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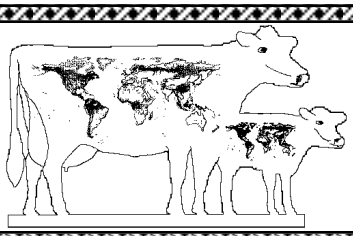

**Dairy Essentials**

# 23) MASTITIS: THE DISEASE AND ITS TRANSMISSION

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## WHAT IS MASTITIS

Mastitis, or inflammation of the mammary gland, is the most common and the most expensive disease of dairy cattle throughout most of the world. Although stress and physical injuries may cause inflammation of the gland, infection by invading bacteria or other microorganisms (fungi, yeasts and possibly viruses) is the primary cause of mastitis.

### Clinical and subclinical mastitis

In clinical mastitis, the infected quarter often become swollen, sometimes painful to touch, and the milk is visibly altered by the presence of clots, flakes, or discolored serum and sometimes blood. In severe cases (acute mastitis), the cow shows signs of generalized reaction: fever, rapid pulse, loss of appetite and sharp decline in milk production.

In contrast, subclinical mastitis is subtle and more difficult to detect. The cow appears healthy, the udder does not show any signs of inflammation and the milk seems normal. However, microorganisms and white blood cells (somatic cells) that fight infections are found in elevated numbers in the milk.

The loss of milk and income due to clinical mastitis are readily apparent—milk production drops sharply and milk from cows treated with antibiotics must be discarded for three or four days. Nonetheless, a lot more milk is lost due to subclinical mastitis because:

- The vast majority of mastitis cases are subclinical (on the average, for every clinical case, there are 20 to 40 subclinical cases);
- The reduction in milk production due to subclinical mastitis tends to persist for long periods of times and thus undermines the yield of infected cows.

Control of subclinical mastitis is more important than simply treating clinical cases because:

- The cows that have subclinical mastitis are reservoirs of organisms that lead to infection of other cows;
- Most clinical cases start as subclinical; thus, controlling subclinical mastitis is the best way to reduce the clinical cases.

The impact of mastitis goes with the milk beyond the gate of the farm. Changes in milk composition (reduction in calcium, phosphorus, protein and fat, and increases in sodium and chlorine) reduce its quality. In addition, the antibiotic used in treating mastitis is an important industrial and public health concern. The presence of antibiotic residue in the milk interferes with the manufacturing process of many dairy products (cheese and other fermented products). Undesirable flavors reduce the value of dairy products and the presence of low levels of antibiotics may cause health problems to consumers.

## DEVELOPMENT OF THE DISEASE

Infections begin when microorganisms penetrate the teat canal and multiply in the mammary gland.

### Invasion of the teat

The teat itself is the **first line of defense** against the penetration of bacteria into the udder. Normally, the sphincter muscle closes the teat canal tightly when the cow is not being milked.

Invasion of the teat most often occurs during milking. Organisms present in the milk or at the teat end are propelled into the teat canal and cistern when there is admission of undesired air in the milking unit (slipping or squawking of the unit or removal of teatcup without first shutting off the vacuum). After milking, the teat canal remains dilated for one to two hours; however, the canal of a damaged teat may remain partially open permanently. Organisms from the environment (manure, bedding, etc.) or those found on injured skin at the tip of the teat may easily invade an open or partially open canal.

### Establishment of infection and inflammation of the damaged area

Some bacteria may proceed into the udder by attaching and colonizing new tissue; others may move around via milk current produced by the cow's movement. Bacteria first damages the tissues lining the large milk-collecting ducts. The bacteria may encounter leukocytes (white blood cells) present naturally in small numbers in the milk. These cells are the cow's **second line of defense** because they can engulf and destroy bacteria. However, during this process, the leukocytes release substances that cause the movement of additional leukocytes from the blood into the milk.

If bacteria are not entirely destroyed, they continue to multiply and begin to invade smaller ducts and alveolar areas (Figure 1A). Milk-secreting cells damaged by toxins and other irritants release substances that lead to increased permeability of blood vessels (Figure 1B). Additional leukocytes move to the site of infection. They enter the alveolar tissue in great numbers by squeezing between the

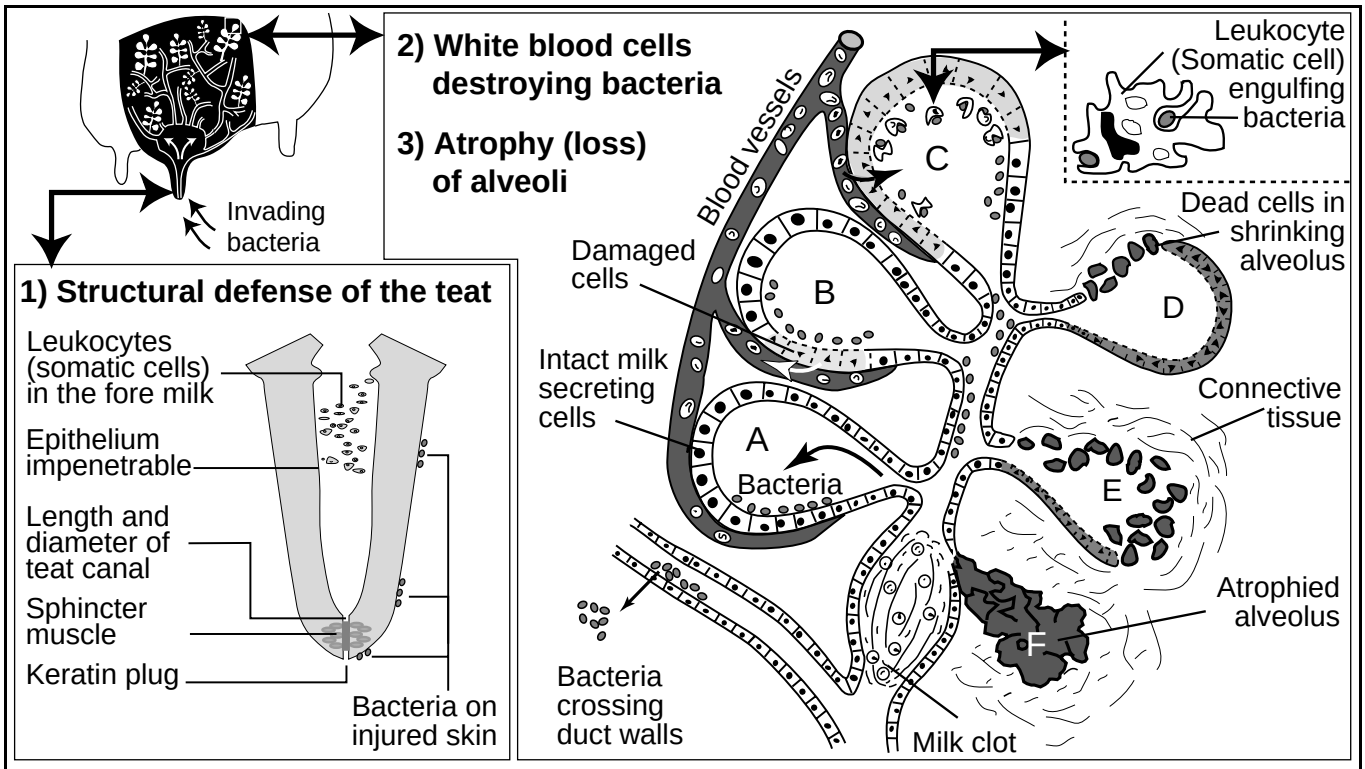


Figure 1: Development of mastitis and the cow's defense against the infection

damaged milk secreting cells (Figure 1C). Fluids, minerals and clotting factors also leak into the affected area. Clotted milk may close ducts, and in effect, isolate the infected regions.

### Destruction of alveolar tissue

Sometimes the micro-organisms are eliminated rapidly and the infection is cleared. In this case, the clogged ducts are opened and milk composition and production return to normal in several days. However, as the infection persists and ducts remain clogged, the entrapped milk causes the secretory cells to revert to a resting (non-producing) state and the alveoli begin to shrink (Figure 1D). Substances released by leukocytes lead to the complete destruction of alveolar structures, which are replaced by connective and scar tissues (Figure 1E and F). The destruction of milk secretory tissue is, in effect, the cow's **third line of defense** to bring the infection under control.

Thus as the disease progresses the number of somatic cells in the milk becomes elevated and associated with a (permanent) reduction in milk yield.

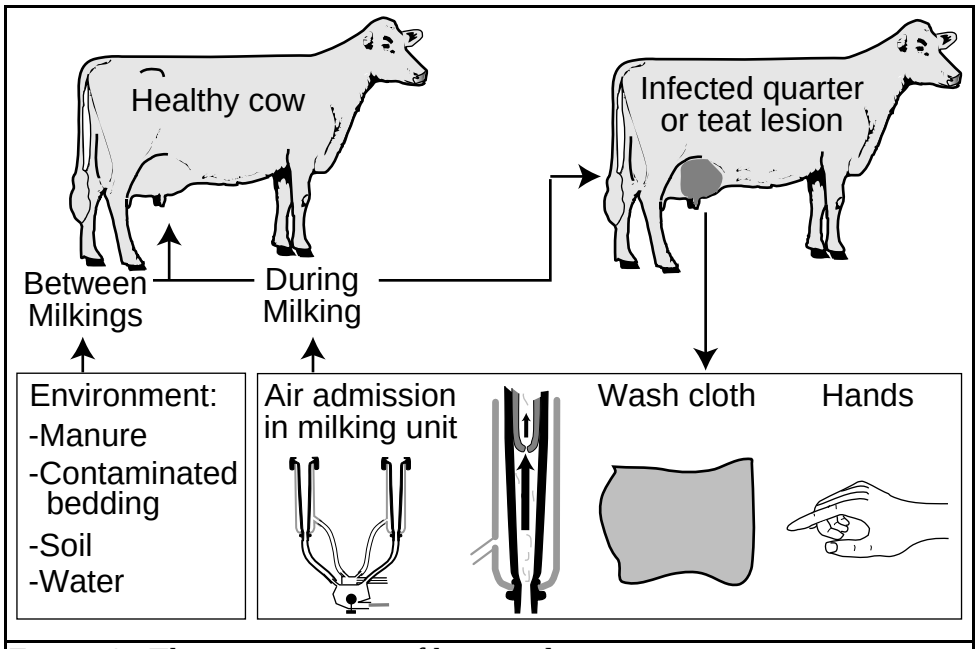


Figure 2: The major routes of bacterial transmission

## TRANSMISSION OF VARIOUS TYPES OF MASTITIS ORGANISMS

In attempting to control different types of infections, it is important to consider the source and means of transmission of the disease. Organisms that cause mastitis live in different environments (manure, bedding, skin, etc.). General cleanli-ness of cows and their housing, as well as good management procedures—especially at milking—are effective ways of controlling the spread of mastitis.

### Streptococcus agalactiae

*Streptococcus agalactiae* is the most common cause of subclinical infections but rarely causes severe illness (acute mastitis). This organism lives in the cow's udder and survives only a short time outside the mammary gland. It spreads primarily during milking via the milking machine, contaminated operators' hands, and materials (cloths) used to wash the udder (Figure 2). This organism may also infect the udder of a young calf if it is sucked by a second calf that has been fed contaminated milk. The infection can remain indefinitely in the heifer's mammary gland. *Streptococcus agalactiae* can be eradicated from a herd by appropriate treatment combined with good milking practices. However, it may easily spread again in a herd after the purchase of an infected animal.

### Staphylococcus aureus

*Staphylococcus aureus* lives inside or outside the udder on the teat skin and causes many cases of both clinical and subclinical mastitis. It usually spreads the

same way as *streptococcus agalactiae* (Figure 2). The infection tends to induce scarring, which results in pockets of infection walled off in the udder that are very difficult to reach with antibiotics. Such pockets may break open and spread to other parts of the gland later.

Table 1: Sources (from the most to the least prevalent) and means of spread of the most common bacteria causing mastitis

| Type of bacteria | Percent of all infections | Primary source | Major means of spread |
|---|---|---|---|
| *Streptococcus agalactiae* | > 40% | Infected udder | Quarter to quarter; cow to cow during milking[1] |
| *Staphylococcus aureus* | 30 - 40% | Infected udder, teat tenderness | Quarter to quarter, cow to cow during milking[1] |
| Environmental streptococci[2] | 5 - 10% | Bedding, manure | Environment to cow |
| Coliforms[3] | <1% | Manure | Environment to cow |

[1] See Figure 2 for more details
[2] *Streptococcus uberis* and *streptococcus dysgalactiae*
[3] *Escherichia coli, Enterobacteri aerogenes, Klebsillia pneumoniae*

### Streptococcus uberis and streptococcus dysgalactiae

These organisms are found in bedding (especially organic bedding: straw, sawdust, etc.), standing water and soils. They can also be found on the cow's skin (teat and belly) and in the reproductive organs. These two organisms are usually transferred from the environment to the teat between milking, but some transfer can also take place during milking. These organisms cannot be eliminated from a herd because they are part of the normal environment. The rate of infection from these bacteria tends to increase when conditions favor their growth—for example, during the wet and humid months of the year. *Streptococcus uberis* and *streptococcus dysgalactiae* are also responsible for most of the mastitis that occurs at either the beginning or the end of the dry period. In addition to these two species of bacteria, there are many other environmental streptococci (*Strep. bovis, Strep fecalis*) that can cause mastitis.

### Coliform bacteria

Coliform bacteria are normal inhabitants of soil and the intestines of cows. They accumulate and multiply in manure and bedding. Coliforms can cause mastitis only if contaminated particles from the environment come in contact with the udder. As opposed to previously described bacteria, the coliform do not attach to the ducts and alveoli in the udder, rather they multiply rapidly in the milk and produce toxins that are absorbed into the blood stream. As a result, coliform infections lead to acute clinical mastitis. The body temperature of the cow may rise above 40°C and the infected quarter will become swollen and sensitive to touch. The cow's defense mechanisms may eliminate the bacteria in the udder, but the toxins remain and the cow may die. Cows free of other mastitis-causing bacteria (*streptococcus agalactiae and staphylococcus aureus*) appear to be more susceptible to coliform bacteria.