MEAT MICROBIOLOGY

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INTRODUCTION

- The meat microbiology as a part of the food microbiology science , deal with organisms that are present, contaminate , or grow in and on red meat, poultry , fish and their product and divided into:-

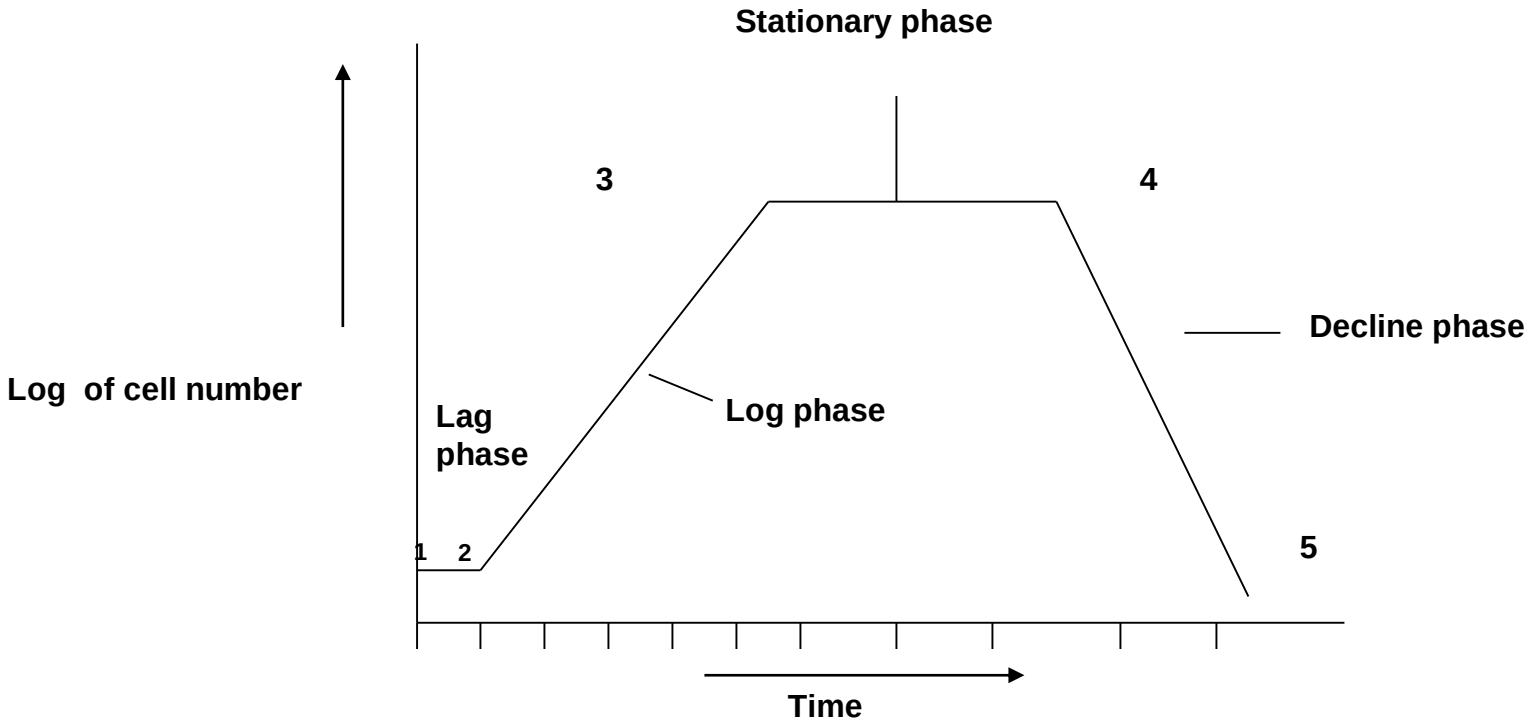
1- **Protection of consumer against food borne diseases**

2- **Prevention of food spoilage**

- Meat microbiology, challenges begin with the slaughtering operation of food animals or birds until consumption of their meats at home. Microorganisms play different important roles during this long chain of meat preparation.

- Meat like all food stuffs is acceptable and susceptible to be invaded by microorganisms and this lead to production of unattractive changes (Spoilage) and this due to their enzymatic protealytic activity.

THE GROWTH CURVE OF BACTERIA



- In a favorable environment growth curve of bacteria showing the four phases of growth.

- **1- Lag phase:1-2**

- After a short period of adjustment to the new environment.

- During this period the cells increase in size and produce new materials but active division does not take place.

- **2- Logarithmic growth phase:2-3**

- Growth begins accelerates to a phase of rapid, constant, exponential growth.

- phase each cell in the population is duplicated and the formed cells are viable and of constant size.

- **3- Maximum stationary phase:3-4**

In the time the environment will change due to the growth of the bacteria causing a depletion in nutrients and an accumulation of waste products (toxic metabolic products) results in a decrease in the growth rate.

- **4- Decline or death phase:4-5**

- The final phase in the growth curve.

- Represents a period when the death rate exceed the rate of multiplication.

REQUIREMENTS OF MICROBIAL GROWTH

- **1- water**
- Growth and welfare of M. O_s Molds have the lowest requirement, followed by yeast, gram negative and gram positive.

- **2- Source of energy**
- Carbohydrates and amino acid are commonly used as carbon and energy sources.

- Fats are used also by M. O_s, as a source of energy (Fat hydrolyzed with the aid of Lipase enzyme → glycerol + fatty acid.

- Sugar, alcohols, amino acid , starches, cellulose, fat →source of energy.

-In general molds can grow in the highest concentrations of sugars and yeasts in fairly high conc., but most bacteria grow best in fairly low conc.

- **3- Source of nitrogen**

- The primary nitrogen sources utilized by heterotrophic M. O_s are amino acid

- The organisms different in their ability to use individual amino acid for energy and in their action on them.

- **4- Vitamins**

- Vitamins such as thiamin, riboflavin and nicotinic acid which are required for enzyme synthesis.

- **5- Minerals**

NATURAL SOURCES OF CONTAMINATION

- from edible plants as flavobacterium, Achrombactor
- from animals as E. coli + streptococci
- from sewage → true faecal type (Coliform – enterococci
- From water as pseudomonas.
- from air as Mold , yeast + Aerobic spore former.

SOURCES OF MEAT CONTAMINATION

A- Endogenous ways

B- Exogenous way

A- ENDOGENOUS WAYS

- **A1 - Diseased Animal** (when the animal is affected by some infections disease as T.B, Anthrax ..... etc.
- **A2- Lowerd natural resistence** due to stress → M. O_s invade the intestinal mucosa and distribution by blood and lymph to different organs and tissues as E. Coli and as well as anaerobic M. Os → Bone taint deep muscular putrefaction.
- The flesh of animals slaughtered either ill or exhausted either ill or exhausted possesses a high PH value alkalin and may have a high blood content, both of these condition favorable to bacterial growth.

- It must again be stressed therefore that slaughter should be prohibited until the animal have been rested and have entirely recovered from the effect of transportation.

- It is show that inadequate rest period may reduce the quality and shell life meat due to → the following

- 1- Incomplete developing of acidity of muscle high PH.

- 2 - Early invasion of the system by spoilage $M.O_s$ from the intestinal tract → Bone taint and ham taint in pig.

- 3-Decrease oxygenation of hemoglobin and muscle myoglobin dark→ colour.

B- EXOGENOUS WAY

- Every treatment deals with the food – animal from the point of slaughtering until it is ready for consumption including preparation of the carcase, transportation and handling will add to the bact. Load of meat.

- **B1- Surface of the carcase**
- **<u>B-1-1- From exterior (soil and hide)</u>**

Harbor large number of different kinds of M. O_s as yeast , mold , proteus, micrococci→ on which the animal carry especially in winter time (the animal entering the slaughter house are often very dirty and legs covered with manure). The skin is the main sources of the contamination of meat.

It is necessary before slaughtering that the animal should be thoroughly washed.

Skinning machine is better than manual one and more preferable. Skinning by hand→ more contamination than in case of machine skinning as the hands transfer the bact. From the skin to the surface of meat during hand skinning.

- **<u>B-1-2- During carcase preparation & Evisceration</u>**

Many M. O_s (*as E. coli,* Enterococci, Clostridia ….., etc) are present in the small intestine→ to carcase and the bact. Number in colon & rectum (10^6-10^9/gm)

- **B-2- Equipment and tools**

Tools, knives and other equipment used during skinning, preparation and processing of meat act as → source of contamination so , to retard this they must be dipped for 5 sec in a bucket with boiling water. And it is necessary that water is thoroughly changed and boiled.

- **B-3- The hands and cloths**

Worker hands often contain a considerable number of M. O_s in the skin folds and under the nails → food poisoning as sal, staph, *Shigella sonni, Shigella desentery* SO, → hands can be easily cleaned by keeping the hand in water at 60°c for few seconds. This will remove all the loose meat particles and fat and the more fixed dirt is moistened so that the following washing is easier performed. It is necessary that one needs warm water and a good alkaline detergent to clean effectively.

- **B-4- Flies, rodents and stray dogs**

- **B-5- Air**

More dust lead to contamination pollution of the abattoir at mosphere and So, contaminate the carcass surface.

- **B-6- Transport and storage**

The packaging meat into → crates, boxes and other containers were contaminated or soiled from air, cloths and during transportation. It retail market, shops, saws, slicer, mincing machine and refrigeration (Cold storage).

- **B-7- The faults which may occur during evisceration.**

The gut of the animal contains great amount of M. O_s but great difference in number and kinds will be found in different part of digestive tract the outer surface is more exposed to contamination from the hide while the inner surface (the thoracic and abdominal cavities) and the organ are equally apt to the gut or from the voided manure through faulty evisceration.

FACTORS AFFECTING THE MICROBIAL GROWTH ON MEAT

- **1- Ienitial count**

The rate of bact. contamination in meat depends upon the conditions under which it is produced, a good sanitary condition → prolong storage time or shell- life.

- **2- Avilable oxygen**

Bacteria have a range of activities with regard to their oxygen requirements. Classification of M. O_s according to their ability to use free oxygen, microcrganisms have been classified as.

- **1- Strict or obligate aerobes:**

- when they require free oxygen.

- strict aerobes in the food environment (e.g. *Micrococci Bacuillus subtilis, B. megaterium,* Bseudomonas, Acinetobacter and Moraxellae) use oxygen as the terminal electron accept or in respiration.

- Slime may be at the surface of meat by growth of pseudomonas

- **2- Strict or obligate anaerobic:**

- When they grow best in the absence of free oxygen.

- Certain members of the genus Clostridium.

- **3- Facultative**

- when they grow well either aerobically or anaerobically.

- **4- Facultative anaerobes**

- Can use as a terminal electron acceptor but its absence they can use a variety of electron acceptors (NO_3, SO_4) E.g. Lactobacillaceae, Enterobacteriaceae.

- They grow on the surface and in the interior of foods; some prossess proteolytic or lipolytic activity.

- They are important food spoilage organisms.

- Some such as Enterobacteria → are organisms of public health significance.

- **5- Microaerophiles**

- Have a requirement for oxygen but at concentration considerabily below those present in air. These bacteria including many Lactobacilli, Streptococci.

- There is a relationship between the oxygen tension that is the concentration of oxygen in the environment and oxidation- reduction (OR) potential.

- **N.B.** Molds are aerobic, most yeast grow best aerobically.

- Anaerobic → bone taint

-Mould & yeast → growth on surface.

- Ozone & CO2 → are effective in retarting surface spoilage of beef quarters under long storage.

- **3- Relative humidity (RH)**
- All microbes absorb nutrient substance in water solution from meat when they develop on solid media. Drying or in↑ salt conc → will ↓the number of developing bact., because the amount of water assimilated by bact.↓
- Relative humidity (RH) of the environment within foods and the growth of Mio_s on surfaces.

- When food with low a_w values placed in an environment of high RH→ the foods pick up moisture till equilibrium has been established

-likewise foods with a high a_w lose moisture when placed in an environment with low R.H.

- Food ↓↓ a_w +↑↑ R.H. →equilibrium
- Food ↑↑ a_w + ↓↓ R.H→ Loss moisture

* Food that undergo surface spoilage from molds yeasts and certain bacteria should be stored under conditions of low R.H.

* The high temperature & lower the R.H. and vice versa must be borne in mind when selecting storage environment for storage of food.

- **N:B** Improperly wrapped meats such as whole chickens and beef cuts tend to surface spoilage occurs due to the generally high R.H. of the refrigerator and the fact that the meat spoilage flora is essentially aerobic in nature , while it is possible to lessen the chances of surface spoilage in certain foods by storing under low conditions of R.H.

- By altering the gaseous atmosphere it is possible to retard surface spoilage without lowering R.H.

- **4- temperature:-**
- Temperature is an important factor affecting growth and metabolic activity of M. O_s each group of M. O_s has their specific temperature.

* Environmental. Temperature reflects on the growth and kind of M. O_s

- Temperature is probably the most important environmental factor affecting the growth and viability of M. O_s.
- Microorganisms grow over a very wide range of temperatures.

- The temperature of a growth medium or food determines the rate of growth of any bacteria associated there with

- Optimum temp: The temperature at which growth is most rapid (grow and multiply well) e.g. enzymatic reaction of M. O_s progress at maximum speed.

- Maximum temp. is the highest temp . at which the organism will grow , this is usually only a few degree above the optimum temp. and can not multiply above it destroyed.

- **-Minimum temp.** is the lowest temp. at which growth of the organism occurs and is usually substantially below the optimum temp.
- **- Thermal Death point TDP**

Is the temperature at which an organism is killed in ten minutes (time constant & temp= variable).

- **- Thermal Death Time TDT**

Is the time required to kill a suspension of cells or spore at give temp (temp constant & time variable).

- **The major physiological groups of bacteria based upon their temp requirement for growth.**
- 1- Psychrotrophes 2- Mesophiles 3- Thermophilis
- **1- Psychrotrophs**

These organisms grow well at refrigerator temp (7°C) and spoilage of meat, fish, poultry, →held at this temperature.

- **2- Mesophilic:**

These organism grow well at room temp. (37°C). Many of animal or human origin including all pathogens and many food spoilage types.

Genera: *Strept, faecalis*

- **3- Thermophilic**
- At this organism grow well at 55C they mainly found in canned food

	Minimum temp	Optimum temp.	Maximum temp.
Psychrotrophs	0°C	7°C	**10°C**
Mesophilic	25°C	37°	**42°C**
Thermophilic	**45°C**	**55°C**	**80°C**

- **Relationship between temp. & growth rate of M.O$_s$ e.g. in meat.**

Rate of penetration of M. O$_s$ inside meat depend on the temp.

↑Temp → ↑ penetration of M, O$_s$ inside meat.

* 2kg of meat at room temp. the microorganism can penetrate→ 3 cm in 24 hrs

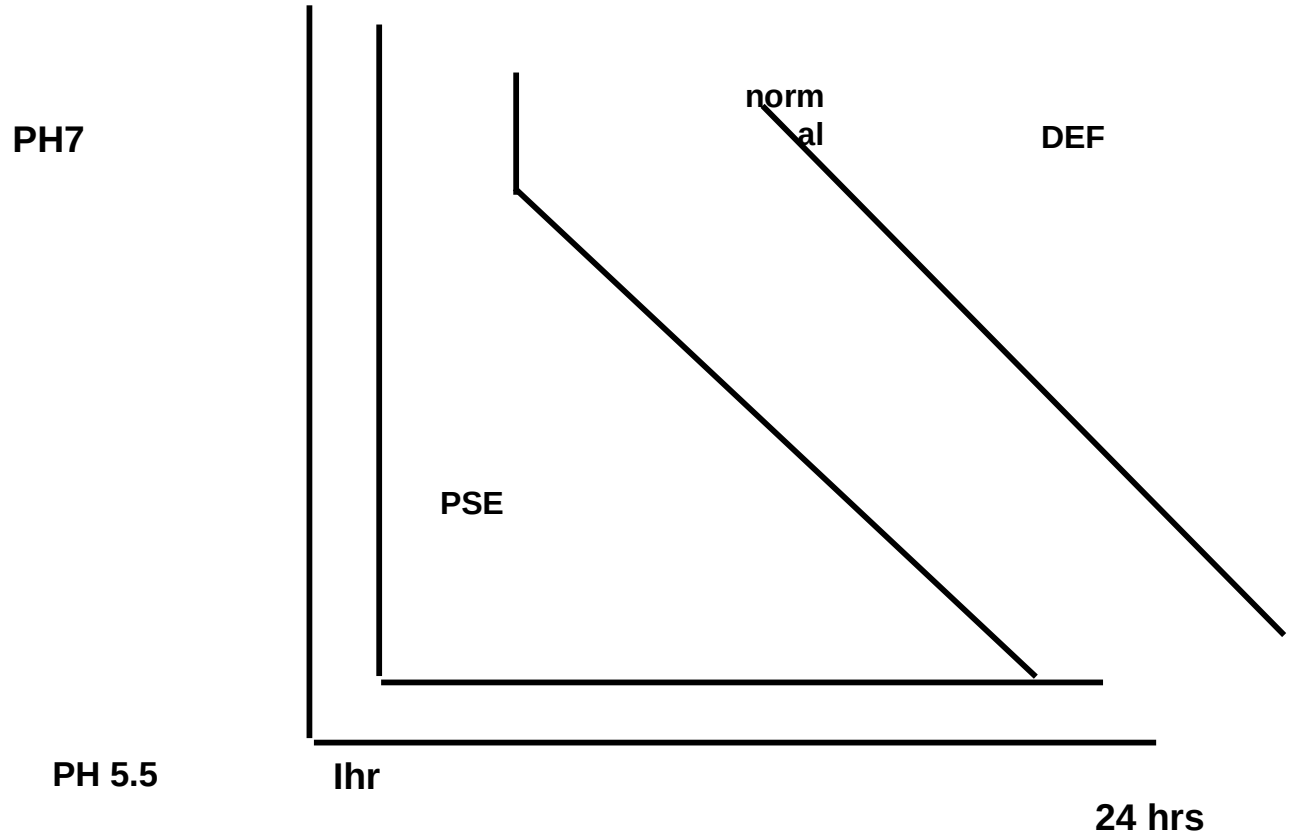
14 cm for pathogen

*2 kg of meatat37°C the M.O$_s$ → can penetrate

*2 kg of meat at (2-4°C) the M. O$_s$ → not morethan 1 cm in 30 days.

5- MEAT REACTION (P.H):

- - PH of meat is amphoteric in action
- - Although different M.O_s can grow best at PH value around 6.6-7.5, most bact. Grow better at PH near the neutral, while molds and yeast →quite talarant to acid.
- - yeast can grow at PH 1.5-8.5 (4-4.5)
- - Mold can grow over wide range of PH2-11 but favour an acid medium
- Putrefactive M. O_s needed high PH.


PH7
norm
al
DEF
PSE
PH 5.5
Ihr
24 hrs

- The PH of freshly slaughtered healthy animals usually neutral (slight acidic or slight alkaline) that range from 6-8 → 7.2 toward netural.
- R.M. (Rigor- Mortis) begins 2 hrs after slaughter and PH of meat gradually changes to acid – side due to lactic acid formation (usually 1% glycogen is converted into lactic cid → depression in PH values).
- - After 20-24-48 hrs → PH of well rested animals is 5.3, 5.8,6.
- - The PH then remain constant for sometimes and this period depend on:
- - Condition of animals before slaughtering
- - Storage conditions
- - The degree of the initial bacterial contamination

- - Later on PH begins to rise slowly due to autolysins and bacterial growth.
- - When PH is reached 6.4 suspicion of the presence of decomposition.
- - When PH is reached 6.8 →objective signs of decomposition become apparent in the meat in the form of a change in odour (off odour) and in colour (greenish colour) and the texture (loose and flabby).
- - The duration of such change in PH differ from animal to animal
- - Meat from fatigued animals spoils faster than that from rested animal
- -In healthy animal, the PH drops gradually and remain constant for a time then rise gradually.
- - In diseased or fatigued animal the PH drop suddenly and rise suddenly
- **in pigs** → PSE→ (Pale Soft Exudative) rapid drop PH 6.1→5.5 within 45-60 min while the carcass still warm.

- In beef→ DFE
- PH is more than 6 after lapse of 24 hours
- Dark = D = dark red in colour
- Firm = F= firm in consistency
- Dry= D= a feeling of dryness of m. fiber.

- **6- Oxidation – Reduction Potential (Eh):**
- **OR** → is essentially a measure of the oxidizing or reducing capacity of the medium.
- **Def**: → As the ease with which the substrate loses or gain electrons.
- When an element or compound loses electrons→the substrate is said to be oxidized, while a substrate that ins electrons reduced.
- *Therefore a substance that readily gains up electrons → is a good
- reducing agent.
- *While one that readily take up electrons→ is a good oxidizing agent.
- A highly oxidized substrate → would have + ve Eh→ Aerobie $M.O_{s.}$
- A highly reduced substrate → would have – ve Eh→ Anaerobic $M.O_{s.}$
- If a strong reducing agent is presem it will lower the OR potential growth of an erobes, conversely since oxygen is an oxidizing agent its presence ensure relatively high OR potential and encourages the growths of the more aerobic $M.O_s$

- The OR potential may also be increased by increasing the cone. of other oxidizing agents → allowing aerobic bacteria to develop in conditions devoid of oxygen itself.
- **In meat** Eh range from – 150 to + 250 mv. There is oxygen requirement for PM tissue. The Myoglobin of muscle can bind oxygen to from oxymyoglobin or it can be oxidized by oxygen → metmyoglobin.

* The surface of a piece of fresh meat →would have have aerobic conditions →support aerobic growth of slime – forming or souring at the same time as anaerobic putrefaction was proceeding in the interior (Clostridium spp.)

* In pre-rigor meat the is sufficiently high to prevent the growth of anaerobic types, but during rigor Eh is reduced to allow Cl. spp. The fall in Eh during storage of a food has been attributed to the liberation of gaseous H_2 and of reducing metabolites by food enzyme or actively growing $M.O_s$

- * processing may remove oxidizing or reducing substance.
- - Initial redox value between – 20 to – 150mv is optimum for canned meats. During long periods of storage the redox of canned pork and beef may drop to – 350mv unfit for human consumption.
- ***Ex:*** oxidizing → nitrite

  Reducing → ascorbic acid

7- MOISTURE CONTENT:

- Water account for some 80-90% of total weight of the living cells, the growth and metabolism of m.o$_s$ demand the presence of water in an available form However, in the processing of food such as drying or freezing, the water is removed or remain in solid state which make it unavailable for the organisms to carry on their normal metabolic activity.

- The exact amount of water needed for growth of m.o$_s$ varies. Bacteria require more water than yeasts which require water more than molds.

- The most useful measurement of the availability of water is water activity (a_w) → water requirement for growth of m.o$_s$.

$$a_w = \frac{\text{Water Vapor Pressure of Meat P}}{\text{Water Vapor Pressure of pure Water P0}}$$

N.B: Pure water has $a_w = 1$

Relative humidity (RH) = 100 X a_w

- Each m.o$_s$ has a maximal, optimal and minimal a_w for growth.
- Bacteria require more moisture than yeasts and yeasts which require water more than Molds There for:

    * Bacteria and yeasts are Hydrophilic m.o$_s$ = water loving.
    * Molds are xerophilic = Dry loving as they need or can grow in low moisture content.

- * **Halophilic bacteria**: (salt loving), bacteria can grow at a_w 0.77 (require minimal cone of dissolved of Nacl for growth and their types are:

- 1- Slight halophiles tolerate salt up 5%
- 2- Moderate halophies tolerate salt up 20%
- 3- Extreme halophiles tolerate salt up 30%
- 4- Haloduric bacteria they are merellay tolerant to salt.

- **Salt – tolerant** they can grow with or without salt.
- Halophilic and haloterant bacteria may be important in highly salted foods and in salt brines.
- **Genera:** Halobactevium – Sarcina – Vibrio – Micrococcus – Pseudomonas – Pediococcus – Alcahgenes.

- * **Xerophilic = Dry loving** those growing rapidly under relatively dry conditions or capable of growth at a_w below 0.85 (yeast, molds) can grow at a_w 065.
- * **Osmophilic** = sugar loving yeast grow best in high cone. of sugar and it can grow at a_w 0.60, but most bacteria called osmophiles are merely sugar tolerant e.g., spp of leuconostoc.
- **N.B**: Most spoilage bacteria do not grow below a_w 0.91

  Most spoilage yeast do not grow below a_w 0.88

  Most spoilage mold do not grow below a_w 0.80

  (S. aureus can grow as low as 0.86 a_w)
- **While:** - Halophilic bacteria can grow at a_w 0.77

  - Xerophilic fungi can grow at a_w 0.65

  - Osmophilic yeasts can grow at a_w 0.60

* Gram – ve bacteria having higher requirement water than Gram +ve

- Growth of aerobes takes place at a lower a_w in the presence of air than in its absence, and the reverse is true of anaerobes.
- Most organisms are most tolerant of low a_w at pH values near neutrality than in acid or alkaline media.
- Most organisms have the greatest tolerance to low a_w at about optimal temperature.

WATER IS MADE UNAVAILABLE IN VARIOUS WAYS:

* Solutes and ions tie up water in solution such as sugars and salts is in effect a drying of the material.

* Hydrophilic colloids (gels) make water unavailable 3 to 4% agar in media prevent bacterial growth by leaving to little available moisture.

* Water of crystallized or hydration is usually unavailable to m.o$_s$,

* The a_w range of 0.995 – 0.980 is best for most bact. and spoilage is encouraged in meat.

* **At a_w 0.98 – 0.93** spoilage by Gram – ve bact. gives ways to spoilage by certain Gram + ve bact.

* **Below 0.93 – 0.85** micrococci, yeast, molds.

* **Below 0.85 – 0.60** certain fungi and yeast predominate.

* **Below 0.60** there is no growth.

8- GROWTH OF CONTAMINATION:

Mainly depended upon the following.

- **8-1 Associated microbial growth**

As bacteria grow faster than yeast and mould and each produce it is characteristic spoilage type.

The kind and the amount of contamination with m.o$_s$ and the spread of these organism in the meat.

- **N.B**: Microorganisms can be broadly classified according to their effect on the food, into three major groups:

1-Those beneficial to Haman as bacteria induce fermentation as lacto bacilli used in fermented sausage.

2- Spoilage bact. That cause spoilage or decomposition.

3- Harmful or pathogenic ones that cause health hazards on human as disease or poisoning.

- **8-2 Environmental conditions:**
- * **<u>Exposed surface</u>** minced meat enhance the distribution of m.o$_s$ and their growth and multiplication.
- The amount of exposed surface of the flesh →air→available→for aerobic organisms.
- * **<u>Meat considered as</u>** enriched media for containing protein, glycogen, fat, minerals →enhance microbial growth
- Fat → may protect some surface but is subject to spoilage it self.
- * **Moisture Content** (a_w) is one of the important factor as available water for enhancing microbial growth.

FACTORS THAT INFLUENCE INVASION OF TISSUES BY MICROORGANISMS.

- 1) The load in the gut of the animal the greater the load the greater the invasion of tissues, for that reason starvation for 24 hrs before slaughter has heen re commended.
- 2) The physiological condition of the animal immediately before slaughter.

If the animals is excited, feverish or fatigued, bacteria are more likely to enter the tissues, bleed is apt to be incomplete, thus encourage the spread of bacteria and chemical change may take place.

More readily in the tissue better bacterial growth→ higher PH because glycogen is used up in fatigue .Earlier release of Juices from meat fibers and more.

- 3) Method of killing and bleeding:

* The better and more sanitary bleeding →better K.Q of meat.

* Electrically stunned animal is than from those killed with Co_2

- 4) The rate of cooling. Rapid cooling will reduce the rate of invasion of the tissues by $m.o_s$.

- **How to produce meat of good keeping quality, prophylactic measures to produce high quality meat or Method for reduction contamination.**
- The following items should le noticed to produce meat of high keeping quality.
- 1) prevent m.o$_s$ from contaminations carcasses F.
- 2) remove contamination and its sources F.
- 3) prevent or retard bacterial growth.

1] PRE – SLAUGHTER PRECAUTION:

- 1. Selection of the healthy animal in farm free from (food additive, Antibiotic or food affect on odour of meat)

*** transportation of animal to slaughter house → adequate lariage for each animal and crowded is prevent .

*** Slaughtered animals were kept in laiarage for at least 24hrs to rest, and tried animal for 72 hrs and not more → to prevent cross

- contamination, with normal feeding and watering.

*** keeping out without feeding for 12 hrs (during night).

*** Allowing drinking water for 3-4 hrs (to wash the gastro intestinal tract and to give chance to meat to free themselves from various toxin).

- Before slaughtering.
- 2. Carefully A.M.I →befor slaughter.

Any deviation of normal temp. should be recorded and corrected with suitable treatment without effect on meat itself. Before going →slaughter house.

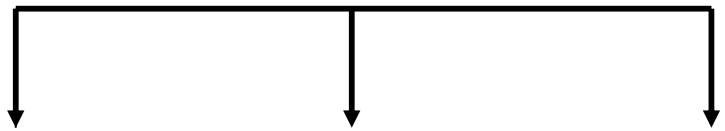
* forbidden to be slaughtering animals affected with fever.

** Diseased or suspect to be diseased animal with (Anthrax, rabies, Enterotoxaemia botulism) →forbidden to be slaughter & Abattoir hall →disinfected.

*** Animal affected with infectious diseases as (T.B, Brucellosis, Listeriosis) Slaughtered in detention room and disinfected

- **Prophylatic disinfection:**
- * remove the deposite and fat by warm water and put disinfect ant as:
- - Caustic sodia 2% at 70-80c˚
- - 20% suspension of formaldhyde
- - chloride of lime with 2% active chlorine
- **Emergency disinfedant:**
- - 10% caustic soda solution
- - active chlorine 5% of chloride of lime.
- - 40% formaldehyde.
- **In case T.B** use 3% formaldehyde. Caustic soda.

Characterized of disinfectant:



High effective → Not inflammable not metal → Not metal corrosion

3) cleaning of animal with spray water before slaughtering to remove dirts especially at winter.
****** water used for skinning and evisceration should be bact. exam. every week.

2] DURING SLAUGHTER:

- - Sterile knife used in slaughter cattle, pig.
- - Hiding process must done mechanically by machines, attention taken to prevent surface contamination.
- - Evisceration should be done directly after slaughtering to avoid substitution of organs and contamination.
- - Stomach & intestine →special department to remove their content.
- - Cleaning of carcasses by running water.
- - Inflation of carcasses →forbidden.
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- **3] During examination of meat:**
- - Avoid contamination of healthy part by diseased one.
- - Meat inspector have 2 knife, one for diseased and one for healthy parts.
- - Avoid more inscion in carcasses.

4] AFTER SLAUGHTER PROCESS:

Meat should le immedially chilled after to prevent bone taint. Good aeration of the carcass if no chilling room.

- - Air contamination → Avoided by:
  * plantation of tree around abattoir.
  * Air filter or ventilators with screamed windows.
- - Air is bacteriologically exam. Every week.
- - Instrument, clothes, equipments, utensils and slaughter hall→ cleaned & disinfected.
- - Avoid the presence of rodents and flies.
- - strict hygienic measures for transportation and handling of meat from time of slaughter till be ready to eat.
- - Butcher's shops should be put under strict hygienic inspection and must be well constructed.
- - Regular and periodical exam. For butcher and employees to emphasize free from infectious disease.

MEAT SPOILAGE

- **Definition:** means break down of complex compound →simple one→ change in the characteristic of meat such as odour, taste and colour.
- Raw meat is subject to change by its own enzymes and by microbial action, and its fat may be oxidized chemically.
- Generally, putrefactive M.o$_s$ result in breakdown of meat protein into:

    a) Proteoses, peptones, peptides, A.A.

    b) Sewage gases →indol, skatol, phenol.

    c) other gases →H_2s, Co_2 , NH_3

CAUSES OF FOOD SPOILAGE:

(1) infestation with insects and other pets.

(2) physical changes during handling, Transportation, processing as dehydration.

(3) Chemical changes as oxidative rancidity and autolysis or proteolysis in absence of m.o.

(4) Microbial activities of non pathogenic $m.o_s$. Microbial spoilage or decomposition is mostly due to.

* Microbial growth and metabolism as slime formation and souring or acid ferment.

* Microbial enzymes as lipolytic rancidity and proteolysis.

FACTORS LEADING TO SPOILAGE INCLUDE:

1) Storage under conditions of ambient temp. which will encourage growth of Bact. And mould.

2) storage of meat in cellophane or plastic containers without means to eliminate moisture, Meat should be removed as quickly as possible from synthetic temporary packaging materials which are closed and do not allow exchange of air.

3) Storage of meat in sealed synthetic containers particularly, if the meat is not properly cooked.

4) Liability of meat for spoilage. e.g meat perishable food.

5) Rate of contamination.

6) Rate of growth and activity of $m.o_s$.

7) Chemical composition of meat.

- Proteolytic m.o$_s$ grow faster on meat which become liquefied or soft, those include:
- **1. Major group** *Cl. perfringens.*- Pseudomonas-Proteus
- **2. Minor group** →as bacilli

THE MAJOR M.O$_S$ RESPONSIBLE FOR MEAT SPOILAGE →PRODUCE THE FOLLOWING ENZYME.

- **(A) Collagenase enzyme:**

  Produced by proteolytic M.o$_s$ →collagenase →hydrolysis of c.t in between muscle bundles.Soft, grayish white, gas production

- **(B) Deaminase** act on free A.A$_s$ forming H_2 & Co_2 & NH_3

- **Typical appearance of decomposition:**
- Colour→grey to green.
- Consistency→soft.
- Odour →repulsive
- Meat reaction →alkaline.

- **C) protealytic M.o$_s$** may ferment muscular or liver glycogen give: → **Acetic acid**

→ **Butyric acid**

→ **Final result of their activity**→ **Unpleasant taste**

→ **foul odour**

D) ***Clostridium perfrengens*** as proteolytic m.o$_s$ produce another protealytic en3yme such as.

- **D-1] Hyalouronidase**

Acts on mucopolyaccharides leading to more invasion by m.o$_s$.

- **D-2] Decarboxylase:**

Acts on histidine (A.A) → histamine which ↑ membrane permeability→ destruction of muscular tissue.

- **D-3] Toxin production:**

By this m.o$_s$ in meat lead to→various biological actions → ill bleed(due to Blood haemolysis) → &Or icterus (tissue cell destruction

TYPES OF MEAT SPOILAGE

1] Meat sliming:

- It is caused by psychrotrophic M.o$_s$ when the meat is kept in refringerator at R.H more than 90% . At first, it appear as drop colonies which coalesce with each other to from yellowish brown slime all over the surface of meat. Accordingly, the meat should be kept at 0-2c° and 88% - 92% RH to avoid this type of spoilage.

2] Meat putrefaction:

- It means hydrolytic cleavage of meat protein by m.o$_s$ to form free A.As (e.g tyrosin +tryptophan) which result in typical putrefaction (odour + flavour).
- **N:B** organs putrefy faster than muscles due to high blood content and high PH due to lack of rigor mortis.

- **Kinds of meat putrefaction:**

- 1- Aerobic putrefaction
- 2- Anaerobic putrefaction
- 3- chromogenic Gram – ve rods

- **(1) Aerobic putrefaction:**
- *** Cause** : →aerobic spore former.
- *** Source**: →skin, surface of carcase, Air.
- Aerobic spor former (*B-anthracis, B. subtilis*, *B.mycoides*) they liquefy gelatin, peptonize meat and Blood haemolysis.
- *** Sit of Beginning:** at surface appearance**:** microscopic colonies later on grow to a size visible by naked eye.
- They assimilate oxygen and lead to anaerobic conditions.
- Meat characters: → Soft in consistency
- →Alkaline PH
- →Chang col., smell

- **(2) Anaerobic putrefaction:**

Cause: anaerobic Spore formers e.g. *Cl. sporogenes, Cl. putreficum* , *Cl. perfingenes.*

Sources: Soil, manure, small intestine.

Site of Beginning: deep seated parts later after aerobic spoilage after consuming of O_2.

Meat characters: →greenish yellow col.

→More & more bad odour.

→Some produce toxine (*Cl. Perfringens* food poisoning.

N.B: Facultative anaerobic bacteria:

As. *Proteus vulgaris*→found in water soil→meat→spoilage→ endotoxin, liquefy gelatin → indol, H_2 s, NH_3 unpleasant flavour.

(3) Chromogenic Gram – ve rods:

- **Causes:** Pigment producing M.o$_s$. e.g pseudomonas + Flavobacterium
- **Sources**: water, soil
- **Site of beginning**: surface of meat At suitable conditions.
- **Meat characters**: some what unpleasant odor
- *Ps. flourescens* →green
- *Ps. prodigiosum* →bloody = red
- Ps. *pyocyanum* →bluish green
- Serratia → red spot
- Have proteolytic properties, some split fat & all of them pigment producers.

(3) OTHER KINDS OF MEAT SPOILAGE:

3-1- soure or acid fermentation:

- **Causes**: acid fermenting M.o$_s$ as lactic acid bacteria different bacilli &Clostridia.
- * the most affected part liver, muscle due to high level of glycogen.
- * Fermentation result in accumulation of acids as lactic acid, butyric acid, bytyl alcohol & acetone.
- **Meat characters:** * soft in consistency.
  * unpleasant odor
  * greyish white colour.
  * PH 5-5.5.
- Acid fermentation not so dangerous to human health.
- **Judgment** early stage → manufacture

  Advanced odor →T.C.

3-2- Bone taint

This form of spoilage → deep seated spoilage

* **Cause** → anaerobic putrefactive m.o$_s$ *Cl. sporogenes, Cl. putrefaciens* (from GI.T →circulation)

* **site** → hip Joint →ox & pig

Shoulder Joint → ox

* Heavy musulture of heavy carcasses

* **Predisposing cause.**

1) Exhausted animal, without rest.

2) high body temp. inside the meat after slaughter without rapid refrigeration

3) Presence of synovial fluid good medium for growth of bact. & has optimum PH 7-8 (alkaline)

- **Meat characters** →consistency →soft
  →Colour →Brown to grey
  →Odour →sewage like
- **Detection**: By insertion of steel trier along the Joint or cutting though muscle and smell.
- **Judgement** Localized contition →partial cond. (aond. Affected parts).

3-3- Meat Moulding:

- Mould develop on the meat surface specially frozen meat & cool stores→ as sticky colony of diffesent colour
- *Sporotrichum carnis* → white spots
- *Cldosporium herbarum* → black
- *Penicillum spp* → green spots
- *Thamnidium elgans* → wisker (white)
- *Asperigelus spp* → black spots
- *Cladosporiunm herbarum* → bleck spots penetrating meat surface with 0.5 mm.
- **Meat characters:**

-↑ pH (alk side) -Mouldy smell

-Decomp. Protein & fat - Change color of surface

DISCOLORATION OF MEAT

- Normal colour of meat meat pigment (myoglobin) oxidation

Oxymyoglobin → bright red color or blooming ⟶ Metmyoglobn brown red color

- **Causes of abnonmal discoloration of meat may be due to:**

* Pigment producing m.o$_s$, mould + yeast .
* Alteration or destruction of meat pigments Myoglobin oxidized brown meta myoglobin.
- it may be combined with H_2S produced by bacteria forming sulphmyoglobin (green).
- It may broken down by H_2O_2 produced by bacteria forming yellow or green bile pigment.

ABNORMAL COLOUR OF MEAT

- Greenish colouration → *penicillum spp*
- Pink colour →*Micrococci*
- Blue colour →*pseudomonas spp*
- Yellow colour → *Micrococci & flavobacteriun*
- Black colour →*Cladosporium herbarum*
- White colour →*thamnidium elgans*
- Black colour →*Halophilic pseudo.* In (Salted meat).
- **Judgement**

* If discolouration accompined by putrefaction→ cond . affect part.

* If discolouration only→ trimming the colour part or whipping of meat surface by a piece of cloth dipped in physiological saline.

* Meat Mouldy → inferior quality meat

- **Wiskers** : cottony or fussy appearance, caused by *Thamnidium elgans* . It is present in frozen meat and give mouldy or myasty or earthy odour as well as toxins e.g. *Aflatoxin, ochratoxin.*

3-4- Toxalbumens

- Poisonous substauces are formed during microbial breakdown of protein and the meat is more dangerous.
- **Causative M.o$_s$** *S. aureus, Streptococci*

  Coliforms

3-5- Phosphorescence:

- There are luminous areas scattered over the meat surface which appears as if it is studded with stars in dark room.
- **Cause** *Pseudomonans phosphorescence* which is naturally present in sea water & fish . Thus, the fish may contaminate the cool store with m.o$_s$ which can be transferred to stored meat.
- Phosphoresence →appear when meat decomposition begins.
- **Judgment** Meat is repugnant, but not putrefied needs trimming to be safe.

3-6 fat decomposition:

- It means change in odor , taste, flavour of fat due to: →Rancidity

  → Absorption of foreign odor

- **There are 2 types of rancidity**
- 1) oxidative rancidity:
- It affects umsaturated F.A_s (Pig fat) by atmospheric O_2

2) Hydrolytic rancidity:

- It is caused by lipolytic M.O_s producing lipase Enzyme as pseud., proteus, Bacillus, yeast, Mould
- Fat molecule →Free F.A& glycerol.
- **When free fatty acid = 3% - Rancidity.**
- * Rancidity do not appear in the deep inter muscular fat but in the more exposed fat (abdominal fat & kidney fat) so, must be removed guickly before Carcase is hung up in the shop.

- **Potamaines , alkaloids → are**
- - basic chemical substance formed by the breakdown or digestion of putrefying tissue.
- - It is the end product of protein decomposition produced by any baet. Capable of splitting protein - simple compound .
- **Cause proteolytic m.o$_{ss}$.**
- **Control of spoilage of meat:**

1) surface drying of carcasses reduces water activity inhibit microbial growth and extend the shelf life of carcass at ambient temp.

R.H. & air speed help in drying process .

2) Reducing of surface pH (to 4 – 4.5) which inhibit the growth of both spoilage and pathogenic m.o.

This can be achieved by treating meat with organic acids such as acetic or lactic acids.

- 3) Using chlorinated & hot wash water

Chlorinated & hot water (60° C for 10 sec) for washing will reduce the number of $m.o_s$.

Hot water may cause slight discolouration, which regained during holding period.

- 4) Cooling or refrigeration (chilling and freezing)
- 5) Salting and curing .

Salting lower water activity & inhibit microbial growth Sorbate treatment.

- 6) Mainly inhibit mould & yeast and also many genera of bacteria as sal.,E coli Staph, Clostridium also Strept.

7) Enzyme inhibitors:

- Epinephrine administration/ A/M control p/m autolysis
- Useful for long term storage and also distribution of meat at ambient temp.

8) Irradiation

- Good in elimination of spoilage & pathogenic m.o. from carcasses cuts or minced meat.

9) Packaging

- Protect the meat from moisture loss, contamination by m.o. changes in colour and physical damage.

10) Reduce the stress as possible before slaughtering

11) Using of antioxidants

12) Balanced relation in cold store between R.H, temp., air velocity

FOOD POISONING

- **Definition :** it may be defined as, any acute illness associated with the recent consumption of food , characterize by sudden onset, short incubation period, gastrointestinal disorders (abdominal pain, diarrhea and with or without vomiting and with or without fever) and it may be accompanied with neurological signs.
- **types of food poisoning :**

food allergy: Hypersensitivity to certain food stuffs (eggs, fish, milk , cheese, ete).

Chemical poisoning: chemical contamination occure due to ingestion af food contaminated with toxic chemicals which may be accidental contamination or undesirable chemical reactions between food stuffs and their container e.g: Arsenic, lead, zinc, residues (heavy metal, pesticides) chemical disinfectants.

- **Microbial food poisoning**: Food poisoning produced due to consumption of food contaminated with food poisoning organism itself and / or their toxin. it may be classified on the basis of mode of illness into 3 groups:

- **1] food infection:**

Infection with living m.o$_s$ which multiply in the food and may produce end toxin inside the body .

- **2] Food intoxication :**

Ingestion of performed bacterial or mould toxin in the food.

* the difference between the two types clinically is the incubation period interval elapase between eating and symptoms developed.

- **3] Potential food poisoning:**

(potential food infection + intoxication) means food poisoning either infection or intoxication that occurs under certain circumstances such as:

* A high number of m.o/gm or milliliter of contaminated food is required for illness to be caused. e.g enterococci gastroenteritis .

* Colonization of the causative organism in the intestinal cell. e.g E.coli gastro enteritis .

[1] FOOD INFECTION :

1. salmonellae .
2. Diarrhoeagenic E. coli
3. Enterococci gastroenteritis.
4. shigellosis.
5. Yersiniosis .
6. Campylobacteriosis
7. Vibro parahaemolyticus

GENERAL CHARACTERS OF FOOD INFECTIONS

* living m.o must be consumed through food.

* The m.o penetrates through intestinal membrane & establish in the epithelial cells of the intestine multiply & produce endotoxin.

* Dose level to cause infection vary greatly according to virulence of each mio. In which range from 10 cells in extreme virulent species as E. Coli O_{157}:H_7 to 10^5 cells in less virulent species as yersina enterocoltica.

* Long incubation period (generally 24 hrs according to the pathogen.

- * **symptoms :** Two Types of symptoms :
- - Enteric – most of them or nearly all .
- - Non enteric – when toxin pass to other organs rather than intestines *vibro, EHEC,* L. moncytogenes
- - Boiling can control the case.

[1] Salmonellae

Belong to Enterobacteriacae, Grams – ve facultative anaerobic, motile rods, Growth temp (5c˚ - 37c˚ - 47c˚)

*** There are more than 3000 serotypes of Sal. distributed in nature. Only 50 sero Types were incriminated in F.P. outbreaks all over the world.

*** The most prevalent serotypes as *S. newport*

S. typhimurium, S. entertains, S. anatum, S. dublin , S. infantis, S. heidelberg.

*** **N:B** *S. typhimurium* is the most virulent one (10^6 is enough to couse F.P) While, *S. pullorum*, *S. galinarum* is less virulant one .

* *S. typi* + *S. parathyhi* → not couse F.p.

Sourees of infection:

Food may be contaminated from the following

*Animal excreta & sewage * polluted water

* food handlers * poultry feed

* flies & cockroasch

* Rodents * Dog & cats

* utensils . Cross infection from raw food .

- **Toxins:** →Produce thermolabile enterotoxin which resulting in inflammatory reaction and fluid accumulationin the intestine.
- **Food association :**
- Food as a source of infection beef, pork, poultry meat, these foods were contaminated directly or indirectly with faecal mather and eaten either raw or under cooked or, contaminated following adequate heat treatment cross-contamination at home and at food services are the major sites of contaminated of foods with salmonella.
- **Susceptibility and viability:**
- * All salmonella grow well at room temp.
- * In moist earth →12 months
- * In dry earth →16 months
- * they can resist chilling , freezing and pickling from several days to many week .Heat sensitive, sensitive to low pH 4.5 or below . multiply in foods without affecting the acceptance qualities.

- *** Disease and symptoms :**
- **Incubation period** →12- 36hrs (24h)
- **Depending on:**
- - viruleuce of the serotype .
- - susceptibility of the individual .
- -The food vehicle involved.
- **Course of disease** →3-5 days
- (self limiting disease) but it is not complete 5% of recovered cases are still carriers.
- **Symptoms:**
- Mild fever, nausea, vomition, chills, headache, Abdominal pain, diarrhea (watery, greenish, foul dour diarrhea) muscular weakness, restless, drowsiness,
- **N:B)))** The disease may be more sever in particularly susceptable groups as very young ages, very old ages at those already ill .
- *** Forms of outbreak:**
- Sporadic (rare) , Family (↑) or large outbreak

- *** Prevention and control:**
- * proper sanitation and strict personal hygiene for food area, handlers, food preservation and storage.
- * prevent contamination of food at home &food services .
- * prevent the growth of m.o by proper cooling or freezing .
- * Destruction of m .o_s by proper heat treatment.
- * proper reheating of a food refrigerated for long time.
- * prevention of cross contamination of ready to eat food with a raw food through cutting boards, equipments, utensils, hand.

[2] DIARRHOEAGENIC E. COLI:

- It is infection type food poisoning arising from ingestion of contaminated food. 10^5 – 10^7 organism/ gm →infection
- *** There are 5 types:**
- 1- Enteropathogenic E. coli EPEC 1440
- 2- Enteroinvaive E. coli EIEC 1951
- 3- Entertoxigenic E. coli ETEC 1967
- 4- Enterohaemorrhagic EHEC 1982
- 5- Enteroadhereut Agg. E. coliEA- Agg EC 1987
- * Gram – ve , motile, facultative anaerobe Grow temp (10 c° - 37 c° - 50 c°), senstive to heat, sensitive to pH 5 or low.
- * because of their – normal presence at very high levels in Gut, for long time, it has been used as an indicator of faecal contamination and the possibility of presence of enteric pathogens as *Sal. typhi.*

- *** Habitat**
- * small intestine of human + animals.
- * The carrier can shed the organism in faeces and can contaminate food, water directly or indirectly.
- *** Food association:**
- * Any food can get contamination either direct or indirect through faecal contamination especially of human origin.
- * food of animal origin is implicated by different serotypes outbreaks of E. coli as improperly cooked and contaminated food as ground beef, hamburger, sausages, pork, poultry and Lamb, calves.

- **1) Entero pathogenic E. coli (Infantile diarrhea)**
- Profuse watery diarrhea, nausea, vomition, chills, cramps, headache.
- *** Incubation period →8 hrs**
- *** Duration of illness →48 hrs**
- - World wide especially in places with poor sanitation.
- - Trans milted direct or indirect through human carriers.
- - Origin of infection in infants - →maternity unit of food.
- **2) Enterotoxigenic E. coli Traveller's diarrhaea**
- * it produce 2 enterotoxins
- - Stable toxin (st) resist 100c° for 15 min
- - Labile toxin (lt) destroyed by heat & acid.

- * **Mechanism of action** ETEC stimulates the release of adenylcyelase enzyme from intestinal cells → ↑ electrolyte secretion ($Na^+ + K^+$)→ fluid accumulation → profuse watery diarrhea → Cholera like illness.
- - Need large infective dose to produce these symptoms.
- e.g – O148, O159, O78.

3) Enteroinvasive E. coli (EIEC) Colitis or shigella like.

- **Course** →7-12 days.
- Their ability to invade and proliferates with the epithelial cells of colonic mucosa results in colitis or dysentery like syndrome.
- **Symptoms** : Abdominal cramps and pain, profuse diarrhea proceeded by the passage of stool mixed with blood, mucous, leukocytes, headache & chill.
- ** e.g $O_{124,}$ O_{167}, O_{164}.

4) Entero adherent Aggregative E. coli

- gt does not invade the intestinal mucosa, but it adhere firmly to them causing definite diarrhea without blood or mucus.

5) Entero hemorrhagic E. coli

5-A Haemorrhagic colitis

5-B Haemorrhagic uremic

5-C Thrombotic thrombocytopenic purpora.

- The main cause of this from is the serotype O_{157} : H_7 which is like other *E. coli* but it can not grow or grow poorly at 44 c°- 45c°also not grow at 10c° (range of growth 30-42c°) & also it does not ferment sorbitol at 24hr , also it does possess B. glucouronidase activity.

5-A Haemorrhagic colitis : (HC)

- Sudden onset of sever crampy abdominal pain followed by watery diarrhea which become bloody, by large amount of blood (all blood & no stool), little or no fever,

Course of symptoms 2-9 days

5-B Haemolytic ureamic symdrone (HUS)

Usually begin with bloody diarrhea and progress to sever damage of R.B.cs and acute nephropathy leading to acute renal failure in children and uremia.

5-C Thrombotic thrombocytopenic purpora

Climically and pathologically similar to Hus but CNS involvement is usually a major feature and death msually occurred.

Disease + symptoms

Differe according to virulence of serotypes and the immunity of the host but generally:

Guclaltion period

I.P→12-36hrs

Course of illness →2 days may be more

- **Prevention and control**
- As salmonellosis in addition to prevent fecal – oral contamination and very strict measures of personal Hygiene

Gategory	Serogroups	Virulence factors
Enteropathogenic **Class I** **Class II**	O_{55}- O_{86}- O_{119}- O_{125}- O_{126}- O_{127}- O_{128ab}- O_{142} O_{18}, O_{44}, O_{112} O_{114}	**Shiga toxin production Fimbrial outer membrane protein adhesion in some strains.**
Enterotoxigenic	O_{6}, O_{8}, O_{15}, O_{20}, O_{25}, O_{27}, O_{63}- O_{78}- O_{80}- O_{115}- O_{159}- O_{167}- O_{148} O_{153}- $O_{12\&ab}$	**Heat - labile and heat - stable toxins Adhesive factors.**
Enteroinvasive	O_{28}ac, O_{29}. O_{124}- O_{136}, O_{143}- O_{144}- O_{152}, O_{164}, O_{167}.	**Epithelial invasion.**
Enterohaemorrhagic	O_{26}, O_{157}, O_{111}	**High levels of shiga toxin. Fimbrial adhesion.**
Enteroadherent- aggregative	**Not defined**	**Epithelial adherence. Toxin production.**

[3] ENTEROCOCCI GASTRO ENTITIES

- *** Cause :** *-Strept. laecalis -Strept. pyogeues-Strept. viridans*.
- * They are weak pathogens so, their Number must reach several billion to cause F.P.
- * One of the indicator organisms of faecal contamination & presence of enteric pathogens.
- *Strept. viridans* → were incriminated in many pathogenic disease
- **Scarlet Fever.**
- *** Habitat**: intestine of man & all animals.
- *** Food association**: food of animals origin as meat +its products contaminated with faecal matters either direct or indirect.
- *** Disease and symptoms:**
- **I.P 8-22 hrs (10hrs)**
- Course of illness one day or less. **Symptoms** Abdouinal pain, nausea, vomition rare & diarrhea.

[4] SHIGELLOSIS (BACILLARY DYSENTERY)

- * The most pathogenic strains are
- * *S. dysentryae* * *S. sonnei*
- * *S. flexneri* * *S. bodyil*
- * The No of S. *dysentryae* required to couse F.P may be as low as 10
- * They are invasive M.o$_s$ to intestinal mucosa → Desentry
- * They are fragile organisms, which don't survive well outside the natural habitat .
- * Habitat* small intestine of man &some Animal
- *** Food asscciation:**
- Different foods especially those handled to . much and ready to eat, also those chopped, diced or cut prior to eating such as many meat products.
- **Disease and symptoms**
- **I.P** → 1-4 days

- **Course** → 2-5 days less sever cases 2-3 weeks more sever cases
- **Symptoms** Abdominal pain, diarrhea aften
- Mixed with blood, mucous and pus, fever chills, headache, vomiting enterocolitis shigellosis)
- Prevention and Control As salmonella

[5] *YERSINIOSIS (YERSINIA ENTEROCOLITICA)*

- - This is a common cause of F.P and it has the ability to grow and multiply at 4c° . Accordingly, it Constitutes a potential food hazard.
- - Yersiniaenterocolitica is a member of the enterobacteriacae. can grow in 5% Nacl and PH above 4.6 & sensitive to heat.one of indicator $m.o_s$
- **Habitat:**
- Normal inhabitant of intestines of food animals, birds, pests, wild animals, human + pigs
- **Toxin:**
- * Not all strains able to produce Yersinnosis.
- * Both pathogenic and non, pathogenic strains produce heat stable toxin, but the pathogenic strains carry an invasive factors that enable it to colonize intestinal epith. Cells.

*** Food associated:**

- *** Pigs** act as chronic carrier to serotypes most commonly in human infection (can be isolated from tongue, tonsils, gut)
- * improper cooked, contaminated food after cooking, ready to eat food & refrigerated foods because it can grow at low temp.
- *** Disease and symptoms:**
- Young children under 7 years are mare susceptible
- *** infective dose** 10^6/cell/ml or gm food required to disease appear.
- *** incubation period** 24 – 36 hr
- *** course of illness** 2-3 days
- *** symptoms** sever abd. Pain, Diarrhea, nausea, vomiting, pharyngitis, anorexia, leukocytosis, lymphadenitis erythema.

- *** Prevention and control:**
- - Adequate cooking - refrigeration.

[6] CAMPYLOBACTERIOSIS

* the most common species causing diarrheal disease in human Camp. Jejuni + Camp. coli.

* Gram – re rods, oxidase + ve, curved (,) or s shape or spiral in shape.

* Microaerophilic (5% O_2) + (8% C°_2)

* For growth → 87%N2

Not grow below 28c° and above 45c°→ Opt. temp.→ around 42c°

* Very sensitive to heat & light & sensitive to many environmental parameters as oxygen, Nacl 2.5% , low PH (below5) , dryness.

** **Habitat:**

- The principle reservoir of pathogenic Campylobacter is GIT of animals and birds and is commonly fond as commensals in GIT of animals and birds (poultry, cattle, sheep, carnivoras, rodent).

- ** **Toxin:**
- *Camp. Jejuni* has a thermolabile enterotoxin which produce the enteric disease symptoms.
- ** **Food Association:**
- - unpasteurized milk. - Raw meat (beef, lamb, pork)
- - Poultry meat. - Improper heated food.
- - Heat processed food by cross contamination Any food can be contaminated with faecal contamin.
- ** **Disease and symptoms:**
- - infective dose → low (only 500 cells).
- - incubation period → 3-5 days (2-11 days)
- - course of ill ness → 2-7 days
- **- symptoms** → a cute enterocolitis sever abdominal pain, diarrhea vomiting rare, nausea, fever, headache and some times →**flu like** **influenza** symptoms.

- ** **Prevention and control:**
- - Adequate pasteurization of milk.
- - Adequate food cooking.
- - Prevent re contamination of food.

[7] Vibrio parahaemolyticus

- Gram – ve short rods curved or strainght, motile, Fac. Anaerbes usually found in sea water, can grow at 3% Nacl (halophilic) opt. growth at 37c˚ , easily killed by cooking sensitive to low PH.

- V. Parahaemolytias were attributed to sewage pollution.

**** Habitat:**

Marina, estuarine environment especially in summer months (above 10c˚). the presence of v. parahaenolyticus always associated with habitate with high organic nutrient content (plankton – biological host).

**** Toxin:**

Heat stale haemolysin.

**** Food association:**

Sea water above 10c˚→ the organism present fish & shell fish from affected water sea. Food products → inadequate cooked or recontaminated after cooking.

Disease and symptoms:

Incubation perlod →12-24hrs

Course of illness →2-5 days.

Infective dose may be high because m.o$_s$ is affected by low PH of stomach 10^5 – 10^7 /cell / person.

- **Symptoms** profuse diarrhea, abd pain, diarrhea (mucoid + bloody) dehydration, nausea, vomition, headache, chills.
- ** **Prevention and Control:**
- - Through cooking of sea food.
- - chilling rapidly after cooking if not eaten.
- - prevention of cross-contamination.
- - treatment of water + swage.
- - lemon Juice →an inhibitory effect of Vparahaemalyticus . of salted om El Kholoul.

FOOD INTOXICATION

GENERAL CHRACTERS OF FOOD INTOXICATION.

- 1* Toxin is produced by a pathogen while growing in food.
- 2* A toxin can be heat stable or heat labile (endo or exotoxin)
- 3* Ingestion of food containing active toxin not viable microbial cell.
- 4* Shorter incubation period than food infection.
- 5* Symptoms. Differ according to type of toxin – ve fever
- Entero toxin →GIT symptoms
- Neurotoxin →neurological

1] STAPHYLOCOCCUS AUREUS

- Intoxication arises from ingestion of performed toxin (exotoxin) produced during the growth & multiplication of *S. aureusin* food befor ingestion.
- *** Growth requirements:**
- - **Temp**: optimum 35c˚ Min 67c˚ max 47c˚. toxin production 21°c
- - **PH:** optimum 7.2 but it can growat 5 or lower. Toxin production 6.1
- - **salt tolerant** 10-20% byt it can survive till30% or more. Toxin production 6.1
- - **Nutrient** A.A_s (arginine, cystime) + vit + (biotin+ nicinee) toxin production starch
- - low a_wo 86%
- - **Coagulase production** + ve ↑ pathogenic& & ve ↓pathogenic
- - No. of *S.aureus* required to produce enterotoxin in food 10^6 – 10^8 /gm.

- **Sources of in fection :**
- 1- food handlers specially those aflected with wound, abscess, boil, ete.
- 2- Upper respiratory tract infected persons e.g sinusitis, naso pharynx lesions.
- **3-Aerosol infection through air & dust**
- **3- Toxin production:**
- *S. aureus* can produce 5 different types of enterotoxins A (highly toxic) B, C, D, E. The entero toxin is exotoxin formed in the food by growth &multiplication of m.o in food.
- **N:B*** *S. aureus* itself is thermo labile (destroyed at 60c° for 1/2 hrs).
- * but it is enterotoxin is thermo stable type B is more heat stale than type A C.
- * Entero toxin are also resistance to proteolytic enzyme (especially type A&C) although their structure is protein.

- **Disease and symptoms.**
- - Incubation period →1-6 hrs
- - Course illness → 24-48 hrs
- - Mortality rate →is rare or nil
- - Treatment needs →bed rest + fluid lilance
- **- symptoms**: nausea, vomition, diarrhea
- Sever abdominal cramps headache, prostration and may subnormal temperatures.
- ** symptoms not all the people eating a suspect meal lecomme ill and not all people experience the same symptoms the severity of the symptoms varies with.
- * Concentration of entero toxin in the food.
- * The amount of food consumed.
- * The susceptibility of the individual.

- **Control measures:**
- 1- Adequate heat treatment or processing of food.
- 2- prepared food must be eaten within hr.
- 3- Good refrigeration of food.
- 4- Avoidance of holding of food in warming device while give chance for growth of m.o.
- 5- periodical examination of food handlers.
- 6- Addition of nisin (Antibiotic) to meat products inhibits the production of entero toxin.

2] CLOSTRIDIUM BOTULINUM:

- It causes food intoxication through production of highly toxic soluble crystalized exotoxin in food during its multiplication *Cl botulinum* Gram + ve rods, obligate anaerobes, sensitive to low PH 4.5 or high qw 0.93 and moderately high salt 5.5%.
- Spore don't germinat in presence of 25pm nitrite.
- **Sources of infection:**
- * *Cl. botulinum* is found in soil, dust, water and mud.
- * Fish & fish products are mainly incriminated in *C. botulinum* outbreaks.
- * $M.o_s$ need many AA_s for growth and inhibited by salt 10% & sugar 50% & pH ↓ 4.5&radiation.

- **Toxin:**
- There are 6 serotypes of *Cl. botulinum* A, B, D, E, F, Toxin.
- Type A, B → survive heating at 100c° for 15min and destroyed at 3.3c°.
- Type A→ heat stable→75% out break
- Type E →heat sensitive (destroyed at 80c° for 10min) and grow well at 3.3c°.
- Type A, B, E, F → botulism in human
- Type C+ D → botulism in animals
- Type E → botulism in fish
- **N:B** in infants *Cl. botulinum* may grow and produce it is toxin inside the gut due to undeveloped competitive intestinal flora.
- *Cl. botulinum* is thermostable resist boiling for 4.6hr its toxin is thermo labile affect C.N.S at synapsis (Neuro muscular Junction)

- **Disease and Symptoms**
- Incubation period →12-48 hrs
- Duration of illness →7-10 days
- Symptoms – Nausea , vomition, Abdominal pain
- Dryness of skin, mouth throat
- Double vision – No fever
- Respiratory failuret & death (30-65%)
- Constipation – Muscle paralysis

- **Control**
- - Home preparing of canned foods must be prevented
- - sufficient heat treatment to destroytype E cl. botul
- - Adequate refrigeration to destroy type A& B Cl. botual
- - Application of strict hygienic measure for personnel &food area.

3- MYOTOXICOSIS

- -Many strains of moulds when grow in food can produce metabolites that are toxic to human, animals and birds.
- Mycotoxin is not a protein or enteric toxin but many are carcinogens and when consumed can cause cancer in different tissues
- -Mycotoxin is heat stale.
- Moulds are aerobic need humid and warm environment can grow slowly at very low qw.65, low temp (refrigeration) and low PH 3.5

- **the most common moulds and its myco toxin:**
- Aspergillus spp (flavus, parasiticus) →Aflatoxin
- Aspergilus (nidulans, versicolour)→ Sterigmatocystin
- Penicillium (Viridicatum) +Aspergillus (ocraceaus)→ ochratoxin
- *Penicillium patulinn + Aspergillus spp →patulin*
- *Peuicillium roquefortil →Roguefortim.*
- **Prevention and Control:**
- *Contamination with mould should be reduced by proper sanitation during preparation, processing, handling and storage.
- * Heat treatment of food to reduce load of moulds.
- * Control of environmental factors as humidity + temp.
- * using antifungal substance in or on food to reduce the mould food.

3)POTENTIAL FOOD INTOXICATION

[1] *CLOSTRIDIUM PERFRINGENS:*

- The are Gram + ve , mesophilic, anaerobic spore forming existing in soil, dust, water, spices + GIT of man and animals. Sewage.
- * Cl. Perfringens produce 6 types of Exotoxins A, B, C, D, E, F.
- * A + C →are the most serious one.
- * A→10^3→infection.
- * C→35 – 40% mortality.
- * spores of *Cl. perfringens* resist adverse environmental contition of drying , heating, freezing as in chicken gravy 80days at-17.7c°.
- * Optimum temp 37-45c° Min. 20c° but not at 15c°.
- * Generation Cycle 10-20 min. *Cl. perfringens* produce enterotoxin inside intestine during sporulation.
- * The entero toxin acts intestinal cells ↑ capillary permeability + ↑ intestinal motility →diarrhea.
- Entero toxin causes →↑↑ increase capillary permeability, vasodilation and excess fluid movement → intestinal lumens, resulting in →these is an ↑ in intestinal motility → diarrhea.

- **** Disease and symptoms :**
- Incubation period →8-22hrs
- Duration of illness →24 hrs
- Symptoms: Nausia, vouition (rare) abd. Pain + diarrhea.
- N:B. Food prepared one day before eaten reheated →spore
- germination→ F.P
- **Control:**
- -Adequate meat cooking (↑ 100c°).
- -Prevent warming and reheating of food.
- -Through washing and sanitation of food mtensiles personal hygiene.
- - After cooking or heat treatment (if the food not eaten), it must be cooked quickly (within hr) to refrigerated temp.
- Reheating is quickly and uniformly (above 60c°) to kill vegetative cells.
- * A chemical added to cured meats is sodium nitrite. This chemical is important in colour fixation of cured meat as well as inhibiting growth and toxin formation by *Cl. botulinum* Cl botulinuene

[2] *BACILLUS CEREUS*:

- - It is Gram + ve, motile aerobic spore forming rod.
- **- Temp**. Min 10-20c° optimum 30-4c° max 48 – 50c°
- B. cereus produce thermo labile toxin destroyed at 60c° for 20 min and sensitive also to proteolytic enzyme (trypsin).
- **N:B.** Toxin may be formed in food or intestince following consumption of very large No of viable m.o$_s$ (10 ^{10}/Jm).
- *B. cereus* may produce lecithinase, hemolysis and phospho lipase.
- *B. cereus* mainly attacks starchy foods as hamburger + kofta + luncheon.

- **Disease and symptoms:**
- Incubation period according to the form infective dose high 10^6 – 10^9/ gm or ml food.
- ** According to the type of the toxin produced. It can be classiled into two forms.
- 1- mild common form (diarrhoeal syndrome) caused by diarrheagenic koxin, which is Thermo labile (destroyed at 55c° for 5mon) and sensitive to proteolytic em3ymen as trypsin. It induces vascular permealilty result in accumulation of fluid in the lumen of the intestine propuse diarrhea + nausea , cramp- lik abd, pain No ferer + No vomition.
- I. P 8-16hrs course 6-12hrs.
- 2- Sever syndrome (Emetic syndrome) caused by heat stable emetic toxin which can with stant heating to 126c° for go min and it is resistant to proteolytic en3yme symptoms.

- **Prevention and control:**
- It is necessary to maintain ↓ m.o in food by standard hygienic measures, adequate cooking + rapid cooling + salt 10% ↑ + PH ↓ 4.5.
- **The food is safe if:**
- - PH not more than 4.5.
- - salt % is 10% or more.
- - ↓ temperature 3 c˚ .
- - heating till 90-100c˚ before consumption immediately.

- **Out break investigation:**
- 1- No. of people at risk (suspected).
- 2- No. of people actively ill (diseased).
- 3- Nature of illness (symptoms).
- 4- Exact time of incubation period.
- 5- Description of all food eaten within 24 hrs.
- 6- information a bout food consumed during the previous 4 days.

TEN GOLDEN ROLES FOR SAFE FOOD PREPARATION:

- **1) Choose food processed for safety:** to improve safety & prolong shelf life time.
- **2) Cook food thoroughly:** many Raw food (poultry & meat) are often contaminated with, disease causing M.o$_s$., so thorough cooking will kil them.
- Temp must be at least 70˚c .
- Frozen meat fish & poultry meat sh. Be thorough salting before cooking.
-
- **3) Eat cooked food immediately:**
- When cooked food cool to room temp, so M.o begin to proliferate so, to be in safe side, must, must be eaten just after cooking.
- **4) Store cooked food carefully:**
- Either hot (over 60˚C) or cold (below 10˚C) which decrease microbial growth.
- **5) Reheat cooked food thoroughly:**
- Temp. at least 70˚C

- **6) Avoid contact between raw & cooked food:**
- To avoid cross contamination (direct, indirect)
- 7) Washing hand repeatedly:
- - before starting preparation of food.
- - after contact with raw food meat poultry fish.
- - if use toilette.
- **N.B.:** if the hand affected by wound or lesion, use bandage or exclude the person from work.
- **8) Keep all kitchens always clean:**
- Food surface, utensils, cloths, come in contact with food etc must be cleaned & boiled daily for use.
- **9) Protect food from insect & rodents & other animals pests:**
- Because they carry M.o$_s$ that cause food borne disease, this is done by putting food in tightly sealed container.
- **10) Use pure water:**
- Which used in preparation & drinking cleaning if you have any doubt boil water before added to food.

Thank you