



Food Hygiene and Veterinary Public Health



Encarta Encyclopedia, David
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Veterinary Public Health

Definition

- Veterinary Public Health is “the contributions to the **physical, mental** and **social** well being of humans through understanding and application of veterinary science.
- Is a component of public health activities devoted to the application of professional **veterinary skills, knowledge** and **resources** for the protection and improvement of human health.
- **Health** is the state of complete **physical, mental** and **social well-being** and not merely the absence of disease or infirmity.

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Objectives of Public Health

- Ensure adequate levels of nutrition of the community
- Prevention and control of human and zoonotic diseases
- Prevention and control of food borne diseases
- Reduce health risks related to poor basic hygiene, sanitation
- Promote waste disposal & management practices

Public health problems affecting developing countries

- Inadequate levels of nutrition
- Low standards of basic hygiene and sanitation practices and infrastructure
- High prevalence of controllable infections
- Poor food hygiene and handling practices
- Accumulation of waste in the environment
- Contamination of water sources and Inadequate supply of potable water
- Proliferation of informal settlements with unsuitable housing facilities
- Natural disasters: floods, droughts, earthquakes.

Duties and Responsibilities of PH Veterinarian

The activities of veterinarians can be described as follows:

1. In animal production and health

2. In food hygiene and zoonoses (prevention and control)

- **Food hygiene** is a branch of VPH which includes all measures necessary to insure safety, soundness and wholesomeness of food at all stages from its growth, production or manufacture to its final consumption.

i.e eliminating or excluding physical, chemical and biological hazards from food.

3. In biomedical research

4. VPH activities related with the environment

5. In disaster medicine:

6. In mental health:



Contamination of food with microorganisms

- Food implies anything that is ingested (including drinks) by human being in general sense but
- From veterinary sense it means meat and meat products, milk and milk products, fish and fish products, egg and egg products and game (wild animals).
 - ❖ It can be processed or semi processed, raw or cooked. All these products contain protein, fat, carbohydrate, etc
- **Food Safety:** Assurance that food will not cause harm/ injury to the consumer when it is eaten.
- **Wholesome food:** is a food that is **sound, clean and free of adulteration** (of any substance that is unacceptable to the consumer) or it is a food suitable for human consumption.

Criteria of food

The food should be:

- Healthy and palatable
- Attractive and pleasant
- It should not show decomposition and adulteration
- It should not contain other substances
- Should have high quality standards: i.e. nutritious, hygienic and psychologically acceptable by the consumer

Contamination of food

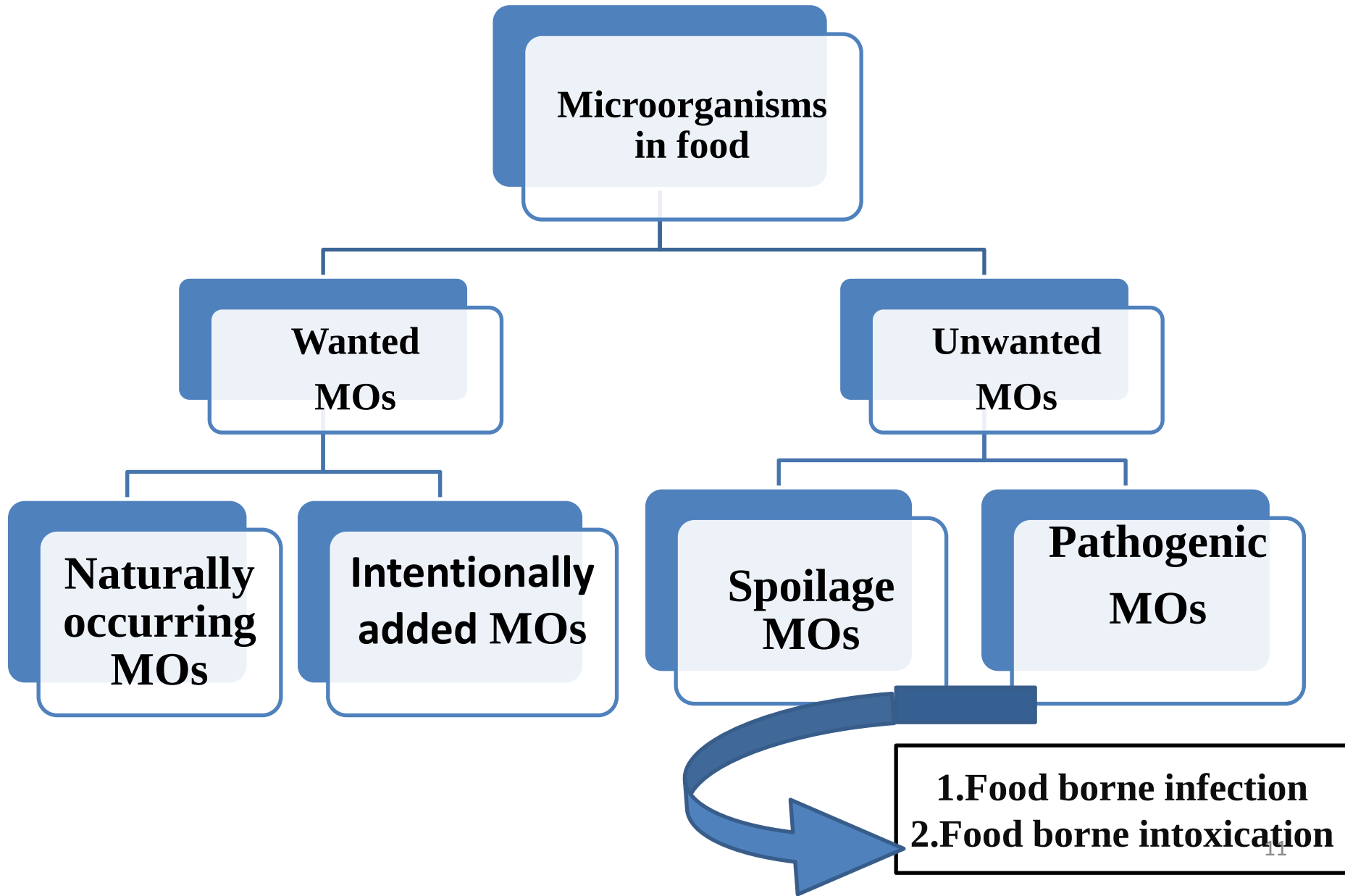
Food contamination: The presence of objectionable levels of **organisms, chemicals, foreign bodies, taints, or unwanted, diseased or decomposed material.**

- Food can be contaminated either by a **primary source** (when contaminant is obtained from the animal) or a **secondary source** (when contamination occurs after a healthy animal is slaughtered).
- **Primary contamination** can be by microbial agents, chemical residues or the discharges from infected animals.
- **Secondary contamination** can be obtained from infected human, other animals (vertebrate or invertebrates), fomites (contaminated air, substances, water, soil or plants)

Objectives : At the end of this class you will be able to:

1. Differentiate b/n food borne infection and intoxication
2. List food borne infection and intoxication causing pathogens
3. List the factors Promoting Food Borne Infections and Intoxication
4. List the different factors influencing bacterial growth in food and explain how they affect
5. Define food spoilage
6. Discuss the causes and signs of signs of food spoilage
7. Discus methods of detection of food spoilage

Microorganisms in food



Unwanted Microorganisms

A. Food Borne Intoxication

➔ **Food borne infection** occurs when a person or animal ingests the food together with viable pathogenic microorganism. But **food borne intoxication** occurs when one ingests preformed toxin produced by pathogenic microorganisms.

➔ **Food intoxication is important than food infection, because:**

1. Even though the food is cooked and the microorganisms are killed, the preformed toxins may remain in the food resisting the heat inactivation
2. **Incubation period is very short in case of FBI** when compared to food-borne infection, because preformed toxins may be absorbed by the intestinal tract immediately whereas infection must wait multiplication of the organisms to cause disease.

- Examples of MOs that can cause food borne intoxications are:

S. aureus, Clostridium botulinum, Bacillus cereus, Clostridium perfringens etc.

- Examples of microorganisms /organisms/ which cause food borne infection are:

Bacteria	Virus	Fungus
• Salmonella Spp • Streptococcus • Mycobacterium • Listeria • Brucella spp. • Campylobacter • Anthrax • Other	• Infectious hepatitis virus • poliovirus • others	• Ergot fungus • Aspergillus spp • poisonous mushrooms • others
Parasites		
• Taenia spp. <i>T. saginata</i> and <i>T. solium</i>, hydatid disease • <i>Trichinella</i>, • <i>Diphyllbothrium latum</i> and Others		

Factors promoting food borne infections and intoxication

1. Inadequate cooking of food
2. Inadequate cold or hot holding
3. Inadequate reheating of food
4. Poor personal hygiene
5. Use of left over
6. Inadequate cleaning and disinfection
6. Cross contamination
7. Contaminated raw materials and ingredients
8. Preparing food ahead of time before serving
9. Toxic containers
10. Intentional or accidental addition of additives

Types of contamination

A. Classification from the **agent point of view**

- ⇒ **Microbial contamination:** due to living agents (bacteria, fungus, virus, parasite etc.)
- ⇒ **Non microbial contamination:** due to residues or chemicals

B. Classification with regard to **temporal (time)**

- **Primary contamination:** begins directly from the food animals
Ex. Animal infected with anthrax or due to antibiotic treatment
- **Secondary contamination:** results from the environment, other animals, man or water or contaminated materials (fomites) and plants (toxic plants e.g wild onion)

C. Types of **bacteria** contained in food

- *Psychrophilics*: grow at low temperature (around 10°C)
- *Mesophilics*: propagate at room temperature (30–40°C)
- *Thermophilics*: grow and multiplies at very high temperature (> 40°C)

D. Classification with regards to the type of fermentation into two groups

- **Homofermentative**: which produce only one product e.g. **Lactic acid**
- **Hetrofermentative**: which produce more than one products.
e.g. Contamination with **yeast** results in CO₂ and alcohol production

Effect of microorganism on food

- **Food spoilage**

- Means the original **nutritional value, texture and flavor of the food** are changed, the food becomes **harmful** to people and **unsuitable** to eat.
 - Is the decomposition of food components resulting in change in quality, **appearance, color, flavor, texture and odor**.
 - Is a **metabolic process** that causes foods to be undesirable and unacceptable for human consumption due to changes in **sensory characteristics**.
- Food Spoilage can be **microbial, enzymatic, physical or chemical** changes.
 - Microorganisms attack or **metabolize** proteins, fats and carbohydrates found in foods.



Spoilage of food by microorganisms could be:-

1. Proteolytic Spoilage
2. Lipolytic Spoilage
3. Glycolytic Spoilage

1. Proteolytic Spoilage: Proteolytic MOs degrade proteins into Amino acids.

- Protein Bacterial enzyme $\rightarrow$ polypeptides $\rightarrow$ peptide $\rightarrow$ amino acids $\rightarrow$ $\text{H}_2\text{S} + \text{NH}_3$ (**foul smelling**)
 $\xrightarrow{\hspace{1.5cm}}$
- The production of H_2S , CO_2 & NH_3 are signs of food spoilage.
- Examples of microorganisms which cause proteolytic spoilage are *Pseudomonas*, *Proteus spp.*, *Bacillus spp*, *Clostridium spp*, etc.

2. Lipolytic Spoilage: Lipolytic MOs degrade fats into Fatty acids and Glycerol and cause food Rancidity

- Fat Bacterial enzyme → Fatty acids + Glycerol → **Rancidity** +(unpleasant smell)

e.g. of lipolytic bacteria includes *Pseudomonas*, *Aeromonas*, *Micrococci*, *E. coli*, etc.

3. Glycolytic Spoilage:

Carbohydrates (Glycogen in meat/lactose in milk) Sachrolytics Glucose → Lactic acid, Acetic acid, Propionic acid, alcohol, CO₂, H₂O

- These products are indicators of food spoilage.

Lactococci and *Pediococci* bacteria can cause glycolytic spoilage.

- **Production of lactic acid is seen as positive effect**, because lactic acid retards bacterial multiplication and prolongs the shelf life of food improving the keeping quality. It is also used in the production of yoghurt.

Impact of food contamination

1. Cause food borne diseases/intoxication
2. Cause huge costs in consumer suffering illness, injury or loss of life.
3. Considerable costs arise due to lost production, recalls and disposal of faulty products.
4. Incidents often result in bad publicity and loss of market for the product.
5. Legal costs related to illness or loss of life.
6. Costs to national/local health service
7. Food loss due to spoilage and unfit food – leads to loss of income.

Factors Influencing Bacterial Growth in food

- The parameters which affect growth of microorganisms in food can be grouped into two as **Intrinsic** and **Extrinsic** factors/parameters

1. Intrinsic Parameters:

They are *inherent property or nature of the food*.

These includes:

1. **Ph of the food:** This is the parameter which indicate whether the media is acidic or alkaline or neutral.
- Most Microorganisms grow best at pH values around 7 (**neutral**). Bacterial growth or multiplication rate decreases at lower pH of the food.

2. Oxidation reduction potential of the food:

- The oxygen tension or partial pressure of oxygen and the reducing and oxidizing power of the food (O-R potential) influences the growth of organisms.
- In relation to oxygen, **bacteria** can be aerobic, anaerobic or facultative, while fungi are mostly aerobic.
- Yeasts are aerobic or facultative anaerobic.
- A high O-R potential favors the growth of aerobic and facultative organisms. Most fresh animal foods have **low O-R potential** in their interior but have higher O-R outside.
- Thus, a fresh piece of meat could support the growth of aerobic organisms in the exterior and the growth of anaerobic organisms inside.

3. Water activity / Moisture Content of the food:

- Most microorganisms grow in food with higher moisture content.
- The water requirement of microorganisms is described in terms of water activity. Water activity is the amount of water found in the food which is available and essential for all living microorganisms.
- Water in food, which is **not bound to food molecules**, supports the growth of bacteria, yeasts and moulds.

The term “**water activity = a_w** ” refers to this unbound water.

- The water activity of food is not the same thing as its moisture content. Although moist foods are likely to have greater water activity than dried foods, this is not always true.

- A variety of foods may have exactly the same moisture content and yet have quite different water activity.

➔ Addition of Salt.

- Moisture Content= unbound free water (water activity) + bounded waters in a food
- The water activity is expressed as a_w and it is **1** for pure water.

4. Nutrient Content of the food:

- In order to grow in/on foods, microorganisms require water, source of energy, source of Nitrogen (Nucleotides, Peptides and other proteins), vitamins and related growth factors and minerals.

5. Antimicrobial Constituents in the food:

- ➔ Some foods may stay for a long time resisting attack by microorganisms due to the presence of naturally occurring substances that have anti microbial activity. e.g.
 - Cow's milk has **Lactoferrin**, **Coaglutinin** but they will be destroyed during pasteurization.
 - Egg contains **Lysosomes**, **Ovotransferrin** which inhibits the growth of Salmonella in egg.
 - Spices have **oil** that possesses antimicrobial activity.
 - Garlic contains ***Allicin***.

6. Biological Structures of the food: The natural covering of some foods provide excellent protection against the entry and subsequent damage by spoilage MOs.

- e.g The Hide of Animals, the Shell of Eggs, Testa of Seeds, outer covering of Fruits, the shell of Nuts, etc.

B. Extrinsic Parameters:

- Extrinsic Parameters of food are those *properties of storage environment* and the presence of substances that affects both the food and Microorganisms. These are:
 1. **Storage temperature:** Based on the optimum temperature requirement for growth and multiplication, MOs are grouped as:
 1. *Psychrophilics*: grow best at low Temperature
 2. *Mesophilics*: grow best at optimum temperature
 3. *Thermophilics*: grow best at high temperature than the normal

“Temperature danger zone”

- 2. Relative humidity of the environment**
- 3. Presence and concentration of gasses in the environment:**
such as CO₂ and O₃
- 4. Presence and Activity of other MOs in the environment of food** that produce inhibiting factors like:
 - » Antibiotics,
 - » Bactericides or
 - » Bacteriostats
 - » H₂O₂
 - » Organic acids

N.B: Food spoilage can be controlled by controlling the intrinsic and extrinsic factors that influence microbial growth in foods.

Signs of food spoilage: Spoiled food can be recognized by: change in **appearance**, change in **consistency**, change in **colour** or change in **flavour**, **presence visible growth** and **gas production**.

N.B. Bacterial spoilage is marked by **foul smelling** of food where as spoilage due to moulds & yeasts is mostly characterized by **whisker**.

- Intrinsic enzymes cause **autolysis** and spoil food after the death

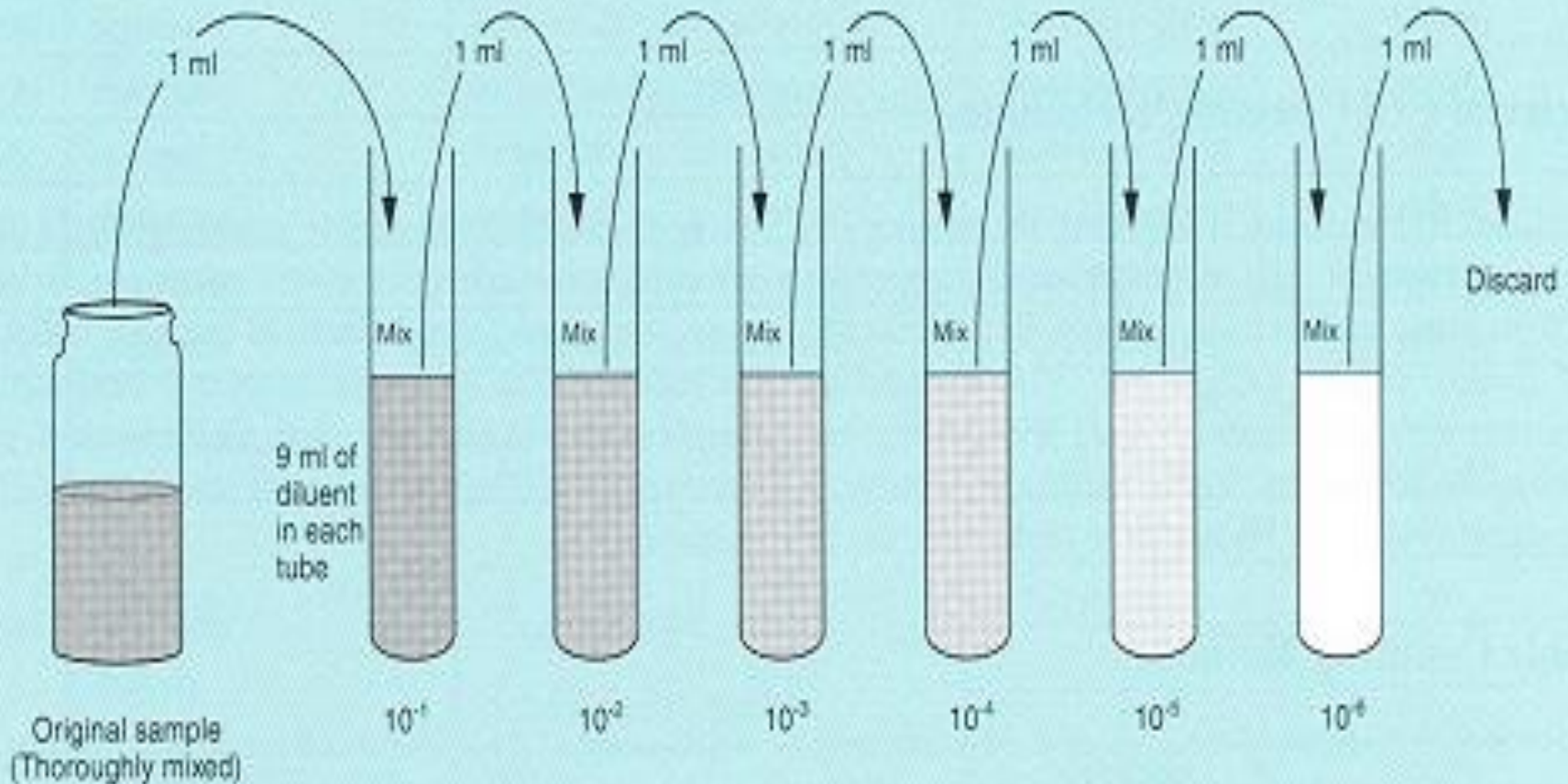
Detection of Food Spoilage/contamination/

1. **Organoleptic methods** (using sense organs i.e. smell, taste, sight, touch ...)
 - Microorganisms Spoil food by **metabolizing** and by producing bacterial end products/metabolites/ such as **Ammonia** (NH_3), **H_2S** , **lactic acid** or other **alcoholic** end products which result/bring/ change in **consistency**, **appearance**, **colour**, **flavour** (taste and smell) of the food. We can detect food spoilage by examining the food for the presence of the above changes using our sense organs.
2. **Supportive tests (laboratory tests):** Since it is not possible to sense **minute spoilage**, supportive tests are important to detect the hidden spoilage.
 - The tests include determination of **pH**, **NH_3** , **H_2S** **volatile fatty acids**, **antibiotic sensitivity tests**, or **residue level determination test**.

➤ **Measuring pH:** The normal Ph of fresh milk lies between **6.3-6.75** and that of fresh meat is about **5.5**. $\text{pH} < 6.3$ in milk suggests Microbial contamination, excessive lactic acid production, but $\text{PH} > 7.5$ indicate the milk is from **mastitic cow**

3. Culturing and bacterial load determination: By counting colony forming units (CFU) / Total aerobic Plate count (APC)

Serial dilution for colony forming unit (CFU) APC method



The importance of this **Serial dilution** is in order to make the counting of colonies very easy

4. Using rapid methods PCR: This could be applied at commercial level

Public health importance of food Spoilage

1. Spoilage results in food-borne infections and intoxications
Eg. Contamination of food by staphylococcus bacteria
2. Economic losses can lead to food scarcity

MEAT HYGIENE

Definition:

- ***Meat Inspection***: it refers to examination of meat for some abnormalities and diseases.
 - It is meat production with an **expert supervision** and with the objectives of providing **wholesome meat for human consumption** by excluding all factors which endanger public health.
- It works with **QSA principle**: Quality, Safety and Acceptability of meat and meat products.
- A **proper meat inspection service** consists of a veterinary examination of the live animal (**ante-mortem inspection**), and examination of the carcass and offal (**post-mortem inspection**) and where necessary, **laboratory tests** of body tissues and fluids

Meat: is the edible parts (Skeletal muscle & offal: Heart, Liver, Kidney, Tongue) of the food animals.

Carcass: is meat excluding blood, feet, head, skin and viscera (internal organs).

Offal: also known as **by-product**; refers to non-carcass materials, which can be classified as edible and inedible.

⇒ **Edible offals:** includes liver, heart, tongue (= *red offals*)
→ stomach and intestine are termed as *green offals*.

⇒ **Inedible offals:** includes feet, horn, hoof, hide/skin, ears, etc.

In general, the inclusion of offals as an edible varies throughout the world owing to **custom, religion** and **reputation** of the product.

Dressing Percentage (Carcass Yield):

- Dressing percentage is calculated by dividing the **warm carcass weight** (after blood, skin/hide/, feet, head, thoracic and abdominal visceral have been removed) **by the live weight of the animal** and expressing the result as a percentage.
- For example, suppose an animal delivered to the slaughter house weighs 300kg and after being killed, the skin, head, feet and thoracic viscera and gut are removed, the carcass then weighs 180 kg. The dressing percent of this animal will be 180 divided by 300 multiplied by 100 equaling 60 percent.
- This “**60 percent**” represents the meat and skeletal portion of an animal compared to its live weight.

- For cattle the carcass weight is expected to be about **53%** of body weight. Therefore, if the live weight of the animal (bovine) is 270 kg, we expect a minimum **Carcass yield** of 53% which is 143.1kg.
- In bovine, bone covers **20 %** of the live animal body weight. (**270x20%= 54kg** of bone)
- Therefore, **Meat Weight = Carcass weight – Bone weight.**

143 kg carcass – 54kg bone= **89kg** of meat

The carcass weight expected for different animal species is as follows:

- Sheep and Goat ~ **50%** of the live animal weight.
- Chicken ~ 72%
- In pig ~ **75 %** of the live animal weight.

Source of Meat

- The animals which furnish meat for human consumption are mostly those which are **domesticated** and **of herbivorous type**: i.e. **Cattle**, buffaloes, **Sheep**, **Goat**, **Camel**, Poultry (**hen**, duck, goose and guinea fowl), rabbit, pig, guinea **pigs** and **fish**.
 - Although theoretically hundreds of animals could supply meat for human consumption, in practice only small number of animal spp are used today.
- This may be due to restriction of the public to certain type of food animals due to their **religion**, **culture**, etc.

Composition of meat:

Lean beef meat comprises of the following constituents

1. Water -----75 %
2. Protein-----19 %
3. Non-protein nitrogen-----1.65 %
4. Lipids (fat and fatty acids)-----2.5 %
5. Carbohydrates (glycogen)-----1.2 %
6. Minerals-----0.65 %
7. Vitamins and other substances constitute minute quantities.

Nutritive values of meat: Why people are fond of eating meat?

- **Meat is a valuable part of the human diet because:-**

1. It is the most concentrated and easily assimilable of nitrogenous foods. It contains all essential amino acids. A vegetable diet, compared with a meat diet, is usually *incomplete in essential amino acids*
2. It stimulates body metabolism because of its high protein content.
3. It is also a good source of fat, carbohydrate, bioavailable minerals and vitamins (Vit B Complexes and fat soluble vitamins → ADEK) and others.
4. The fat in the meat delays emptying of stomach and alleviates hunger.

5. Suitable treatment (cooking) imparts meat **palatable flavour** and acts as a **stimulant to gastric secretion** and is readily digested.

Contamination of Meat

The organisms that contaminate meat may get access through:

- **Infection of live animal: endogenous** sources or
- **Contamination of meat after the animal is slaughtered:**
Postmortem contamination (**exogenous source**)

Sources of Contamination for Meat

1. **Outer integuments** (Hide, Skin, hair, feet, etc)
2. **GIT contents** (stomach and intestine)
3. **Sticking point**: if the sticking material is **not clean**, the bacteria may get access to get into the jugular vein, then to vena cava and finally reach to the meat
4. **Physical contact with structures /premises/ vehicles/**
5. **Operatives**: personnel working in the slaughter house
6. **Equipments / utensils**: such as knife, saws, cutters
7. **Vermin**: animals obnoxious to human (beast or insects)
8. **Chemical contaminants**: Chemicals used for cleansing the materials

Signs of Meat Spoilage

- Marked change of color to grey, yellow, green
- **Stiffening** in the consistency of the tissue
- Pronounced repulsive odor
- An alkaline reaction caused by the formation of ammonia (NH_3)
- ❖ These changes can be detected by sensory analysis (**organoleptic tests** and/or Laboratory tests)

Production and Transportation of food animals

- To produce a hygienic meat, the control should start **from farm (during production)** in addition to the **processing centres** and **final consumption**.

Food animals should be:

- Raised in hygienic environment,
- Free from epizootic and zoonotic diseases,
- Free from residue and
- Properly transported to the abattoir.

Transportation of food animals

- ⇒ Meat consumers are increasingly demanding that animals be **reared, handled, transported and slaughtered** using **humane practices**.
- ⇒ During transportation of food animals, they should be kept free from:
 - **Injury and disease**
 - **Stress and loss of weight,**
 - Unnecessary **suffering** while being loaded and unloaded_____
- ➔ It is essential that animals should be slaughtered **as near as possible** to the point of production in order to avoid unnecessary injury. (Though it is may not be possible always)
- ➔ Transportation of **unfit animals** and those likely to give birth during the journey should be prohibited.

Slaughter animals should be transported with facilities to the abattoir that ensure that:

1. Soiling and cross-contamination with faecal material is minimized
2. New hazards are not introduced during transport;
3. Animal identification as to the place of origin is maintained; and
4. Consideration is given to avoid undue stress.

Means of animal Transportation

Animals may be transported by the following **4 methods**:

1. Driving on hoof: Can be done if animals movement is permitted and the abattoir not too far from the farm or market

Feed and water must be provided during the journey.

❖ **Advantage:** It is very cheap

❖ **Disadvantage:** It causes **weight loss**, take **longer time** to reach abattoir, may cause **mortality**; and animals may contract and transmit **diseases** on their way to the abattoir.

2. Transport by vehicle: It is an excellent method if the road has good standard and the vehicle is designed for the transportation of animals (with **non-slippery floor, adequate ventilation, sun protected**).

3. Transport by rail: Where the roads are poor standard, transport by rail is more reliable.

4. Transportation by ship or by plane: During live animal export

- The advantage of transporting animals other than on hoof is **rapid** and provides **protection**,
- But there may be **injury during loading and unloading**. → On the other hand it requires a **high investment** cost.

Transport vehicles should be designed, constructed and maintained so that:

1. Animals can be loaded, unloaded and transported easily and with **minimal risk of injury**
2. Animals of **different species**, and animals of the same species likely to cause injury to one another, are physically separated during transport
3. Use of **floor grating, crates** or similar devices limits soiling and cross-contamination with fecal material
4. It should be **easy to clean and disinfect**
5. **Ventilation** should be adequate to prevent suffocation

Adverse effects of Transportation on Animals

During transportation, animals are subjected to a number of adverse effects like:

1. Loss of body weight: It depends on the **body condition** of the animals, **season** and **time** of the journey and **species** of animal being transported.

➤ The causes are depletion of glycogen by **long, delay in transit** and **lack of feed and water** during transportation period.

2. Injury/ trauma: It is mainly due to **lack of bedding, mixing of** horned and polled animals or different age groups, **overloading** or **excessive use of beating** and **poor ramp design**.

Bruising: is a damage of the underlined tissue with the skin remained unaffected.

Economic implication of bruising:

- » **Loss of meat** (the bruised part has to be trimmed, even extensive bruising can result in total condemnation of the meat)
- » Trimming **impedes** slaughtering operation and also requires extra labor
- » The meat **tests after blood**
- » Presence of blood in the bruised carcass **leads to meat spoilage**

3. Disease: as a result of lack of **water and feed, suffocation and contact with other animals.** e.g. shipping fever due to *Pasteurella multocida*, Salmonellosis

4. Mortality: due to **suffocation, trampling and adverse climatic condition or diseases.**

➤ Shoats & pigs are highly affected by suffocation.

Measures to reduce adverse effects of Transportation

1. **Different group of animals like** young and adults, females and males, horned and polled, secured and unsecured should not be transported in the **same undivided vehicle**.
2. **Use well designed car** which have **non slippery floor, adequate ventilation and protection against rain and sun**. The minimum floor requirement on vehicles is
For pig = **335 cm²** Sheep = **213 cm²** Calf = **271 cm²** Cattle = **56 cm** cross wise
3. **Loading and unloading should be using a loading ramp**; the slope of the loading ramp should not exceed **30⁰**. Manual lifting for smaller species is better if used.
4. **Don't load** earlier than a few hours before departure.

5. **Avoid unnecessary use of sticks** when loading unloading and during transport on hoof
6. **Avoid overcrowding** but pack the animals **tight enough** to prevent them lying down
7. **Provide water and feed during the journey and after arrival.** If the journey exceeds **24-36** hrs the practice should be done at resting ground not in the **vehicle** and **wagon**
8. **Insure that the animals are rested** (if the journey is very long and the environment is difficult)
9. In order to prevent disease transmission, **vehicles should be cleaned and disinfected** before loading and after unloading.

Pre-slaughter Care of Animals

1. **Resting:** It is necessary to rest fatigued and excited animals before slaughtering at least **12 hrs or more**

Inadequate Resting may cause:

- **Reduced keeping quality of meat** and facilitate early invasion of the carcass by putrefactive bacteria. (Due to incomplete development of acidity of the meat and incomplete bleeding)
- The actual resting period depends on:
 - ❖ Species of animal
 - ❖ Sex, age and body condition of animals
 - ❖ Season of the year
 - ❖ Method of transportation, length of the journey → degree of fatigue
- During resting period, animals must be kept under conditions, which prevent any further **contamination** of **feet, fleeces** or **skins**.

2. **Watering:** During detention in the lairage, animals should get ample water
→ This serves to **lower the bacteria load** in the intestine and **facilitate easy removal of skin or hide.**
3. **Feeding:** Animals having long journey should be fed and rested near the slaughter house before they are slaughtered.
4. **Fasting:** Animals should not be presented for slaughter with full stomach.

If slaughtering takes place within **12 hours** of animals arrival at the slaughter house, there is no need to feed the animal.

Slaughter house/ Abattoir

- Are establishments where **livestock** are killed prior to human **consumption**.
- Animals should be subject to **inspection** to ensure that the meat they produce is safe to eat.
- This includes **ante mortem inspection** (inspection of live animals), and **postmortem inspection** (examination of organs and carcasses).

Importance of constructing abattoir and slaughtering animals in slaughterhouses

1. An immediate **inspection** by meat inspectors is impossible.
2. **People** who are included in **killing** and assisting in the **handling** of the meat will be the first **victims** of any disease that may occur.
3. **Eating raw meat**, such as the **tongue** and a portion of tripe called “**semler**”, immediately **after slaughtering** they may contact **tapeworm** and other meat borne illness.
4. The **stunning** and **slaughtering** practice may be incomplete and as a result a portion of the **blood may remain within the meat** and may lead to **spoilage** of the meat during storage.

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5. **Poor/ unhygienic handling** of meat during animal slaughter in **open fields** as a result **keeping quality** of the meat will be affected.
 6. **wastage** of certain byproducts which normally require special collection and care for **further processing** to be converted to **valuable by-products**.
 7. The **quality of hides and skins** that may be collected is usually highly affected to the extent that their **market value** will be **diminished or rejected**.
 8. Create an **insanitary environment** that causes the **breeding** of flies, smell and **trouble** to the nearby **inhabitants**.
- ❖ To overcome the above and other related problems, It is necessary that the slaughtering of animals for human consumption be carried out in **establishments** especially **designed** and **constructed** for this purpose and kept under constant **sanitary control**.

Unhygienic slaughtering in a makeshift slaughter slab in Kenya.





Overhead rails are made of **stainless steel**, while the walls and floors are made of **ceramic tiles** for easy cleaning and hygiene.



Meat inspection

Ante mortem inspection

- Is **examination** of **live animals** on entry to the slaughterhouse.
- This is the **most important** process of examination, without which no **adequate post mortem** inspection of the carcass is possible.
- Many diseases like rabies, anthrax and tetanus that may not produce visible lesions and any evidence of **abnormality** can only be **detected** on **ante mortem inspection**.
- An animal showing **signs** of **illness, injury** or exposed to **sudden accident** must be subjected to a **thorough examination** and **follow-ups** before taking final action.

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Signs of health

Active and alert
Muzzle - moist and wet, cool
shiny bright coat
Skin – loose and elastic
Clear bright eyes
Breathing – easy and regular
Feed and drink normally
Normal temperament
Normal dung
Normal temperature
Remain in herd
General good body condition

Signs of sickness / Disease

Inactive, dull and hanging head
Dry muzzle, warm
Rough, dull coat
Skin - sticky (tight skin)
Dull, sunken and discharging eyes
Difficult, rapid or painful, breathing
Loss of appetite, refusal of food
Abnormal behavior
Bloody diarrhea
Abnormal temperature
Separate from herd or lag
Emaciated body

- The major causes of **ante mortem rejection** of animals are emaciation, exhaustion, pregnancy, sheep-pox, foot-rot, actinomycosis, brucellosis, febrile conditions, diarrhea, very dirty animals and other diseases of an infectious nature

Methods of slaughter and bleeding practices

1. **Stunning** is a process for rendering animals **unconscious**.
 - Is performed by **mechanically** operated instrument and **electricity** or **gas anesthesia** without any adverse effects on the condition of the meat or its products.
 - It is done to avoid unnecessary suffering of the animals (humane slaughter) and avoid risks of hurting slaughter personnel.



2. Bleeding: is the process of **draining out** the **blood** from the animal's body by severing the large blood vessels of the neck

- Bleeding should be as **competent** as possible.
- In general it should last for at least **six minutes** and the amount of blood allowed to flow out should be the **maximum**.
- A **healthy** animal usually **bleed well**, while the **ill** ones may bleed badly in that **most of the blood remains in the flesh**.
- **Imperfect bleeding** is an indication of **illness**, suffering from **fever** and other situations.
- The **efficiency of bleeding** has a most important bearing on the subsequent **keeping quality** of the carcass.

Post-mortem examination

- Is **examination** of the **carcass** and **organs** after **slaughtering**.

Main purpose PME is :

- ❖ Detect and eliminate **abnormalities** and
- ❖ Detect the states of **contamination**
- It should be carried out **immediately after** the **slaughter** and if possible a **follow up inspection** is done from **slaughtering** to **dressing** stages of the carcass.

Important requirements:

- Be carried out in a **methodical manner**, following a definite sequence.
- The commonly used PM inspection techniques are **visualization, palpation, incision** and **olfaction**
- Be performed by **experienced meat inspectors**.
- Performed in a **hygienic manner (avoid contamination)**

Cont'd

- Avoiding **unnecessary cuts** and **mishandling** (without impairing the **market value** of the meat).
- Ensuring that the meat is **fit** for human **consumption**.
- If the carcass or organs require **detail examination** then **bacteriological** examination needs to be done in detail for further examination in part or whole.
- All carcasses or organs found to be **free from disease** and **abnormal conditions** must be **stamped** as **fit** for human **consumption**.
- Those that are **unfit** should be **condemned** and immediately removed to a final **disposal** place.
- Carcass should be transported soon after completing **PME**.

Categories of PMI Judgments (Decisions)

The final judgment during PMI may fall into one of the following six categories:

a) Approved as fit for human consumption: This judgement is passed

- When no disease or abnormal condition or residues are detected and
- If the slaughter operation has been performed in hygienic manner

b) Totally condemned from human consumption: Carcasses and offal shall be condemned, if one or more of the following conditions are met.

- If the animal is **infected by contagious disease** or **zoonotic disease**.
- If **residue** beyond the normal limit is detected
- If there is **severe organoleptic deviation** from normal meat or show extensive decomposition, injury, swelling, edema, emaciation or contamination

c) Partially condemned for human consumption:

- ❖ This judgement is passed, if abnormalities or defects are encountered in localized parts of the organ or carcass. The healthy and clean part of the carcass is passed for human consumption after trimming of the affected part.

d) Conditionally approved for human consumption:

- ❖ This judgement is passed, if the carcass or organ poses hazards to the public or animal health but if the hazard can be eliminated through proper treatment, e.g. as in the case of *C. bovis*, which can be killed by **freezing** or **cooking**.

e) Inferior meat:

- ❑ A carcass is classified as inferior, if the meat is below accepted standard, but does not pose public hazard when consumed. e.g. abnormal odour or taste or colour caused by non infectious cause

f) Approved for human consumption with distribution restricted to limited areas:

—The judgment is passed, if the animal originated from an area where there is an outbreak of disease and slaughtering has been recommended to contain the disease in that area; or if the animal comes from quarantine stations.

g) Detained:

- Carcass may be detained for further inspection and if chemical, toxicological or microbiological examination is required; or if there is slight **discolouration** e.g. as in the case of jaundice.
- Upon re-examination, the carcass may be approved or condemned depending on the result.

The following measures can be put in place at primary production of livestock to ensure safety of meat:

- Implementing good agricultural, animal husbandry and hygienic practices in animal production;
- Avoiding the use of areas where the environment poses a threat to the safety of animal products
- Prevent contamination of animal feedstuffs with food borne pathogens
- Control of animals diseases through regular vaccination and prompt treatment
- Responsible and prudent use of veterinary drugs and strict observation of withdrawal periods.
- Ensuring effective animal welfare practices.

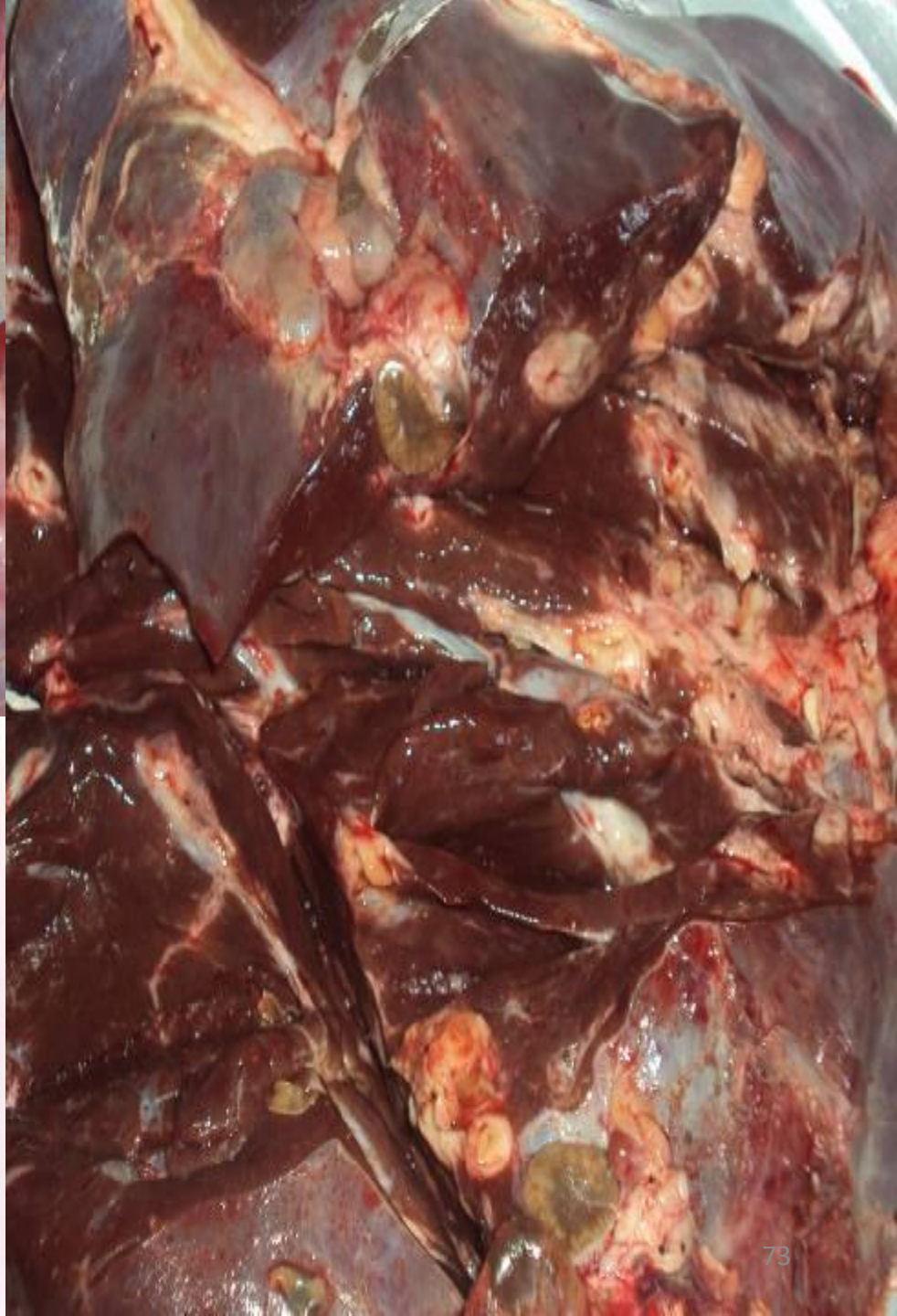
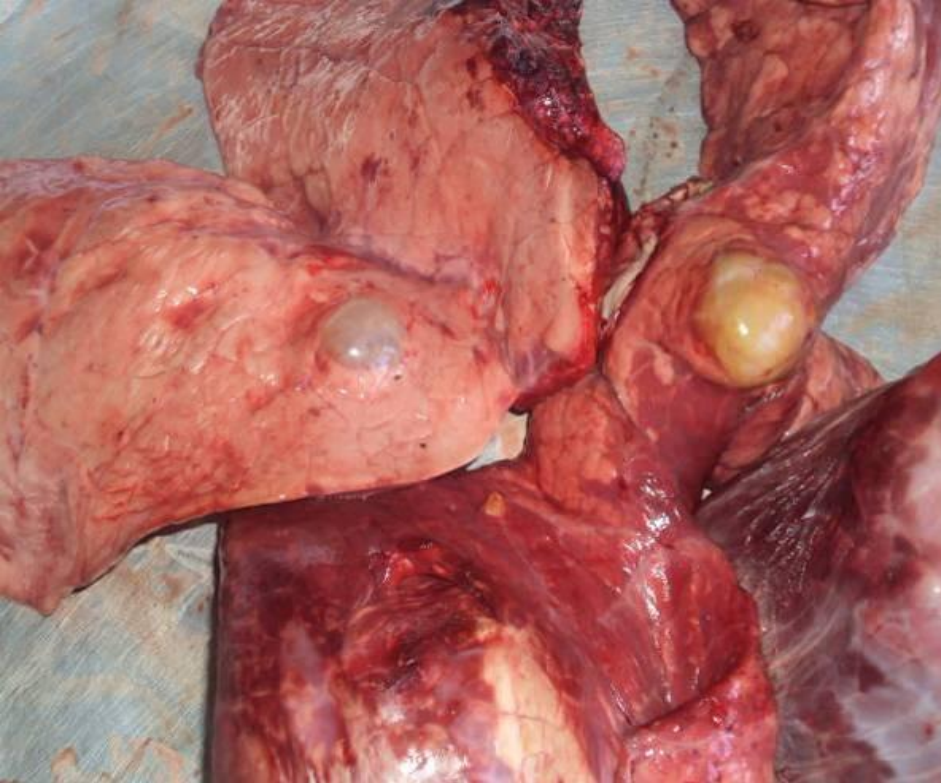
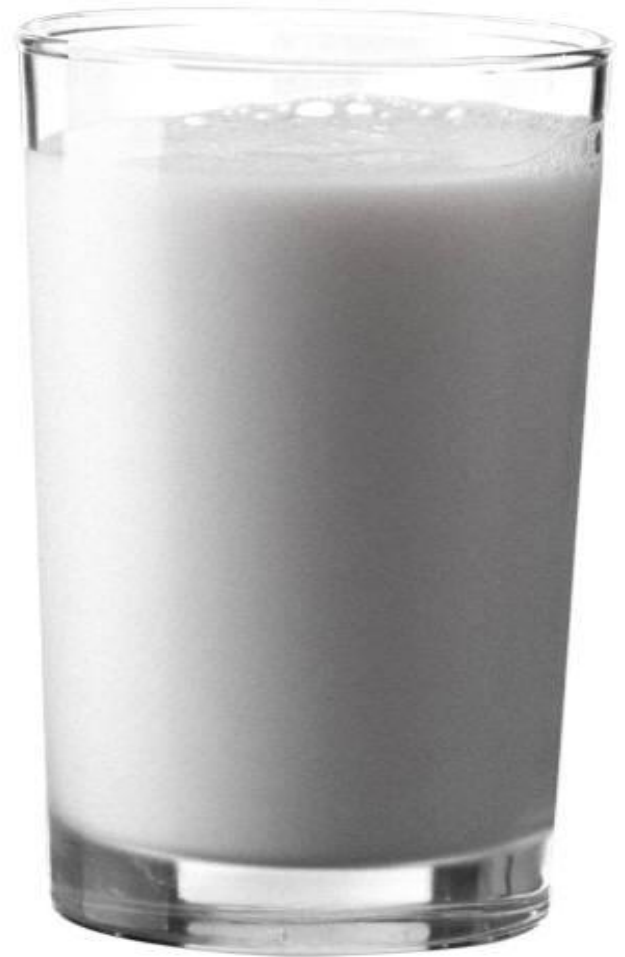


Fig. 5. Hydronephrosis of kidney.

MILK HYGIENE



MILK HYGIENE

- Milk is a fluid secretion by the **mammary gland** of mammals to feed their offspring.
- Nutritionally milk is a **well balanced** diet.
- It contains almost all the essential nutrients such as protein, fat, glucose, minerals and other nutritive substances to sustain life.
- “**nature's single most complete food**” or “**the most nearly perfect food**”.
- Additionally it is **palatable**, **easily digestible** and it **assimilates** very easily and good **growth promoter** (Child feeding).

- **Milk hygiene:** All conditions and measures necessary to ensure the **safety** and **suitability** of milk at all stages of milk production chain.

Objectives of milk hygiene: -

- To provide consumers with wholesome milk and thus, **safeguard the public from milk borne zoonotic diseases and residues.**
- **To advise dairymen, creameries and consumers** on the proper handling of milk and milk products.
- **To reduce economic losses** resulting from milk spoilage and other problems associated to milk with poor hygiene.

Composition of milk

- **Composition** of milk is **not constant**, but shows a wide variation. It depends on the:
 1. Species and within species of animal
 2. Between breeds and within a breed
 3. Feeding and season
 4. Stage of lactation
 5. Completeness of milking: First milk differs from the last milk drops
- ❖ Consists mainly of **water**, **protein**, lactose and fats, inorganic salts, vitamins, enzymes, gases and other substances.
- The sum of **all** the **compositions without water** is called **Total Solids (TS)**.

- If **milk fat** is **not included** in the **Total Solids** we speak of the **Solids Non Fat (SNF)**. $SNF = TS - \text{fat}$

$TS = \text{fat} + \text{protein} + \text{lactose} + \text{ash or minerals} + \text{vitamins}$

- The **nutritional** as well as the **economic** value of milk is directly associated with its **solids content**.
- The **higher** the **solids content** the **better** its **nutritional value** and the **more** of a **milk product** can be made out of it.

1. **Water**: is the principal constituent.

- Medium in which all constituents are in **solution/suspension**.
- **Adulteration** of milk by the addition of water is commonly practiced.

2. Fats (lipids): is suspended in the milk in the form of an **oil-in-water** emulsion.

- Is the most **variable** in the constituents of milk.
- Fat, known as cream, occurs in the form of **globules** or **droplets** and is **lighter** than water and tends to **rise** to the surface of the milk if not homogenized.
- Churning, causes the fat **globules** to gradually **coagulate** into **larger drops** and lumps to form **butter**.

3. Protein: three principal proteins found in milk in are **casein**, **lacto albumin** and **lacto globulin**.

- If milk pH falls below 5, the casein **precipitates**.
- Liquid portion is referred to as whey.
- During **curding** or **souring** of milk the **casein** is **precipitated** by **lactic acid** produced through the **action of bacteria** on **lactose**.

4. Lactose (milk sugar): is composed of the simple sugar **glucose** and **galactose**.

- Lactic acid bacteria present in milk readily germinates it.
- These bacteria produce an enzyme known as **lactase** which splits the **lactose** and ferments it into **lactic acid**.
- This causes the milk to **sour**.

5. Minerals (ash): includes calcium, phosphorous, sodium, potassium, magnesium and chlorides.

- Milk is a source of **calcium** and a rich source of **phosphorous**.

6. Vitamins:

- **Vitamin A:** heat resistant
- **Vitamin B1** (thiamine): heat resistant
- **Vitamin C:** Milk is a less dependable source of vitamin C, which is heat **sensitive**
- **Vitamin D:** heat resistant
- **Vitamin E:** heat resistant
- **Vitamin B2** (Riboflavin): heat resistant
- The fat of milk is a rich source of vitamin A.
- Therefore **butter**, **cream** and all kinds of **cheese products** which are made from **whole** milk are outstanding sources of vitamin A.

7. Enzymes:

- Are protein compounds which act as **biological catalysts** having the ability to **speed** up or **retard** the **chemical reaction** without themselves being changed.
 - Enzymes are **specific** in their **action**. For example, lipase acts only on fat, lactase acts only on lactose, phosphates acts only on phosphate etc.
 - Enzymes are relatively **unstable**.
 - High temperatures, an unfavorable pH, light, and certain chemicals tend to destroy or inactivate them.
-

9. Trace components of milk: Includes **somatic** or **body cells** and **microorganisms**.

- i. Somatic or body cells:** Body cells or leucocytes are always found in fresh milk, even if milk is drawn from healthy quarters.
 - **California Mastitis Test** is used to estimate **number** of **leucocytes** and thus, evaluate the **quality of milk**.
 - The number of somatic cells may vary considerably, but it is generally **lower** than **200,000 per ml**.
 - Counts of 500,000 and more are an evidence of abnormalities, usually being an indication of mastitis.

ii. Microorganisms

- **Unfavorable microbes:** cause milk spoilage and such MOs should be controlled or destroyed to make milk safe.



- **Favorable micro organisms**

- Microbes which bring **favorable** changes in **flavor** and **appearance** of milk and such microbes are **beneficiary**.
- E.g. **Starter cultures**

The three main functions of Starter cultures are:

- Produce **acid**,
- Produce desired characteristics of **flavor** or **aroma**
- **Prevent** the **growth of unwanted microorganisms**.

Physical properties of milk

- The major physical properties of milk are color, specific gravity, freezing point and boiling point.
- These are **influenced** by the **composition** of **milk**.
- They are also a great help in the **processing** and **testing** of milk for **adulteration** and determine sound and unsound milk and thus, to **safeguard** the **public** and save/or **minimize economic** losses.

1.Color: ranges from **bluish-white** to **golden yellow**.

Milk pigments influencing the **color** of milk are:

- **Carotene (Vitamin A)** of the fat in the milk that gives a **golden (yellowish)** color.
- **Riboflavin (B2)** of the whey that gives a **bluish** color.

2. Taste: sweet due to presence of **lactose**.

3. Specific gravity: is the ratio of the **weight** of a **volume** of a **material** compared to the **weight** of the **same volume** of **pure water**.

- Milk contains many constituents whose specific gravity is greater than that of water.
- Therefore milk is heavier than water.
- Fat is the only important constituent with a specific gravity of less than 1. Specific gravity of milk is ranges between 1.0295- 1.0350 which usually determined at 20 ° C.
- This is important to determine **adulteration** of milk or **removal** of **fat butter** from milk.

- Milk with a lower fat content has higher specific gravity than milk with higher fat content.
4. **Freezing points:** freezing point of milk is almost a **constant** value and freezes at -0.55°C .
 - As the freezing point of normal milk is constant, an **increase in freezing point** indicates the presence of **added water** in the milk.
 5. **Boiling point:** freshly drawn milk boils at about 100.17°C .
 - An increase in osmotic pressure raises the boiling point of the liquid.
 6. **pH:** pH tells us whether the milk is acidic or alkaline.
 - Normal milk has a PH of 6.5 -6.8. PH meter, colorimeter, litmus paper can be used to measure pH.

Contamination of raw milk

- Sources of milk contamination

1. Practices related to the animal:

- Animals are **not healthy** or suffer from **mastitis**;
- Animals are **dirty**, in particular the **udder**, the **teats**, the **hind quarter** and the **tail**.

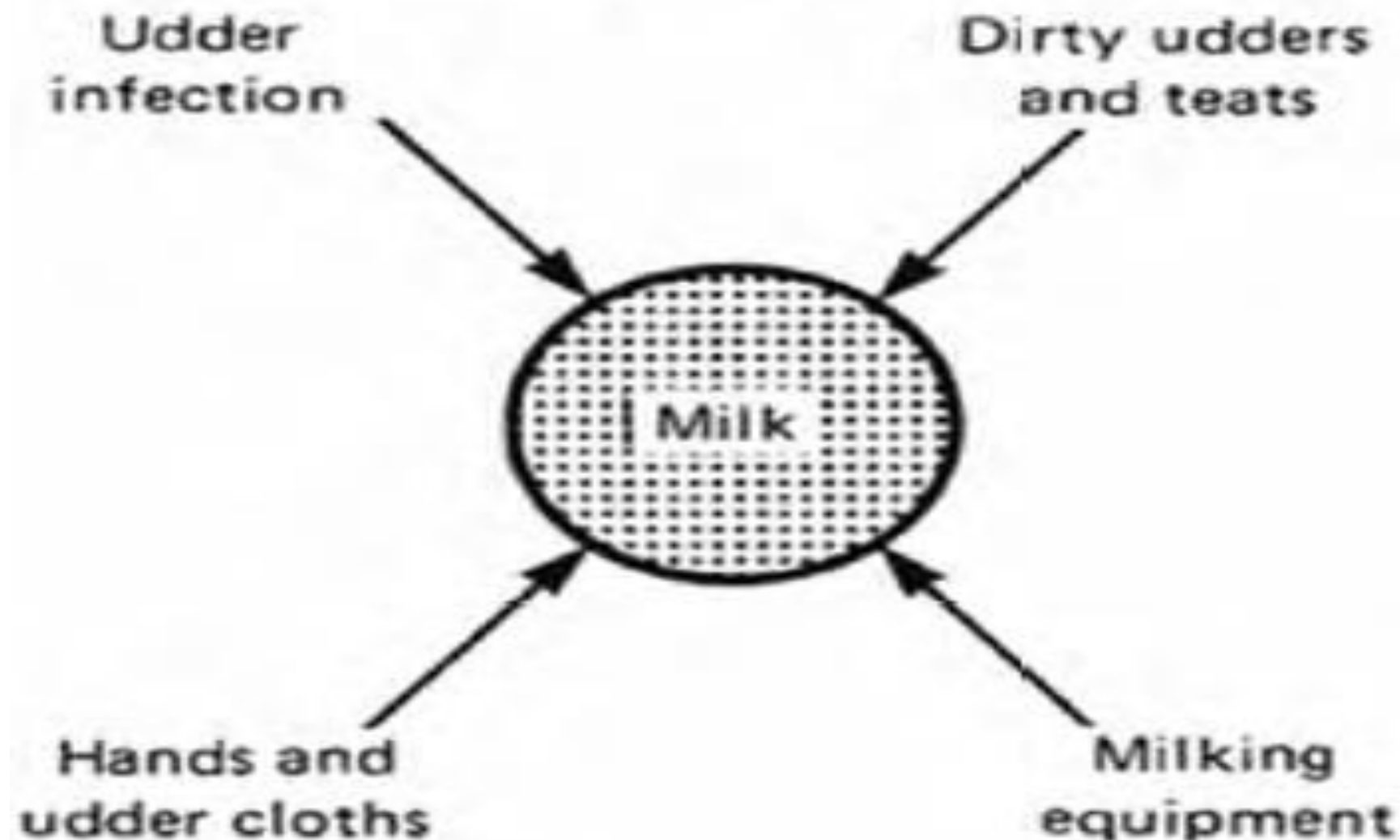
2. Practices related to the milker:

- **Hands** and **clothes** of the milker are **not clean** and he or she practices
- **Unhygienic personal habits**.

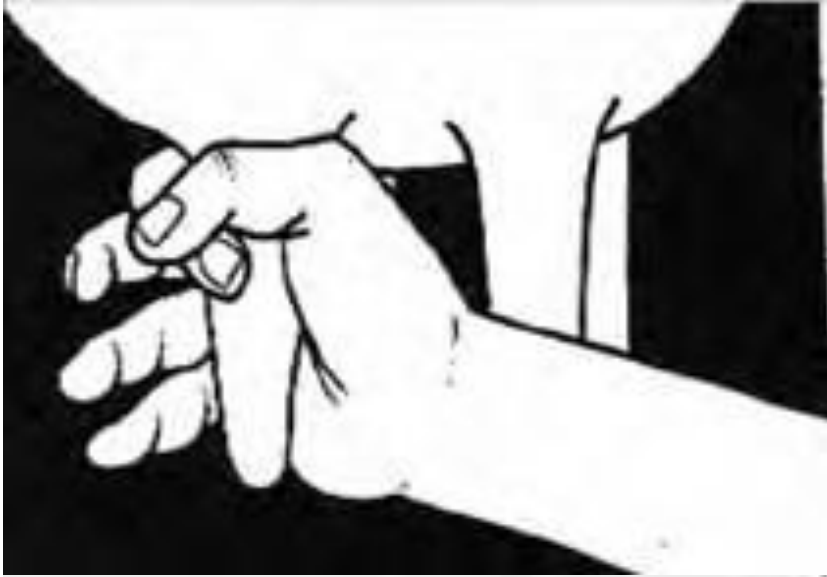
3. Practices related to the milking process:

- Wrong milking procedures (like stripping) are used,
- The **utensils** and the milk **containers** are **not cleaned properly**.

SOURCES OF CONTAMINATION



proper milking technique



1. As long as the milk is still in the udder of a **healthy animal** the bacterial count will be low. After the milk leaves the udder, contamination will take place during **milking, milk handling, transport and storage**
2. The micro-organisms will begin to **grow** rapidly particularly at high ambient temperature and cause **marked deterioration/spoilage** and thus badly affect the **keeping quality** of the raw milk/ spoil milk for liquid consumption/ and the **quality of the products** manufactured from such milk. Milk contaminated with pathogenic bacteria is **harmful** to human health.
3. Dirt such as dung/ so does bacteria in the intestinal tract, soil, bedding, feed, dust, hair and etc from the skin of the body of the animal in general and udder and flank in particular may fall in to the milk during milking.

4. Milking in the rain may badly affect the quality of the milk if the rain water is allowed to flow from the animals' body into the milk.
5. Milk may be contaminated by the **hands** of the **milkers** as dirt could fall from his/her hand in to container.
6. The milker may be a source of pathogenic bacteria of human origin. Moreover, a disease can easily be carried from one animal to another on the milker's hands.
7. **Generally**, the source of bacterial contamination of milk may be within the **udder**, or on the surface of the **cows**, **milkers**, and other **personnel**, or the **environments**.

Milk hygiene practice

1. Animals must be **clean** and **healthy**.
2. **Milking** should be done away from the herd.
3. The **milk handler** should also be **clean** and healthy. She/he should **wear clean outer garments** during milking or processing the milk.
4. The **milking room** should be **clean, ventilated** and **dustless**.
5. **Utensils** and **equipment** for milking and milk handling must be cleaned well.
6. Immediately before milking the **udder** and **teats** of the cow must be **washed** with clean lukewarm water and dried with clean cloths
 - ❖ a separate one for each cow.
7. Immediately after milking the milk must be removed from the shed, placed in a clean and covered container and kept in a cool place.

MILK PROCESSING

- Basically, milk is processed to **increase palatability** of milk products and **shelf life**.
- Milk is processed in different ways; **traditional** or **industrially**.

1. Cream: A portion of milk containing milk fat.

- Cream may be taken from milk by “skimming “or “separating”

Skimming is the process of removing manually the cream, which rises to the surface, after milk stands in a container. The remaining part of the milk is called skimmed milk.

Cont'd

- **Separating** is the process of removing cream mechanically. The remaining part is called **separated milk**.
- In the industrial production of cream this process is accelerated by using **centrifuges** (3000rpm) called "**separators**".

2. Yoghurt:

3. Butter- Is concentrated fat obtained by churning **cream** or **sour whole milk** and collecting the fat in compact mass.

- Cream is violently churned up and shaken so that the fat globules are broken up and closed together into pieces of mass called **butter**.
- Compositions of butter are butter fat, moisture, salt and curd.

4. Cheese- Is formed by coagulation by direct **acidification**, by **lactic acid produced by bacteria**, by adding **rennet**, or a combination of acidification and addition of rennet.

- Rennet is a variety of enzymes of animal, plant or microbial origin used to coagulate milk in cheese-making.

Food technologies of major public health importance

First and the best approach to **ensure the safety of food** is naturally to **prevent contamination during production**. This may be possible for certain contaminants.

Eg. Contamination of milk with *Brucella spp* and Levels of pesticide residues

Preventing contamination, however, is **not always possible**.

- 1.Despite all efforts at good agricultural practice, certain raw foodstuffs may still become contaminated with **pathogenic organisms** particularly in countries where **food animals are not vaccinated**, **untreated wastewater** is used for irrigation or where **human excreta** is used as fertilizer.
- 2.The **hot** and **humid** climates of many developing countries favor microbial growth
- 3.Improper handling during later stages in the food chain (i.e., **transport, storage, distribution** and **preparation**) may also increase the level of contaminants.

- **Thus Application of food technologies** is essential to prevent **food borne diseases**.

- From a **public health viewpoint**, food technologies may be divided into three groups, depending on their potential for **preventing, reducing (killing) or controlling contaminants**:

1. **Those used to render food safe** (i.e. reducing MOs present in food);

2. **Those used to keep contaminants under control** (i.e., preventing the growth of organisms or the production of toxins)

3. **Those used to prevent contamination during or after processing.**

In practice, combinations of **two or more** such technologies are frequently applied. Eg. raw milk is **pasteurized** to render it safe. It is **aseptically packed** to **prevent re-contamination**.

1. Technologies used for rendering food safe

a. Heat treatment: Boiling, cooking, frying, baking and roasting are steps in many food preparation and food manufacturing processes at household and industrial levels.

- They lead to physicochemical changes which **increase the digestibility** of certain foods and thus **nutritional quality** and improve **texture, taste, smell and appearance**.

pasteurization: The term 'pasteurization' usually refers to a process involving heat **treatment** at a prescribed **time-temperature combination** to kill vegetative forms of pathogens that may be present. It cause minimal changes in the **composition, flavour, and nutritive value** of food.

Commercial sterilization: is another type of heat treatment used in **canning** to **render food safe**, **kills** all **pathogenic** and **non-pathogenic vegetative cells**, as well as the **spores** of pathogens, and is therefore of great importance for elimination of spore-forming pathogenic bacteria such as ***Clostridium botulinum***.

- **Commercial sterilized food products** can be stored at **room temperature** without the product becoming **unsafe** or **spoiled**.

b. Freezing: is mainly used to **prevent** growth of microorganisms (both **spoilage** and **pathogenic** organisms) **but:**

- Certain parasites, i.e., helminthes, are killed by freezing which can thus be used for killing helminthes such as *Trichinella* and *Taenia* in beef and pork.

c. Irradiation:

- **At low doses** (up to 0.5 kGy), irradiation may be used to destroy larvae parasites in meat (e.g., *Trichinella spiralis*, *Taenia saginata*).
- **At higher doses** (3-10 kGy), This technology can be effective in destroying bacteria such as *Salmonella*, *Shigella*, *Campylobacter*, *Vibrio*, *Yersinia* and other non-spore forming pathogens.

d. Disinfection with chemical agents is one of the most important technologies applied in the **public health control of disease**, especially in the **treatment of water supplies**.

- Water (used for **drinking** or as a **processing aid** or **ingredient**), can be a source of pathogenic organisms. Disinfection with chemical agents ensures its microbial safety and prevents contamination of food.
- **Chlorine** is effective in preventing waterborne diseases (**cholera**, **typhoid** fever, **shigellosis**, **salmonellosis**, **amoebiasis** and **hepatitis A**).

e. High Pressure Technology. This is now under development and makes use of high pressures (up to 1000 MPa) to **kill microorganisms**. As the technology has **little effect** on chemical constituents, it keeps the **natural flavor** of food intact.

2. Technologies used to control contaminants

- The minimum infective dose (MID) required for bacteria to cause disease varies with the type of organism; however, in most cases high doses are required. For example, diseases caused by pathogenic strains of *E. coli* require (MID) of about 10^6 bacteria.
- Certain food technologies are important because they can prevent the growth of pathogenic bacteria to **disease-causing levels** or **the production of toxins**.
- These make use of **one** or a **combination of several factors** which affect the growth of bacteria, such as **temperature, gaseous environment, acidity, water activity** or the presence of other substances with **bacteriostatic** effects. Depending on the factors involved, different food technologies can be applied.

1. Temperature: Cold holding, chilling, hot holding:

Microorganisms grow within a specific temperature range, known as the 'danger' zone. Outside this zone, growth is slowed down or stopped.

- For most pathogenic bacteria the danger zone is between 10°C and 60°C. By keeping food at temperatures above 60°C (**hot holding**) or below 10°C (**cold holding/ chilling**), it is possible to prevent or slow down the growth of most pathogenic bacteria or the production of toxins.
- However, certain bacteria (e.g. *Listeria*, *Yersinia* and *Cl. botulinum type E*) can grow at temperatures below 10°C. Therefore, chilling may not always be a suitable technique to prevent bacterial growth.

2. PH: Microorganisms are sensitive to pH, and their growth or survival is affected by the acidity of the food.

- **Acidification** with vinegar (acetic acid) or other types of acid foods or agents is a simple technology which makes use of the sensitivity of pathogens to low PH.
- **Fermentation** is a technology by which growth and survival of microorganisms (including pathogens and those causing spoilage) are regulated by low pH, competition for nutrients, and/or **bacteriocins** resulting from the metabolic activity specific to non-pathogenic bacteria (e.g., lactic acid bacteria) or yeasts.

3. Water activity: In their natural state, many foodstuffs contain sufficient water to support the growth of microorganisms.

- By decreasing the amount of water in food or its availability to microorganisms (for example, by binding to other substances such as salt or sugar or by freezing), the growth of microorganisms can be prevented. A number of food technologies are based on these principles.

a. Use of salt or sugar or other water-binding agents is a well established method of preventing growth of microorganisms and food preservation. examples **Salted fish and marmalades**

b. Drying has been used since ancient times to preserve foods and for the prevention of pathogen growth. Eg. Milk powder

- **Spray (air)** and **freeze** drying being among the most modern. Solar drying is a simple technology still used in developing and developed countries. Drying of cereals and grains is particularly important for prevention of mould growth and production of mycotoxins.

c. Freezing: prevents the growth of microorganisms by reducing the **availability of water** (reduced water activity) and by low temperature, and is effective against both spoilage and pathogenic organisms. Most bacteria survive freezing process and upon thawing, particularly at temperatures corresponding to the danger zone (10-60°C), surviving bacteria can grow.

4. Antimicrobial agents: In addition to substances used to reduce water activity or for acidification, other agents with **specific antimicrobial effects** may also be used to prevent the growth of microorganisms. These usually fall under one of the following main categories:

a. Curing salts, such as **nitrites** used in meat products to prevent growth of *Cl. botulinum* as well as to give them an attractive reddish colour

b. bacteriocins, e.g., nisin produced by lactic acid bacteria, are active against pathogens such as *Listeria monocytogenes*, *Cl. botulinum*, *Staphylococcus aureus*

c. gases used as preservatives (e.g., CO₂ used in **modified atmosphere packaging**, which acts in two ways - as **an antimicrobial agent**, and by **replacing oxygen** which is required for growth of certain microorganisms).

- The effects of antimicrobial agents on microorganisms are often selective and they are generally used to **control specific organisms**. Their effectiveness also depends on other environmental factors, e.g., **temperature** and **pH**.
- Some technologies are based on a combination of these factors. For example, microbial safety of **smoked foods** is achieved by a combination of **heat treatment**, **drying** and sometimes **antimicrobial agents** which are present in the smoke.

3. Technologies to prevent re-contamination during or after processing

a.Packaging, whether in metal, glass, paper or plastic, is important in preventing contamination of food after processing and during storage.

- In addition to preventing contamination by pathogenic organisms or chemicals, appropriate packaging protects foods against moisture, and thus prevents chemical and physical changes during storage and thus prevents the growth of undesirable organisms including moulds.

b.Disinfection of equipment: is an essential measure for industrially-produced foods and it is crucial for preventing contamination of food during processing.

- **Heating and ultraviolet light** can be used.

- Disinfecting with chemical agents such as **chlorine, iodine, or quaternary ammonium compounds** which are effective against most or all of the microorganisms present on the surface of equipment.
- Disinfection is usually **preceded** by a thorough cleaning with water and a suitable detergent to remove traces of food, and **followed** by a thorough rinsing.
- c. **Hygienic design of food processing equipment** is essential for prevention of contamination **during** processing. If equipment is of **poor design**, it will be difficult to clean and ensure that it is free from harmful microorganisms. Residues of food remaining in crevices serve as culture media for the multiplication of microorganisms.
- Those equipment parts coming into contact with the food should be **inert** to the product as well as to **detergents** and **disinfectants** under operating conditions.

ZOONOSES

The word “zoonoses” was first coined by Dr. Rudolf Virchow, a German physician in 1880 to describe the animal diseases transmissible to man. He made an important observation that **“Between human and animal diseases, there is no dividing line nor should there be”**.

- WHO in 1959 defined zoonoses as **those diseases and infections which are naturally transmitted between vertebrate animals and man**. The health of human being is tied to the health of animals.
- Today, man is exposed directly or indirectly to the dreaded (feared) risks of more than **300** zoonotic diseases of multiple etiologies, the reservoirs of which occur in **domesticated, pet, farm, captive and wild animals**.

- Any disease or infection that is naturally transmissible from vertebrate animals to humans and vice-versa is classified as a **zoonosis**
- They are caused by **all types of agents**

Percentage of Zoonoses from human infectious diseases:

- **61%** of human infectious diseases are zoonotic
- **75%** of human emerging infectious diseases are zoonotic (pathogens originating from an animal or from products of animal origin)
- **33%** of Zoonoses are transmissible between humans.

Classification of Zoonoses

- Zoonoses are important public health problems in many developing countries of the world.

- As a result of

1. Improved laboratory facilities,
2. Well trained staffs,
3. Adequate manpower and
4. Increased awareness among scientists,

large number of zoonotic diseases of diverse etiologies have been recognized. This therefore, demands for a classification of zoonoses. zoonoses are classified as follows:

A. According to the type of causative/etiological agents:

- 1. Viral zoonosis:** It is caused by a virus, e.g. RVF, rabies, avian influenza, orf, etc
- 2. Bacterial zoonosis:** This zoonosis is caused by a bacterium, e.g. anthrax, brucellosis, tuberculosis, colibacillosis, leptospirosis,, salmonellosis, tetanus, yersiniosis, listeriosis, staphylococcus, etc
- 3. Rickettsial zoonosis:** The etiologic agent of this zoonosis is a rickettsia, e.g. coxiellosis (Q fever), rickettsial pox
- 4. Chlamydial zoonosis:** Chlamydia is the cause of this zoonosis, e.g. chlamydiosis.

5. Fungal zoonosis: Fungus is involved in the etiology of this zoonosis, e.g. Aspergillosis, Cryptococcosis and Dermatophytosis (ring worm).

6. Protozoan zoonosis: The causative organism of this zoonosis is a protozoa which is a unicellular, motile, eukaryotic organism, e.g. giardiasis, Trypanosomiasis, leishmaniasis and toxoplasmosis.

7. Helminthic zoonosis: This is further divided into three categories:

I. Cestodiasis: e.g. Taeniasis, diphyllbothriosis and echinococcosis.

II. Nematodiasis: e.g. Ascariasis, Filariasis, Larva migrans and Trichinosis.

III. Trematodiasis: e.g. Fascioliasis and Schistosomiasis.

8. **Ectoparasitic zoonosis:** Arthropod is incriminated in the etiology of the disease, e.g. scabies
9. Unconditional agents: **Creutzfeldt-Jakob disease**

B. According to the reservoir host:

- 1. Anthroozoonosis:** Infection is transmitted from lower vertebrate **animals** to **man**, e.g. anthrax, brucellosis, contagious ecthyma, dermatophytosis and rabies.
- 2. Zooanthroponosis:** Disease is transmitted from **man** to **lower vertebrate animals**, e.g. infectious hepatitis, measles, Trichophyton rubrum infection and tuberculosis (M. TB).
- 3. Amphixenosis:** Infection is maintained in **both man** and **lower vertebrate animals** and may be transmitted in either direction, e.g. Salmonellosis and staphylococcosis.

C. According to the mode of transmission (its maintenance cycle in nature):

1. **Direct zoonosis:** It is transmitted from an infected vertebrate host by **contact, vehicle or mechanical vector**, e.g. TB, Brucellosis, chlamydiosis, glanders, leptospirosis, ringworm and scabies.
2. **Cyclozoonosis:** It requires **more than one vertebrate host** but, **no invertebrate** host for the completion of the life cycle of the agent, e.g. echinococcosis and taeniasis.
3. **Metazoonosis:** It is transmitted biologically by **invertebrate vector** in which the agent develops, multiplies or both in the vector, e.g., babesiosis, leishmaniosis, trypanosomiosis and yellow fever.
4. **Saprozoonosis:** It requires a **vertebrate host** as well as **non-animal sites** like **soil, pigeon** dropping and **plant material** for the development of an infectious agent, e.g., Aspergillosis, histoplasmosis and **cryptococcosis**.

Modes of transmission of zoonotic pathogen

1. **Direct contact:** contagious ecthyma, cow pox, monkey pox, goat pox, dermatophytosis (**ring worm**), **Marburg** disease and scabies.
2. **Ingestion:**
 - A. **Milk:** Brucellosis, campylobacteriosis, coxiellosis (Q fever), tuberculosis.
 - B. **Meat:** *Taenia saginata*, *Taenia solium*, *Trichinella spiralis*.
 - C. **Fish:** *Diphyllobothrium latum*, *Vibrio parahaemolyticus*.
 - D. **Poultry:** **Salmonella** infection, **Campylobacteriosis**.
 - E. **Water:** Amoebiasis, giardiasis, infectious hepatitis, shigellosis.

3. **Inhalation:** Anthrax, Aspergillosis, Bird flu, Coxiellosis, Q fever and Tuberculosis.
4. **Bite of animals:** rabies, cat scratch disease, herpes simiae and rat bite fever
5. **Bite of arthropods:** Leishmaniosis, plague (*Yersinia pesti*), scrub typhus, trypanosomiosis, yellow fever.
6. **Intrauterine/transplacental:** Listeriosis, Toxoplasmosis Brucellosis.
7. **Abraded skin/wound infection:** Erysipelothricosis, necrobacillosis, tetanus and orf .

Important bacterial zoonoses

1. Anthrax

Synonymes: Malignant pustule/carbuncle/ splenic fever, wool-sorter's disease

Local Names: “Aba Sanga“, ” Afrit”

- **Aetiology:** *Bacillus anthracis*. Gram-positive aerobic bacillus.
- This organism is found in vegetative state in man and animals.
- When exposed to oxygen in the air, it forms spores that are highly resistant to physical and environmental agents.
- Bioterrorism agent

Geographic distribution: Worldwide

Occurrence in man:

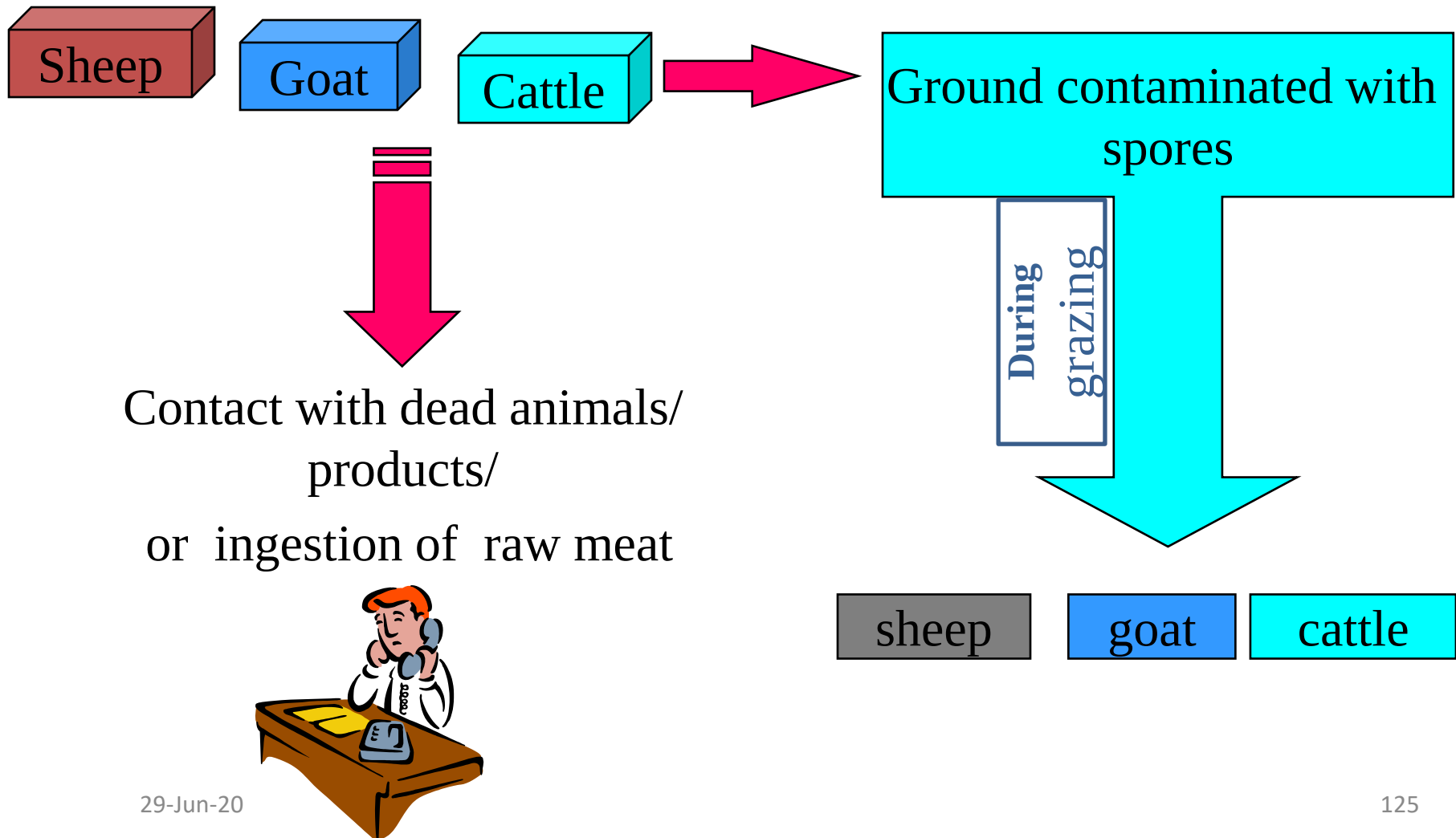
- Anthrax in humans is correlated with the incidence of the disease in domestic animals.
- Human Anthrax is most common in endemic areas in developing countries among those who:
 - Work with livestock
 - Eat insufficiently cooked meat from infected animals or
 - Work in establishments where wool, hides and skin are stored and processed.
- In developed countries, it occurs only occasionally among humans. Some cases stem from the importation of contaminated animal products

Sources of infection and modes of transmission

- **For man:** infected animals, contaminated animal products, or environmental contamination by spores from these sources.
 - a. **Cutaneous anthrax** is contracted by inoculation during the process of **skinning** or **butchering** an animal or by contact with an infected **leather, wool** or **fur**.
 - Products made from contaminated hair (shaving brushes), skins (drums) may serve as sources of infection.
 - b. **Pulmonary anthrax** comes from inhaling spores from contaminated wool or animal hair.
 - c. **Gastrointestinal form** is contracted by the ingestion of meat from domestic and wild animals that died from anthrax.

Anthrax transmission cycles b/n animal and human

Animals infected with *B. anthracis*



The disease in man occurs in three clinical forms:

1. **Cutaneous form** (malignant carbuncle/pustule): This is the most common form & is contracted by contact with infected animals usually carcasses or contaminated wool, hides or skin.
 2. **Pulmonary form** (wool sorter's disease): This form of anthrax is contracted by inhalation of *B. anthracis* spores.
 3. **Intestinal form**: It is contracted by ingestion of meat from infected animals. It is manifested by **violent gastroenteritis** with **vomiting** and **bloody stools**.
- ❖ In animals anthrax occurs in three forms as per acute, acute/sub acute and chronic.

Control

❖ In man, the prevention of anthrax is based mainly on:

- Control of the disease in animals,
- Prevention of contact with infected animals and contaminated animal products,
- Environmental and personal hygiene in places where products of animal origin are handled,
- Prompt medical care for suspected human cases.

In animals, anthrax control is based on:

- ❖ systemic vaccination in enzootic areas.
- ❖ Do not open carcasses of animal that have been died due to anthrax.
- ❖ Preventing animals from grazing on contaminated pasture or land

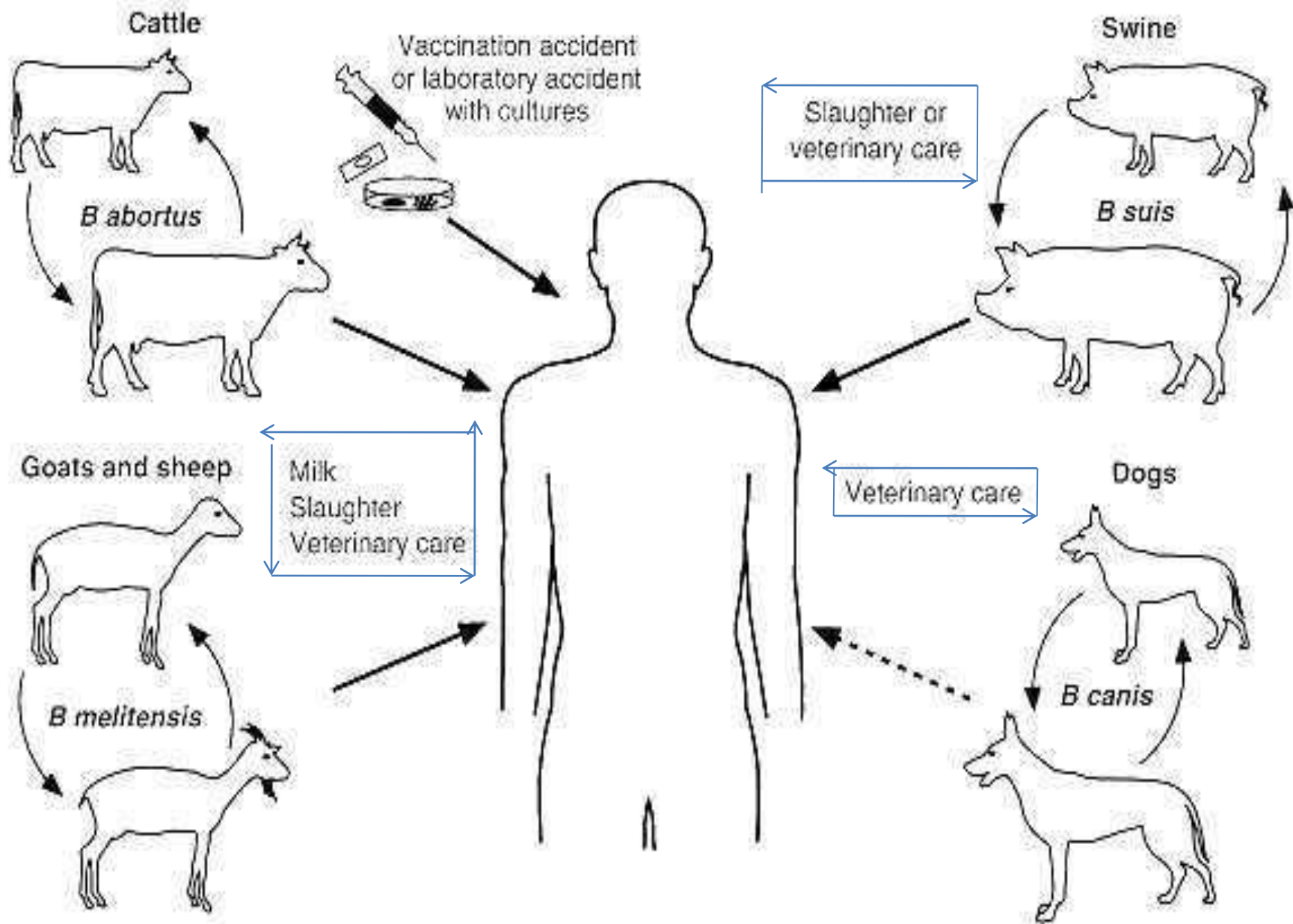
BRUCELLOSIS

Etiology: Disease is caused by *Brucella abortus*, *B. canis*, *B. melitensis* and *B. suis*

▪ **Host:** - Man, buffalo, cattle, camel, goat, sheep, horse, pig, poultry

Transmission:

1. **Direct contact** with infected uterine discharge, aborted foetus, placenta, urine and other body fluids and tissues.
2. **Ingestion** of **unpasteurized**, untreated, raw milk and other dairy products from infected animals.
3. **Inhalation** of infectious aerosol
 - Pens, Stables, Slaughter houses
 - Laboratory transmission
4. **Accidental** inoculation with animal vaccines



Symptoms:

Man:

- Undulant fever characteristic
 - Intermittent or irregular fever with variable duration.
- Non specific and variable symptoms
depression, headache, weakness, arthralgia, fatigue.

In animals

- **Female:** Abortion, loss of milk yield, retention of placenta, repeat breeder, sterility and mastitis.
- **Male:** Orchitis, periorchitis, vesiculitis, ampullitis, arthritis and hygroma;

Control:

1. Surveillance

2. Control in animals

- Pregnant animals (advanced) should be kept in isolation until parturition.
- Hygienic disposal of aborted fetuses, fetal membrane and discharges with subsequent disinfections of contaminated area.
- Test and slaughter of positive reactors:
- Quarantining of imported stock
- Immunization: using vaccines
- Chemotherapy:

Tuberculosis

Etiology:

The genus *Mycobacterium* comprises more than 70 species.

⇒ Many of the species occur in the environment and are rarely associated with disease in humans/animals/.

Human **TB** ⇒ *Mycobacterium tuberculosis*, *M. africanum*.

TB in bovines & many other animal spp ⇒ ***M. bovis***.

Host: - Man, cat, cattle, chimpanzee, deer, dog, elephant, goat, horse, leopard, monkey, parrot, pig, sheep, other wild animals.

Transmission:

1. **Inhalation** of infectious droplets or droplet nuclei from active pulmonary lesion of a tuberculous infected person/animal/.
Nosocomial infection very common
2. **Ingestion** of unpasteurized or raw milk from cows infected with *M. bovis*. Or consumption of raw or undercooked meat of infected animals.
3. Transmission may also occur from infected **dam** to **offspring** by milk.

Symptoms:

Man: Productive cough, fever, fatigue, weight loss, chest pain,, haemoptysis night sweat are the signs of pulmonary tuberculosis.

In extra pulmonary form, cervical lymphadenitis (scrofula), osteomyelitis, meningitis, pericarditis, genito-urinary disorder are observed.



Animals: The organism can infect any organ/tissue/ of body; chronic cough, dyspnoea, depression, emaciation, fever, lymphadenopathy, dysphagia, intestinal ulceration, diarrhoea, weight loss, weakness, polyuria, osteomyelitis, chronic and unapparent infection.

Prevention of Transmission of Zoonotic TB to Humans

1. Effective and well-controlled pasteurization of milk and dairy products.
⇒ Effectiveness of the pasteurization process in individual plants should be closely monitored.
2. Educate farmers and farm families about the particular risks associated with the consumption of milk from tuberculosis-positive herds.
3. When private domestic consumption of milk by farm families is practiced **proper boiling** is recommended.
4. **Educate dairy farmers**, cheese makers and their families about the risks of consuming unpasteurized milk.

5. **Prohibition** of the sale of unpasteurized milk intended for human consumption.
6. **Audit** of the *ante-and post-mortem* inspection of carcasses at abattoirs so as to verify the control and removal of **carcasses** or **parts thereof**, considered unfit for human consumption because of the presence of tuberculosis is recommended.

4. Salmonellosis

Etiology:

- In 1885, the bacteriologist Theobald Smith (1859-1934) isolated *S. Cholerae suis* from porcine intestine and the genus *Salmonella* was named after Daniel Salmon, his laboratory chief.
- The genus *Salmonella* consists of three spp:
 1. *S. enterica*,
 2. *S. bongori*,
 3. *S. subterranea*

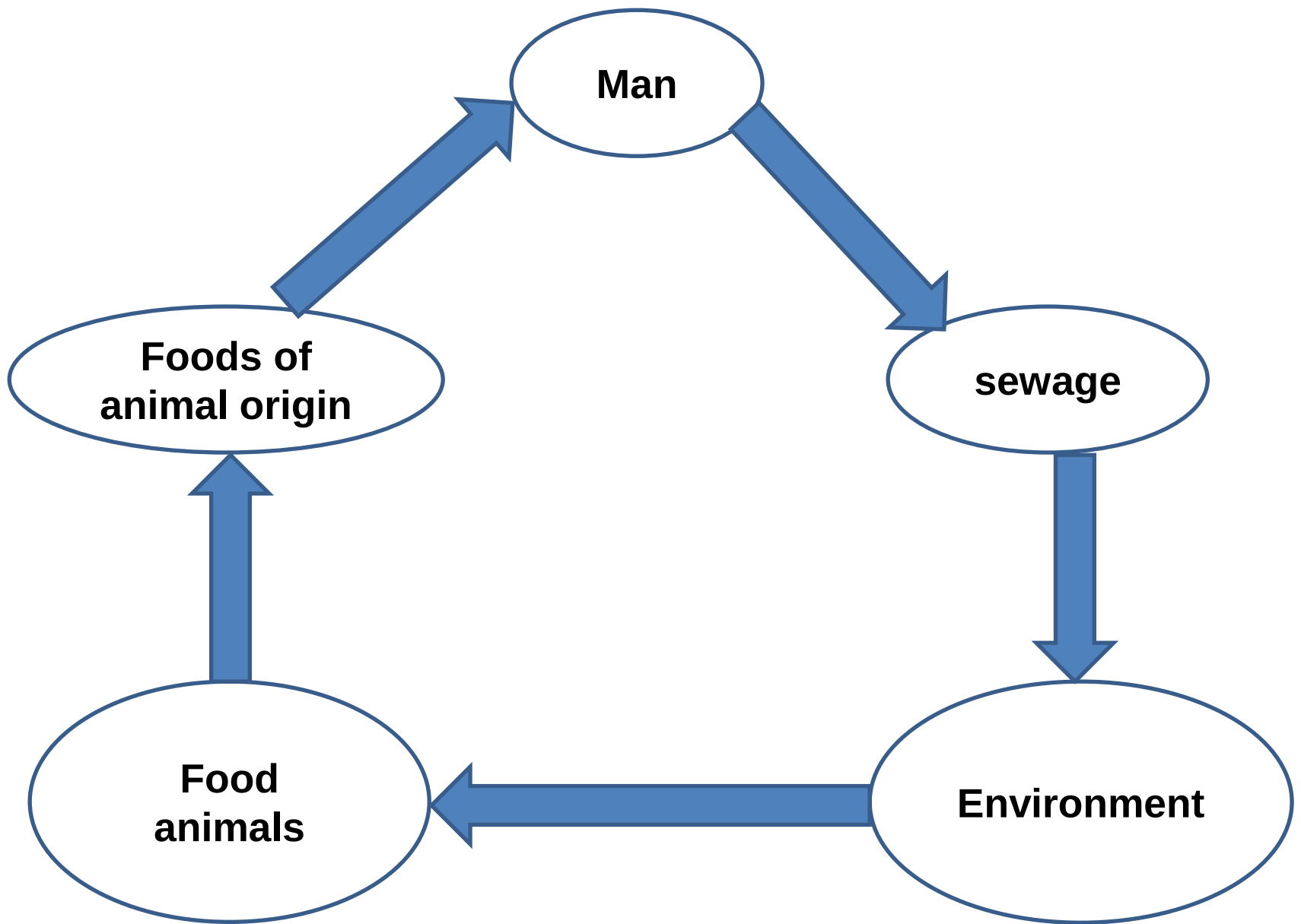


Host: Man, cat, cattle, deer, dog, elk, fowl, goat, horse, opossum, rabbit, raccoon, rodent, sheep, tortoise, turtle.

Source of infection for humans: Poultry (eggs, meat), pork, beef, milk and milk products, vegetables, dirty utensils and water.

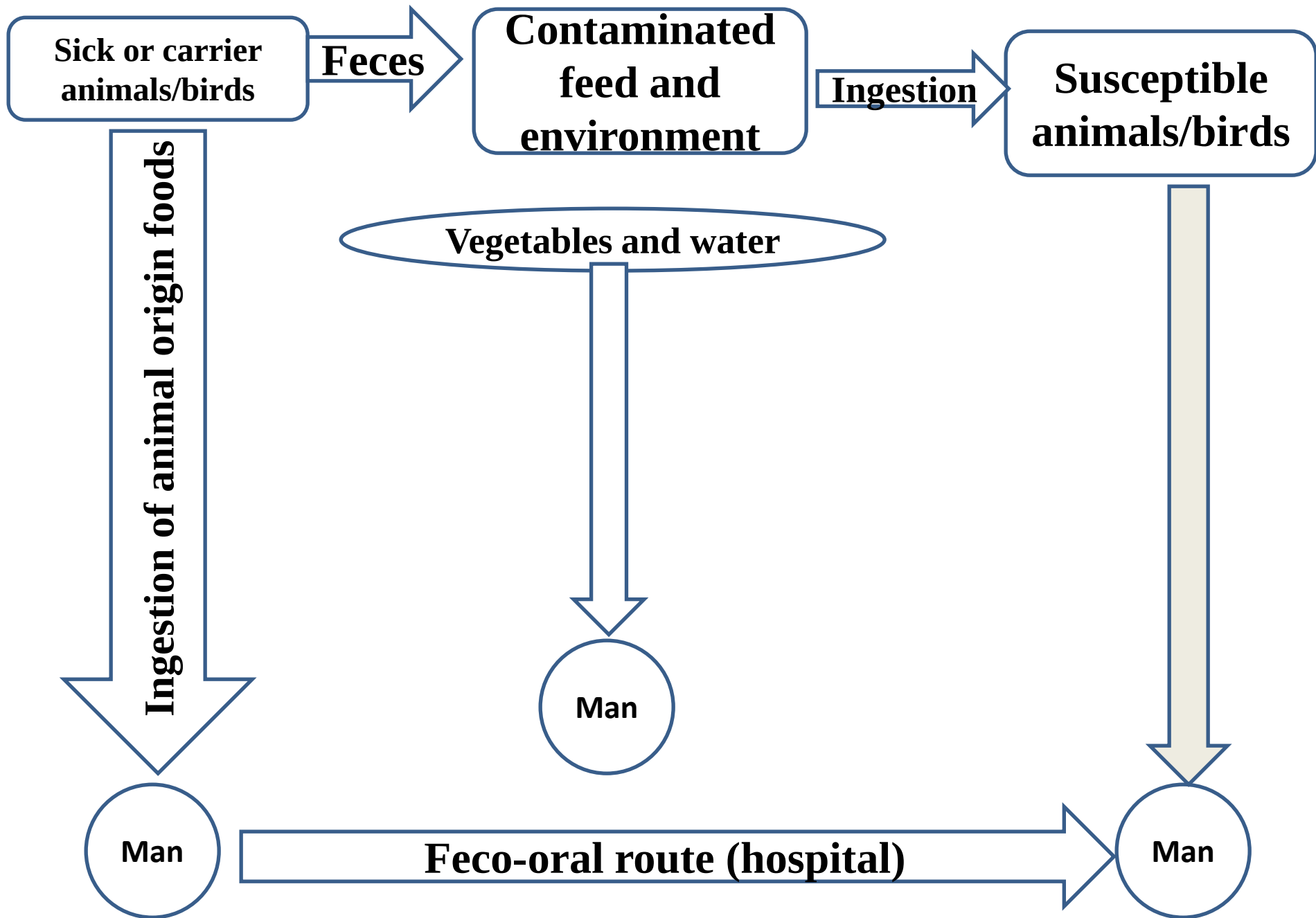
Transmission:

- 1. Ingestion** of Salmonella contaminated water, milk, meat, poultry, egg products, vegetables and other foods.
- Infection can also be acquired by **direct contact in hospital** (infected patients, their discharges, contaminated fomites like bedding, towel, lines etc...
- In endemic areas, **arthropods** may carry the organisms mechanically.



Predisposing factors: The following facilitates humans infection

1. Inadequate cooking
2. Cross contamination
3. Inadequate refrigeration/reheating/
4. Infected food handler
5. Animal carriers perpetuate the animal to animal cycle.
6. Contaminated feed such as **bone meal, meat meal, blood meal, fish meal** play an important role in the transmission of salmonellosis in animals.



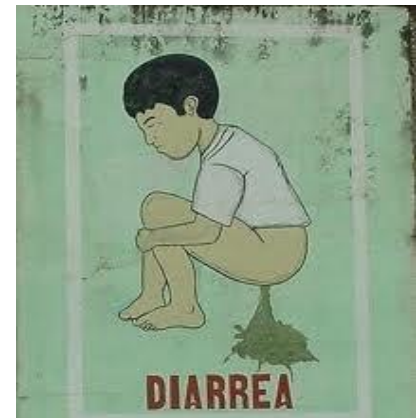
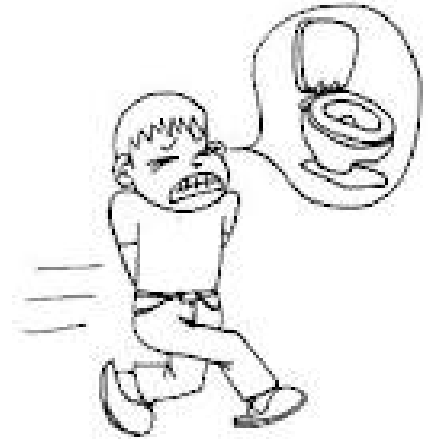
Symptoms:

Man:- Fever, headache, nausea, vomiting,

- Abdominal pain and diarrhea.
- **Squeal**: reactive arthritis, rheumatic syndrome.
- Death in very **young**, very **old** or in debilitated persons.

Animals: Four types:

- Per acute septicemia
- Acute enteritis
- Chronic enteritis
- Subclinical carrier



Control:

A. Surveillance

B. Control in animals

1. Hygienic management of livestock and poultry farms
2. Bacteriological control and decontamination of animal feed
3. Vaccination where applicable

C. Control of vehicles: Adhere to codes of hygienic practices of production, processing, storage, transportation and distribution of foods

D. Prevention in man:

- 1) Avoid eating food from unknown sources, especially raw or **inadequately cooked food of animal origin** and **salads**
- 2) **Avoid cross-contamination** of cooked food with raw products
- 3) Maintain sanitary kitchens and protection of foods against rodent and insect contamination
- 4) Avoid contact with animals suffering from salmonellosis or suspected of infection.

THANK YOU!

THIS IS THE END