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Microbial spoilage, sources of contamination, control of spoilage of meat, poultry, sea foods

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- ❑ Microbiological profile of meat products is the sum total of slaughtered animal health, rearing conditions, quality of slaughtering, processing, packaging and conditions under which meat stored.
- ❑ Meat pathogens can cause human enteric diseases or systemic and fatal infections of immunocompromised, elderly and young.
- ❑ Meat associated pathogenic bacteria include *Clostridium perfringens*, *Staphylococcus aureus*, *Salmonella* spp., pathogenic strains of *E. coli*, *Campylobacter* spp., *Yersinia enterocolitica*, *Listeria monocytogenes*.

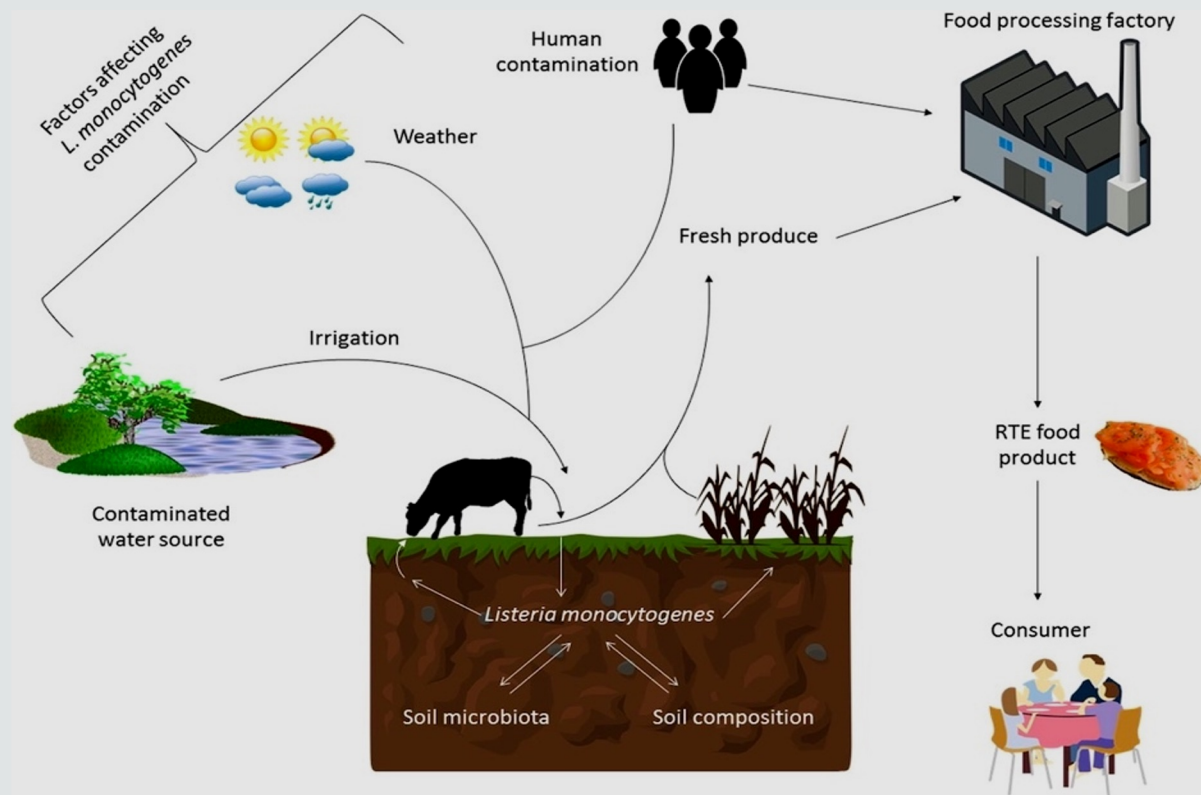


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Microorganisms Associated with Meat during Processing

- Meat spoilages indicate (a) color changes (b) textural changes and (c) development of off-flavour/off-odor/slime as result of microbial growth.
- *Salmonella*: Primary microbial challenge for poultry.
- Primary microbial to beef industry is *E. coli* O157: H7.
- *Listeria*, which is an adulterant with zero tolerance, is major problem for ready to eat meat products.





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Contaminations of Meat



**At the Farm or
In Field**



**At Slaughter
House**



At Processing



Transportation



At Retail Shop



**At home (storage &
cooking)**



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- Treatment with organic acids, hot water steam carcass pasteurization and steam carcass vacuuming, trisodium phosphate, acidified sodium chlorite, chlorine dioxide, peroxyacetic acid, sodium lactate, sodium acetate, ozone and radiation have been used as microbial decontaminants during meat processing operations.
- Carcass washing with hot water of 80°C for 10 secs can reduce microbial loads by 2 logs.
- HACCP (Hazard Analysis Critical Control Point) food safety system with an objective to provide safe food for consumption and prevent chemical, physical and biological hazards.
- Gram-negative bacteria: *Psychrobacter immobilis*, *Pseudomonas fluorescens*
- Gram-positive bacteria: *Brochothrix thermosphacta*

Fresh Meat

1. Muscles of healthy animals do not contain any bacteria or fungi but slaughtering leads to exposure to contaminants and good sanitation practices are essential to produce high quality meats.
2. Large variety of microbes are commonly found on fresh meat, but different microbes become dominant during spoilage depending on pH, composition, temperature and packaging atmosphere.
3. *Pseudomonas* spp. (catabolizes gluconates and amino acids and produces malodorous sulfides, ammonia and amines (putrescine and cadaverine) is the predominant spoilage bacteria in aerobically stored raw meat and poultry.
4. *Shewanella putrefaciens* do not grow on meat at $\text{pH} < 6.0$ but produces sulfides and ammonia in presence of glucose.



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5. *Brochothrix thermosphacta* grows on aerobic stored fresh meat at refrigeration temperatures.
6. *Serratia*, *Enterobacter*, and *Hafnia* causes spoilage in vacuum-packed, high pH fresh meats (produces organic acids, hydrogen sulfide and greening).
7. LAB (weakly proteolytic) grow on meat and poultry packaged under vacuum and modified atmospheres, producing organic acids from glucose by fermentation, thereby giving aciduric off-odors, gas, slime and meat greening.
8. *Clostridium* spp. produce "blown pack" meat spoilage (excessive gas formation with off-odors due to formation of butyric acid, butanol and sulfurous compounds).
9. Yeasts and molds grow relatively slow on fresh meat in comparison to bacteria.





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Processed Meat

- Addition of NaCl, nitrites, seasonings, emulsifiers and preservatives changes the environment and also the spoilage flora of processed meats.
- Dried and dry-fermented meats generally do not support microbial growth.
- Spoilage organisms can grow on fresh and cooked cured meats, so they are best stored chilled, under a vacuum or modified atmosphere.
- *Pseudomonas* spp. usually do not cause spoilage in processed meats (sensitivity to curing salts, heat pasteurization and their inability to grow well in meats packed with a vacuum or high CO₂ atmosphere). But, opened packages and insufficient curing can spoil refrigerated processed meats.
- Some cold- and salt tolerant Enterobacteriaceae lead to spoilage in some ham or bacon.



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- LAB is primarily associated with spoilage of processed meats producing sour off-flavors, gas, slime, and greening, and this spoilage may be more severe than in fresh meat because of presence of added carbohydrates.
- Sporeformers are usually not a spoilage problem in processed meats because of presence of nitrite and other curing salts. However, faulty cooking/cooling procedures or through spices can lead to growth of these organisms.
- Yeasts cause some spoilage in processed meats but only important when sulfite is used as preservative or when meats have been irradiated or are stored aerobically in the cold are prevented. Slime may be produced along with vinegary or malty off-odors in some sausages.





**Surface slime: *Pseudomonas*,
Moraxella, *Streptococcus*,
Leuconostoc, *Bacillus*,
*Micrococcus***

**Change in colour of meat
pigment (red colour of meat
may be changed to green,
brown or grey by
Lactobacillus and
Leconostoc spp)**

**Unsaturated fat in meat gets
oxidized by lipolytic bacteria
which produce off odours
due to hydrolysis of fats and
production of aldehydes and
acids (*Pseudomonas*)**

**Surface color change
(*Serratia marcescens*, caused
red spots on meat, Blue
color surface is caused by
Pseudomonas syncyanea and
yellow color is caused by
Micrococcus sp)**

**Volatile acid like formic,
acetic, butyric and propionic
acid produce sour odor and
Actinomycetes produce
musty or earthy flavor. Yeast
cause sliminess discoloration
off odor and taste defects**

**Aerobic mold also cause
stickiness, whiskers, black-
spot, white-spot, green
patches off odor and off taste**





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Spoilage under anaerobic condition

Souring

- Souring is caused by production of formic, acetic, butyric, lactic, succinic and propionic acid

Putrefaction

- Caused by decomposition of proteins under anaerobic condition by *Clostridium* sp.
- Foul smell is due to production of H_2S , mercaptans, indol, scatol, ammonia and amines.



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Meat Borne Diseases

- Food borne pathogens associated with animal health pandemics include Avian Influenza (AI) and Foot and Mouth Disease (FMD) viruses.
- Avian influenza is not of concern to poultry meat safety, because it is inactivated at 70°C.
- Oral route of transmission is less important than non food borne route.
- There is continuous adaptation and development of resistance by pathogenic microorganisms to antibiotics and potentially to food preservation barriers, like low pH, heat, cold temperatures, dryness, low water activity and chemical additives.



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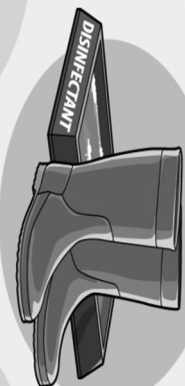
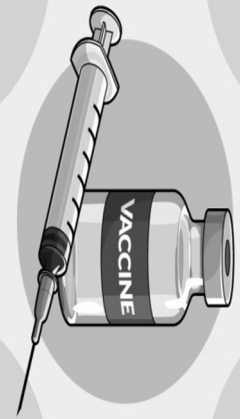
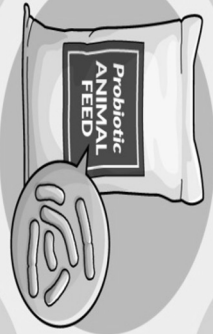
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Control of Meat-borne Pathogens

- **Antimicrobial intervention**
- **Pre-harvest pathogen control interventions** (diet manipulation, use of food additives, antibiotic, bacteriophage therapy, immunization of the animals, probiotics and proper animal management practices)
- **Inspection regulations** (sanitation standard operating system, operations under the HACCP system, establishment of good manufacturing practices and good hygiene practices)

water storage biotechnology hygiene expiration moisture salmonella safety hazards pesticide additives handling cooking controlling lab safe trichinosis foodborne coli radiation industry routines food safety market regulated temperature labeling inspection disease microorganism gmo preparation certification illness botulism poisoning residues consumer health healthy modification food preparation certification

HACCP Certified





Microbial spoilage of Eggs

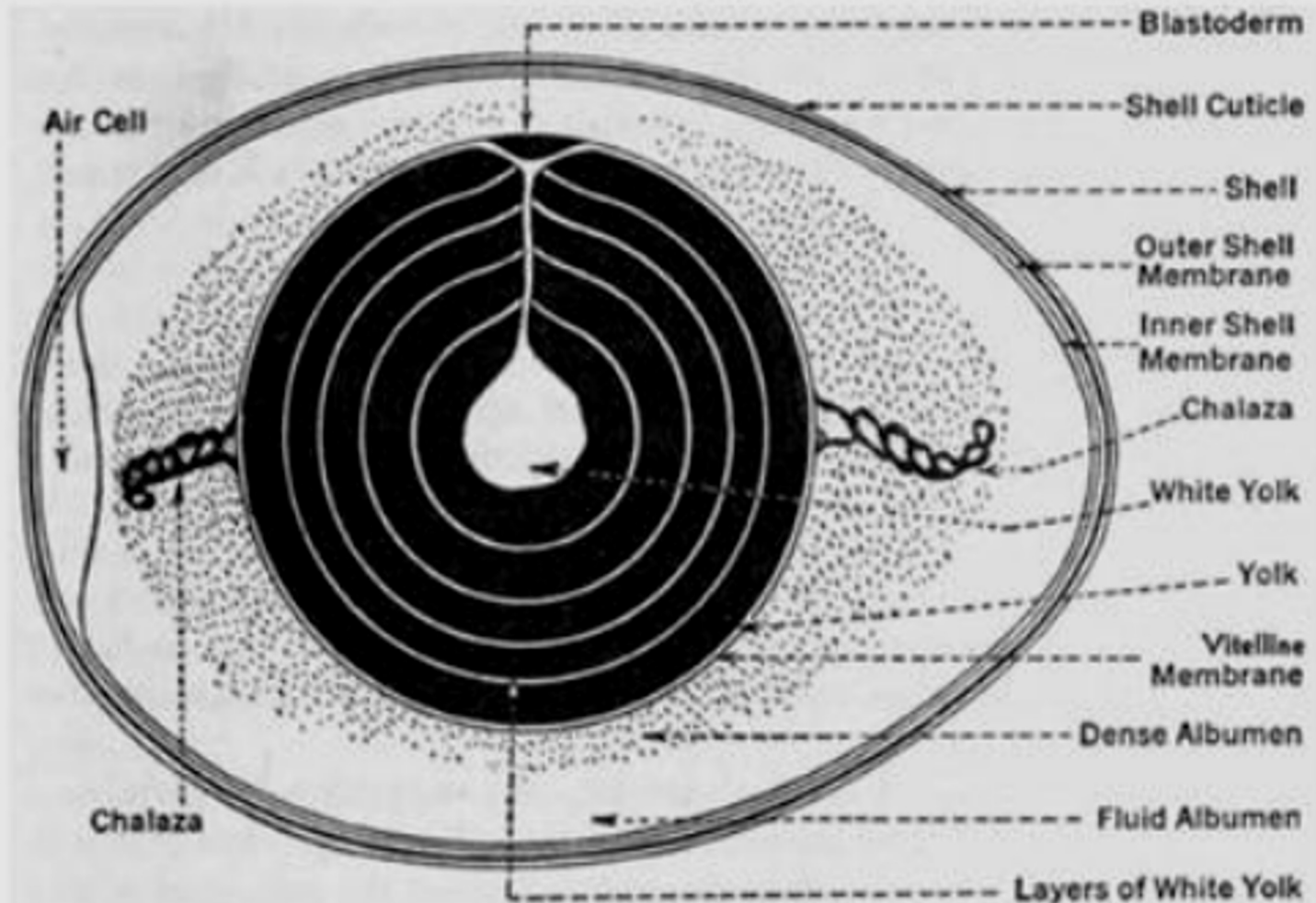
Freshly laid eggs are generally sterile (inner contents). However, the shell gets contaminated from the environmental sources (fecal matter of the bird, beddings, by the handlers and wash water and packaging materials e.g. *Pseudomonas*, *E. coli*, *Enterobacter*, *Micrococcus*, and *Bacillus*).



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- **Waxy shell membrane retards entry of microorganism.**
- **Several antimicrobial factors present in egg albumin such as lysozyme, conalbumin (binds iron), avidin (binds biotin), or alkaline pH (8.0 to 9.0), can control bacterial growth.**





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- Breaks or cracks in egg shell during transportation or mechanical damage may allow microorganisms to enter in to the egg yolk and cause spoilage on storage.
- Egg white becomes thinner and more watery on storage.
- Green rot (*P. fluorescens*)
- Black rot (*Proteus*, *Pseudomonas*)
- Red rot (*Serratia* spp.)
- Growth of *Aeromonas* in egg yolk turns it to black color and produce putrid odour due to formation of H_2S . Storage of eggs in high humid atmosphere may help in growth of several molds on surface of egg shell (*Penicillium*, *Mucor*, *Alternaria*).





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Spoilage of Poultry

- Poultry meat is also susceptible to contamination.
- Contamination of skin and lining of body cavity take place during various processing operations.
- *Salmonella* spp., *Campylobacter jejuni*, Gram-negative psychrotroph (*Pseudomonas*, *Acinetobacter* and *Flavobacterium*) are linked to poultry carasses.
- Ground turkey may carry fecal streptococci.
- Freezing (-18C or below) the poultry fast keeps it in good condition for several months as well as reduces number of microorganisms.





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FISH SPOILAGE

- Fish is a very perishable, high-protein food that typically contains a high level of free amino acids.
- Lipid content of the fish is up to 1-20%.
- Fish flesh generally contains 15-20% protein and less than 1% carbohydrate.
- Non-fatty fish (teleosts cod, haddock) fat levels are only about 0.5%, but fatty fish (mackerel and herring) levels can vary between 3-25%.
- Microbes metabolize amino acids, producing ammonia, biogenic amines (putrescine, histamine and cadaverine), organic acids, ketones and sulfur compounds.
- Degradation of lipids in fatty fish produces rancid odors.
- Marine fish and some freshwater fish contain trimethylamine oxide that is degraded by several spoilage bacteria to trimethylamine (responsible for fishy off odors).





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- *Pseudomonas* and *Shewanella* are the predominant species on chilled fresh fish under aerobic conditions. Packing under CO₂ and addition of low concentrations of NaCl favor growth of LAB and *Photobacterium phosphoreum*.
- Halophilic bacteria (*Serratia*, *Micrococcus*, *Bacillus* and *Pseudomonas* cause spoilage of salt fish).
- Shell fish are spoiled by *Acinetobacter*, *Moraxella* and *Vibrio*.
- Crab meat is spoiled by *Pseudomonas*, *Acinetobacter* and *Moraxella* at low temperature and by *Proteus* at high temperature.
- Microbial loads in shrimps, oysters, and clams depend on quality of water from which they are harvested. During handling, fecal coliforms, fecal streptococci and *S. aureus* may incorporate into product.
- Seafood is source for *Pseudomonas* spp., *C. perfringens*, *L. monocytogenes*, *V. parahemolyticus*, *S. enterica* serovar *enteritidis* and *typhimurium*, *Campylobacter jejuni*, *Yersinia enterocolitica* and Hepatitis A.
- Smoked salmon and shrimps carry pathogenic *L. monocytogenes*.