

Mammals, Mammary Glands and Milk: It's All About Lactation

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Week 3

Coursera.org

Search for Lactation Biology

Video on milk ejection

<http://youtu.be/ifPd6vU3SqA>

Overall learning objective:

To start us thinking like a lactation biologist
[It's not just about milk]

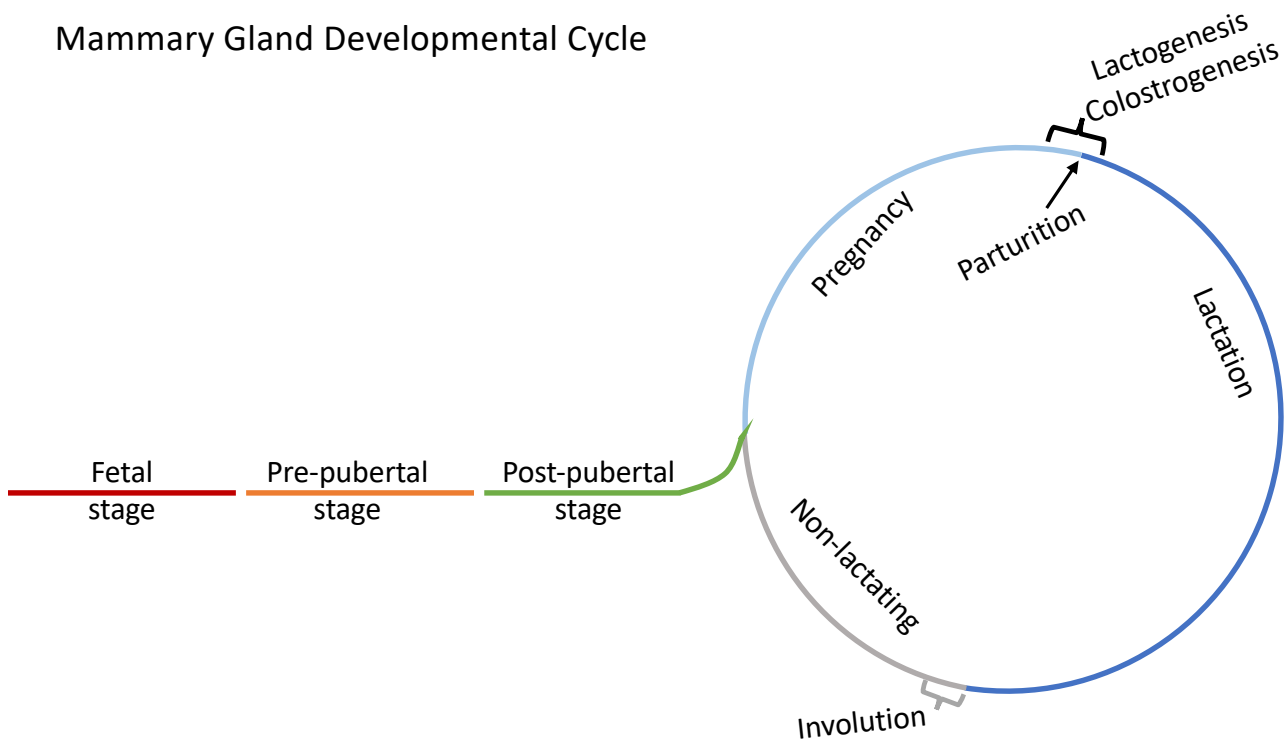
Today's learning objectives:

Identify the stages of lactogenesis

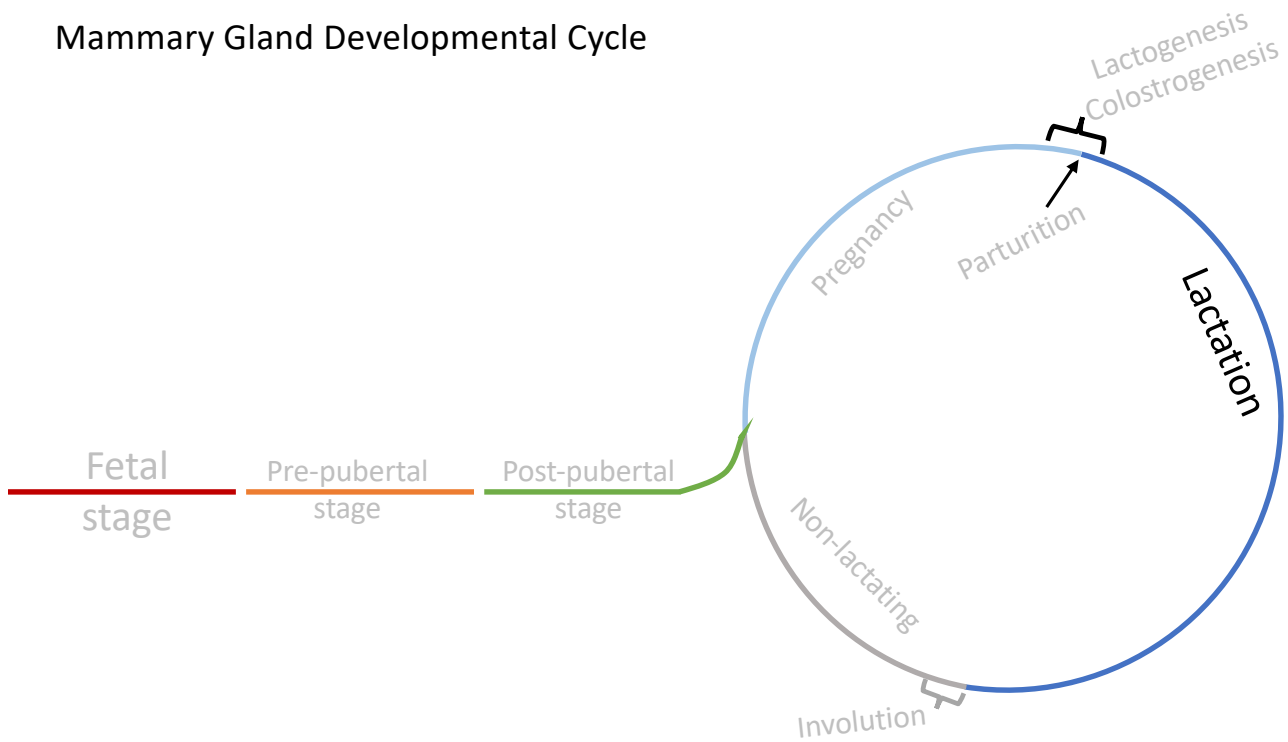
Characterize colostrum

Understand the process of milk ejection

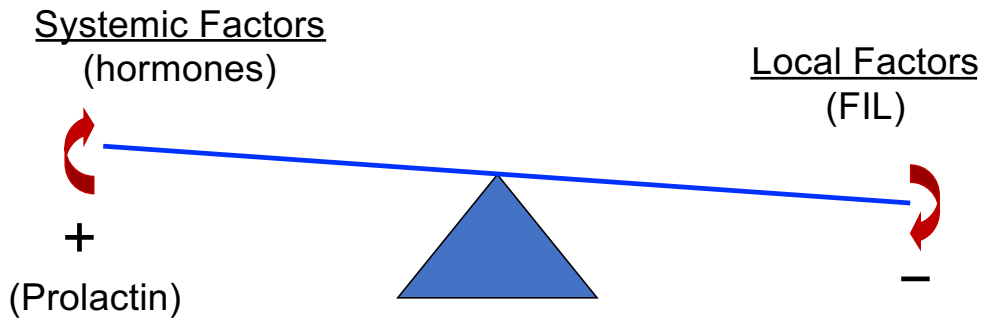
Mammary Gland Developmental Cycle



Mammary Gland Developmental Cycle

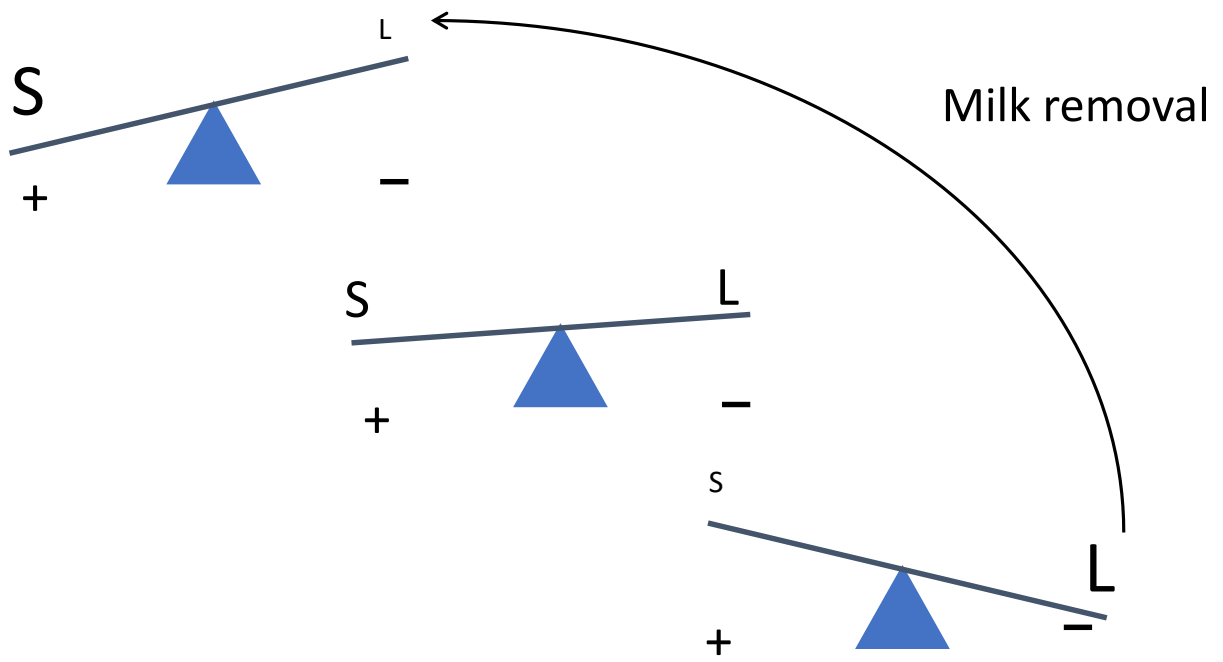


Balance of systemic and local factors in maintenance of lactation

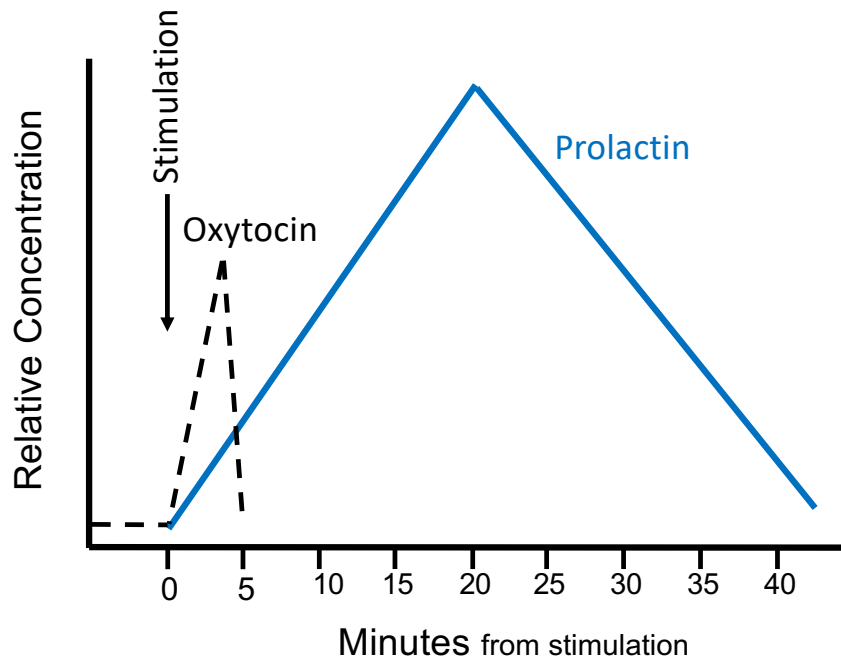


To maintain lactation, milk must be:

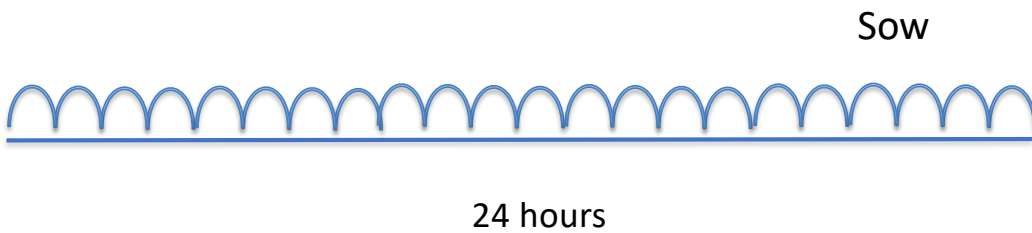
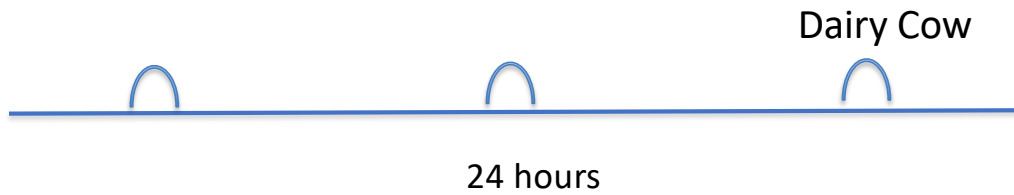
physically removed from the gland



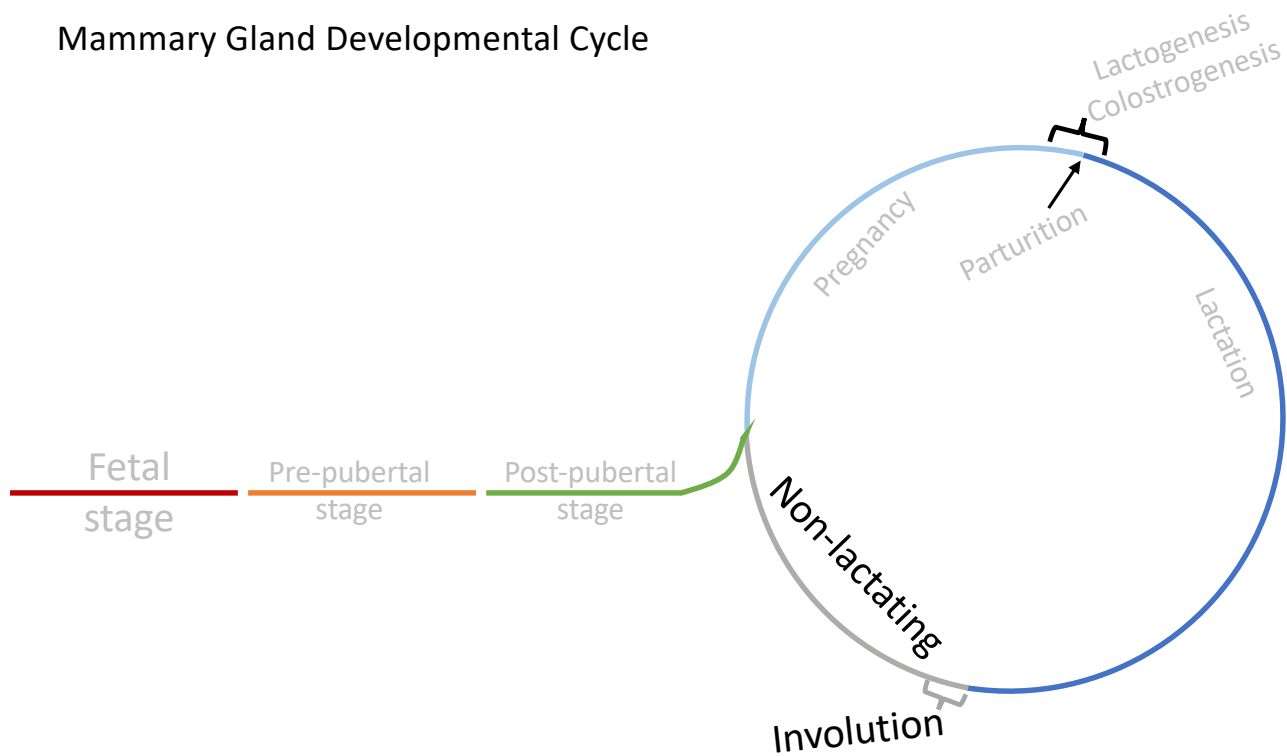
Suckling/milking induced change in oxytocin and prolactin



Suckling-Induced Prolactin Secretion

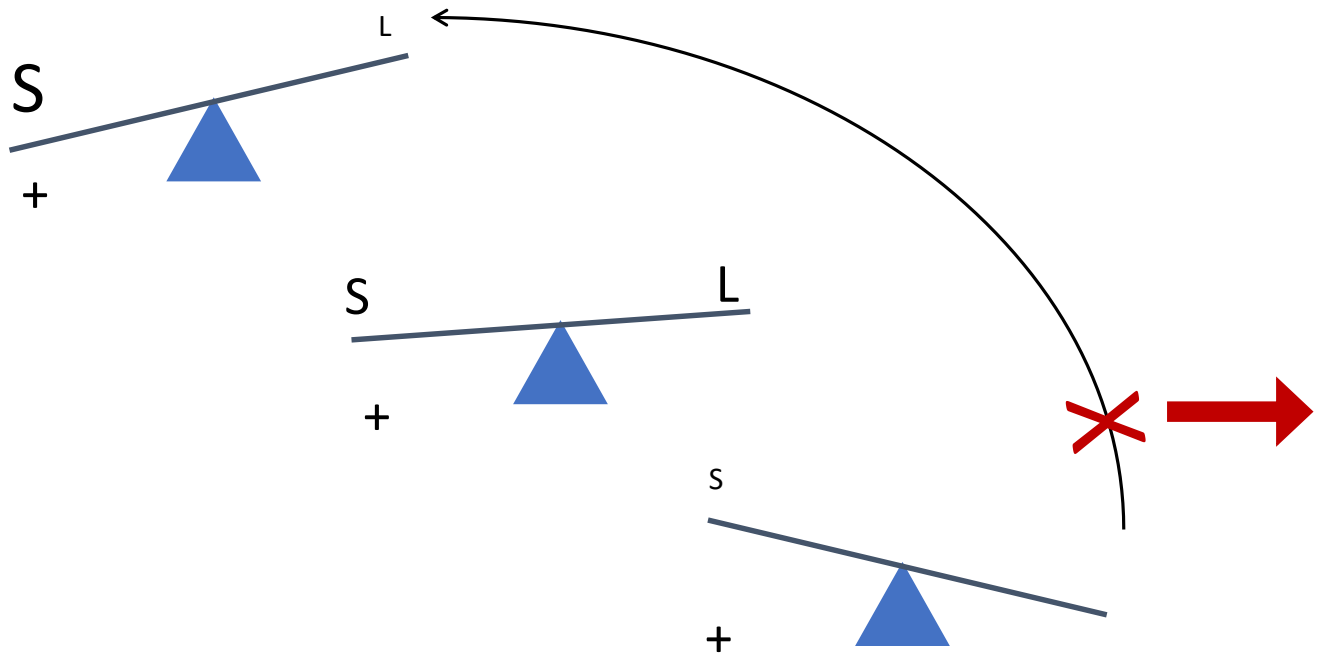


Mammary Gland Developmental Cycle



Milk Stasis -

- Eventually initiates the process of involution
- Milk secretion is stopped
- Programmed cell death of epithelial cells
- Changes in tissue structure
- Changes in secretion composition
- Changes in tissue function



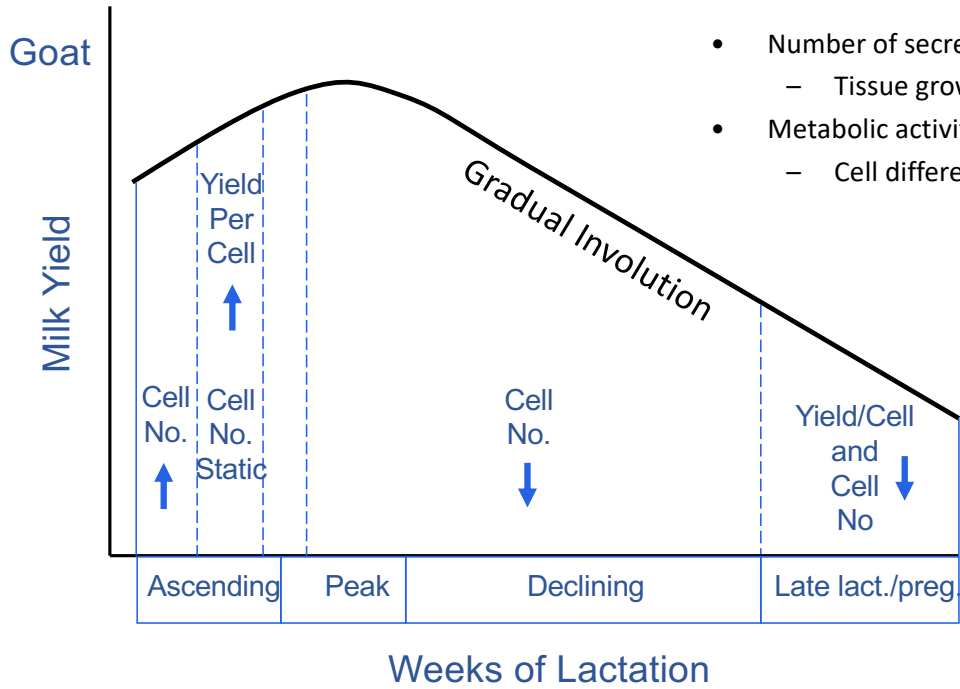
Types of Mammary Gland Involution

Senile Involution: regression of the gland as a result of tissue senility (end of reproductive life).

Gradual Involution: regression of the gland during the course of normal lactation (declining phase of lactation).

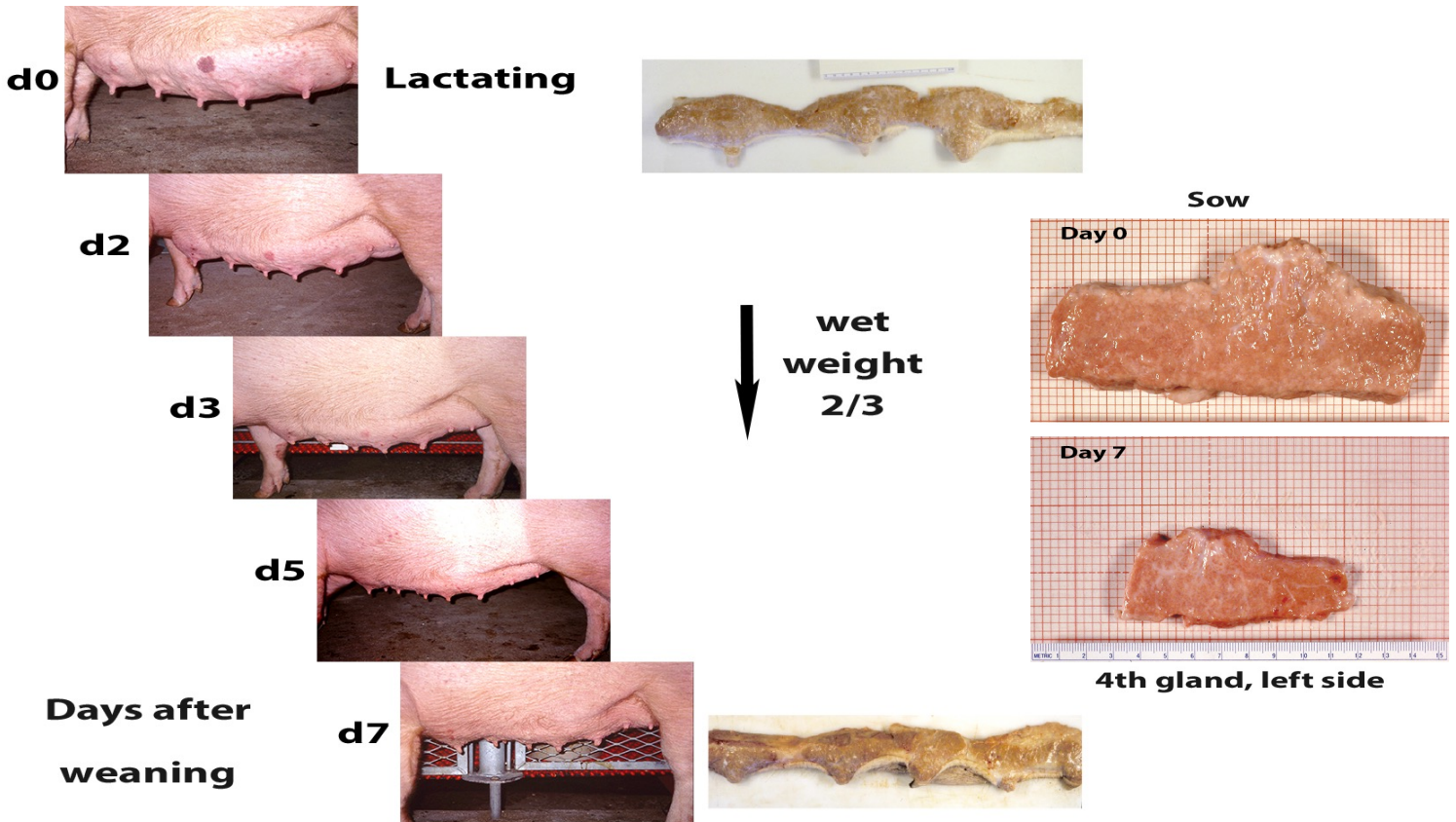
Initiated Involution: regression of the gland as a result of sudden cessation of milk removal (drying off a cow, rapid weaning).

Milk Yield Determinants

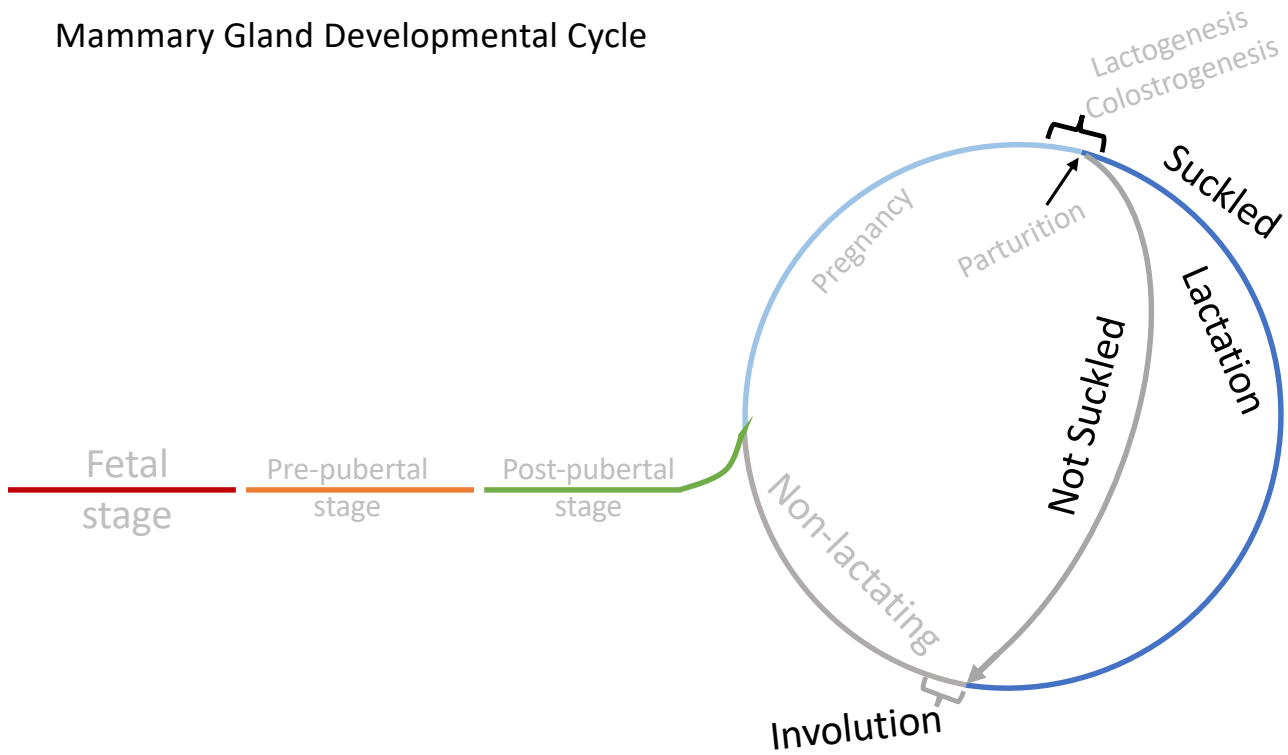


- Number of secretory cells
 - Tissue growth – number of cells
- Metabolic activity of secretory cells
 - Cell differentiation – yield/cell

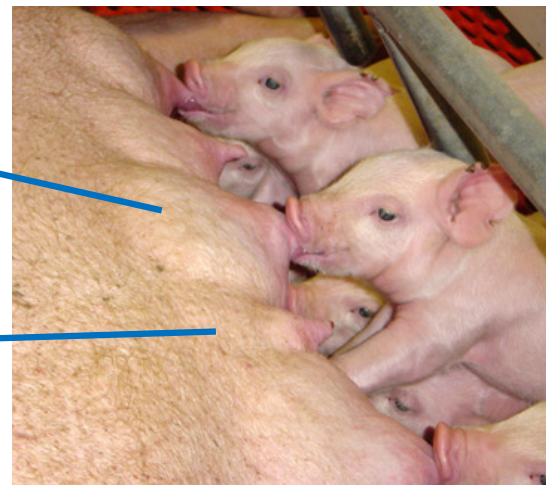
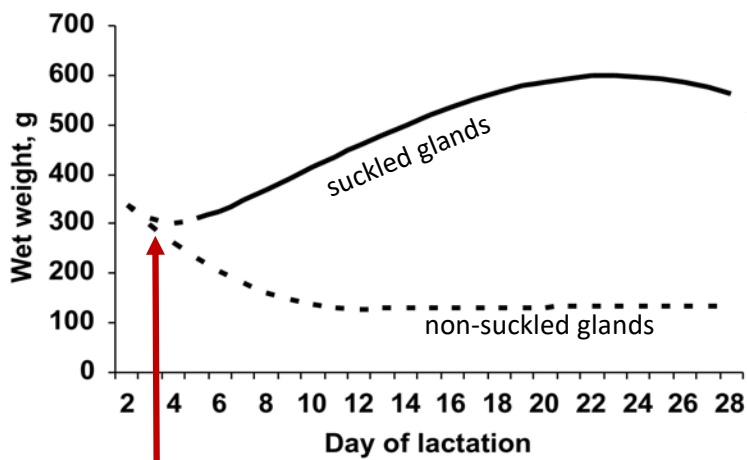
Adapted from Knight & Peaker, 1984



Mammary Gland Developmental Cycle



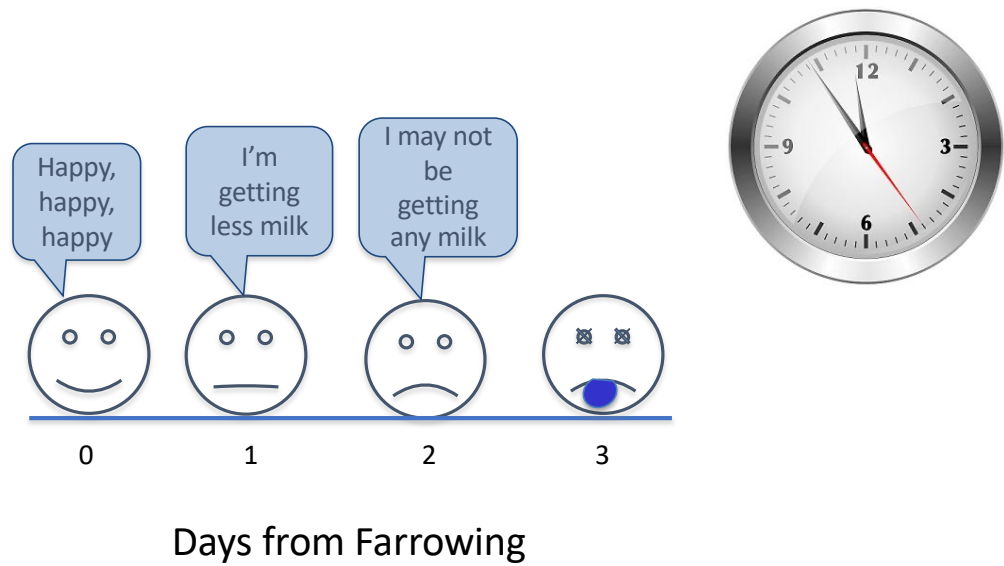
Suckled vs non-suckled glands



Function is lost by day 3 in non-suckled glands

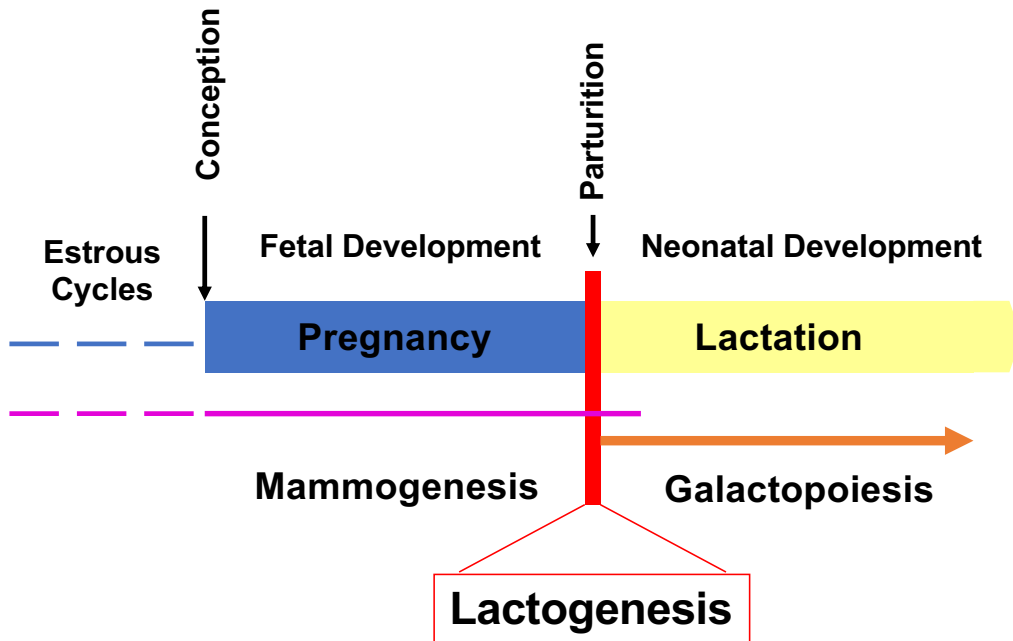
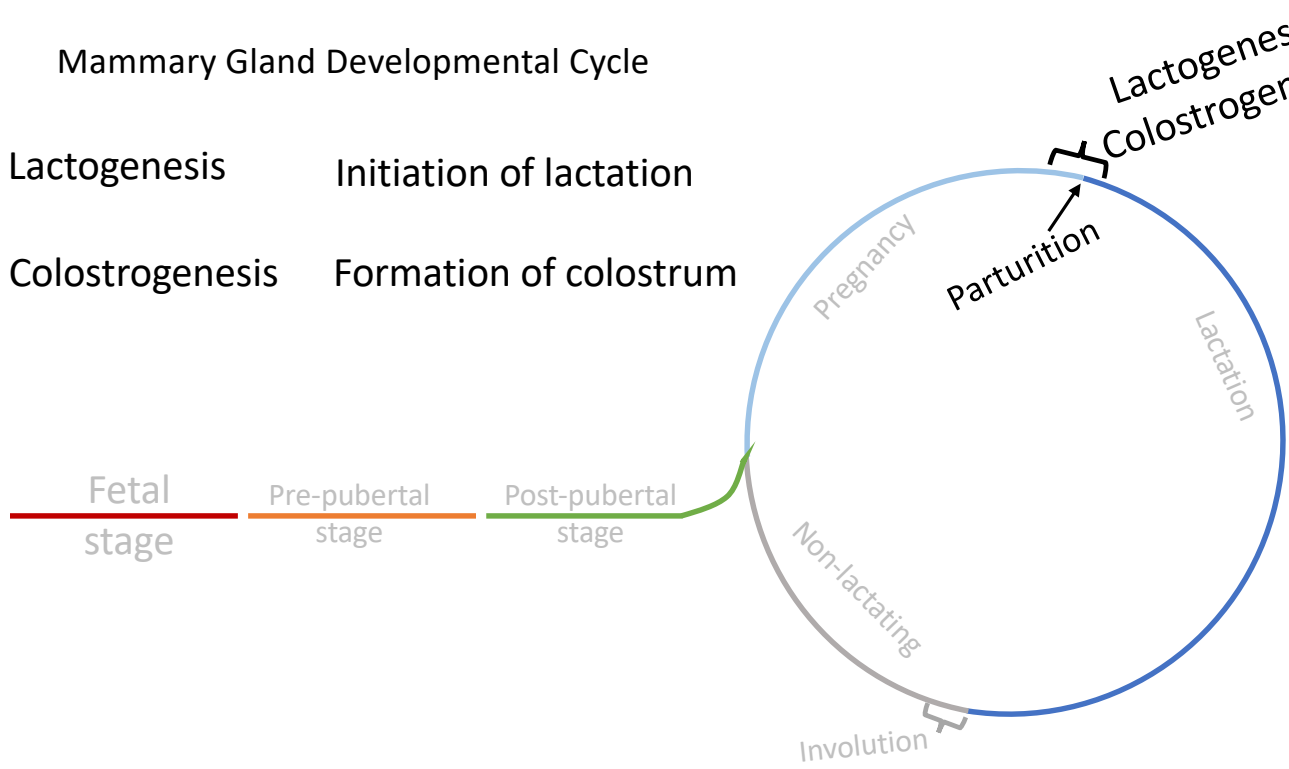


Limits to cross-fostering piglets in early lactation



Mammary Gland Developmental Cycle

Lactogenesis Initiation of lactation
 Colostrogenesis Formation of colostrum



Mammogenesis
Mammary gland growth
 Estrogen
 Progesterone
 Prolactin
 Growth Hormone
 Many others

Lactogenesis
Initiation of lactation
 Prolactin
 Glucocorticoid
 Insulin-like Growth Factor
 Many others

Galactopoiesis
Maintenance of lactation
 Prolactin
 Glucocorticoid
 Growth Hormone
 Many others

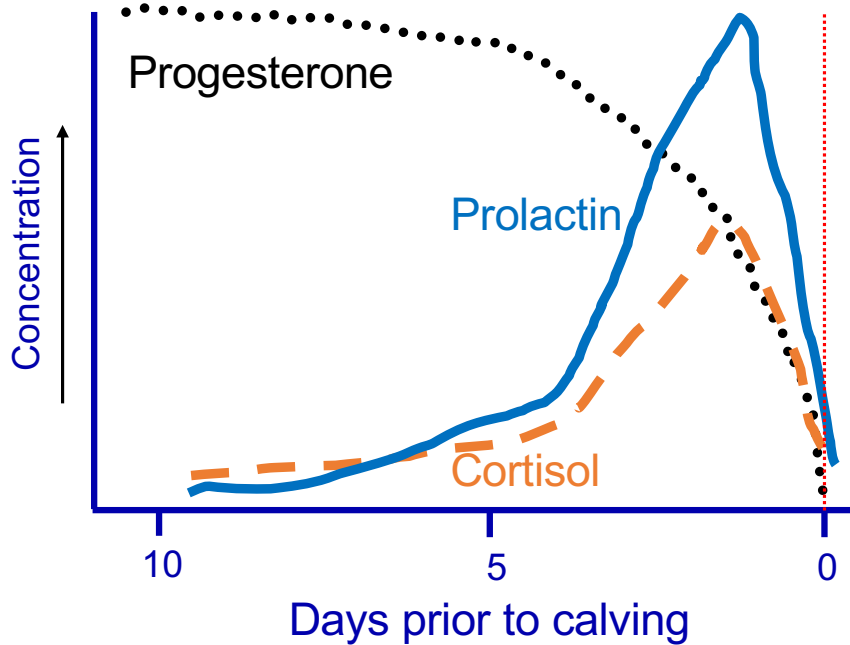
Lactation

Milk ejection →

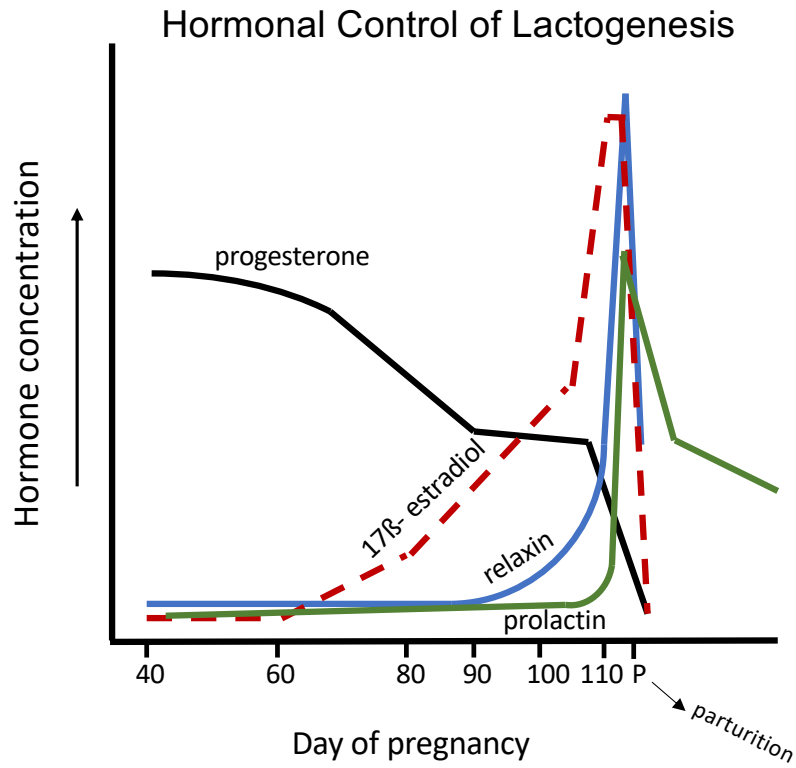
Milk removal
 Milk removal
 Milk removal

Cow

Hormonal Control of Lactogenesis

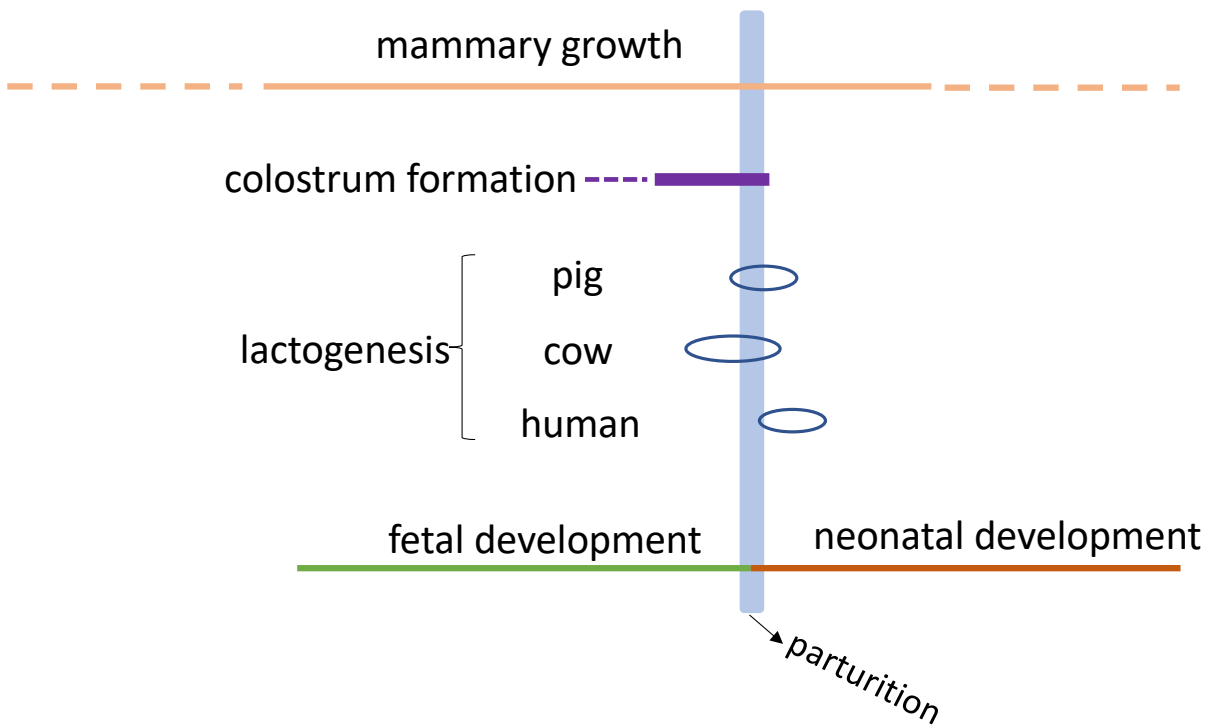


Pig



Eldridge-White *et al* 1989
Dyck & Swierstra, 1983

What is happening around the time of parturition?



Lactogenesis is a two-stage process

Secretory Differentiation

Mammary epithelial cells differentiate into lactocytes with the capacity to synthesize milk components

Coincides with limited synthesis and secretion of milk components even before parturition

Starts in late pregnancy

Secretory Activation

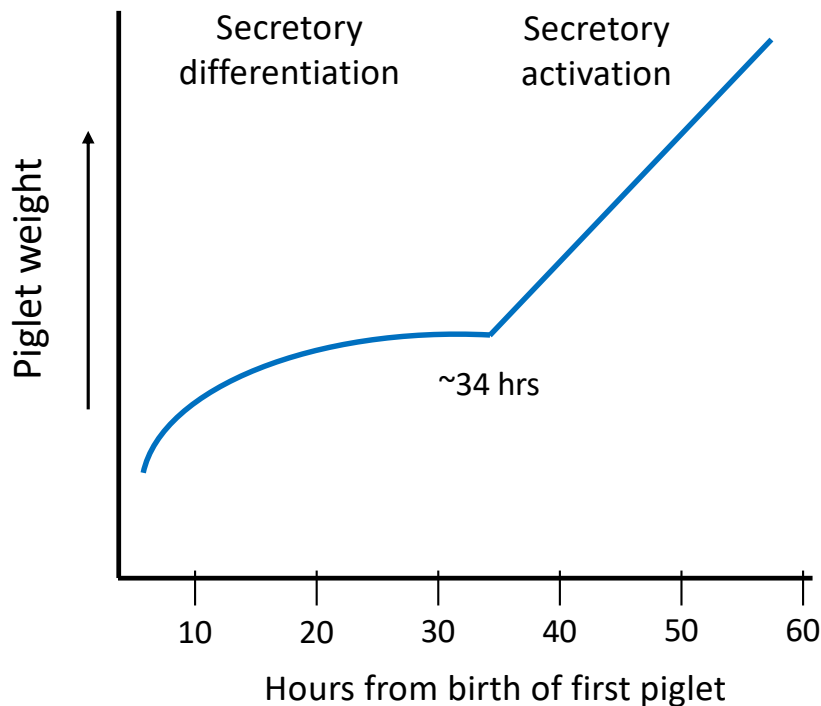
Initiation of copious milk secretion

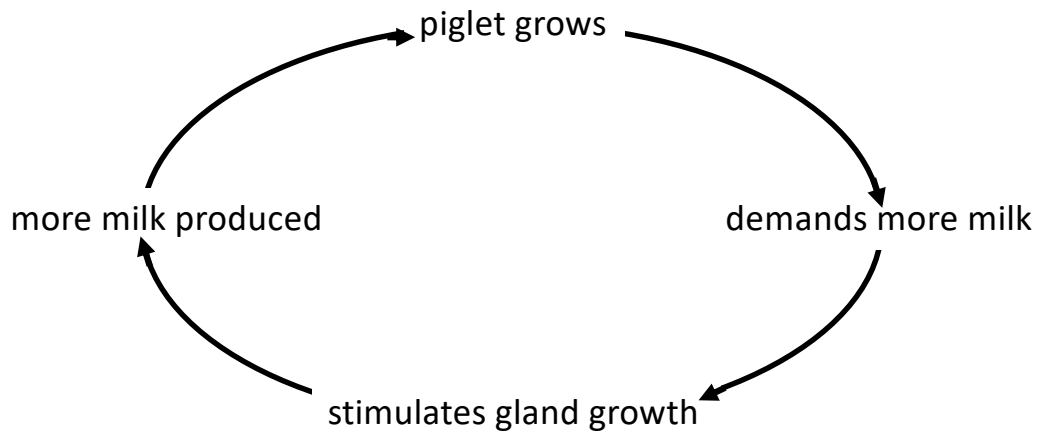
Associated with major changes in concentrations of many milk components

Occurs at a time after the decline in serum progesterone

Timing is variable among species

Pig





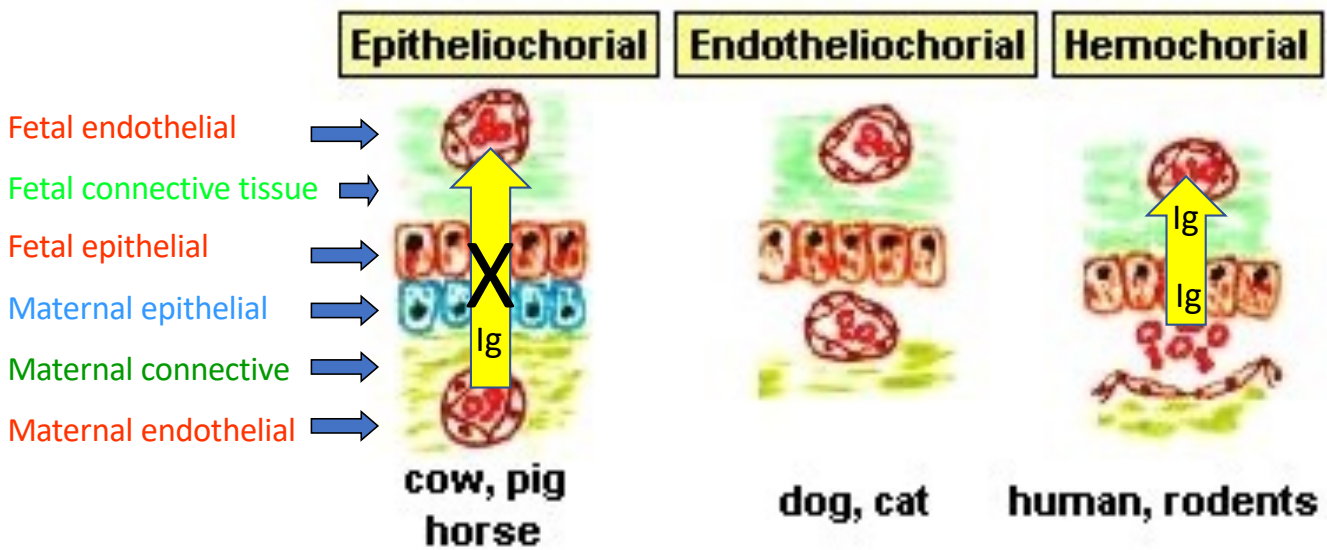
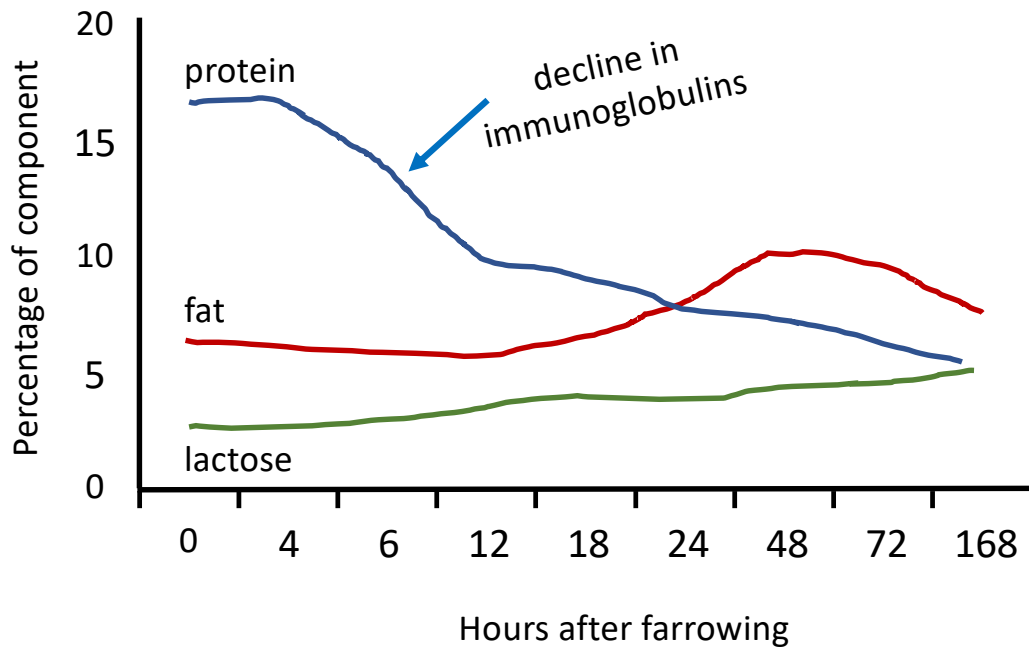
Colostrum composition

Concentration of components in colostrum of most mammals compared with milk is:

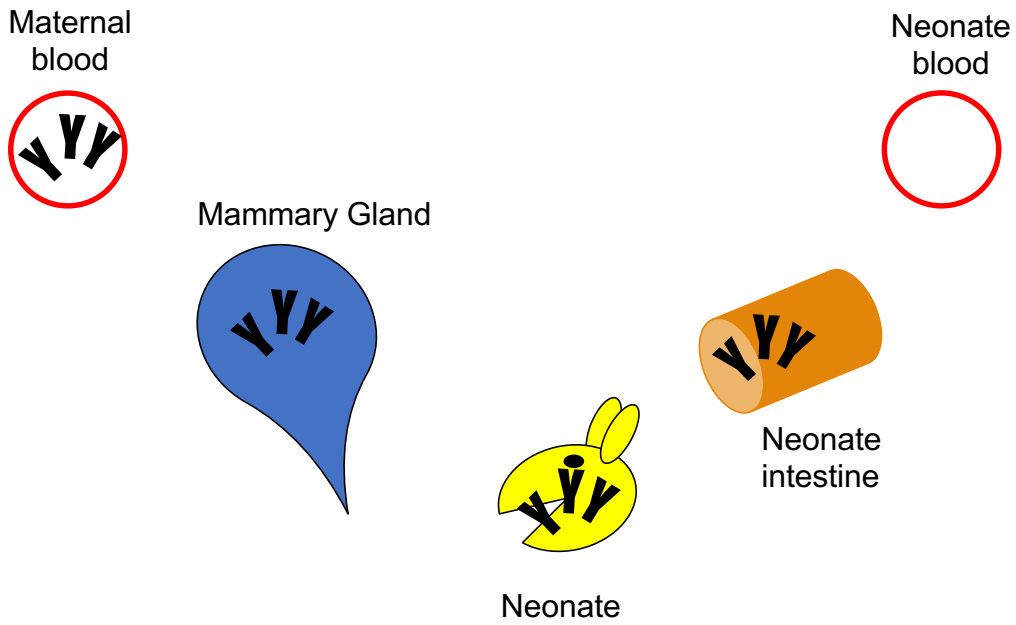
- higher in protein
- higher in immunoglobulins (antibodies)
- lower in lactose (major milk sugar)
- relatively high in fat, but may not be higher than milk
- higher in many hormones and growth factors, and some vitamins
- higher in many antimicrobial factors

Pig

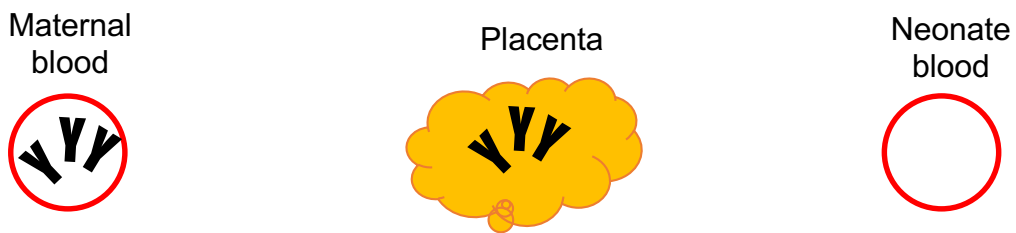
Changes in mammary gland secretion composition



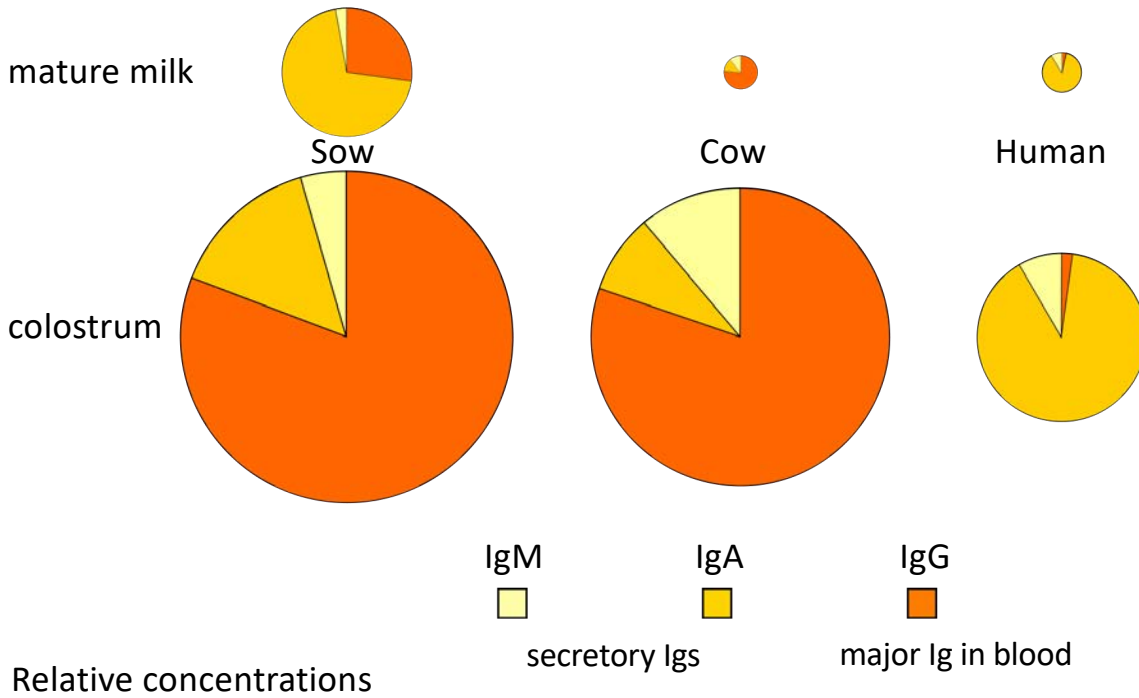
Transfer of Passive Immunity Cow, sheep, goat, pig, etc



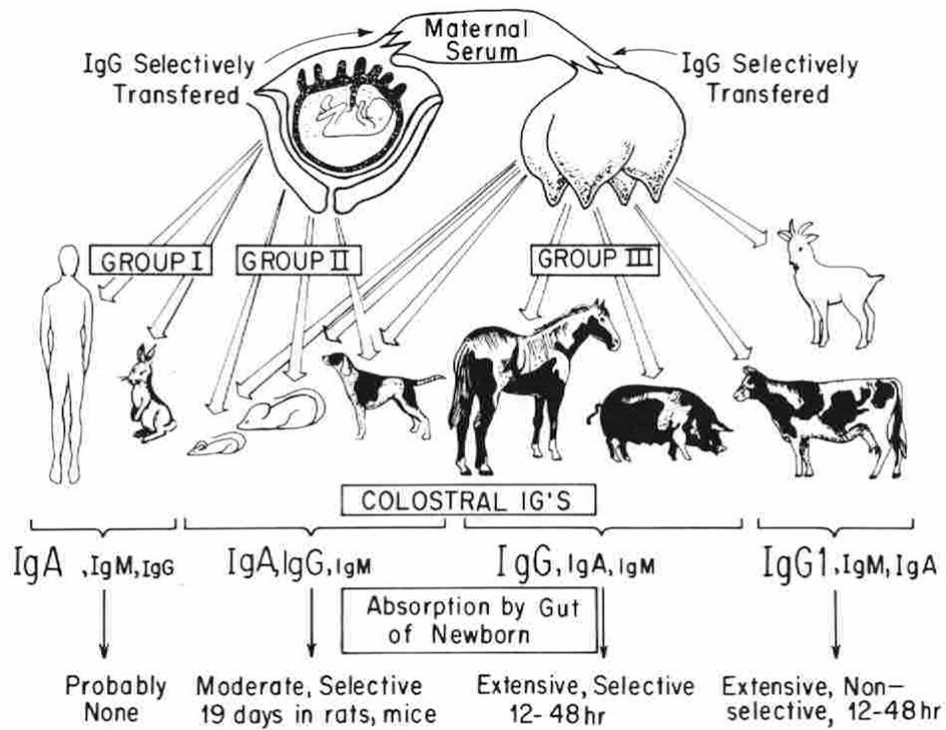
Transfer of Passive Immunity Human, primates



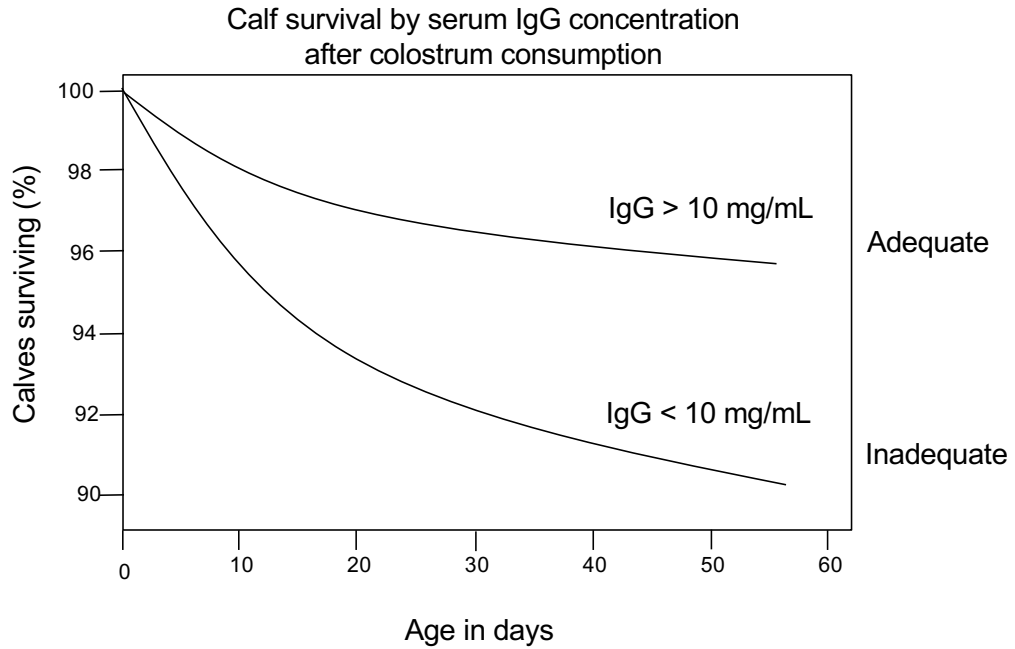
Ig = Immunoglobulin = antibodies



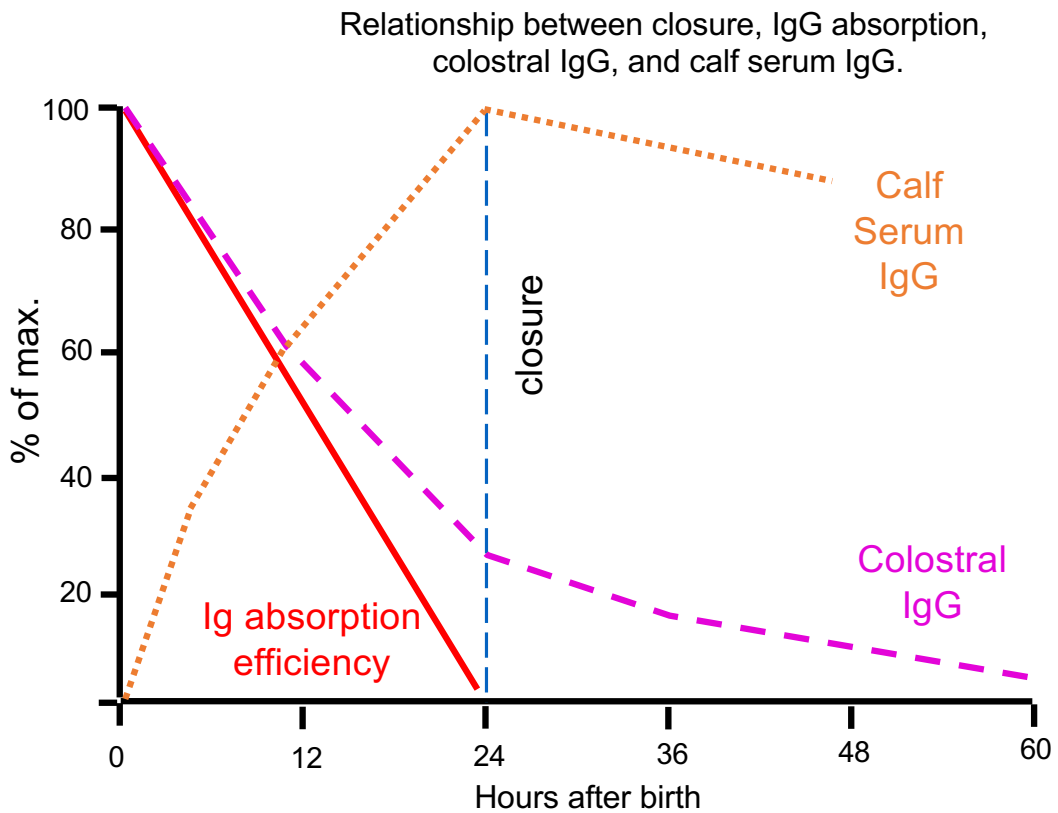
Species comparison of Transfer of Passive Immunity

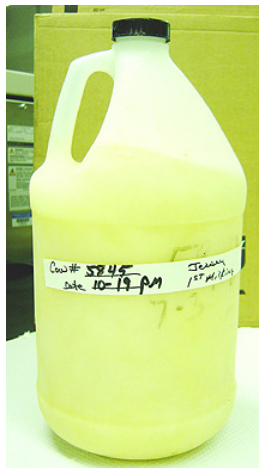
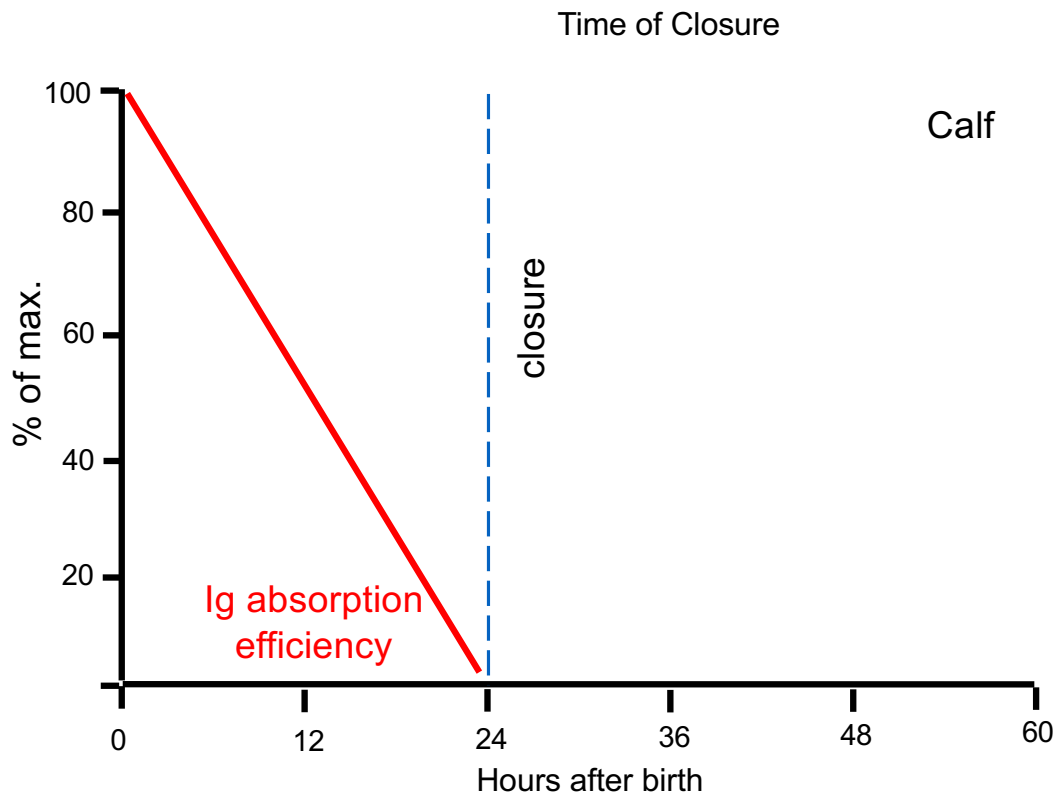


Transfer of Passive Immunity



From Davis & Drackley, 1998







Nursing may be :

Continuous :
kangaroo



At intervals of :

1/2 h whale, dolphin

1 h pig

4-6 h cow

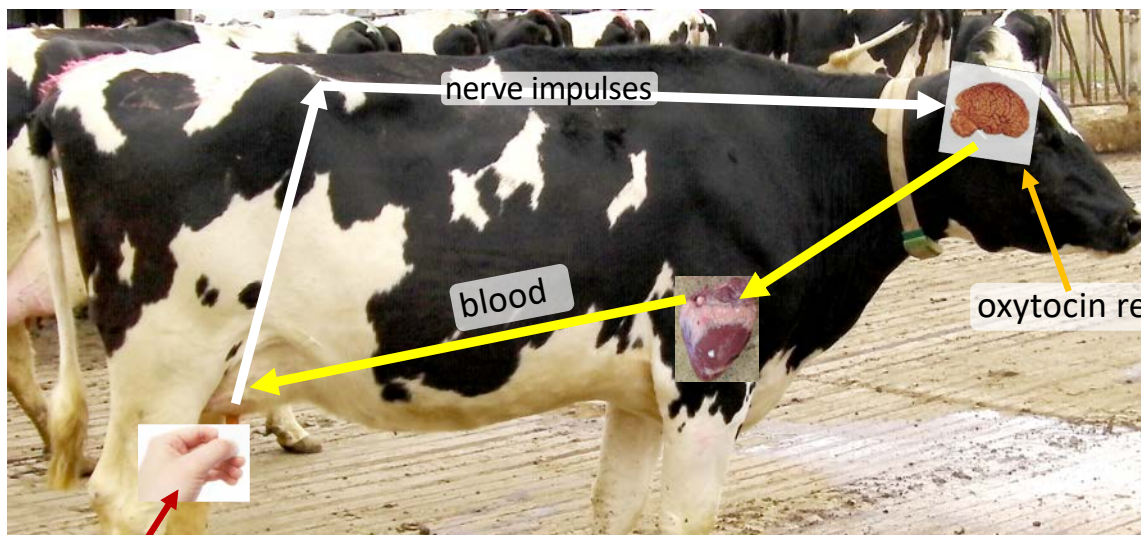
1 d rabbit

2 d tree shrew

1 wk northern fur seal



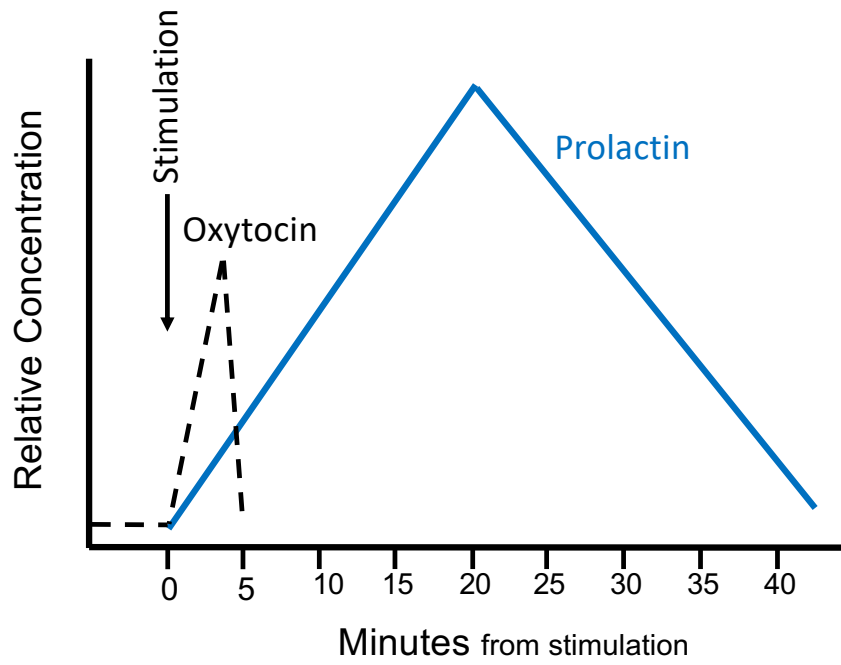
Milk Ejection



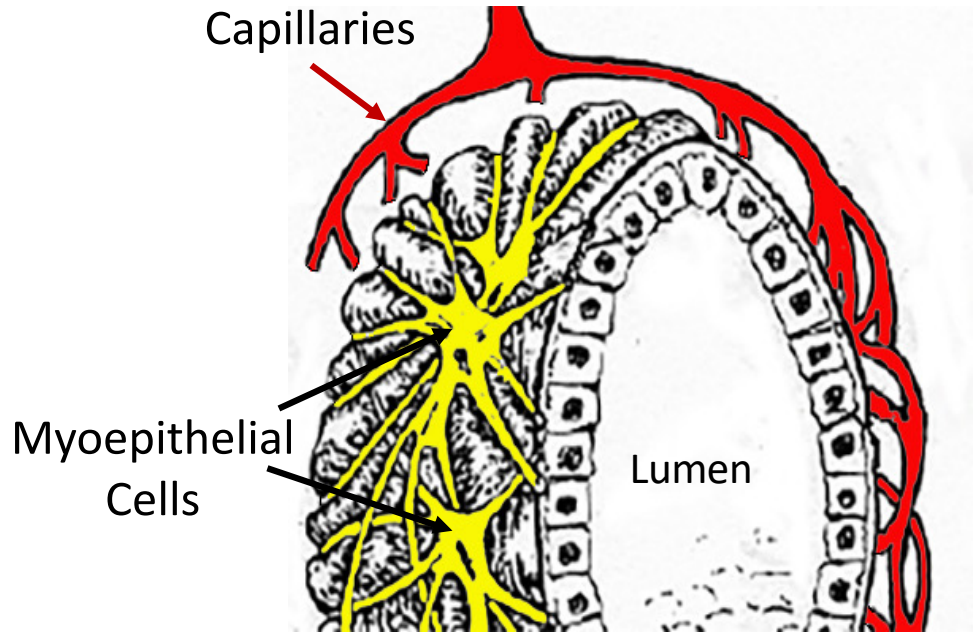
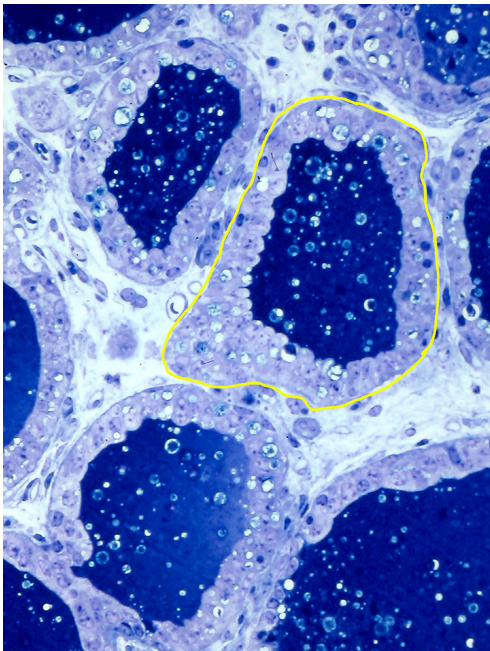
mechanical stimulus

Response time about 2 min

Suckling/milking induced change in oxytocin and prolactin




Alveolus



Oxytocin

Oxytocin may be released by
Auditory cues
Visual cues

Other roles for Oxytocin:

- 
- 1) Maternal behavior
 - 2) Insulin-like activity
 - 3) Osmoregulation
 - 4) Autonomic regulatory function
 - 5) Prolactin release

Questions through the lens of a lactation biologist:

What about the interspecies nursing?

Does it happen?

Maternal behavior Behavior of the neonate

What about the mammary gland?

What was the physiological state?

What was the stage of lactation?

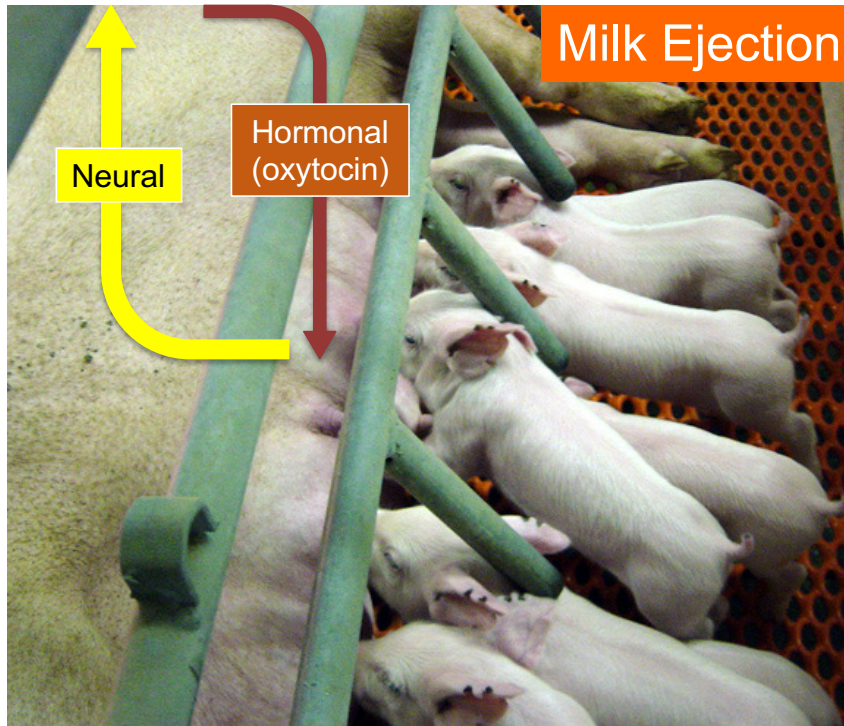
What about the milk?

Was enough milk produced?

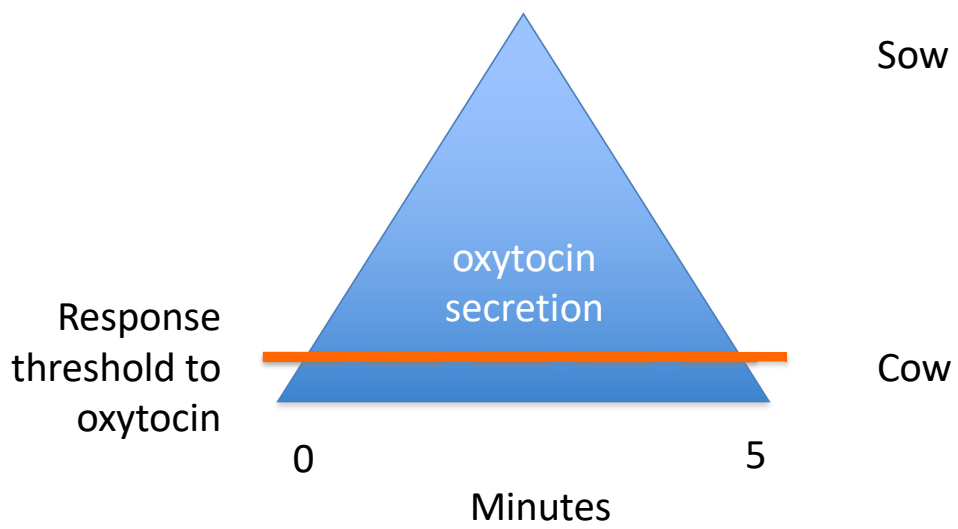
What was the composition of the milk produced?



Milk Ejection: Physiology & behavior



Milk Ejection: Physiology & Behavior





Suckling



Nuzzling



Milk ejection

Milk Ejection: Physiology & behavior

