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Lecture title: **Mammary Gland and Milk Biosynthesis: Nature's virtual bioprocessing factory**

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Summary:

Mammary Gland and Milk Biosynthesis: Nature's virtual bioprocessing factory

Anatomy of mammary glands of domestic animals

The mammary glands of cows, sheep, goats, camels, and horses are located in the inguinal region. Cows have four functional glands and teats, whereas sheep and goats have two separate glands, and each teats has one streak canal to drain milk from the udder. cow udder is semicircular with two halves.

The udder of cows is composed of two halves, each of which has two separate quarters, and each quarter has a separate teat. Each quarter is separated from the others by connective tissue and has a separate milk collecting system. The medial suspensory ligament arises from the abdominal wall and is attached to the medial flat surfaces of the two halves of the udder to form a septum between them.

The secretory tissue is made up of alveoli. A number of alveoli are joined together by a common duct and are surrounded by connective tissue to form a lobule. Many lobules are again surrounded by connective tissue to form lobes. The milk is synthesized and secreted from the alveoli cells into small milk ducts, from small milk ducts to large milk ducts, then drained into the gland cistern, then through the cricoid fold into the teat cistern before being ejected out from the streak canal and meatus, which is closed by a sphincter muscle.

A sphincter muscle is located at end of the teat channel to close the flow of milk between milking. The muscle prevents milk from leaking out of the teat and controls entry of bacteria and other harmful microbes.

Milk Biosynthesis

The mammary gland comprises only 5–7% of the dairy cow's body weight, it represents perhaps the animal's highest concentration of metabolic activity. Milk is produced in secretory cells clustered in groups known as alveoli. These cells feed milk through an arborescent duct system that collects milk into the udder. Production of milk is strongly controlled by endocrine hormones. Following parturition, the cells secrete antibody-rich colostrum for several days until milk secretion begins. Continued production of milk is stimulated by suckling or by milking through the stimulation of several hormones (prolactin, oxytocin).

Nutrients for milk synthesis are provided to the udder through the blood via a pair of major arteries. The ability of the mammary gland to capture milk originator effectively from the arterial blood supply-expressed calculated from the difference of precursor concentrations in arterial and venous blood-is truly impressive when one considers the rapid flow of arterial blood through the udder, which in dairy cows can approach 20 L/min. Production of 1 L of milk requires approximately 500 L of arterial blood flow through the udder.

MILKING

Example: one cow producing per day 30 Liter milk. For this cativity the cow need daily 12000 Liter blood through the udder.

Milk Ejection

A hormone oxytocin must be released into the cow's bloodstream in order to start the emptying of the udder. This hormone is secreted and stored in the pituitary gland. When the cow is prepared for milking by the correct stimuli, a signal is sent to the gland, which then releases its store of oxytocin into the bloodstream. The oxytocin is released when the cow feels the calf sucking or conditioned to react to other stimuli, i.e. to the sounds, smells and sensations associated with milking.

The oxytocin begins to take effect about one minute after preparation has begun and causes the muscle-like cells to compress the alveoli known as the letdown reflex. The pressure forces the milk down into the teat cistern, from which it is sucked into the teat cup of a milking machine or pressed out by the fingers during hand milking.

The effect of the letdown reflex gradually fades away as the oxytocin is diluted and decomposed in the bloodstream, disappearing after 5 - 8 minutes. Milking should be completed within this period of time. Mammary gland has a sophisticated level of organization with a remarkable ability to convert circulating nutrients from blood into milk components. Mammary epithelial cells synthesize complex milk constituents from simple components present in circulating blood.

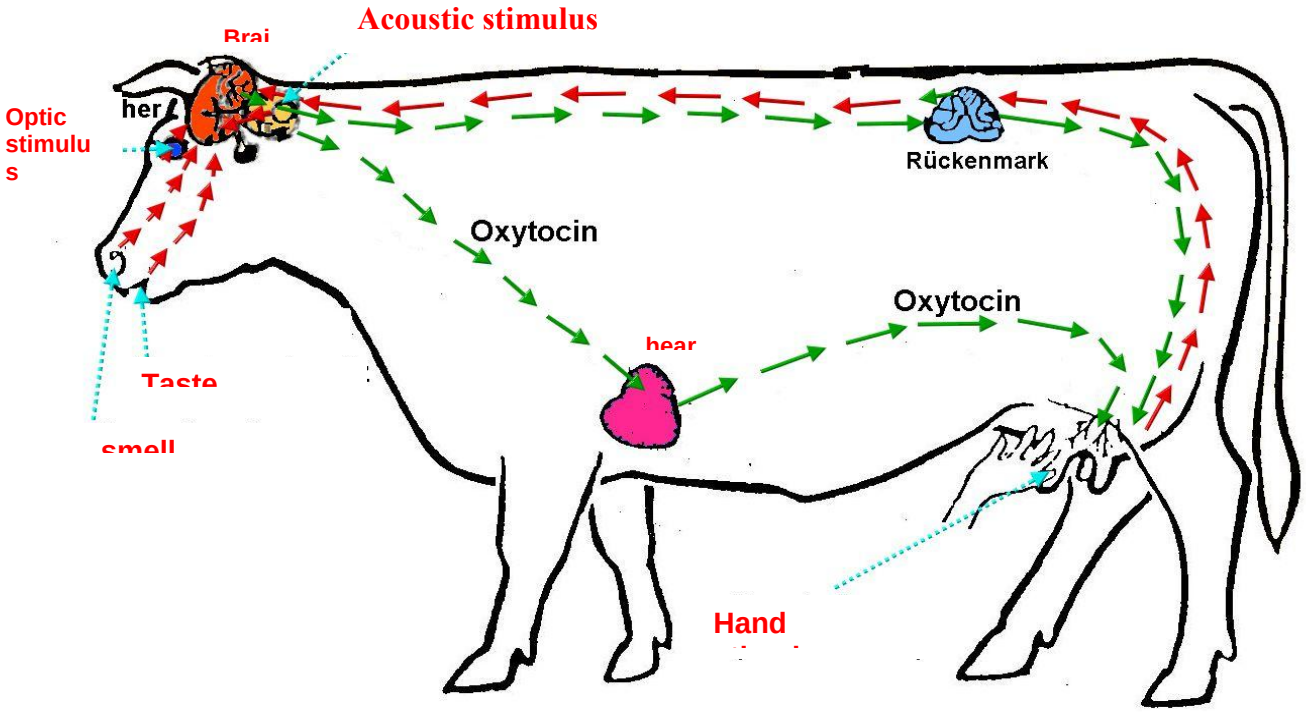

Figure : Indication of Oxytocin development and milk stream

Types of milking

There are two types of milking

1. Hand milking

2. Machine milking

1. Hand Milking

On many farms all over the world milking is still done by hand in the same way as it has been done for thousands of years. Cows are usually milked by the same people every day, and are quickly stimulated to let down just by hearing the familiar sounds of the preparations for milking. Milking begins when the cow responds with the letdown reflex.

The first lets of milk from the teats are rejected, as this milk often contains large amounts of bacteria. A careful, visual check of this first milk enables the milker to detect changes that may indicate that the cow is ill.

2. Machine milking

On large dairy farms, the usual practice is to milk cows by a machine similar. The milking machine sucks the milk out of the teat by vacuum. The milking equipment consists of a vacuum pump, a vacuum vessel which also serves as a milk collecting pail, teat cups connected by hoses to the vacuum vessel, and a pulsator which alternately applies vacuum and atmospheric pressure to the teat cups.

Chilling Milk on the Farm

Milk leaves the udder at a temperature of about 37°C. Fresh milk from a healthy cow is practically free from bacteria, but must be protected against infection as soon as it leaves the udder. Microorganisms capable of spoiling the milk are everywhere on the udder, on the milker's hands, on air-hair and in the soil. Careful attention must be paid to hygiene in order to produce milk of high bacteriological quality. However, despite all precautions, it is impossible to completely exclude bacteria from milk.

On one hand, milk is in fact an excellent growth medium for bacteria – it contains all the nutrients they need. On the other hand, the milk leaving the teats contains certain original bactericides which protect the milk against the action of microorganisms during the initial period. Milk should be chilled quickly to about

4°C immediately after it leaves the cow. At this temperature the level of activity of microorganisms is very low.