectum (prolapsed return) or uterus
d. Protruding from the vagina (prolapsed uterus)
e. Growths on the eye and bloody diarrhoea

Abnormal colour such as black areas on horse and swine, red areas on light coloured skin (inflammation), dark blue areas on the skin or udder (gangrene).

An abnormal odour is difficult to detect on routine ante-mortem examination. The odour of an abscess, a medicinal odour, stinkweed odour or an acetone odour of ketosis may be observed.

Since many abattoirs in developing countries have not accommodation station or yards for animals, Inspector's ante-mortem judgement must be performed at the admission of slaughter animals.

General Guidance for Inspection of Meat

i. Carcasses, organs and viscera of all animals slaughtered for sale must be inspected at the time of slaughter and dressing of the carcass and passed as fit only if they satisfy the basic hygienic conditions expected. When diseases is obviously present in an advanced or generalized degree so as to make further inspection unnecessary, the carcass and organs should be rejected forthwith.

ii. Animals to be slaughtered for emergency reasons, or suspected of being diseased at ante-mortem inspection, should be kept apart from others and should be slaughtered in the casualty block where such blocks exist. Where this is not possible, such animals should be slaughtered after killing of normal animals is completed.

iii. Tools, implements and equipment must be kept clean before and after use.

iv. Inspecting officers and slaughter men shall have at least two knives so that replacement of a contaminated knife is possible at any time. A contaminated knife must be cleaned and sterilized by boiling before further use.

v. Inspecting officers should incise selected organs and parts of the carcass. All incisions should be made, if possible, in such manner as not to impair the market value of the carcass, organ or part. If the routine incisions are not

sufficient to reach a diagnosis the inspecting officer may incise other parts of the carcass as he may deem to be necessary.

vi. When incising diseased parts of organs, the inspecting officer should avoid contaminating healthy parts of the carcass and organs, the floor and abattoir equipment.

Ante-Mortem Examination Procedure

The disease and management history of the animals should be recorded and reported on an ante-mortem inspection card with the following information:

a) Owner's name
b) The number of animals in the lot and arrival time
c) Species and sex of the animal
d) The time and date of ante-mortem inspection
e) Clinical signs and body temperature if relevant
f) Reason why animal is held
g) Signature of inspector

Ante-mortem examination should be carried out in adequate lighting where the animals can be observed both collectively and individually at rest and motion.

The examination should be carried out in two stages:

Stage I

General Examination: Meat animals should be observed in the lairage during rest as well as in motion. The general behaviour, reflexes, fatigue, excitement, gait, posture, evidence of cruelty, level of nutrition, clinical signs of diseases or any other abnormalities should be closely observed.

Stage II

Detailed examination: Suspected or diseased animals should be segregated for detailed examination. Their temperature, pulse rate and respiration rate should be recorded. Animals showing elevated temperature and systemic disturbance should be detained for further inspection and treatment in the isolation pen.

Some of the abnormalities which are checked for are:

i. abnormalities in respiration
ii. abnormalities in behaviour
iii. abnormalities in gait
iv. abnormalities in posture
v. abnormalities in structure and conformation
vi. abnormal discharges or protrusions from body openings
vii. abnormal colour
viii. abnormal odour

Principles of Judgement in Ante-Mortem Examination

a) *Fit for slaughter*. Animals which are normal and free from any clinical signs of disease should be sent for slaughter.
b) *Unfit for slaughter*. Highly emaciated, skin bound animals and those affected with tetanus or communicable diseases like rabies etc. or diseases which can not be treated should be declared unfit for slaughter.
c) *Suspects*. All suspected animals need further attention. Some animals with localized condition and recovered cases should be passed for slaughter as suspect with instructions for careful post-mortem examination.
    i. *Detained animals*. Some animals need to be detained for specified period of time for treatment of disease or excretion of known toxic residues.

ii. *Emergency slaughter*. It is recommended in cases where the animal is in acute pain or is suffering from a condition where any delay in slaughter would be contrary to the welfare of animal. It is done under strict supervision so that there is no hazard to the consumer health. Such condition could be recent injuries, recent fractures, tympany (bloat), prolapse of uterus etc.

Ante-mortem examination of meat animals is of prime importance from Public Health point of view. It is the initial step in detection of any sign of disease, distress, injury etc. which helps in taking appropriate decision before slaughter of animal. It should be done properly and systematically by Veterinarians, which will in turn help in maintaining high standards of meat quality.

Specific diseases that can be encountered in different meat animals during ante-mortem examination and their judgement

S/N	Disease/Condition	Salient signs	Judgment
1.	Emaciation	Pathological condition due to chronic illness, higher metabolic rate	Unfit for slaughter
2.	Rabies	Acute infective disease due to bite of an infected animal manifested by neurological disorder	Unfit for slaughter (to be destroyed)
3.	Anthrax	Acute manifested by fever, bloody diarrhoea and red dark discharge from natural openings	Unfit for slaughter (to be destroyed)

4.	Foot and Mouth Disease (FMD)	Most contagious, causing dullness, depressed appetite, lameness etc.	Unfit for slaughter
5.	Actinomycosis	Chronic granulomatous disease diagnosed by lumpy jay	Suspect
6.	Actinobacillosis	Marked development of fibrous tissue causing enlargement and hardening of tongue (wooden tongue)	Suspect
7.	Black Quarter	Acute infection characterized by severe inflammation of muscles followed by crepitant swelling on shoulder, neck, breast, loins or thigh	Unfit for slaughter (remove at once)
8.	Tetanus	Acute highly fatal infective disease characterized by spasmodic contraction of voluntary muscles especially masseter muscle often causing lock jaw condition	Unfit for slaughter (remove at once)
9.	Mastitis	Inflammation of the mammary gland	Suspect
10.	Tuberculosis	Chronic inflammation f lungs, swelling of retropharyngeal lymph gland	Unfit for slaughter

11.	Sheep scab	Parasitic disease caused by sucking mites, crust formation on the skin coupled with progressive emaciation	Suspect
12.	Caseous lymphadenitis	In sheep and goat, externally placed lymph nodes enlarged and contain a greenish yellow gelatinous pus	Generalized - Unfit for slaughter; Localized – Suspect
13.	Pneumonia	Nasal discharge, lungs are severely affected	Suspect
14.	Swine fever (Hog cholera)	Acute highly contagious disease, with signs of septicaemia in the form of multiple haemorrhages	Unfit for slaughter
15.	Atropic Rhinitis	In pig, snout becomes inverted, with wrinkling of skin over the affected area. Nasal septum distorted with bloody nasal discharge	Suspect
16.	Swine Erysepalus	Characterized by different forms such as acute septicaemia, skin form, chronic arthritis and vegetative endocarditis	Suspect
17.	White Scour	In calves, a large abscess in the abdominal wall near	Unfit for slaughter

		umbilicus which becomes hard and swollen	
18.	Calf Diptheria	Characterized by foul smelling diptheric patches and ulcers in mouth, tongue, gums and pharynx	Unfit for slaughter
19.	Salmonellosis	Severe diarrhoea with foul-smelling which may contain blood, fever, loss of appetite, dullness, dehydration	Unfit for slaughter
20.	Listeriosis	Stiffness of neck, uncoordinated movement of limbs, paralysis of muscles of jaw and pharynx	Acute case - Unfit for slaughter Recovered – Suspect
21.	Selenium poisoning	Peeling of the skin	Unfit for slaughter Recovered animal – Suspect

Slaughtering and Handling of Meat

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

Slaughter types

Home slaughter

In developing countries animals are often slaughtered at home, and this practice is likely to continue for many years to come. Domestic slaughter of animals is not recommended. Instead, animals should be taken for slaughter at an approved slaughter slab.

The assurance of clean, wholesome meat; the elimination of contamination of the premises of the owner with blood or intestinal contents and the danger of diseases spreading to animals and man are the factors in favour of using a slaughter slab. In slaughtering, a hole 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 clean as possible. Only the slaughterer should be allowed to touch the meat, while other people may only handle hides and intestinal contents.

Emergency slaughter

As an emergency, animals that have been hit by a vehicle, or have broken limbs, or have been gouged by horns, or damaged in any other accidental way can be slaughtered on the understanding that slaughter takes place immediately after the accident before the multiplication of pathogenic and other micro-organisms can start and all broken, damaged or bruised bones or meat are considered as condemned and discarded as such.

Dry slaughtering

This occurs when all the operations: flaying, evisceration, splitting and despatching are done without the carcass coming into contact with water, either directly or through wet walls, floors or equipment. It must not however be understood to mean that the premises are dirty

or unwashed, on the contrary, strict pre-slaughter hygiene and thorough cleaning and washing of the premises and equipment must be carried out after each slaughter operation so that the next slaughter takes place in clean, dry premises. Care must be taken that meat 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 the point of entry to exit. This however does not interfere with strict meat inspection.

Muslim method of slaughter or Halal

When animals are to be slaughtered according to Muslim injunction, the meat produced thereof is known as *Halal* meat. Such must follow the following principles:

a) The animal must be healthy and conscious.
b) Slaughter should be quick, with a single stroke cut to the throat without inflicting suffering to the animal. Stunning is not acceptable.
c) The animal should be slaughtered lying on the floor with its head facing Mecca. The neck of the animal is severed by cutting the four major blood vessels (carotid arteries and jugular veins) with a sharp knife. The spinal cord is left intact. So the nerve centres controlling the heart and lungs remain functional and an efficient bleeding is ensured. It also enhances the keeping quality of meat.
d) The name of Allah be invoked during the slaughter
e) Since pig is regarded as unclean animal, and the consumption of pork is prohibited under the Muslim injunction, it is not acceptable to slaughter pigs under the same roof as cattle, sheep or goats. Also, a meat shop

selling mutton, goat or beef slaughtered according to Muslim rites cannot sell pork to non-Muslims.

Humane Slaughter of Food Animals

This is also known as scientific slaughter. Such a slaughter avoids unnecessary pain and cruelty to food animals and ensures as complete bleeding as possible. It also ensures speed of operation and safety of the personnel.

Stunning is a process employed to create a state of immobility or unconsciousness at the time of slaughter. Immediately, the animal is hoisted and blood vessels on the neck are severed (sticking) to bleed the animal to death. It is important to note that in stunning the animal is not killed but only made unconscious.

Stunning Techniques and Devices

They fall into three main categories:

1. ***Mechanical instruments***. Instruments such as *captive bolt pistol, percussion or stunner* cause damage to the brain so the animal immediately looses consciousness. Application point of captive bolt pistol differs with species. In effective stunning, the animal immediately collapse followed by tonic spasms and then movements of the hind legs.
2. ***Electrical stunning***. It is conveniently employed in stunning of small ruminants, pigs and poultry. The instrument carries electrodes by which alternating current is passed through the brain. Bleeding is very efficient and the power consumption 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 of meat besides compromising the safety of the handler. On

the other hand, too high a current may cause *splash*. It refers to the appearance of petechial haemorrhages throughout the subcutaneous tissue in pigs. The capillaries get ruptured due to excessive increase in blood pressure. Signs of efficient electrical stunning include (a) hind-legs stretched 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 labour and permits speedy operation

(ii) humane because unconsciousness is immediately produced and the electrode is painless on application

(iii) no mutilation of any part of the animal, hence may be acceptable 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 anaesthetised that are then shackled and bled.

Advantages of this method include:

(i) Bleeding is quite efficient since carbon dioxide stimulates respiration favouring blood circulation

(ii) There is no splashing because blood pressure is not increased.

(iii) Less dangerous than electrical and mechanical methods.

Disadvantages of this method include:

(i) the system is not fast and requires a lot of space.

(ii) animals have different sensitivity to carbon dioxide

Slaughter without previous stunning

These include Jewish slaughter and Moslem (Halal) slaughters. These methods employ one stroke to cut the throat, severing altogether the trachea, oesophagus, blood vessels and muscle except the cervical vertebrae and the vertebral artery and spinal cord within it.

Advantages

1. Proponents of the method claim that unconsciousness is attained immediately upon severing of the carotid arteries, hence the method is humane.
2. Since breathing and heart action are not markedly reduced, bleeding is thought to be enhanced.

Disadvantages

1. Unconsciousness may be immediate because of the possible supply of blood to the brain through the vertebral – condyloid anastomoses which remains intact. This circulation may be aided by the blocking of the proximal ends of the severed carotid artery.
2. Stomach contents may be regurgitated and contaminate the tissues of the neck or aspirated to the lungs and mixed with the blood.

Sticking or Bleeding of the Animal

It is important that bleeding should be done as soon as possible after stunning so as to minimise 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 venacava.

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

Dressing of Slaughter Animal

Dressing techniques and sequence of dressing operations vary from place to place and are very much influenced by the equipment and facilities available in the abattoir. The present trend in organized abattoirs is towards line dressing whereby once the animal has been hoisted to the bleeding rail, it is not lowered to the floor till the entire dressing operation is completed. The carcass is conveyed by gravity or power driven along an overhead rail. Equipment such as brisket saw, hock cutter, hide puller, bone cutter etc. facilitate the dressing.

The process includes the opening of the carcass, flaying, evisceration, splitting, inspection and despatch.

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 can be done by hand or by dehairing machine. Plucking or Defeathering is the removal of feathers of poultry. This can be done by 2 methods (a) Dry method whereby the feathers are plucked after destroying the nerve centre behind the brain with a knife. (b) Wet method: here, scalding tank with water is heated to 130^0F is used to loosen the feather and facilitate plucking.
3. *Evisceration*: Removal of the viscera from the carcass.

Dressing of Cattle

1. After stunning, the animal is hoisted by one leg to the overhead rail. It is brought above bleeding trough or gully and an incision is made just in front of sternum cutting the main blood vessels.
2. Bleeding is done into a specially built bleeding trough which carries the blood into a blood-collecting tank. Complete bleeding is essential as blood is an excellent medium for multiplication of bacteria throughout the carcass.
3. A cut is made across the larynx, the oesophagus is tied off and 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 is hung by tendons on the spreader.
6. Deskinning (flaying) is carried forward from hind and forequarters and hide is now pulled with the help of a hide puller.
7. Brisket is now opened along with the midline and the pelvic cavity is opened along the abdominal cavity. Evisceration commences 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 pouch which includes stomach and intestines. The thoracic viscera are hung on hooks over the viscera inspection table or on special edible offal carries attached to overhead rails. This is done without delay. The intestinal contents should not be allowed to spill over the carcass and the floor of the slaughter hall. The testicles, penis and tail should be removed and not allowed to contaminate the carcass. The mammary gland should also be removed without it being punctured.

8. Now the carcass is sawn into two halves along the vertebral column.
9. Spray washing of the carcass. The carcass is then inspected and from the inspection line the carcass is transferred to the chilling room.

Dressing of Sheep and Goat

1. Every effort should be made to ensure that dirt is not carried on the hair/wool into the slaughter place.
2. After stunning, the animal is hoisted to overhead rail and an incision is given in the jugular furrow near the head severing both carotid arteries.
3. The forelegs are knuckled and a cut is made to the front, the forelegs are removed at knee.
4. The neck and cheeks are skinned along with the shoulder. The throat is opened up and oesophagus is tied.
5. The hind legs are knuckled and a cut is made to the root of the tail. The legs are skinned.

6. The skin is incised in the middle of the bell and skinning proceeds towards the flank. Now skin is pulled down over the backbone and base of the head.
7. The head and hind legs are removed. Treatment and the use of the head depend on different customs in various countries.
8. A small cut in the abdomen is extended to the brisket and the breast bone is also split.
9. The pluck and viscera are removed. Kidney and its fat are left in the carcass. Under conditions where a sheep/goat gantry hoist does not exist, all processes should be carried out on a skinning cradle.
10. Spray washing of the carcass is done followed by transfer to the chilling room.

Dressing of Pig

1. Sticking (Killing). After stunning, the pig is hoisted to the overhead rail. An incision of 5 to 10cm is made at the mid - point of neck facing breast bone. The knife is inserted in this incision at an angle of 45^0 and is forced down and back at least 12 – 15 cm to a point below the front of the breast bone. 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 tank maintained at a temperature of 60 -62^0C for about 6 minutes.
4. Scrapping or Dehairing. Raise the animals on the overhead rail and pull off the dew claws and toes while hot. Scrap the loosened hair with the help of a hog scrapper or dull knife

hindquarter downwards. Then rinse the carcass with warm water.

5. Singeing. It is done with the help of a blow lamp in which a high temperature is achieved and all the remaining hair is burnt. Besides, singeing sterilizes the cuticle and firms up rind giving it a better appearance and keeping quality.
6. Removal of head. Done at atlas joint before the carcass is opened.
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 chilling room.

Post abattoir Handling of Meat

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

The aim of hygienic procurement, slaughter and dressing is to ensure that inspected meat derived from healthy, properly slaughtered animals reaches the consumer clean, unspoiled and in a wholesome state, free from danger of infection or intoxication.

Great care should be exercised in the method used for transporting meat from the place of slaughter to the place of sale. Unhygienic transport, exposing the meat to heat, dust and bacterial contamination can nullify all the measures taken at the most hygienic slaughter facility and properly constructed and operated butcher's shop. Where the output is large, special meat-carrying vehicles insulated, metal lined and if possible, equipped with hooks for

hanging the meat is recommended. Care should be taken to ensure that carcass meat is not mixed with tripe or other offal.

Refrigeration of Carcasses

The carcasses with identification numbers after complete washing and inspection are brought to the chilling room where they are kept for about 24hrs to bring the pH below 6. The carcasses should be as dry as possible. The aim of chilling is to retard the bacterial growth during 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 carcasses hung on the rails. The chillers should not be overloaded and spaces should be left between carcasses for the cold air to circulate, otherwise cooling will be insufficient and carcass surface will remain wet for rapid bacterial growth.

Personal Hygiene and Cleanliness

For production of clean and wholesome meat, personal hygiene and attitude of the workers towards clean habits are very important. Personnel with clean hands, clothing and good hygienic practices are absolutely essential to the production of high quality meat.

All clothing should be clean and in good repair. No person working with meat should wear any kind of jewellery, badges or button that may come loose and accidentally fall on the product. All persons working with exposed meat should have their nail cut, hair cut or under control either completely covered with a clean cap or confined by hairnet to prevent the hair from falling into the product. Safety devices such as aprons and mesh gloves must be clean and in good repair. All unsanitary practices should be avoided by meat handlers. No one should smoke or use tobacco anywhere in the plant area. When handling meat, scratching the head, placing fingers in and

around the nose or the mouth, sneezing or coughing on the product, should never occur. Staff should guard against contaminating the product from localised infection or sores.

Hands should be washed frequently to remove all visible soiling. Liquid disinfectant, soap and paper towels should be made available.

Post Mortem Examination

Definitions

Post Mortem Inspection is the examination of carcases and organs after slaughter to assess whether these products are fit for human consumption.

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

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

Condemned meat is meat and meat products which have been found by an instructor not to be fit for human consumption. All diseased and defective carcasses or part of carcasses will be declared condemned material by the inspector and severely contaminated products may also be included in this category.

Routine post mortem 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 human consumption are not passed as food. All organs and carcass portions should be kept together and correlated for inspection before they are removed from the slaughter floor.

Post mortem inspection should provide necessary information for the scientific evaluation of pathological lesions pertinent to the wholesomeness 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 – acute or 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 systemic pathological lesions and their relevance to major organs and systems, particularly the liver, kidney, heart, spleen and lymphatic system.
5. co-ordinating all the components of ante mortem and post mortem findings to make a final diagnosis.
6. submiting the samples to the laboratory for diagnostic support, if abattoir has holding and refrigeration facilities for carcasses under detention.

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 and a generalized condition in the judgement of an animal carcass. In a localized condition, a lesion is restricted to a certain area or organ. Systemic changes associated with a localized condition may also occur. E.g. jaundice caused by liver infection or toxaemia following pyometra.

In a generalized condition, the animal's defence mechanisms are unable to stop the spread of the disease process by way of the circulatory or lymphatic systems. The lymph nodes of the carcass should be examined 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 the lymph 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.

Specific Indication rendering carcass Unfit for human consumption.

The following diseases and conditions may result in the declaration of meat or carcass as unfit for human consumption.

- Actinobacillosis (generalized)
- actinomycosis (generalized)
- Anemia (advanced)
- Anthrax
- Black leg
- Metritis (generalized)
- Odour(abnormal or sexual)

- Botulism
- Brucellosis (acute)
- Severe bruising
- BSE
- Caseous lymphadenitis (generalized)
- *Cysticercus ovis* (generalized)
- Decomposition (generalized)
- Enteritis
- Fever
- Foot and Mouth Disease (FMD)
- Glanders
- Jaundice
- Malignant Catarrhal fever
- Mastitis (acute septic)
- Melanosis (generalized)
- Tumors (malignant or multiple)
- Edema (generalized)
- Pericarditis (acute septic)
- Peritonitis (acute diffuse septic)
- Pleurisy (acute diffuse septic)
- Pneumonia (acute septic)
- Pyaemia
- Rabies
- Sarcocysts (generalized)
- Septicemia
- Stillborn/Unborn
- Swine erysipelas (acute)
- Tetanus
- Toxemia
- Trichinellosis
- Tuberculosis (generalized or with emaciation)
- Uremia
- Viraemia

Routine Post Mortem Examination

Cattle

Head: The gums lips and tongue should be inspected for lesions of FMD, necrosis, stomatitis, actinomycosis, Actinobacillosis; the tongue being palpated from dorsum to tip for the latter disease. Incisions of internal and external masticatory muscles for *Cysticercus bovis* should be made parallel to the lower jaw. Retro pharyngeal, sub maxillary and parotid lymph modes should be incised for Tuberculosis lesions. The tonsils, of cattle and pigs frequently harbour

tuberculosis bacilli and should always be examined and removed as unfit for food.

Sheep and goats

Vesicles and ulcers: These are commonly encountered in foot and mouth disease and Orf (contagious pustular dermatitis)

Judgment:

Partial condemnation of the affected parts.

Parasitic disease: *Oestrus ovis* larvae are deposited in the nostrils of sheep and invade the nasal cavity where a chronic catarrhal inflammation develops.

Judgment: Condemnation of affected head.

Pigs

Abscesses: Cases of abscesses should always be subject to a further inspection and examination for pyaemia

Atrophic rhinitis: This is a chronic condition in pigs the cause of which is not fully known.

Pneumonia is often found in animals suffering from atrophic rhinitis

Judgement: In the absence of systematic changes, the affection may be regarded as a local one, with condemnation of the head only.

Cysticercosis: Cysticercus cellulose is frequently found in the tongue and masticatory muscles of pigs in countries where parasite is commonly found.

Affections of the Stomach and the Intestines

Cattle

Actinobacillosis in the mouth may occasionally spread via the esophagus to the wall of the fore-stomachs resulting in marked development of fibrous tissue and nodules with a centre of pus.

Judgment: Total condemnation if accompanied by emaciation, otherwise local condemnation of the affected parts.

Enteritis:

Chronic enteritis is very often due to parasitic infestation in the digestive system with parasites as Haemonchus, Trichostrongylus, Ostertagia and Oesophagostomum. Chronic enteritis is seen as diffuse hypertrophy of the mucosa of the ileum, caecum, and colon. The mucous membrane is folded into thick transverse folds with hyperemia of the crests. The mesenteric lymph nodes are also enlarged and pale.

Judgment: Total condemnation in acute enteritis with fever or signs of intoxication or Septicemia /chronic enteritis with emaciation or abnormal odour: In other cases, which are not accompanied by systemic affections condemnation of the affected intestines.

Traumatic reticulitis: Presence foreign bodies e.g. nail, broken bottle or pointed objects which may penetrate the wall of the reticulum and affect the surrounding organs.

Judgment: In cases with pyaemia, fever or emaciation: Total condemnation. Old chronic abscesses with formation of fibrous tissue necessitate only local condemnation.

Parasitic disease: Two parasitic infections leave white characteristic lesions in the intestines.

Pimply gut (Nodular intestinal worm disease) caused by a roundworm, *Oesophagostomum radiatum*, which lives in the lumen of both the small and large intestines. A transverse section of the nodules will show a content of caseous matter with a greenish color. In the younger nodules, larvae may be found.

Judgment: Local condemnation of the intestine.

Linguatula serrata They are usually found in the periphery of the mesenteric lymph node. The encapsulated larvae often undergo caseation and calcification. The content can easily be removed from the capsule.

Judgment: Affected nodes should be condemned

Sheep and Goat

Enteritis: As described for cattle

Judgment: Total condemnation in cases accompanied by fever, emaciation and edema.

AFFECTIONS OF THE LIVER

Cattle

The liver is an important indicator of acute infectious diseases being one of the first organs to show macroscopic changes and if the animal survives, it is the last organ to return to normalcy.

1. **Cloudy Swelling:** At Post Mortem (PM) the liver will appear enlarged and so will the portal lymph nodes. The enlargement can be recognized by rounded edges of the organ and the bulging of the cut surface. Furthermore, the color of the organ becomes dull and grayish and the consistency softer than normal. The liver is said to be friable and have a parboiled appearance.

   Petechial hemorrhages may at the same time be scattered on the surface of the liver and in the liver tissue itself.

   Judgment: Total condemnation, as it is a sign of systemic disease.

2. **Fatty change:**

   At PM the liver will be enlarged with a uniform light yellow color and a consistency like soft dough. In case where no

pathological factors can explain the fatty change it must be regarded as physiological.

Judgment: Total condemnation in case of pathological fatty change.

3. **Amyloid degeneration**: This condition is secondary to some chronic diseases such as tuberculosis or suppurations. Affected livers are enlarged with rounded edges, pale and heavy with a rubber-like consistency. It is often part of a generalized amyloidosis with Amyloid degeneration also in the kidneys, spleen and mucous membrane of the intestine.

   Judgment: Local or total condemnation depending on the general condition of the animal.

4. **Necrosis:** is death of tissue, which is still part of the living body.

   Judgment: Total condemnation if the condition is accompanied by systemic changes, otherwise local condemnation.

5. **White nodules on the liver surface:** This may sometimes appear as grey-brownish discoloration and small grey-white foci scattered on the surface of the liver.

   Judgment**:** Local condemnation

6. **Tuberculosis:** The liver may be affected by tuberculosis in three different ways

   Judgment: Local condemnation of the liver, if it only effects the liver, otherwise total condemnation of the carcass if the lungs, intestines, and head are also involved

7. **Abscesses/Purulent hepatitis:**

   In most cases, the liver abscesses are localized, however, the condition often result in pyaemia.

Judgment: When localized abscesses are present in the liver, without systemic involvement, the liver can be condemned and the carcass passed.

Parasitic diseases:

a. **Hydatid cyst**: The cysts are usually found in the liver and lungs, but occasionally in other organs. The size of the cysts usually ranges from that of a pea up to the size of a tennis ball. Many of the cysts show degenerative changes in which the fluid disappears and the cavity becomes filled with a yellowish-green caseous material which often undergoes calcification.

   Judgment: The liver must be condemned and destroyed in order to break the life cycle of the parasite. The liver and the other organs should be checked for cysts.

b. *Cysticerous tenuicollis*: The larvae migrating leave a tortuous tract of red soft material. They may also be seen as grayish white tortuous cords in the liver tissue.

   Judgment: The liver should be condemned if several cysts and/or tortuous cords are present. .

c. *Cysticercus bovis*: Lesions and judgment as above

d. Fascioliasis: Their presence in the bile ducts leads to an inflammation, which results in a considerable thickening of the walls of the ducts. Calcification of the walls often occurs.

   Judgment: Local condemnation of the affected liver

8. Melanosis: In the liver appears as black spots of unequal size scattered on the surface of, and in the liver tissue itself.

   Judgment: In cases of extensive discoloration, condemnation of the liver. In cases where only a few spots are present they should be trimmed off and the liver passed.

9. Cirrhosis: The consistency of the liver will become firm due to the fibrous tissue and may appear grayish in color.

   Judgment: This depends on the original cause

10. Icterus or Jaundice: Seen as yellowish discoloration of the liver

    Judgment: Total condemnation in case of systemic involvement, otherwise local condemnation .

Sheep and goat

Most of the diseases mentioned in connection with liver affections of cattle are found in sheep and goats, with the judgment being the same

Pig

"Milky spot" livers: The migrating larvae of *Ascaris suum* pass the liver where some are caught in the capillaries, characterized by irregular white spots on the liver surface. These spots are known as "milky spots", and they consist of fibrous tissues.

Judgment: In cases where it is possible, the liver should be trimmed.

AFFECTIONS OF THE KIDNEYS

Cattle

1. Non-purulent nephritis: The common types of chronic nephritis are cases of local intestinal nephritis, where bright yellowish or grey spots are seen protruding out of the surface of the kidneys. On cross-section they appear wedge-shaped.

   Judgment: Local condemnation

2. Abscess/Purulent nephritis: When pyogenic bacteria are seeded in the kidneys from the blood stream during pyaemia, small abscesses are formed. The abscesses, which may be few or many, are normally confined to the cortex. Smaller

lesions (from a pinhead up to 2-3mm) are greet-yellow foci, which contain a droplet of pus. A zone of hyperaemia often surrounds them. Larger abscesses are readily visible through the capsule as dirty-white raised nodules, which may rupture, releasing their pus, when the kidneys are decapsulated.

Judgment: Total condemnation.

3. Pyelonephritis: The affected kidney(s) and the pelvis of calyces is normally dilated and filled with a greasy purulent mass containing fibrinous clots. The walls of the pelvis and ureters are opaque, hemorrhagic and often ulcerated. The ureters are greatly thickened (up to 2.5cm in diameter).

   Judgment: This depends on the seriousness of the disease. In cases where there are no signs of systemic reaction such as fever or uremia, and where the animal is in good condition, only the kidneys need to be rejected. Fever, pyaemia, uremia, or emaciation results in total condemnation.

   Infarcts: This is caused by emboli. The lesions are at first hemorrhagic, but they become pale following the onset of necrosis in the affected area. On the cut surface the infarct appears wedge-shaped, with the base on the surface of the kidney and the apex towards the centre.

   Judgment: This will depend on the cause of the embolism.

   Tuberculosis in the kidneys: Is always of haematogenous origin and is therefore a sign of generalization. The lesions and judgment are as described in other organs.

   Leucosis: The nodular type of leucosis among the organs frequently affects the kidneys.

   Judgment: Trimming or local condemnation.

   Hydronephrosis: This is an affect

ion of the kidneys characterized by the dilation of the renal pelvis (calyces) associated with progressive atrophy and cystic enlargement of the kidneys.

Judgment: Total condemnation if uremia is present, otherwise local condemnation.

Parasitic affections: These occur rarely in the kidneys, but exceptionally migratory *Fasciola hepatica* and *C. bovis* may be found. A more common parasite in the kidneys is the hydatid cyst, which develops in the same way as in other organs, and they are situated under the capsule or in the cortex.

Judgment: Local condemnation

Sheep and Goat

The lesions and diseases found in the kidneys of small stock resemble those described for cattle.

Pig

Infarcts: The lesions appear on the kidney surface as pale depressed area of irregular shape and different size. Upon incision they appear wedged-shaped.

Judgment: The cause of infarcts should be considered before the final judgment.

Stephanurus dentatus is the kidney worm of the pig. The adult worm is found in the renal area where cysts have been formed containing the worm and some greenish pus.

Judgment: The kidneys affected should be condemned, and the carcass judged on its merits.

AFFECTIONS OF THE HEART

Cattle

1. Fibrinous Pericarditis: The liver will appear enlarged (rounded edges).

Judgment: Total condemnation in cases with systemic reactions. Where the lesions are obviously localized, the heart should be rejected and the rest of the animal may be passed.

2. Purulent Pericarditis: Occurs almost solely in the ox as a result of traumatic perforation by foreign body from the reticulum. There is presence of pus in the liver

Judgment: Total condemnation in cases with fever, large accumulation of exudates, circulatory disturbances, degenerative changes in organs or a normal odour. In the absence of these, the carcass can be released after local condemnation of the affected parts.

Sarcocysts may be found in the heart muscle appearing as small rice grain-like calcified cysts.

Judgment: Condemnation of the heart, and the carcass should be checked for cysts.

Sheep and Goat

The diseases and pathological conditions which have been described in cattle occur in sheep and goats as well. The only difference is that Cysticercosis is caused by *Cysticercus ovis* instead of *Cysticercus bovis.*

Cysticercus ovis: This is the cystic stage of Taenia which lives in the intestines of dogs. It is frequently found in the myocardium, either as a fresh transparent bladder cyst or as a calcified one.

Judgment: Condemnation of the heart. The carcass should be checked for cysts.

Pig

Pericarditis: Often noticed as the formation of adhesions.

Judgment: In acute cases total condemnation.

Endocarditis: In the chronic form of swine erysipelas the heart valve are often inflamed. It is the vegetative type of affection, where cauliflower-like growth covers the valves. The vegetations consist mainly of masses of fibrin and these are normally soft, friable and yellowish-grey in color.

Judgment: Total condemnation if accompanied by general edema, general congestion, fresh red infarcts in the kidneys or emaciation; otherwise Local condemnation.

BASIC CONSTRUCTION PRINCIPLES OF FUNCTIONAL ABATTOIR

Definitions

Abattoir

- any establishment where specified animals are slaughtered and dressed for human consumption and that which is approved, registered and/or listed by the authority for such purposes.

A competent authority

- the official body charged by the government with the control of meat hygiene,
- including setting and enforcing regulatory meat hygiene requirement.

Lairage

- a place that provides temporary housing for animals prior to slaughter.

Isolation pens

- special pens in which animals can be held, separated from their congeners to facilitate Veterinary inspection or treatment.

Consideration for location of an Abattoir

- Size of the area.
- Range of operations
- target market(s) to be covered by the abattoir
- Other consideration in determining the size of the area is capital (funds available for the project).
- Distance from the cattle and meat markets where purchase of live animals can be made and meat can be sold.
- Availability of electricity.
- Water source/supply.
- Access road
- An abattoir must not be sited close to residential
    - o to avoid environmental pollution and the adverse effect on people's health.
    - o It also prevents accidents from moving animals
- It must not be close to a latrine
- It must be located away from factories to avoid smoke or dust which can cause contamination of meat and meat products.
- It should have adequate space for lairage, areas for digging pits for condemned meat, for tripe and hide treatment facilities and also for future expansion.
- The whole slaughter facility complex should be fenced

General Principles of Abattoir Design and Construction

The design of abattoir varies from situation to situation. There can be no single blue print for all the situations. The guiding principle should be to provide all related services under hygienic conditions at lowest

cost. In general, the following basic guidelines should receive serious consideration:

There should be provision of an area for the containment of animals prior to slaughter

1. The operational facilities should be so designed and located that a clear demarcation exists between clean and unclean sections. Workrooms, structures and equipment should be designed and constructed to allow for effective cleaning and monitoring of hygienic status.
2. Facilities for personnel should include changing rooms, toilets with hand-washing and drying facilities, showers and a separate room for eating and drinking.
3. Suitable conditions must be provided for the preparation and storage of meat.
4. A maintenance programme must be followed to ensure that facilities and equipment meet the required standards.

The abattoir should have the following essential facilities:

1. Resting place for animals before slaughter
2. Ante-mortem examination
3. Humane slaughter
4. Flaying, dressing and washing of the carcases.
5. Hanging carcasses and edible offals.
6. Handling by products.
7. Inspection of meat and disposal of condemned carcasses or part thereof.
8. Staff welfare

Lairages

The lairage provides temporary housing for the animals prior to slaughter and it's design should take into account the following

needs; animal welfare, maintaining cleanliness and separation of sick or “suspect” animals. It must be designed and constructed to allow the following physical activities:

Animal activities	Human activities
Eating	Ante-mortem inspection
Drinking	Sorting
Lying and resting	Cleaning and disinfection
Comfortable movement	

The key elements in the design of a lairage are:

- Sufficient light for satisfactory ante-mortem inspection.
- Floors that drain easily and do not compromise the cleanliness of animals’ coat
- No sharp objects that could injure animals.
- Isolation pen available for the containment of sick or “suspect” animals, with separate drainage.
- Physical separation of lairage (dirty area) from the area where edible products are produced.

Equipment for hygienic and efficient slaughtering

All equipment used in the slaughterhouse should be durable and made from easily sterilized material. Its size should be in relation to the function it performs.

- *Overhead rails with the following accessories:*
    - overhead rollers
    - beef trees sheep carriers
    - pig shackles
    - extension chains for beef quarters
    - hooks for beef quarters
- *Pipe-made dressing rails*

The basic equipment used in the different slaughter procedures are as follows:

- *Hand tools* :
    - stunning pistol,
    - sticking and skinning knives,
    - axe/meat and bone cutting saws/choppers.
- *Floor rings*
- *Skinning cradles*
- *Visceral inspection table and hook rail*
- *Pig scalding vat and dressing equipment*
- *Sanitation equipment*
    - *Sterilizer*
    - *Dirt –removing carts*
- *First-Aid Materials*

DISPOSAL AND TREATMENT OF ABATTOIR EFFLUENT

Abattoir Effluent

- the outgoing water from the abattoir environment containing waste materials
- are highly nitrogenous, biologically degradable
- with relatively high concentrations of suspended and dissolved solids, fats, scraps, blood, gut contents, detergents, hair and hide scraps.
- some of these materials can be recovered and may eventually be useful materials.

The load or concentration of organic matter is measured in terms of *biochemical oxygen demand* (BOD) and is expresses as ppm or mg/litre.

- The BOD is the amount of oxygen required to decompose the organic matter completely by aerobic biological action in certain period at $20^{o}C$.
- While the BOD of normal domestic sewage is 250 – 300 ppm (mg/litre),
- that of abattoir effluent is between 1600 and 2000ppm (about 5 to 6 times the BOD of normal domestic waste).
- abattoir effluent thus has a high potential for polluting the water courses,
- it is then important that on-site treatment of the effluent is carried out before the effluent is connected to the municipal sewer line.

General Principles of Treatment

Although there are several systems of effluent treatment, the basic principle involves

- screening of solids, removal of fat particles
- decomposition of organic matter by bacteria either aerobically or anaerobically in the tanks or ponds.
- The entire process can be carried out in two stages.
    - In the first stage, gross solid particles suspended solids and fat particles are separated (physical process/treatment).
    - In the second stage, remaining organic matter is subjected to biodegradation (biochemical process).

In general, abattoir effluent treatment involves the following steps:

i. Physical Processes

- *Screening.*
- *Sedimentation*

ii. Biological Process

The aim of the biological process is to remove the organic component in the effluent where it cannot be removed by physical methods.

- *Aerobic Pond System.*
- *Anaerobic System.*

iii. Chemical Process

iv. Treatment of Manure Laden Effluent

UTILIZATION OF ANIMAL BY-PRODUCTS

Animal by-products refer to the parts of the food animal not used for food by man. In liberal terms, animal by-products include every part of 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 between edible and inedible by-products is governed by a number of factors such 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 as follows:

a) Agricultural by-products: meat meal, bone meal and fertilizer
b) Industrial by-products: gelatine, glue and casings
c) Pharmaceutical by-products: insulin, pepsin, bio-chemicals and hormones

B. Classification according to origin

- *principal by-products*,
- *secondary by-products*

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	Tallow for soap, machine oil, leather dressing, candles, meat and bone meal

	trimmings	
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

Utilization of Hides and Skin

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

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

(b) Those from which the external covering is removed before processing 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*

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 as follows:

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

Utilization of Horn and Hoof

- raw material for the production of gelatine
- bone meal production.
- used for the manufacture of buttons, comb and decorative pieces.
- fertilizer

Utilization of Organic Waste

Wastes from the animal include dung, droppings, urine etc. These can be subjected to rendering processes and utilized as products such 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 instruments etc.

Utilization of Bones

- Bones can be processed as a source of gelatine and glue;
- Bone meal and fertilizer

FOOD MICROFLORA AND SPOILAGE

Bacteria are everywhere, the most common ways in which bacteria and other micro-organisms spread are in the air, by contact and via insects and other creatures. In meat processing, the common way of spread of micro-organisms to meat is through cross contamination from 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 of protection of the consumer against food-borne microbial diseases and the prevention of meat spoilage due to microbial activities.

Food micro-flora are basically moulds, and bacteria.

Moulds.

- are multicellular, filamentous fungi that grow on foods
- they have cottony appearance and may sometimes be coloured
- while some are useful (e.g. in the production of cheese)
- others cause spoilage of food thus making such food unfit for human consumption.
- some in addition to spoilage produce various toxic metabolites such as *mycotoxin* that is toxic.

Bacteria.

- Bacteria growth in and on foods is often extensive, this can cause food spoilage and makes food unattractive in appearance.
- pigmented bacteria cause discolouration on the surfaces of foods.
- films may cover the surface of foods and cause it to be slimy.
- bacteria growth in liquid such as milk may result in cloudiness or sedimentation.

The following are the bacteria commonly associated with food spoilage and are important in meat hygiene:

Pseudomonas, Vibrio, Escherichia, Salmonella, Enterobacter, Shigella, Klebsiella, Yersinia, Streptococcus, Staphyllococcus and Lactobacilli.

Contamination of Food

- Food contamination is the physical presence of impurities and micro-organisms in food.
- this can lead to food poisoning, intoxication and spoilage.
- Food contaminating flora originates from three main sources :
    - Soil,
    - Water
    - 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 before releasing such for human consumption
b) Keeping edible meat from offals

c) All equipment used in the processing of meat and meat products must be kept clean and disinfected from time to time.

d) Use of clean potable water for all operations in the meat processing plant

e) Personal hygiene must always be observed throughout the period that meat will be handled

Food Spoilage

- disagreeable change in food's normal state
- such changes can be detected by smell, taste, touch or sight
- food decays or spoils due to the metabolic activities of micro-organisms that are present in the food therein
- the micro-organisms use the food as substrate or medium of growth 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) by the action of bacteria. Gram negative organisms that can grow at low temperature and low humidity (such as *Pseudomonas*) mainly cause the surface spoilage of meat, while spoilage of deep tissues is mainly due to anaerobes (such as *Clostridia).* The organisms excrete coagulase, which hydrolyses the connective tissues leading to tissue liquefaction, gas and acid production. The acids produced are the cause of bad flavour and foul smell of spoilt meat.

The signs of decomposition include changes in colour; grey, yellow or green, softening of meat, production of slime and the production of repulsive odour.

The rate of decomposition of meat is determined by the factors affecting bacteria growth (temp. moisture, pH). Other factors include the type of bacteria present and its initial load, and the condition of the animal prior to slaughter. Delay in evisceration of the carcase can lead to invasion of bacteria from the gut to the tissues and cause spoilage of the meat. The presence of greenish hue on the kidney fat and peritoneal is a strong indication that evisceration has been delayed.

Bacterial food poisoning and intoxication

Bacterial food poisoning results from ingestion of food containing large numbers of living organisms or their toxins. There are three categories of food poisoning bacteria:

(a) Those that grow and produce toxins in foods before they are eaten. E.g. *Staphylococcus aureus* and *Clostridium botulinum*

(b) Those that multiply in the intestinal tract and cause disease by infection 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* and enteropathogenic *E. coli.*

Some important Food-borne Infections

- *Staphylococcal food poisoning*
- *Botulism*
- *Vibriosis*
- *Salmonellosis*

MILK HYGIENE

Milk hygiene is the safety and quality assurance programme for milk and diary products that cover the whole diary chain fro farm to table, so that milk and milk products derived thereof are wholesome and fit for human consumption.

Definitions

Milk is the normal lacteal secretion from domesticated animals produced from one or more milking, without either addition thereto or extraction such animals include cow, goat, camel and buffalo.

Milk products are products exclusively derived from milk and other substances necessary for the manufacture of such product, provided that these substances are not intended to take the place in part or in whole of any milk constituent.

Whole milk: milk as is drawn from the cow.

Skimmed milk: milk from which part of the fat has been removed. It may be sweetened with sugar.

Ice cream : this is frozen mixture of various diary products, sweeteners, stabilizer and various flavourings.

Butter: this is fairly solid yellow milk fat brought together by a form of agitation called churning.

Milk composite products: these are milk products in which milk is an essential part added to other food items, but these other food items are not intended to take the place of any milk constituent.

Composition of milk

Water	87.25%
Milk fat	3.75%
Milk sugar (lactose)	4.70%
Protein (casein, lacto albumin)	3.40%
Ash (Nacl, Potassium chloride, Potassium citrate)	0.75%

Vitamins and others 0.15%

Sources of Milk Infection and Contamination

- Infection of milk by disease organisms can be derived from the dairy animal itself, the human handler, or the environment (including the milk utensils).
- these organisms can be excreted through the udder directly into the milk, or originate from the skin and mucous membrane of the animal or milkier and contaminate the milk and milk utensils.
- one of the most important extraneous sources of contamination is water used in the processing plant.

The essential requirements are

- to maintain udders free from infection (mastitis),
- manage cows so that udders and teat are clean,
- milk them in such a way that minimises bacterial contamination,
- store milk in clean containers at temperatures which discourage bacterial growth until cooled.

Hygiene in Milk Production

- Milk should be protected against direct or indirect contact with any source of external contamination during all the steps of milking, collection and transport.
- Particular care should be taken to avoid the direct physical contact of milk with unclean surfaces such as those of milking utensils, udders teats and the hands of milkier.

Milk Pasteurization

- Pasteurization is the process of heating of milk to such temperatures and such periods of time as are required to destroy any pathogen that may be present,

- whilst causing minimal changes in composition, flavour and nutritive value
- Pasteurization helps in destroying pathogenic organisms and a majority of pathogenic organisms and a majority of non-pathogenic ones,
- it also inactivates the enzyme phosphatase, which is abundantly present in raw milk.
- Thus, if a phosphatase test is carried out immediately after pasteurization and it gives a positive result, it is an indication that the milk has not been properly pasteurized.

Processes of Pasteurization

There are several methods of pasteurization of milk and these include:

The holding or Vat method – milk is held at pasteurization temperatures for seconds:

(a) Batch holding 60 - 65^{o}C for 30min

(b) High temperature short time (HTST) 72^{o}C for 15sec

(c) Ultra high temperature (UHT) 80^{o}C for 1 – 40 sec

(d) Bottle pasteurization 70^{o}C for 30min

(e) Flash process 75 – 80^{o}C for 30min

Laboratory tests to determine the quality of milk

- Standard Plate Count Method
- California Mastitis Test (CMT)
- Methylene Blue Reductase Test (MBRT)

PRESERVATION OF MEAT

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 based on these principles include
    - dehydration,
    - salt curing,
    - chemicals,
    - irradiation,
    - chilling and freezing
    - heat processing

Physical Changes in Stored Meat

Meat undergoes the following superficial changes as a result of storage

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

ii. **Swelling:** This means condensation of water vapour on meat brought from a cold store into ordinary room temperature.

iii. **Loss of Bloom:** Bloom is defined as colour, texture and general appearance of carcass surface. This is caused by excessive intake of water, dehydration or undue oxidation.

Dehydration

This is an old method of food preservation which is still popular in Nigeria today. To achieve best results, meat should be pre-cooked at temperatures below 70^{o}C. Low fat meats dry more rapidly and they are more easily rehydrated. Dehydration does not affect the gross chemical composition of meat. However, dehydrated meat reabsorbs water only to about 60% of the original moisture content. Some of the disadvantages of drying include:

1. Flavour loss due to conversion of water soluble compounds to insoluble compounds
2. Loss of some nutritive components especially thiamine and pantothenic acid which are components of the Vitamin B complex

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
$NaNO_3$ or KNO_3	21.25g
Sugar (optional)	56.75g

The action of salt curing on meat can be preservative or bacteriostatic.

a) Preservative action
b) Bacteriostatic action

Smoking

Smoke is produced as a result of anaerobic distillation of wood followed by partial oxidation. If the oxidation is complete, there will be production of water and oxygen and not smoke, since wood's main

components 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 oxidative activities, provide flavour for the meat and have germicidal effect.

Smoking is the process of allowing smoke produced from natural wood, twigs, heather or the fruits of trees to act on the surface of meat and meat products. During smoking the smoke is transferred to the product through the process of absorption, adhesion, condensation, diffusion, dissolution and deposition.

There are many methods of producing smoke these include; smouldering of wood, by friction, steam, gas pyrolysis, vibratory feeder 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 relative humidity and the smoke temperature. At relative humidity of 65 – 70%, the surface of the meat will be dry. During smoking, as temperature increases from 49^{o}C to 82^{o}C, the meat protein coagulates and the meat is toughened.

Colour: The surface colour of well-smoked meat is light golden yellow to dark brown shades. The colour varies with the type of wood burnt, the density of smoke and the temperature of the smoke.

Flavour: The smoky taste in smoked meat product is as a result of the phenolic fraction of smoke. The type of wood can also affect the flavour, soft woods give acrid flavours.

Chemical preservatives

Antibiotics: these have been used to preserve and improve the keeping quality of beef carcases, poultry and fish. These antibiotics are added to water in a proportion of 5 to 40ppm and the meat is

dropped into the treated water. Alternatively, the antibiotic is added to ice in amounts of 2 – 5ppm and the fish (or meat) is transported in the treated ice. The storage life of such treated meat, poultry and fish is considerably increased.

Disadvantages of this method include

1. Antibiotics are not effective against yeasts and moulds
2. These antibiotics may occur as residues in the meat which when consumed may be hazardous to the health of the consuming populace.
3. The widespread use of antibiotics in food encourages the appearance of antibiotic-resistant strains among pathogenic bacteria present.
4. There is the danger that producers may tend to depend more on drugs than good hygienic practices.

Cold storage

Chilling

Chilling involves refrigerating meat to temperature just above freezing point. This temperature must be maintained throughout the meat until it is delivered to the consumer. Meat will not keep for a long time unless it is proper chilled. In chilling, care should be taken to prevent meat from being frozen as meat upon thawing develops characteristics which are considered not so desirable than those possessed by chilling. Quick chilling of carcase is necessary in order to prevent the growth of spoilage organisms. This process is achieved by rapid circulation of air at low temperature (1 to 2^{o}C or as low as -7^{o}C) and controlled humidity. Chilling of some of the thicker muscles is sometimes accelerated by the injection of liquid carbon dioxide 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 is retained better.

In freezing meat, the internal temperature of the meat should be reduced to -18^{o}C. To store already frozen meat, the air temperature must be equal to or less than -14^{o}C and this will kept the meat for 9months and above. Pork should be stored at -18^{o}C and will keep well for 6months. There should be proper spacing of boxed meat or meat 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 air temperature of -10^{o}C.

Food Irradiation

Food irradiation is a physical means of food treatment by exposing food either pre-packed or bulk to gamma rays, x-rays or electrons, in a special room and for a specific duration of time to achieve a desired aim.

Technically, gamma rays can be produced from radioisotope sources e.g. ^{60}Colbat or ^{37}Cesium. Foods treated with ionizing radiation are safe for human consumption. It has been shown that it is not possible to activate or induce radioactivity in any food material passed through irradiator regardless of the length of time of radiation exposure, hence toxicological testing of foods so treated is no longer required. Gamma rays kill micro-organisms in meat without a significant rise in the temperature of the product. However, the resultant chemical changes in the irradiated product have been found to change the aroma and odour of such product.

DRUG RESIDUES IN FOOD ANIMALS

Residues of drugs in food animals refer to the presence of drugs as residual deposits in meat, milk, eggs and other foods of animal origin at 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 antimicrobials are used for the prevention and treatment of animal diseases and to improve the efficiency of animal production. These agents usually find their way into animal tissues by direct routes through injections or indirectly via the feed.

Antibiotics used for the treatment of food animals do not pose a health hazard to the consumer, provided they are properly used in accordance with the recommendations for their use: proper dose, proper route of administration, proper species of animal and adequate withdrawal period before slaughter.

Residues of drugs in meat, milk or eggs and processed foods may result from intentional or accidental exposure of animals or animal products to drugs. Intentional exposure is a result of drug usage for the purposes of prevention and treatment of diseases, growth promotion and as feed preservatives. Accidental exposure, which is also referred to as unintentional exposure however occurs as a result of circumstances not intended to protect the feed or the food-producing animals. This includes the contamination of food and water by industrial chemicals.

Residues which may consist of parent compound, metabolites or decomposition products may accumulate and be deposited or stored within cells, tissues or organs of food producing animals, and may produce deleterious effects on the health of the consumers. The

public health concern is because of the potential carcinogenicity, mutagenicity, teratogenicity and long term toxic effects of the residues of these drugs on human. The concern about antibiotic residues in meat however is mainly on hypersensitivity reactions and the possibility of the development of micro-organisms resistant to antibiotics in human.

Antibiotic residues in animal tissues may lead to the emergence of resistant strains of bacteria in animals and the passage of these via the food chain of animals to man.

Apart from the safety aspect, the presence of antibiotics in milk can interfere with micro-organisms essential for the maturation of cheese and yoghurt and their presence in meat can also cause fermentation failure 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 Veterinary drugs 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 meat products 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.