



COURSE TITLE: FOOD AND INDUSTRIAL MICROBIOLOGY
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MICROBIOLOGY OF MEAT, POULTRY AND SEA FOODS

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What is Spoilage?

Spoilage is the process in which food deteriorates and produced undesirable changes in the product and becomes unsuitable for human consumption.

What is microbial spoilage?

A number of different types of microorganisms are responsible for the spoilages of meat. When they breaks different components of any food items, acids and other waste products are created. Sometimes the microbes itself may or may not be harmful but the metabolites or waste items produced may impart unpleasant taste and colour to our food which is harmful to human's health

How it occurs?

- Normal slaughtering techniques
- External sources during bleeding, handling, skinning, cutting and processing.
- Intestinal tract of animals, exterior of animals (hide, hooves and hairs)
- Knives, cloths, air, and hands and clothing of workers.
- Depends on methods of slaughtering methods such as mechanical, chemical, electrical etc.

Meat Microbiology

- Why study meat microbiology ?
- Food Borne Diseases
- Food Spoilage
- Meat Quality
- Preservation
- Flavor Alteration



Deep animal tissue is sterile. The main area of concern is tissues near the surface of a carcass and whole muscle cuts.

MEAT SPOILAGE

- Raw meat starts deteriorating by its own enzymes and microorganism and chemically oxidize the fat.
- Autolysis changes include some proteolytic action on muscles and tissues resulted in hydrolysis of fats.
- Defects caused by autolysis called “souring”.

Invasion of tissue by micro organism -- Invasion of tissue by contaminating micro organism takes place after death of animals.

Factors affecting the invasion includes :-

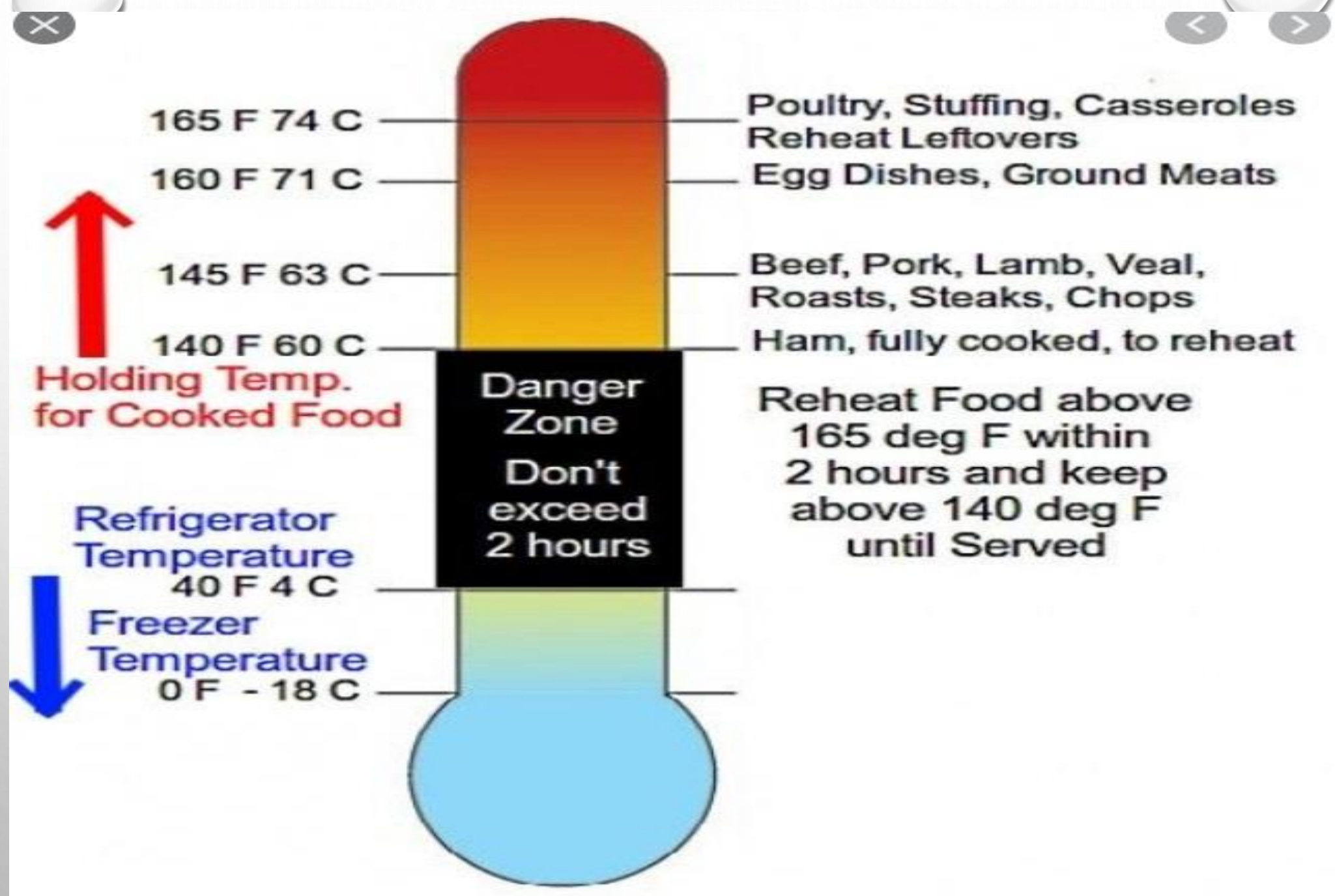
- Microbial load of the gut of slaughtered animal
- Health and Physical condition of the animal before slaughter
- Method used for slaughtering and bleeding
- Rate of cooling

Growth of micro organism in Meat --- Meat is an ideal food for a number of microorganism because its high moisture content, richness in nitrogenous components in meat with various degree of complexity, high amount of minerals and various growth factors. It also contains fermentable carbohydrate(glycogen) and favourable pH range which suits most of the contaminating micro-organism.

Factors influence growth of microorganism

- The kind & amount of contamination with microorganism and the spread of these microorganism in the meat.
- The physical properties of the meat
- Chemical properties of the meat
- Availability of oxygen
- Temperature





.Types of Spoilage of Meats • Spoilage under 1) Aerobic conditions 2) anaerobic conditions

Under aerobic conditions bacteria may cause the following- Surface slime – which may be caused by species of *Pseudomonas*, *Acinetobacter*, *Moraxella*, *Alcaligenes*, *Streptococcus*, *Leuconostoc*, *Bacillus*, and *Micrococcus*, It is an indication of spoilage, often observed before expiry date.

Changes in colour of meat pigment- The red color of meat, called “bloom”, may be changed to shades of green, brown, gray as result of the production of oxidizing compound . e.g. hydrogen peroxides, hydrogen sulfide. *Lactobacillus* and *Leuconostoc* are basically responsible.

Changes in fats:- The oxidation of unsaturated fats may takes place chemically in air and may be catalysed by light and copper. e.g. oxidative rancidity. *Pseudomonas* and *Achromobacter* are responsible for oxidative rancidity or by yeast.

Surface colour discolouration due to pigment forming bacteria:- red spot may be caused by *Serratia marcescens* or other bacteria with red pigment. *Pseudomonas syncyanea* can impart blue colour to the surface, *Micrococcus* or *flavobacterium* imparts yellow colour

Off odours and off taste:- “Taints” or undesirable odours and off taste that appear in a meat . “souring” that gives the sour odour that may be due to volatile acids. e.g. formic, butyric, propionic acids by the action of mos. Sometimes “Cold storage flavour” or taint observed in meat and its nothing but stale flavour. In case of musty or earthy flavour, meat contaminated with *Actinomyces* are the causative agent for the same.

Aerobic growth of moulds may causes

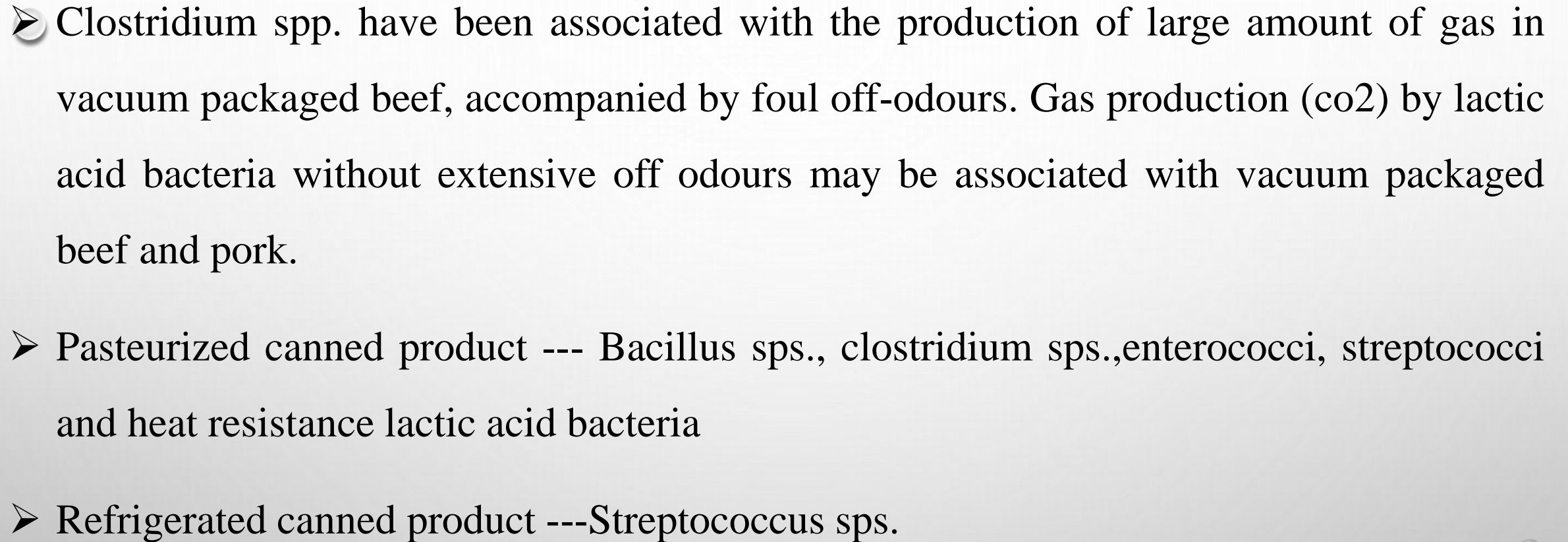
- Stickiness – surface becomes sticky
- Whiskers- when meat is stored in frozen condition, mycelial growth may takes place without sporulation.
- Black spot- caused by *Cladosporium herbarum*
- White spot- caused by *Sporotricum carnis*.
- Green patches- caused by Penicillium such as *P. expansum*, *P. oxalicum*
- Decomposition of fats- many molds produces lipases and cause hydrolysis of fats .

Spoilage under anaerobic conditions

Facultative and anaerobic bacteria can able to grow within the meat under anaerobic conditions and cause spoilage.

Following changes occurs in such conditions

- ❑ **Souring** -- It imparts sour taste to meat due to acids such as formic, propionic, acetic etc. meat's own enzymes are responsible for it .
- ❑ **Putrefaction** -- True putrefaction is the anaerobic decomposition of protein with the production of foul smelling compound such as hydrogen sulfide, indole, ammonia, amines due to Clostridium species.
- ❑ **Taint** --- Taints” or undesirable odors and tastes, that appear in a meat

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- Clostridium spp. have been associated with the production of large amount of gas in vacuum packaged beef, accompanied by foul off-odours. Gas production (co₂) by lactic acid bacteria without extensive off odours may be associated with vacuum packaged beef and pork.
 - Pasteurized canned product --- Bacillus sps., clostridium sps., enterococci, streptococci and heat resistance lactic acid bacteria
 - Refrigerated canned product --- Streptococcus sps.

Poultry Meat

Poultry meat like meat of other animals is also susceptible to contamination by various sources. Contamination of skin and lining of the body cavity take place during various processing operations. The organisms of great importance in poultry are *Salmonella* spp. and *Campylobacter jejuni*. Several Gram negative psychrotropic bacteria viz., *Pseudomonas*, *Acenitobacter* and *Flavobacterium* have also been isolated from poultry carasses. Freezing further reduces the number of microorganisms in the poultry meat provided the temperature is maintained quite low (-18°C or below).

Poultry can be kept in good conditions for months when its frozen

Poultry should be frozen fast enough to retain most of the natural bloom and the external appearance of a freshly dressed fowl

The storage temperature should be below -17.8°C with 95% humidity

- The skin of live birds may contain numbers of bacteria averaging 1,500 per centimeter and could also be derived from the feet, feathers, and feces
- Contamination of the skin and the lining of the body cavity occurs during **washing, plucking, and evisceration**
- The process of **sticking and bleeding** can also introduce contamination
- **Knives, cloths, air, and hands and clothing** of the workers can serve as intermediate sources of contamination
- After the handling of the meat contamination can come from **carts, boxes, or other containers**



Spoilage in fish



Spoilage in fish generally accompanied by change in its physical characteristics. Change in colour, odour, texture, colour of eyes, color of gills and softness of the muscle are some of the characteristics observed in spoiled **fish**. **Spoilage** is caused by the action of enzymes, bacteria and chemicals present in the **fish**.

- At chilling temperature – *Pseudomonas, Achromobacter, Flavobacterium*
- At ordinary atmospheric temp.- *Escherichia, Proteus, Serratia, Sarcina & Clostridium*
- At higher temperature- *Micrococcus & Bacillus*

FISH SPOILAGE

PUTREFACTION
(breakdown of protein)
SLIME

SOURNESS
(production of lactic acid)
DISCOLORATION

RANCIDITY
(breakdown of fats)
RANCID ODOR

In addition, the following factors contribute to spoilage of fish.

- ❖ High fat content
- ❖ High protein content
- ❖ Weak muscle tissue
- ❖ Extent of bacterial contamination
- ❖ Ambient temperature
- ❖ High moisture content
- ❖ Unhygienic handling
- ❖ Rigor mortis hastened-- struggling of fish, lack of oxygen, warm temp.
- ❖ Use of an antibiotic, ice or dip

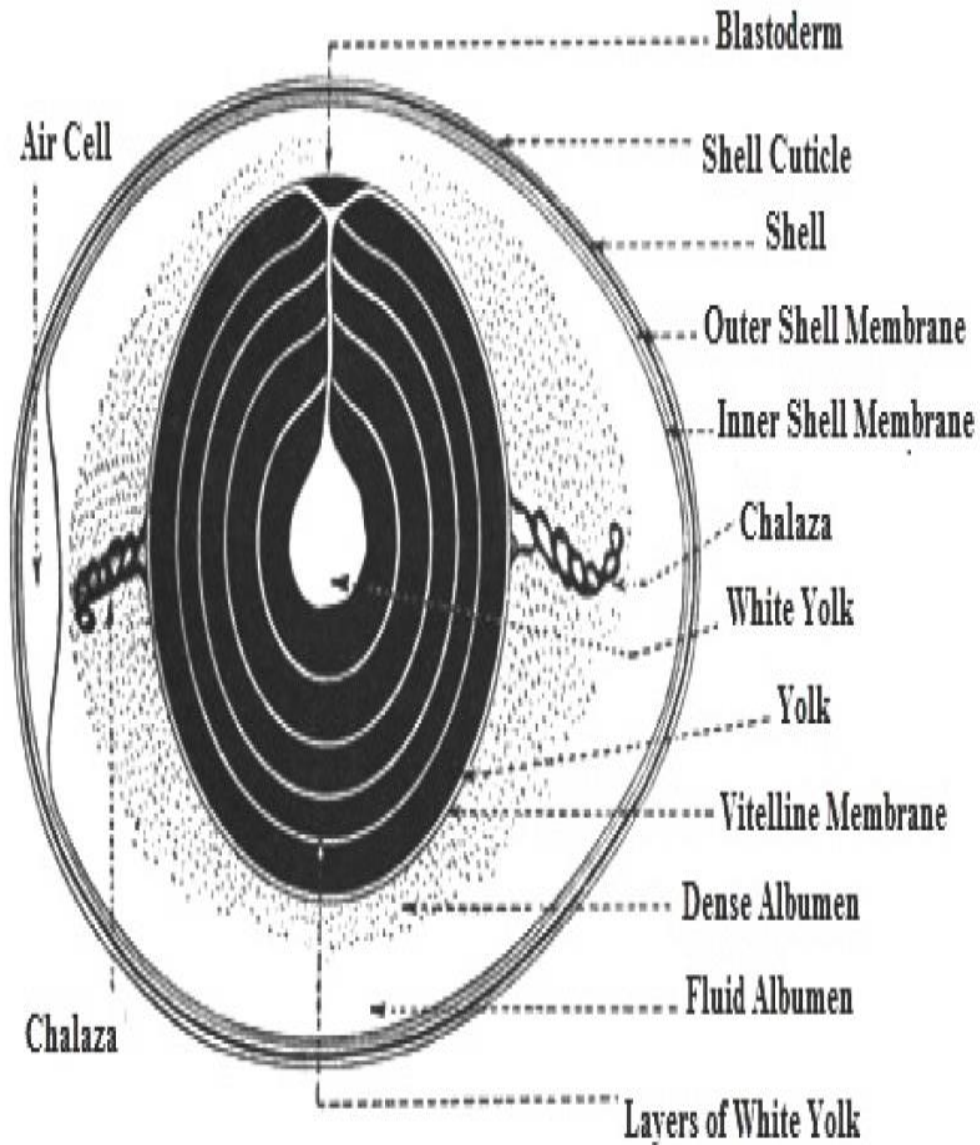
Fish Spoilage

Fish is a very perishable, high protein food that typically contains a high level of free amino acids. The lipid content of the fish is up to 25%. Composition of a fish

Water 65 – 80 %, Fat 1 – 20 % and Protein 14 – 20 %

Microbes metabolize these amino acids, producing ammonia, biogenic amines such as putrescine, histamine, and cadaverine, organic acids, ketones, and sulfur compounds. Degradation of lipids in fatty fish produces rancid odours. *Pseudomonas* species are the predominant group found on chilled fresh fish under aerobic conditions. Packing under carbon dioxide and addition of low concentrations of sodium chloride favour growth of lactic acid bacteria and *Photobacterium phosphoreum*. *Pseudomonas* species are the predominant on chilled fresh fish under aerobic conditions. Packing under carbon dioxide and addition of low concentrations of sodium chloride favour growth of lactic acid bacteria and *Photobacterium phosphoreum*. *Salmonella* also found in oysters possibly due to contaminated water. Seafood also is the source for *Pseudomonas* spp., *C. perfringens*, *L. monocytogenes*, *Vibrio parahaemolyticus*, *Salmonella enterica* serovar *enteritidis* and *typhimurium*, *Campylobacter jejuni*, *Yersinia enterocolitica*, and Enteroviruses (Hepatitis A). Smoked salmon and shrimps also are found to carry pathogenic *L. monocytogenes*.

Spoilage of Egg



Courtesy of Institute of American Poultry Industries

Freshly laid eggs are generally sterile particularly the inner contents. However the shells get contaminated from the environmental sources such as faecal matter of the bird, beddings, by the handlers and wash water and also the packaging materials in which the eggs are packed. Breaks or cracks in egg shell taking place due to transportation or mechanical damage may allow microorganisms to enter in to the egg yolk and cause spoilage on storage. In general the spoilage of eggs is caused by bacteria as compared to molds and can be described as green rot due to the growth of *Pseudomonas fluorescens*, colourless rot due to the growth of *Pseudomonas*, *Acinetobacter* and other species; black rots due to *P. roteus*, *Pseudomonas*; red rots due to *Serratia* spp. Molds causing spoilage of eggs include species of *Pencillium*, *Mmucor*, *Alterneria* etc.

Organisms of Concern

Salmonella (infection)

- 800,000 to 4 Million cases per year
- 500 Deaths per year
- Source animals or animal products
- Poultry and Swine
- Spread by direct contact with contaminated people or animals, and by handling during the manufacture and transportation of food and food ingredients
- Killed by pasteurization
- avoid cross-contamination of cooked product with raw product
- Symptoms---Nausea, Vomiting, Abdominal cramps, Diarrhea, Fever, Headache
- Result-- 6 To 72 Hours
- Infective Dose As Few As 15-20 Cells
- Last 4-7 days



Escherichia coli

- E. coli is one of the most wide spread organisms in nature
- Most strands are good teria
- E. coli 0157H7 enterotoxin
- contamination occurs usually via improper slaughter procedures or improper and unsanitary handling of cooked product
- Produces a potent toxin that cause sever damage to the lining of the intestine other damage

Symptoms

- Severe cramping, watery diarrhoea which becomes bloody occasionally vomiting,
- low grade fever which last 8 days
- Very young hemolytic uremic syndrome resulted in renal failure
- As few as 10 organism
- Associated with undercooked hamburger, dry-cured salami, lettuce, meat
- Mortality rate in elderly as high as 50

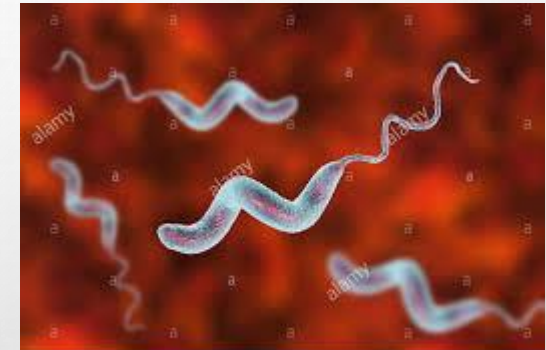


Campylobacter jejuni (infection)

- Leading cause of bacterial diarrheal illness in U.S.
- Not carried by healthy individuals but is isolated from healthy cattle, chickens, birds and flies.
- will not grow at temperatures less than 86 F and easily destroyed by pasteurization
- key --- avoid cross-contamination of cooked product with raw product

Associated Foods

- Raw chicken
- 20 to 100 of retail chicken contaminated
- Bacteria carried by flies
- Non chlorinated water
- Up to 4 million cases/year
- 1 death/1,000 cases
- Children under 5 and young adults most frequently afflicted



Clostridium botulinum (anaerobic, intoxication)

- Heat labile Neurotoxin
- A few nanograms of toxin can cause illness
- 180F for 10 minutes
- Spores are heat resistant
- High mortality rate
- Associated with inadequately processed home canned food
- Widely distributed in nature



Clostridium botulinum Associated foods

- Low acid canned foods
- Sausages
- Meat products
- Seafood
- Almost any type of food that is not very acidic (pH gt 4.6) can support growth and toxin production

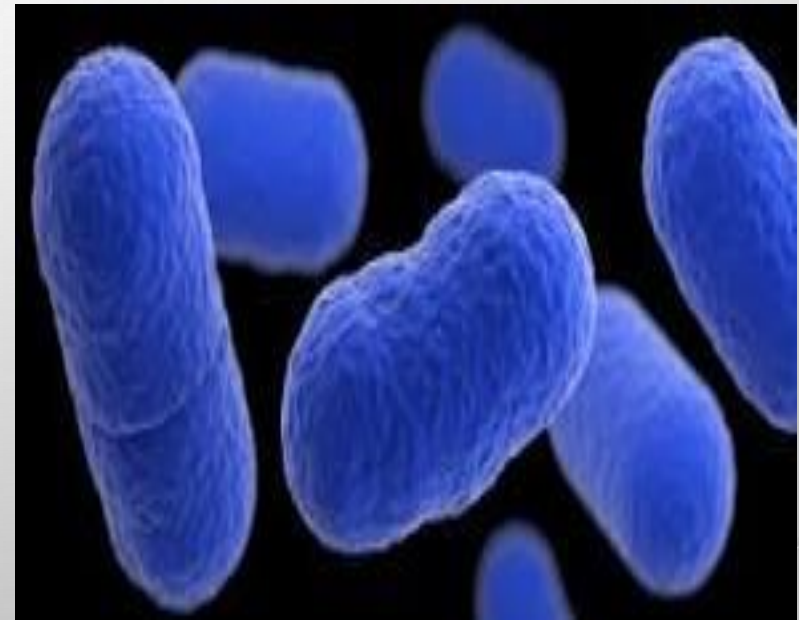
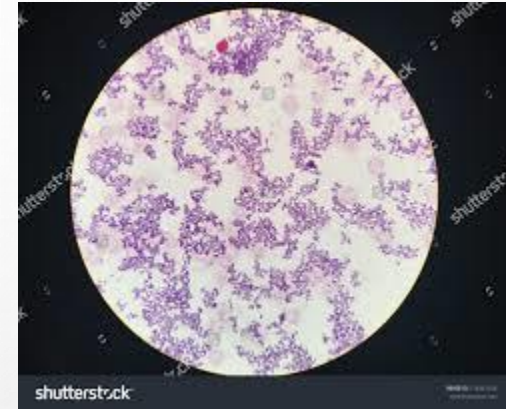


Listeria monocytogenes (infection)

- Listeria is everywhere -- in soil, vegetation, all types of animals and water, Cold/Heat/Drying resistant
- Does not form spores
- Key - avoid post-cooking contamination
- Big concern in ready to eat products
- Lunch meats, Hot Dogs, etc

Associated foods

- Fermented raw meat sausages
- Raw and cooked poultry
- Raw meats
- Raw and smoked fish



The microbiological hazards in the processing operation are difficult to control effectively because of the technological limitations in the processing which leads to cross-contamination. Implementation of the HACCP system does not completely check this drawback, but has a number of clear benefits mentioned below:

1. The system ensures regular monitoring of the processing operation.
2. Hygiene control should be optimized during processing as required by FSSAI.
3. Checking of control parameters and recording and proper documentation of results are an integral part of the system.
4. Compliance with hygiene legislation is ensured.
5. Staff awareness of food-safety requirements is increased.
6. As a result of national HACCP implementation, an operational standards in all the related Industry become more uniform.



REMEMBER KEEP IT

- COLD
- CLEAN
- DRY
- MOVING
- COOK IT!



THANK YOU