

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

Walt Hurley

Week 2

Coursera.org

Search for Lactation Biology

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 development of the mammary gland

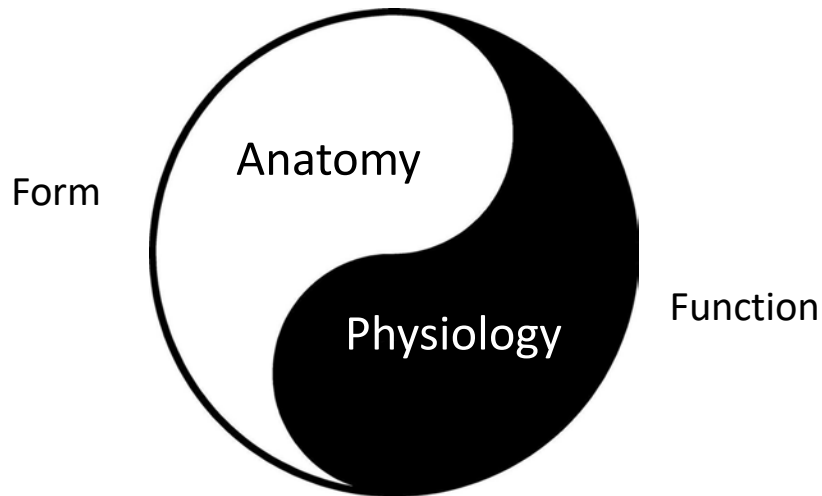
Identify the components of the mammary gland that develop at each stage

Describe the major factors that regulate mammary gland development

Physiology of Lactation

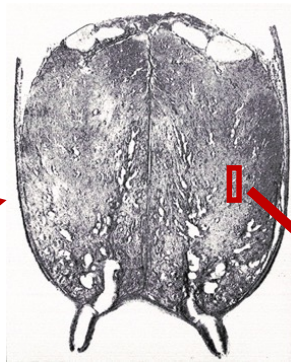
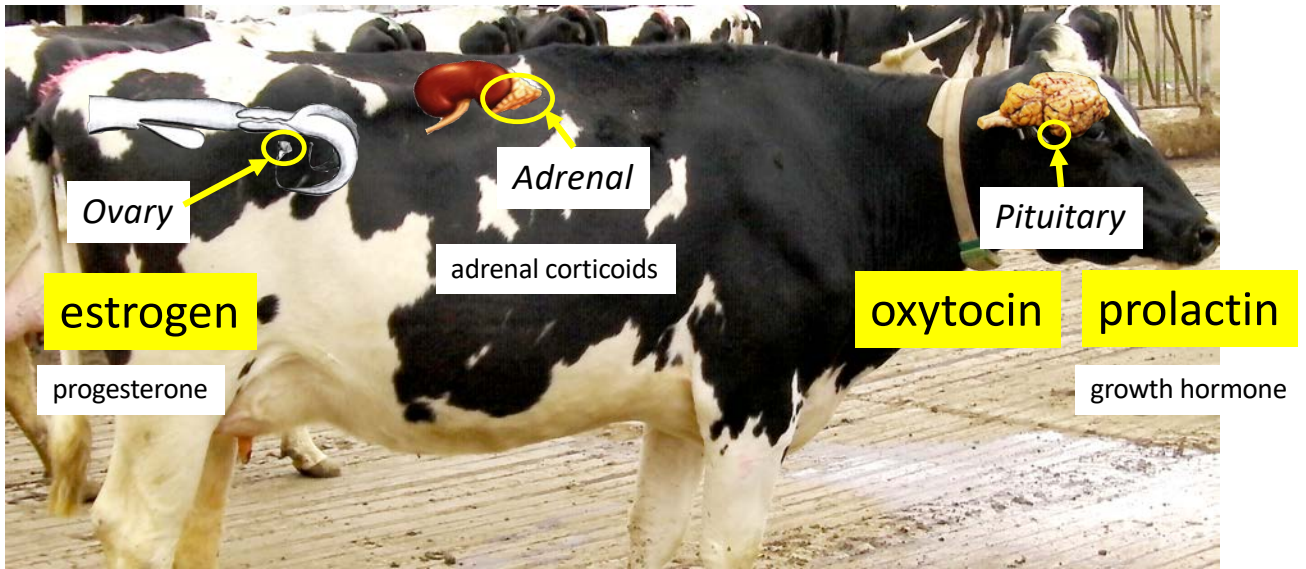
Changes over time

Mammary gland

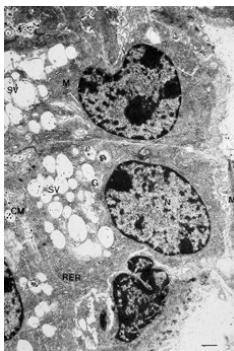
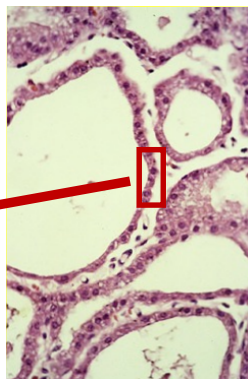
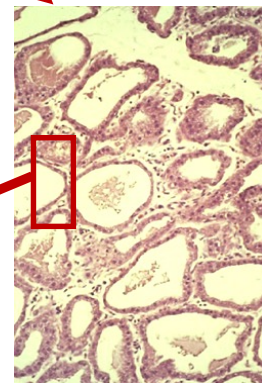


Physiology	The branch of biology that deals with the normal functions of living organisms and their parts		
Endocrinology	The branch of physiology and medicine concerned with endocrine glands and hormones		
Endocrine glands	Ovaries	Adrenal gland	Pituitary
Hormones	Synthesized and secreted from endocrine glands Travel to target tissues via the blood Affect the growth and/or function of target tissues		
Growth Factors	Locally produced in a tissue Affect cells in that tissue		

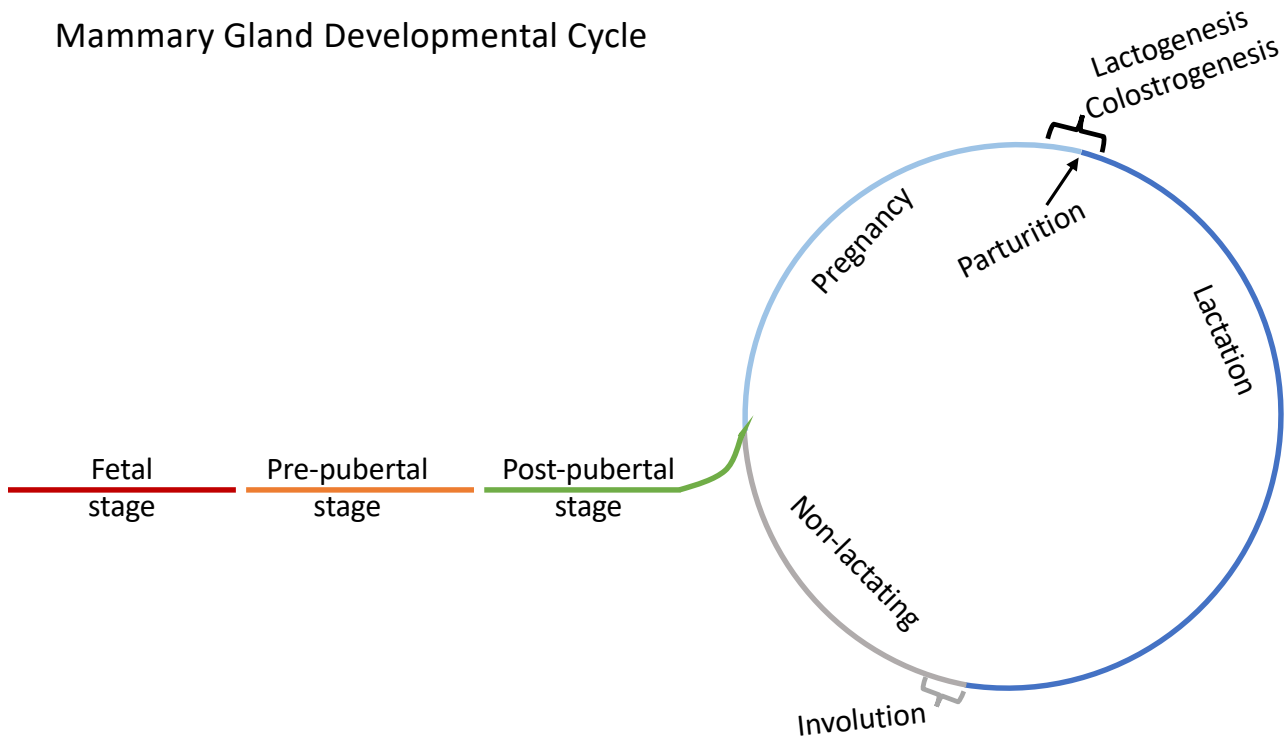
Primary hormones of mammary gland growth and function (lactation):



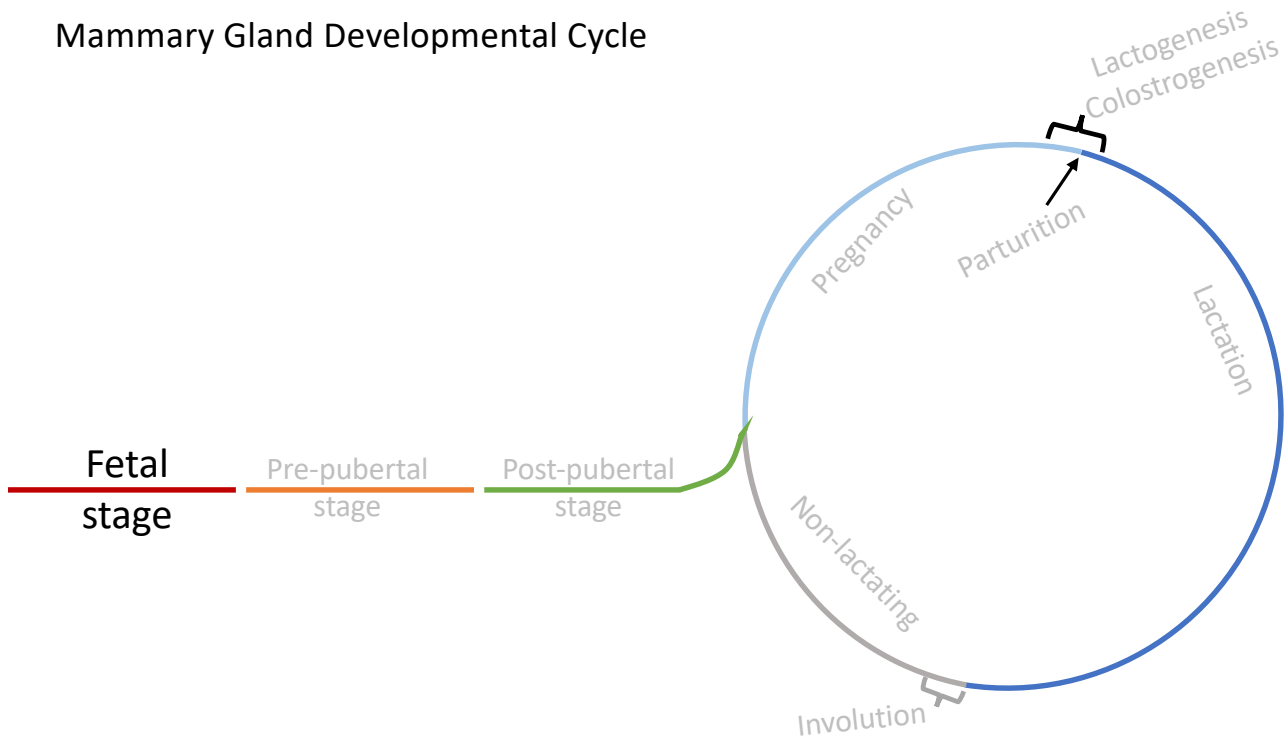
Cow
Macro to Micro



Mammary Gland Developmental Cycle



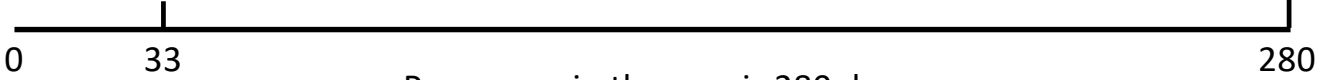
Mammary Gland Developmental Cycle



The Cow



First signs of a developing mammary gland



Pregnancy in the cow is 280 days

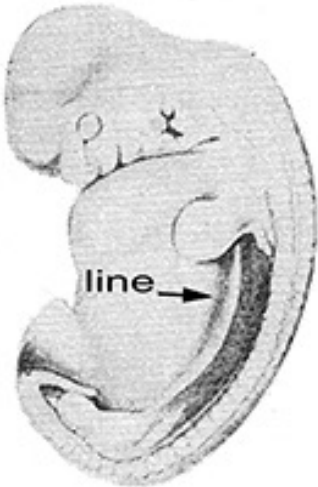
Pig Fetus

Pregnancy is 115 days

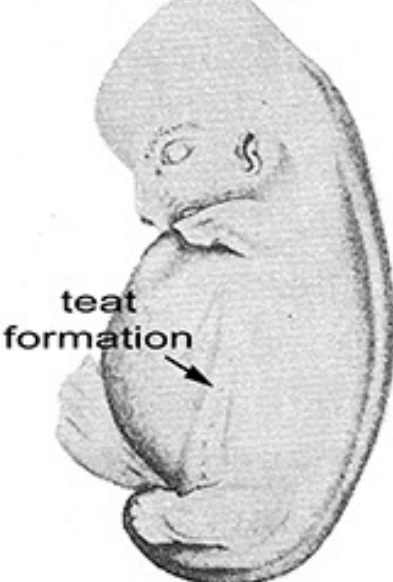
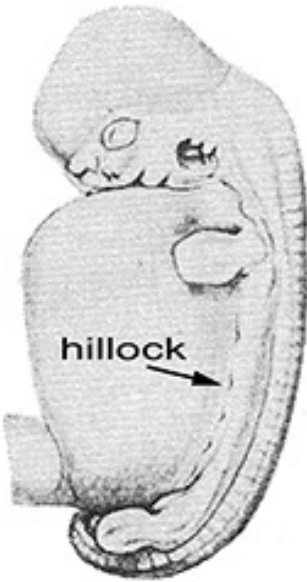
Day 21

Day 28

Day 50

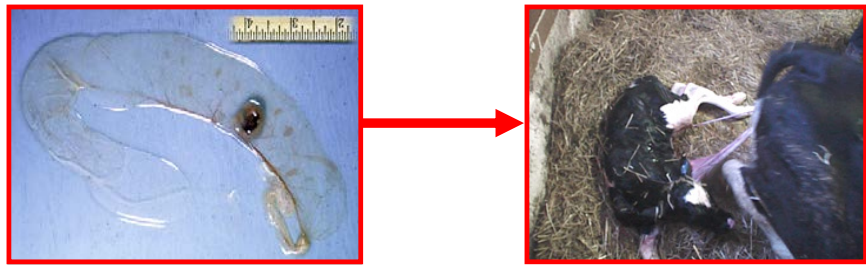


First signs of the mammary gland



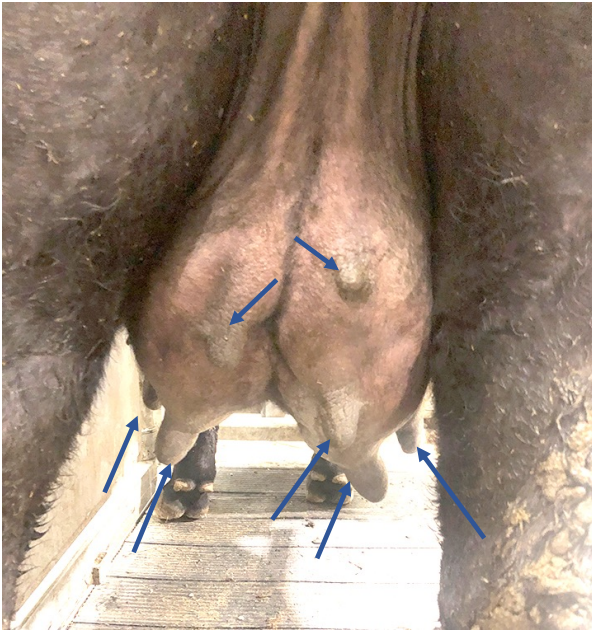
Fetal Stage

What has developed?



- Teat/Nipple
- Supporting connective tissue structures
- Major ducts
- Fat pad
- Responsiveness to hormones





Polymastia

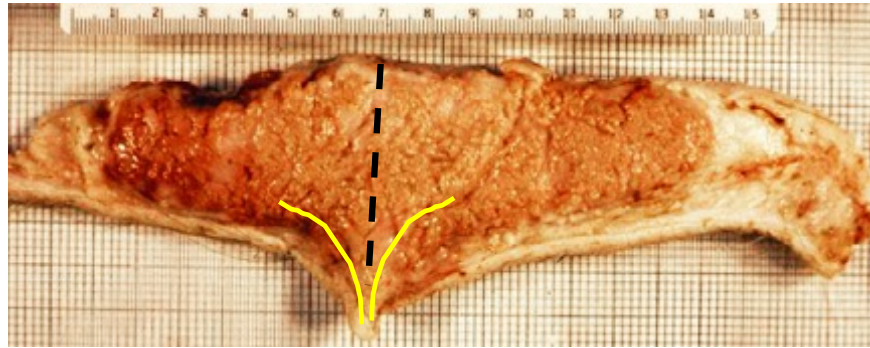


Nipple with underlying mammary tissue

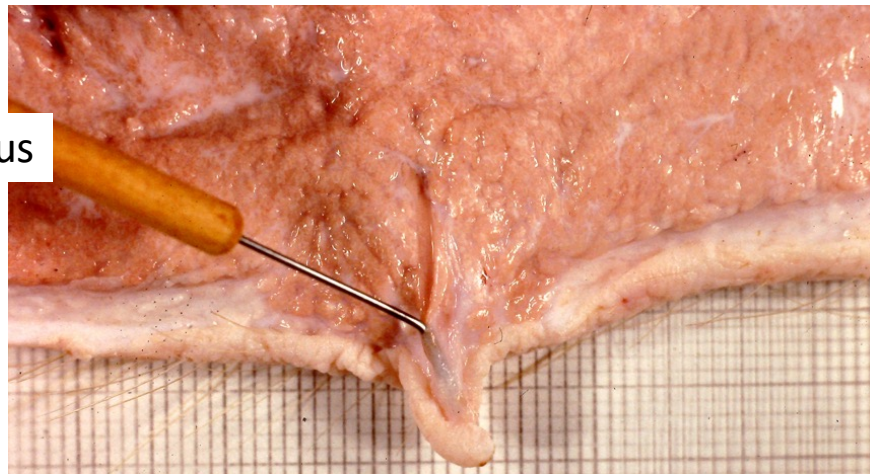


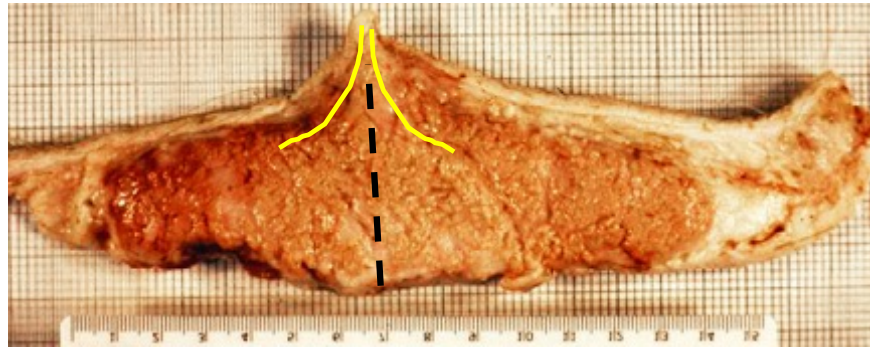
Polythelia

Nipple without underlying mammary tissue

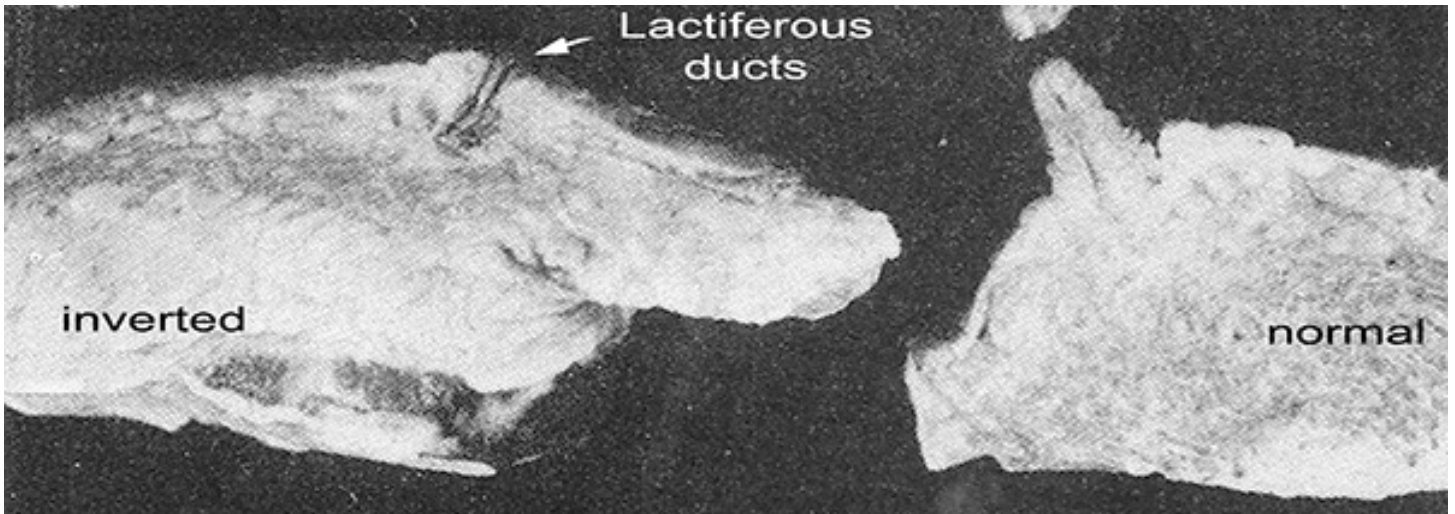
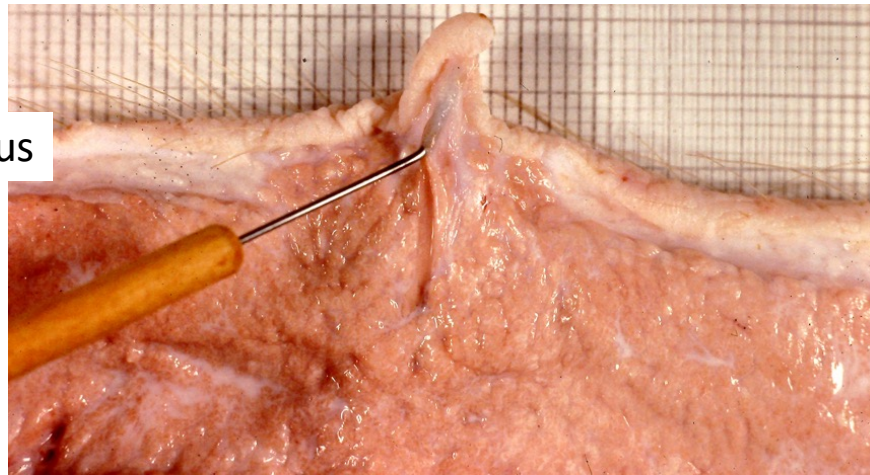


Lactiferous sinus

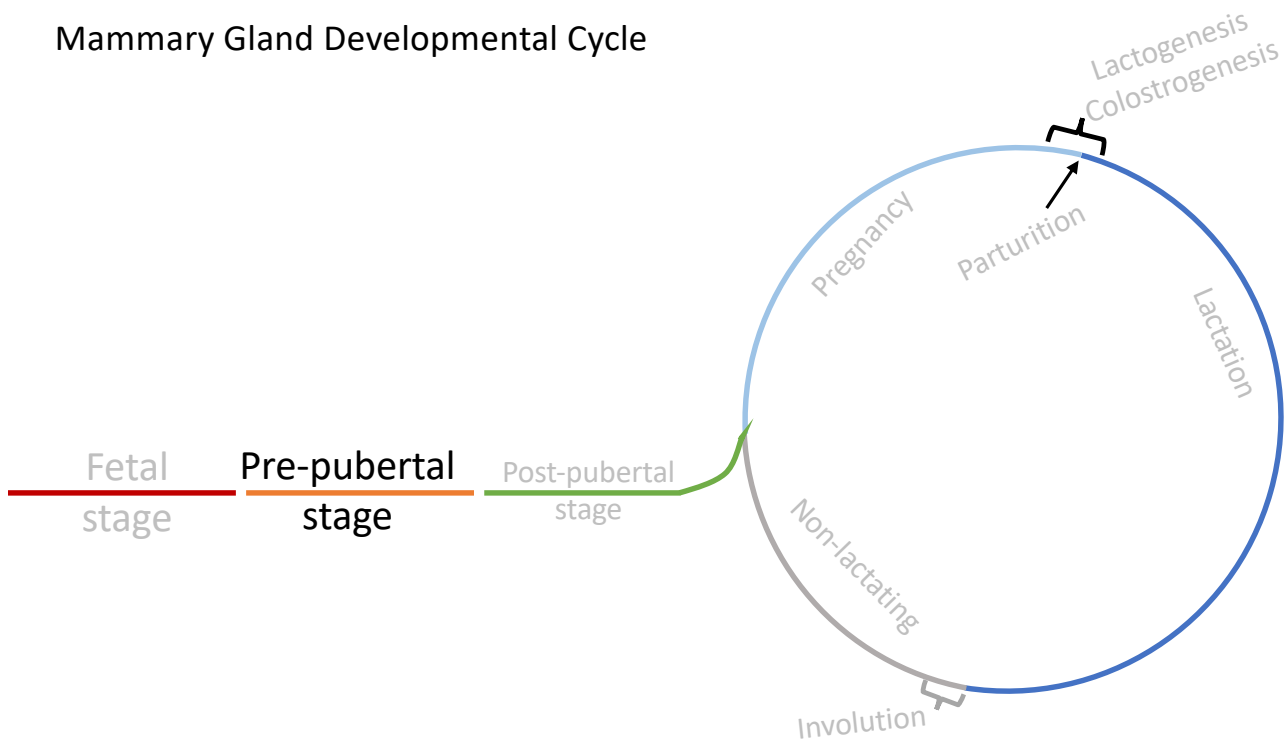




Lactiferous sinus



Mammary Gland Developmental Cycle



Prepubertal Period

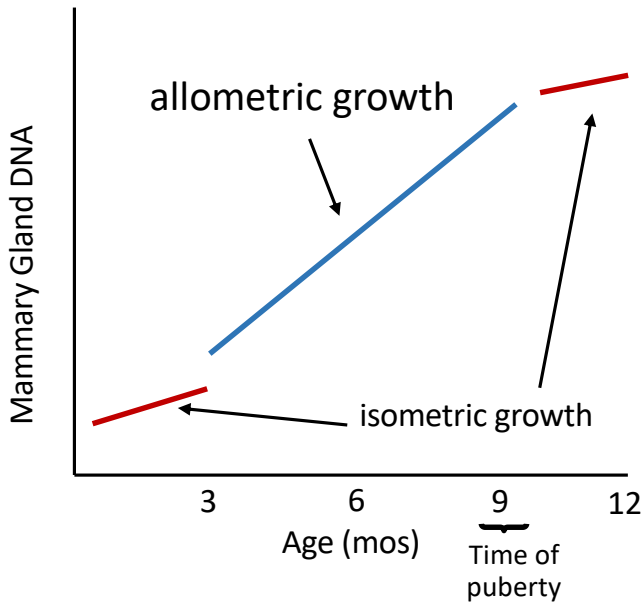
Wax cast of heifer gland



Adult cow



Prepubertal Mammary Growth

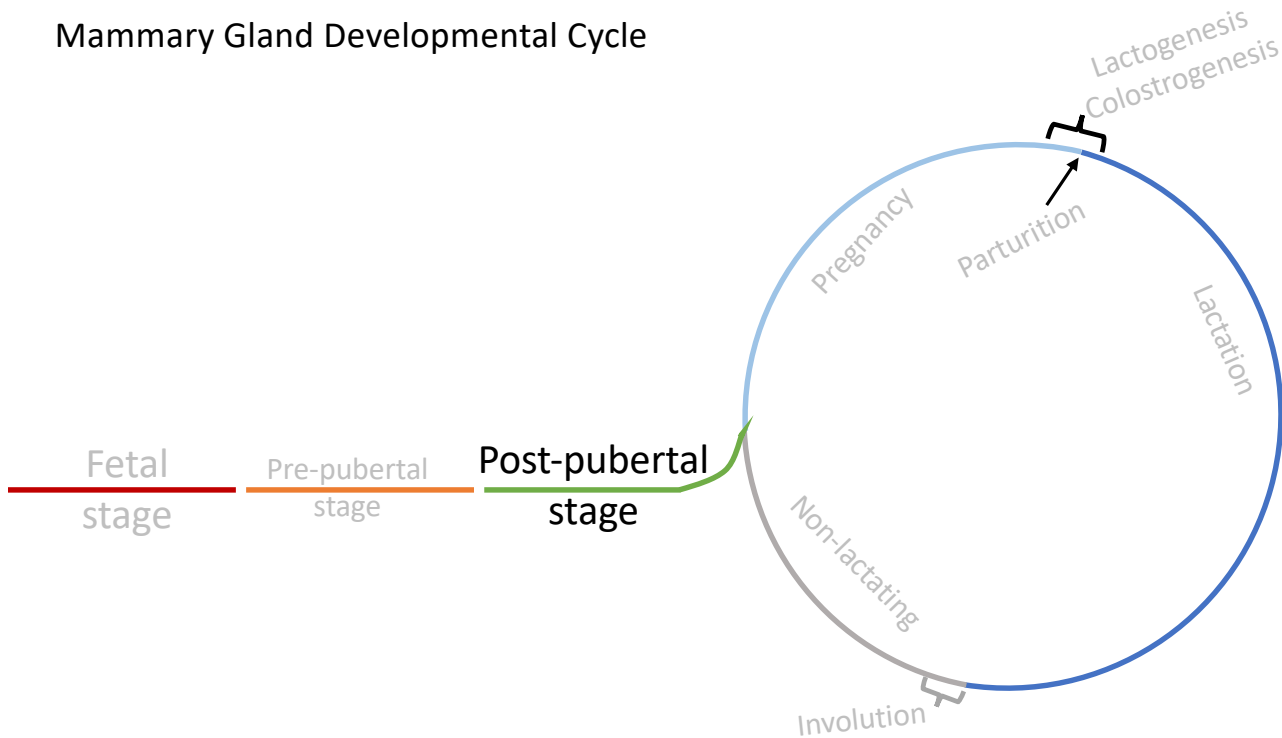


isometric growth : growth rate of the tissue is the same than the rest of the body

allometric growth : growth rate of the tissue is faster than the rest of the body

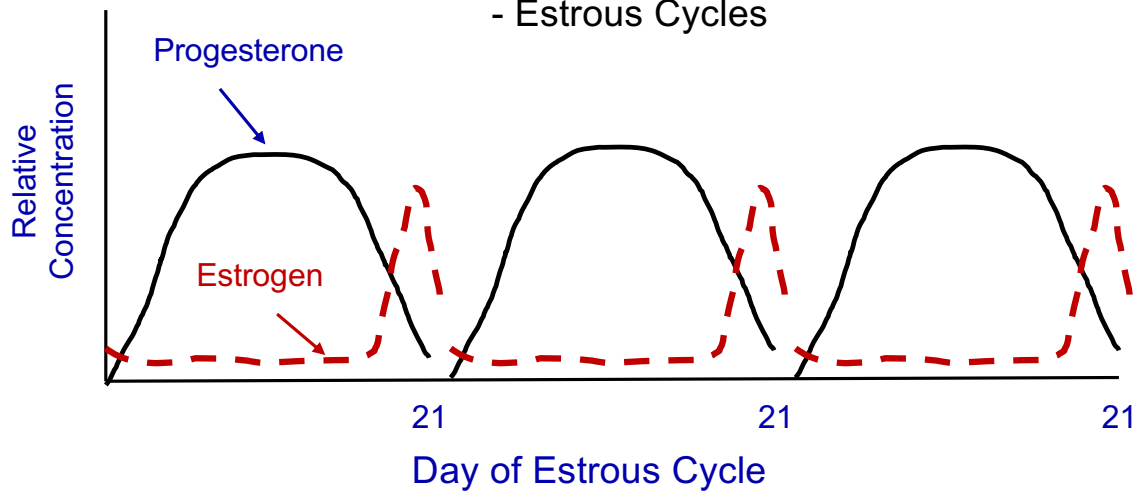
Growth is controlled by hormones, especially growth hormone

Mammary Gland Developmental Cycle

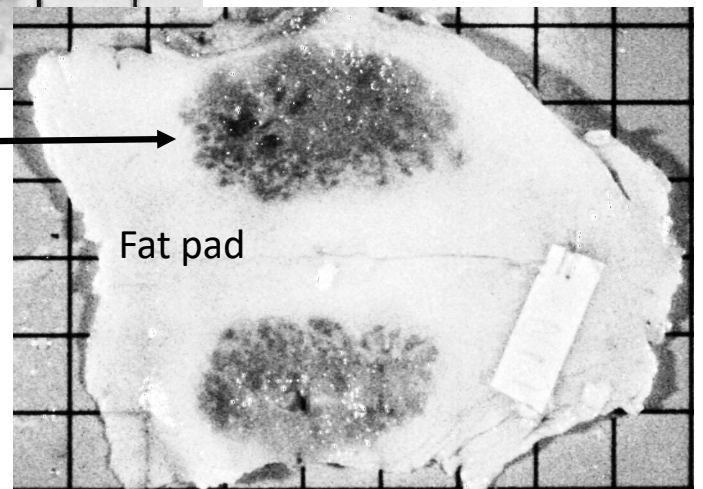
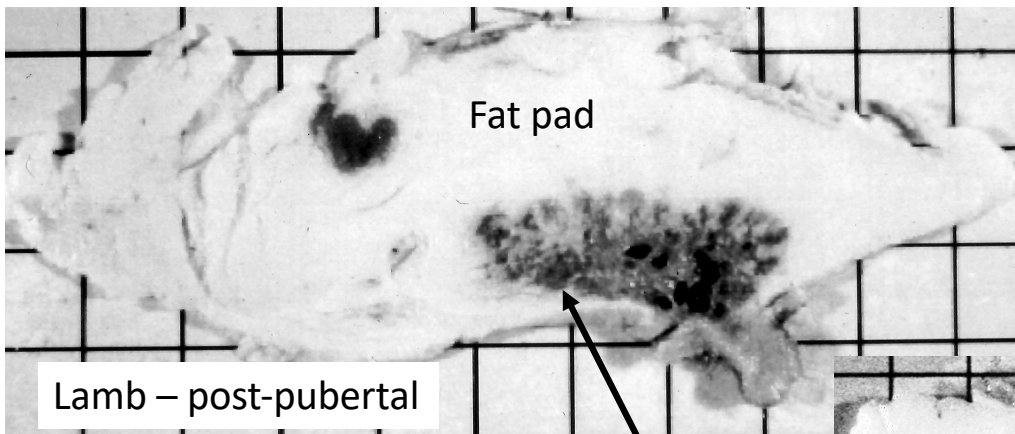


Postpubertal Period

- Estrous Cycles



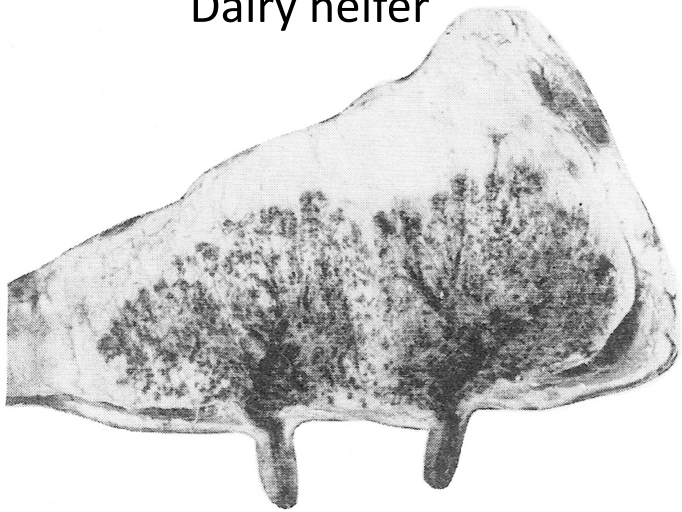
Mammary gland growth is stimulated by cycles of elevated **estrogen** in the blood, followed by elevated **progesterone**



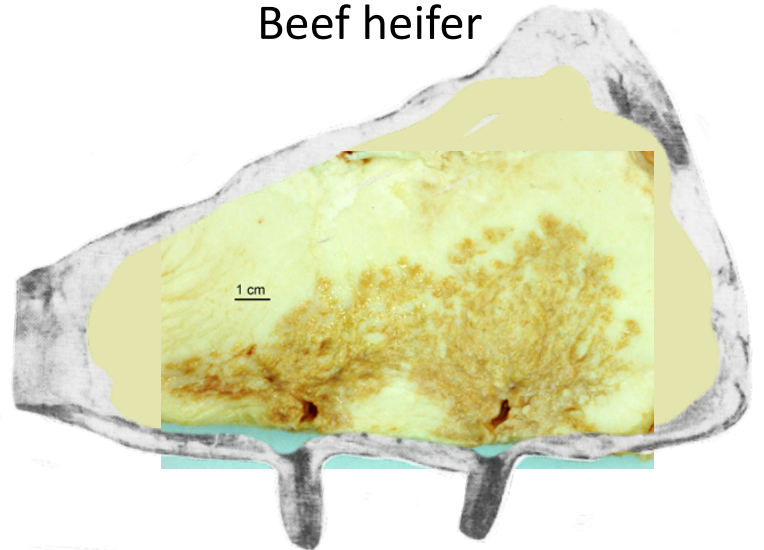
- Increases in fat pad
- Limited elongation and branching of ducts into the fat pad

Post-pubertal heifers

Dairy heifer



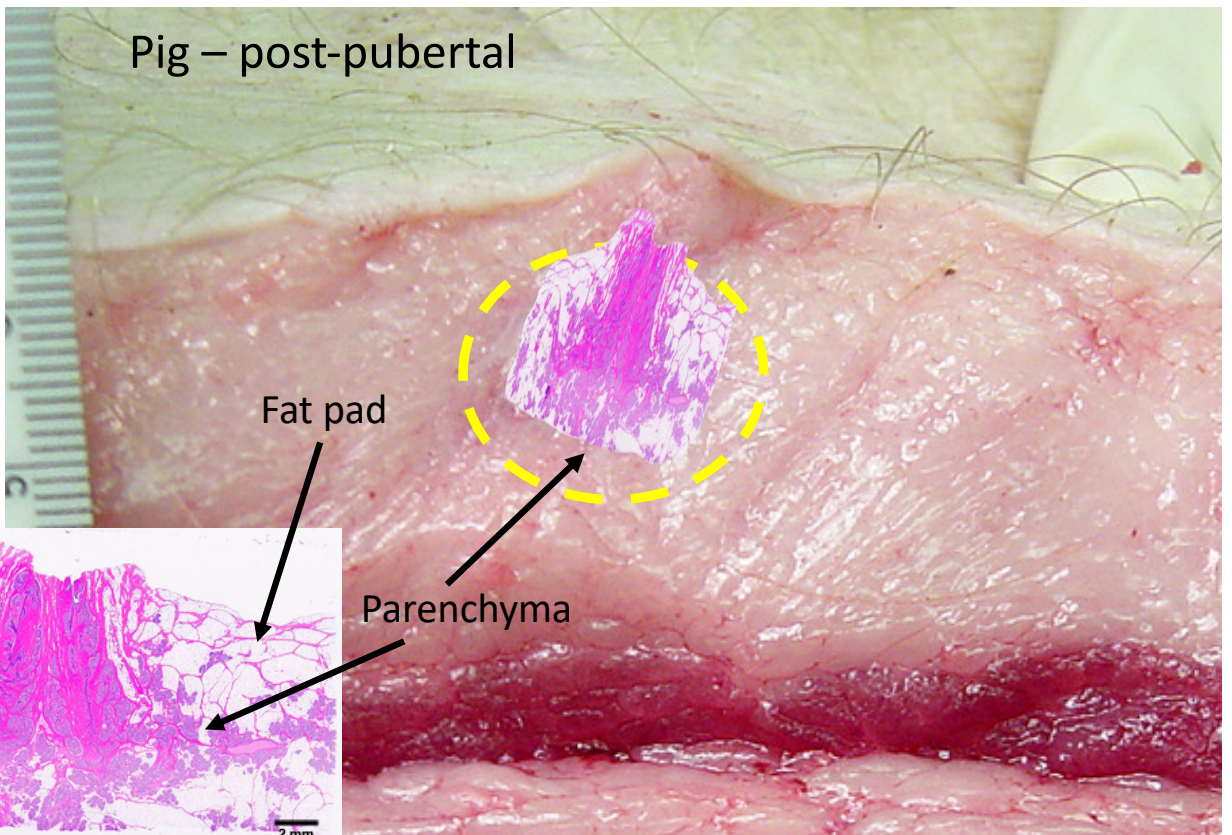
Beef heifer

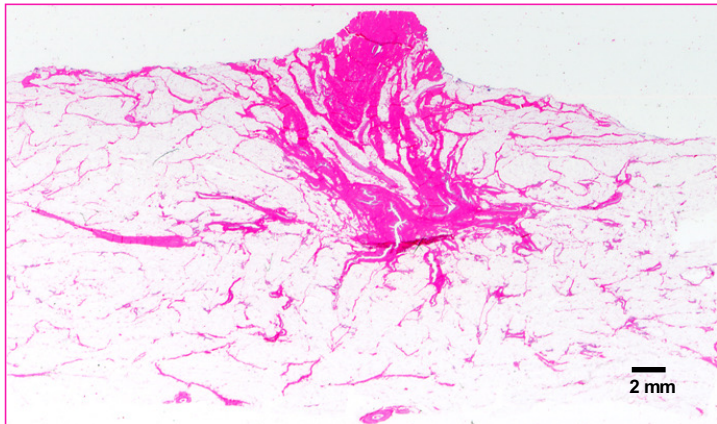


Mammary gland growth occurs through:

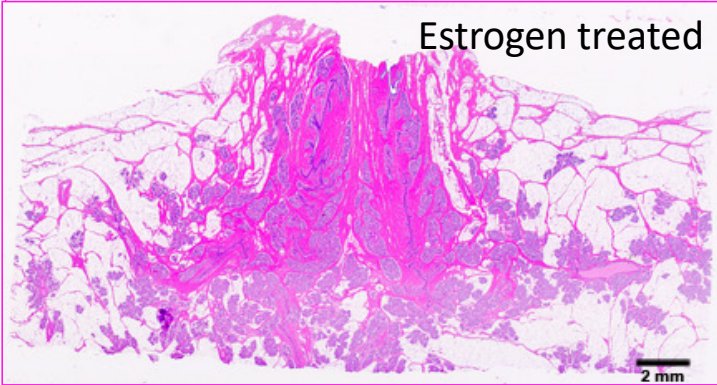
- Increases in fat pad
- Cyclic elongation and branching of ducts into the fat pad

Pig – post-pubertal





Ovariectomized gilts

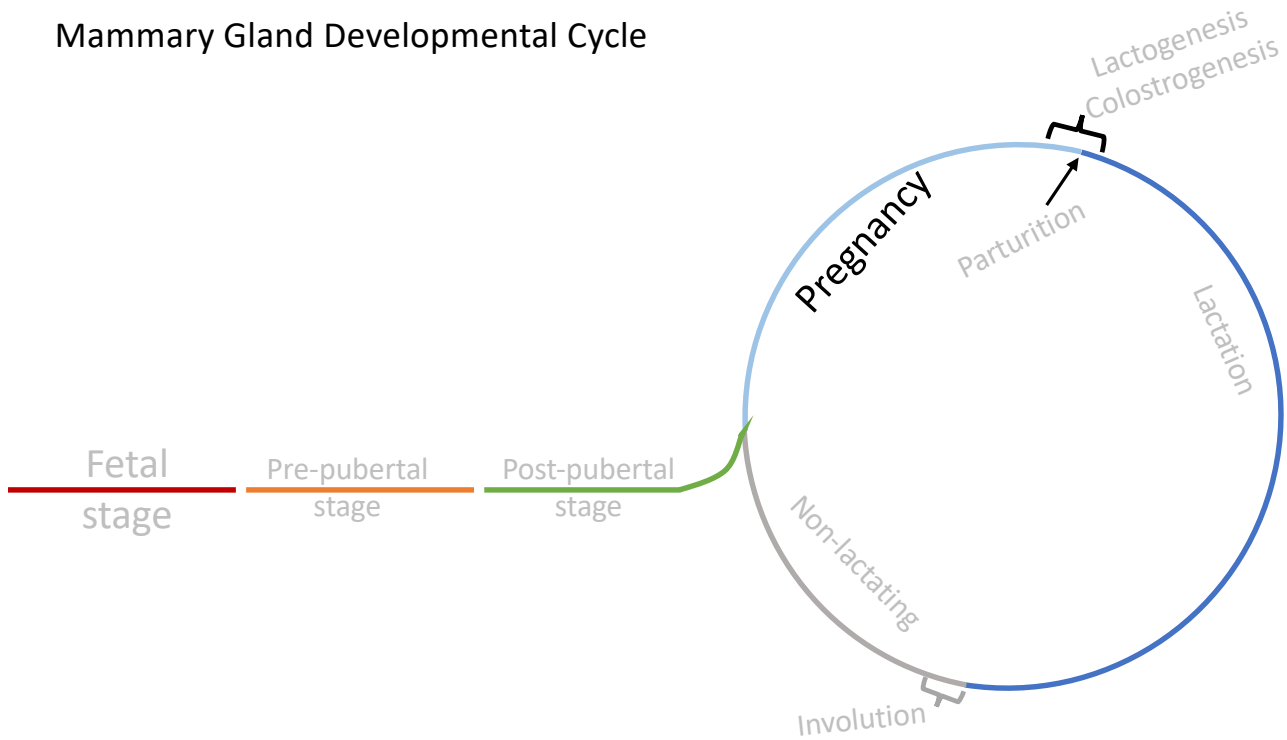


Estrogen treated

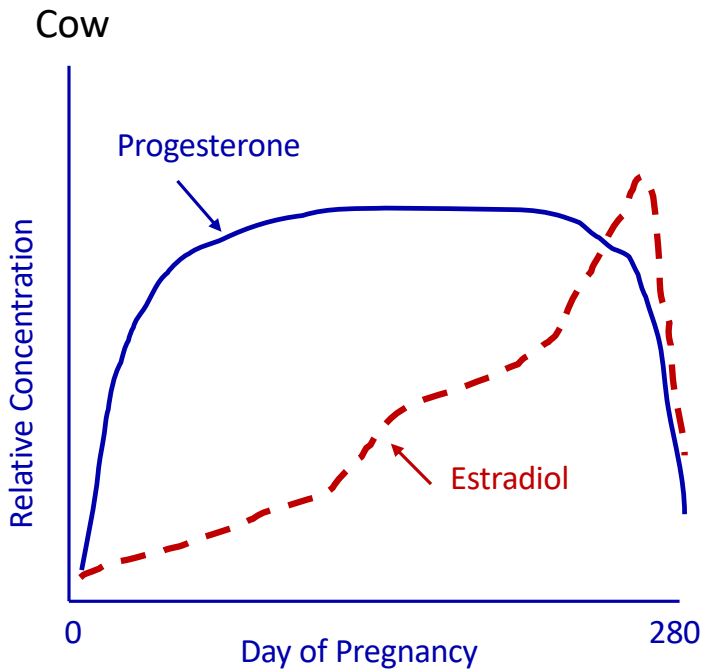


Backfat

Mammary Gland Developmental Cycle



Pregnancy

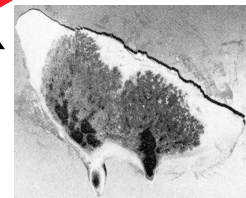
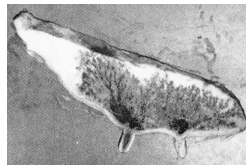
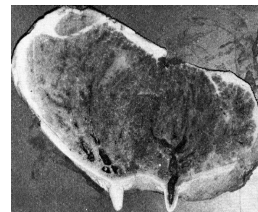
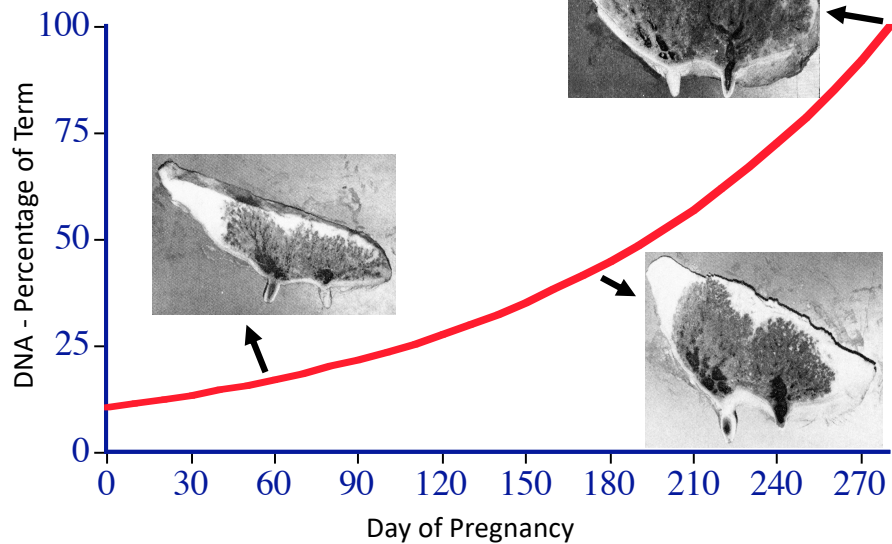
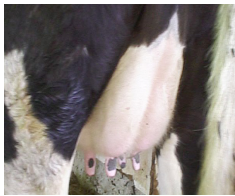


Primary tissue components: rapid elongation and branching of ducts into the fat pad, formation of lobules and alveoli (lobuloalveolar development), accumulation of secretion in late pregnancy.

Primary control: persistently elevated levels of estrogen and progesterone

Pregnancy

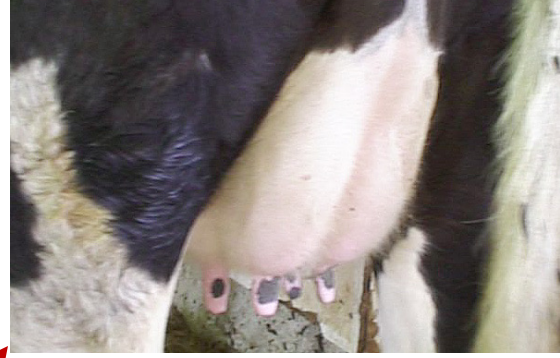
Mammary growth during pregnancy is exponential.



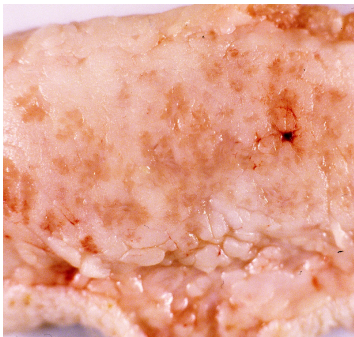
Mammary glands of yearling heifers



Heifer mammary gland late pregnancy

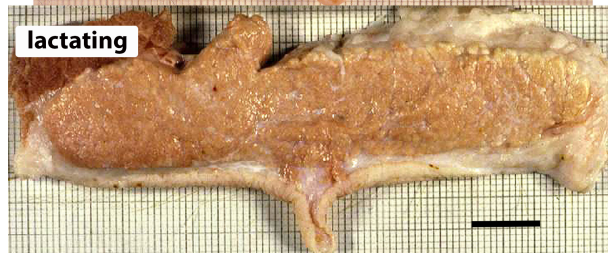
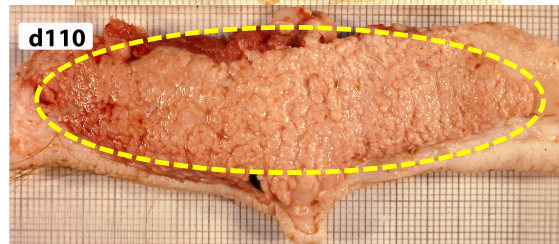
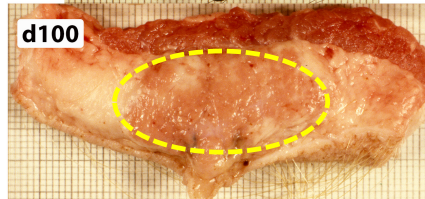
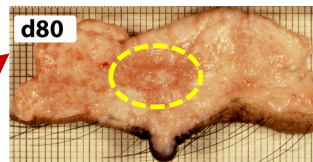


Pig – first pregnancy



Early pregnancy

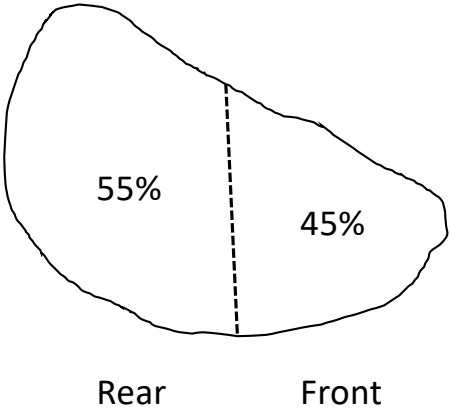
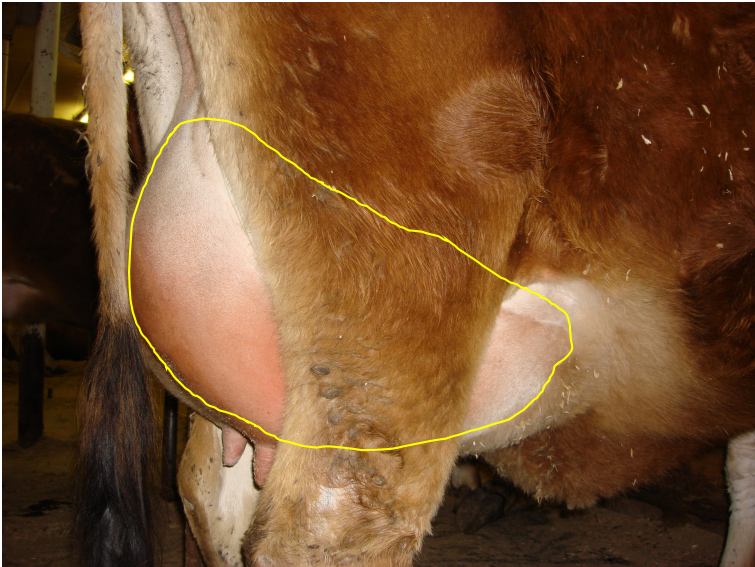
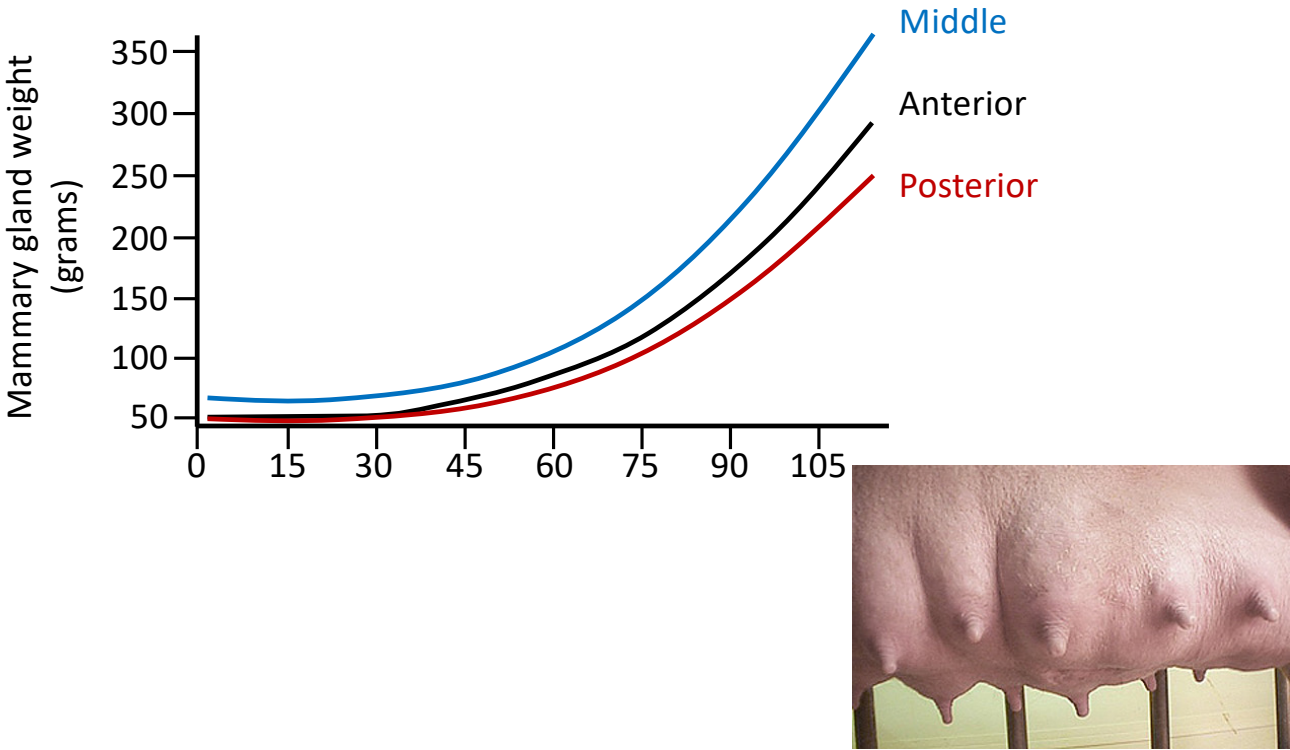
Pregnancy is 115 days



20 days

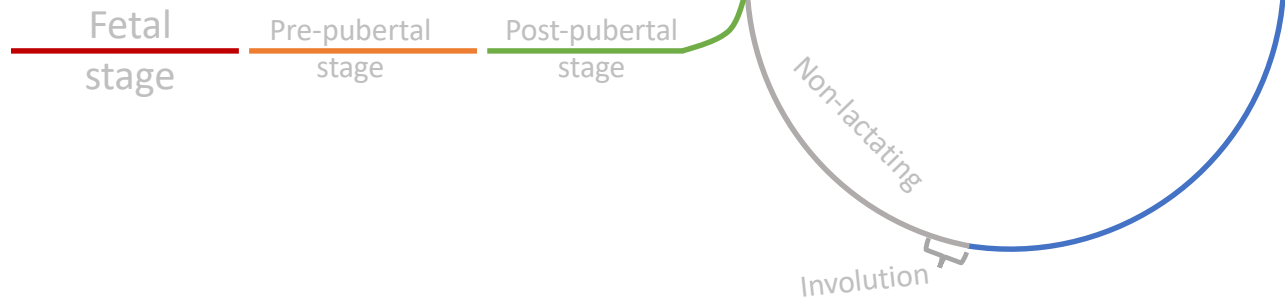
10 days

Increase in mammary parenchymal mass during pregnancy in the gilt

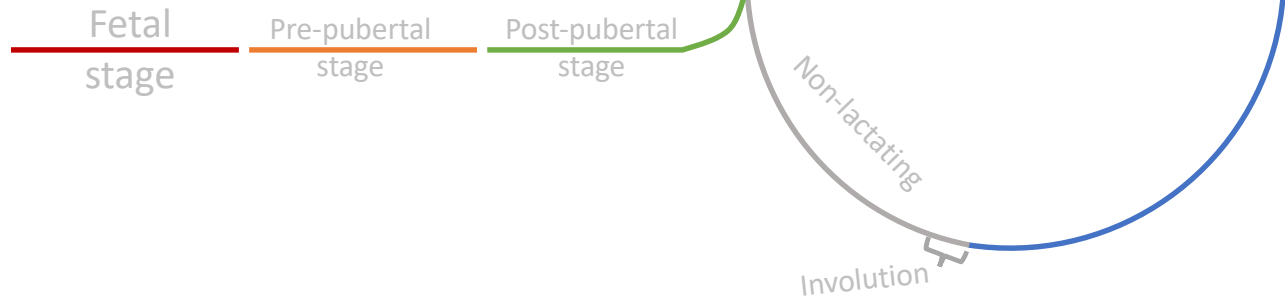


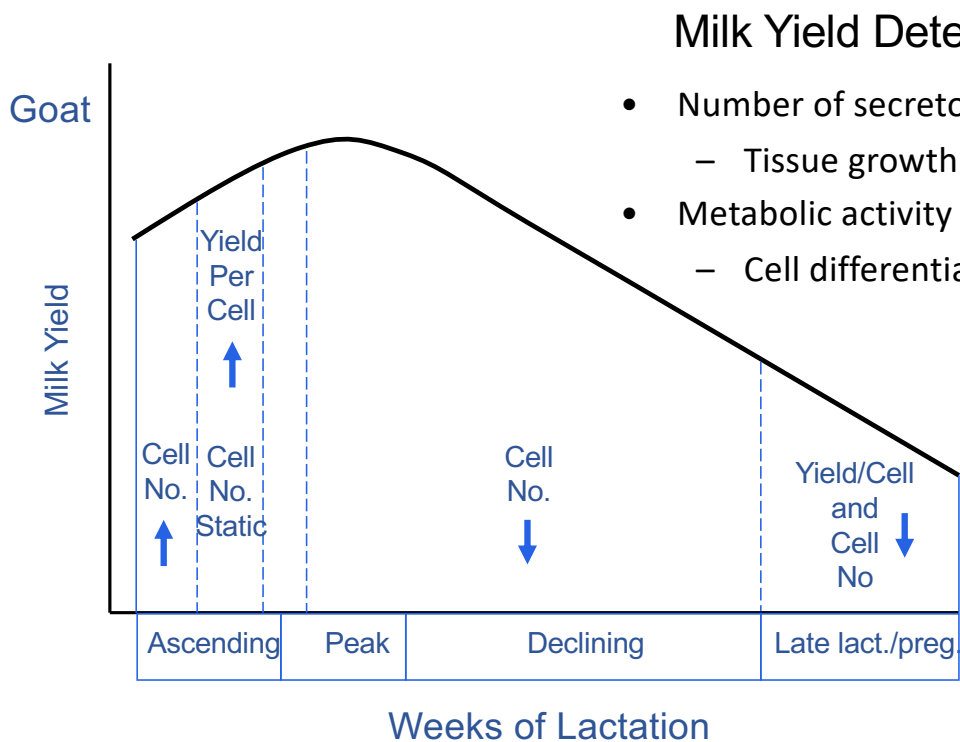
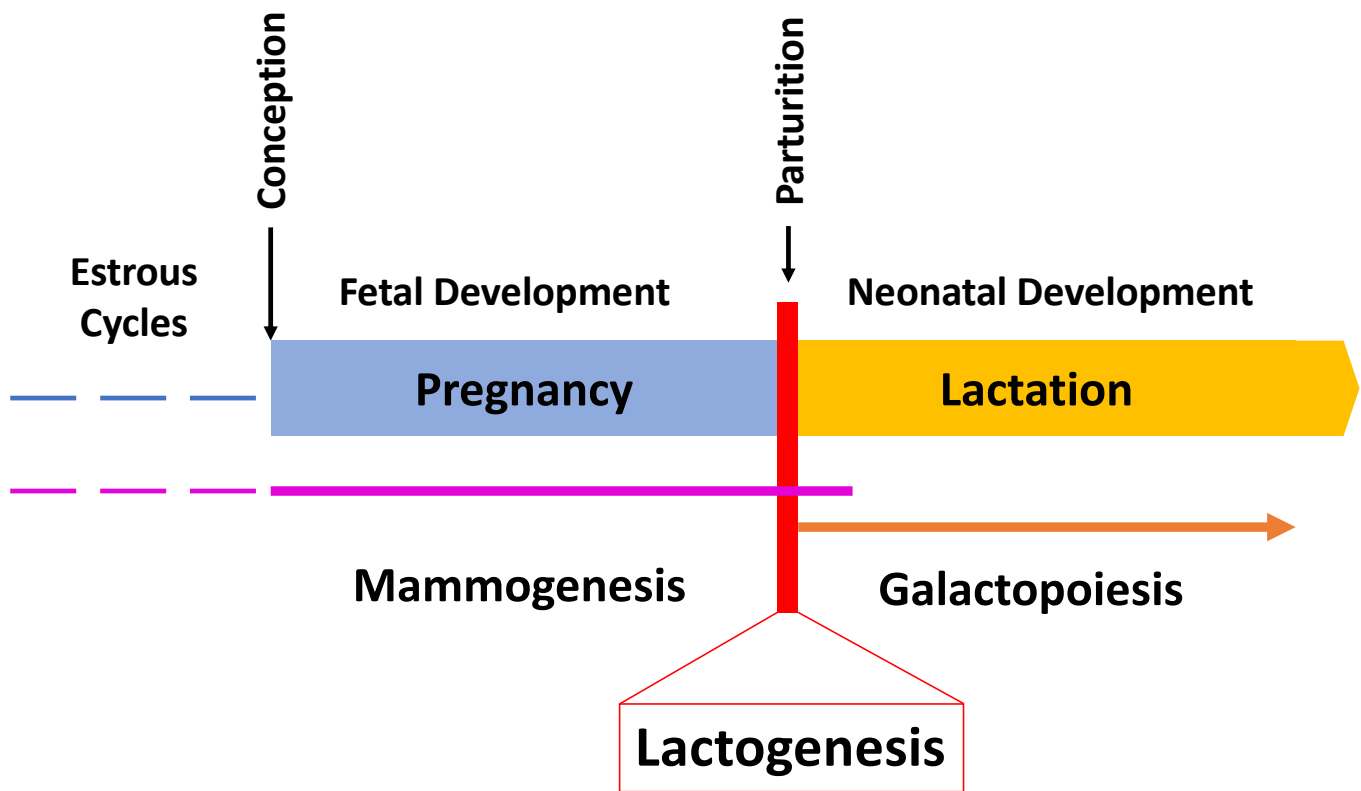
Mammary Gland Developmental Cycle

Lactogenesis Initiation of lactation
Colostrogenesis Formation of colostrum



Mammary Gland Developmental Cycle

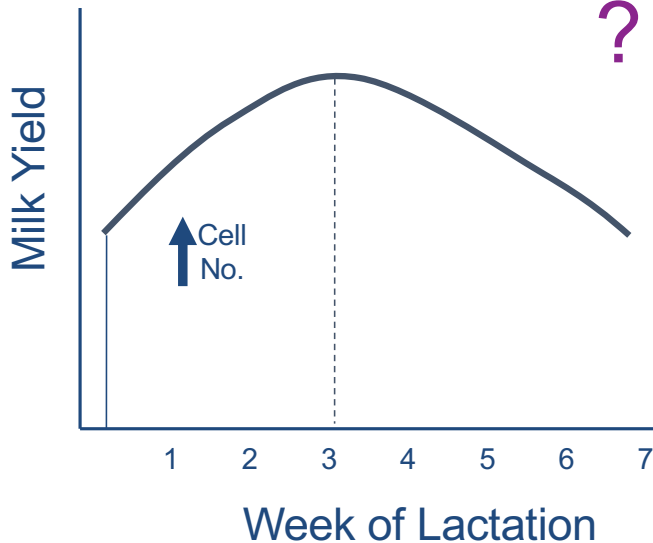




Milk Yield Determinants

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

Gilt



Milk Yield Determinants

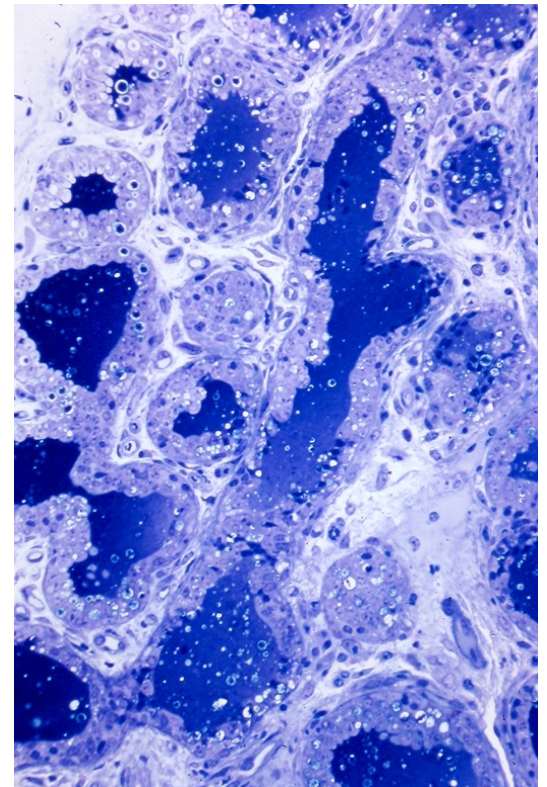
- ✓ • Number of secretory cells
 - Tissue growth – number of cells
- ? • Metabolic activity of secretory cells
 - Cell differentiation – yield/cell

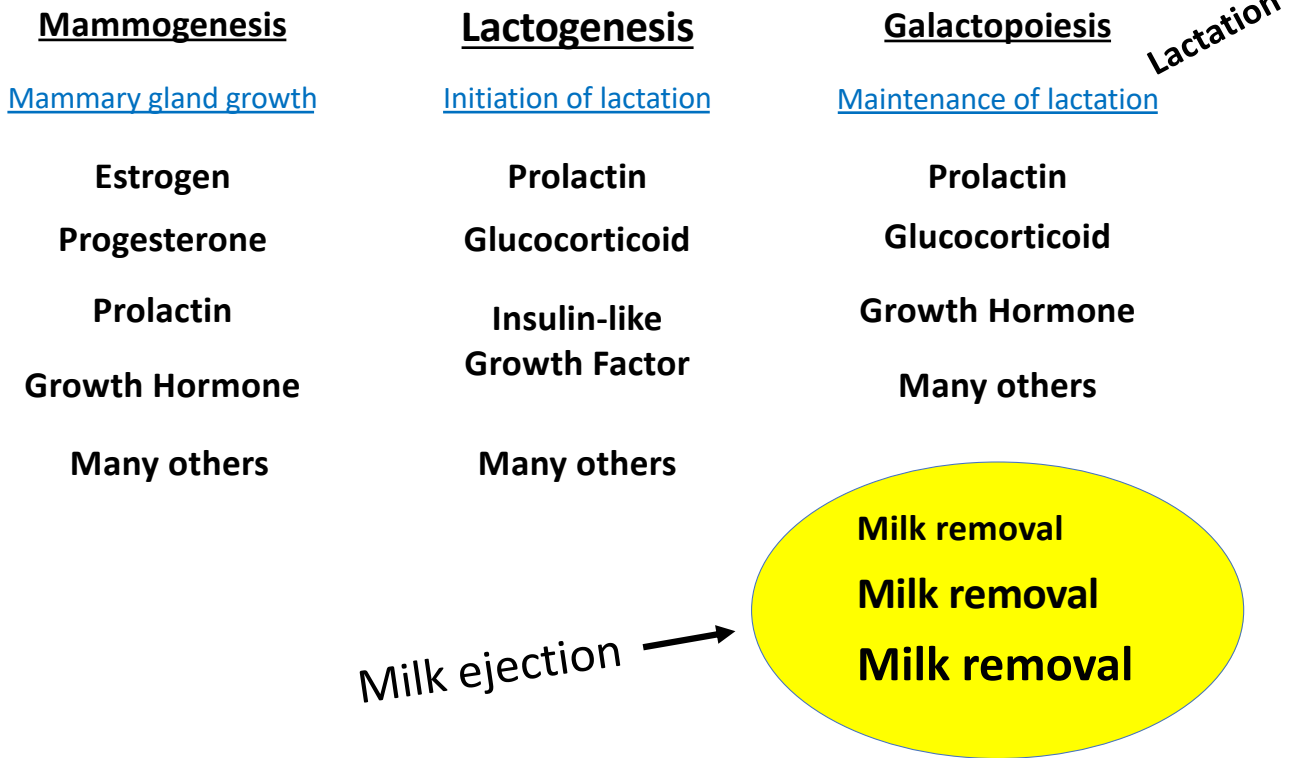
Suckled Glands:

- Mammary wet weight increases by over 50%
- Mammary DNA increases by 100

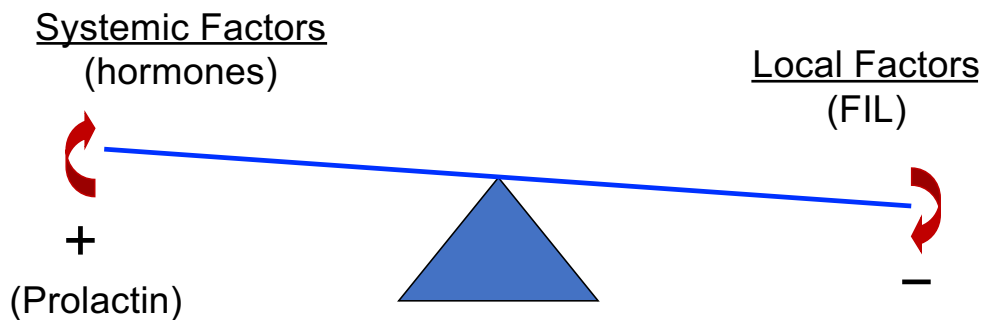
Primary tissue components: continued branching of ducts, formation of lobules and alveoli, milk secretion

Primary control: controlled by milk removal; prolactin and other galactopoietic hormones



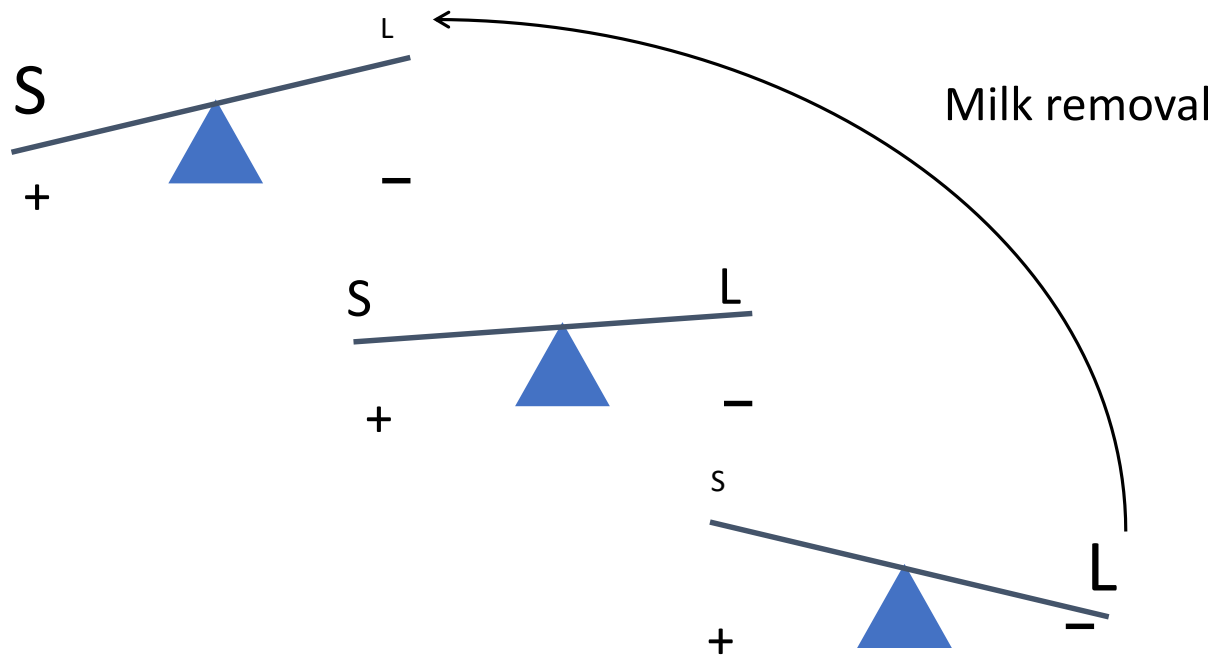


Balance of systemic and local factors in maintenance of lactation

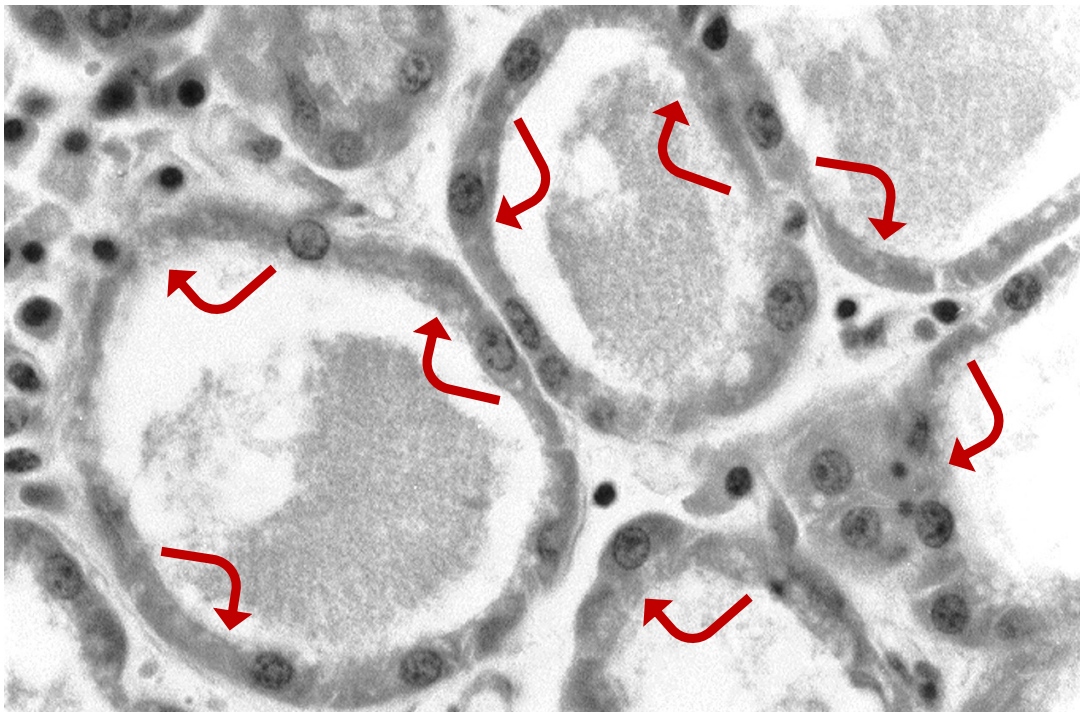


To maintain lactation, milk must be:

physically removed from the gland



Alveoli



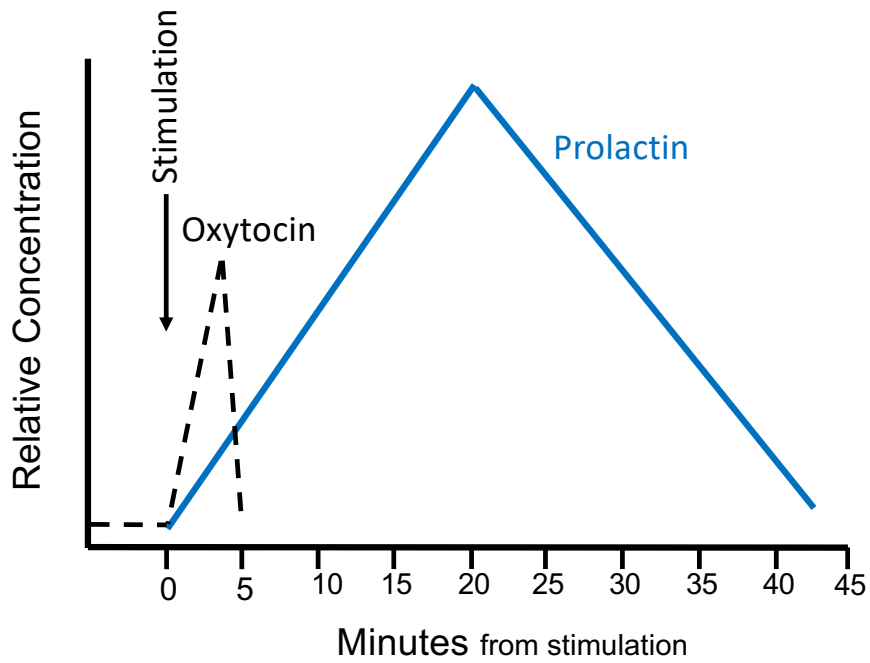
When milk is removed :

- Prolactin release is stimulated (systemic factor).
- Intramammary pressure is relieved.
- Removal of FIL (feedback inhibitor of lactation)(local factor).
- Allows the gland to refill with milk.

If milk is not removed – Milk Stasis :

- No stimulation of prolactin release.
- Acute accumulation of milk in the gland:
 - increased intramammary pressure
 - activation of sympathetic nerves
 - decreased mammary blood flow
 - decreased hormones and nutrients to gland
- Accumulation of FIL in the alveoli.
- Decreased rate of milk secretion.

Suckling/milking induced change in oxytocin and prolactin



Some hormones released during suckling/milking:

- Prolactin
- Growth Hormone
- Glucagon
- Vasoactive Intestinal Polypeptide (VIP)

Suckling-Induced Prolactin Secretion

Dairy Cow



Sow



Milk Removal

- Interval of suckling - (frequency)
- Litter size
- Size of piglets
- Milk letdown
- Other

Dairy Cow



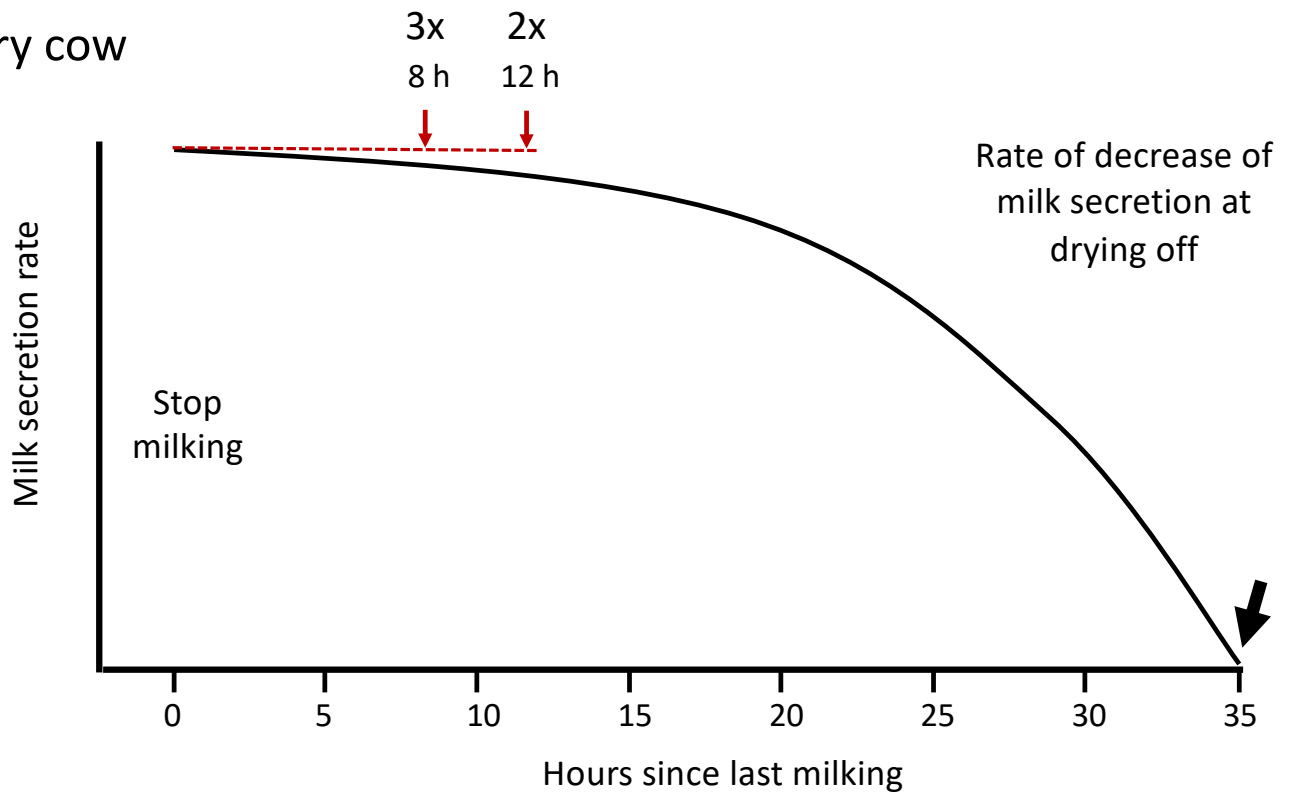
Milking Machine



2-3x/day

Milk removal

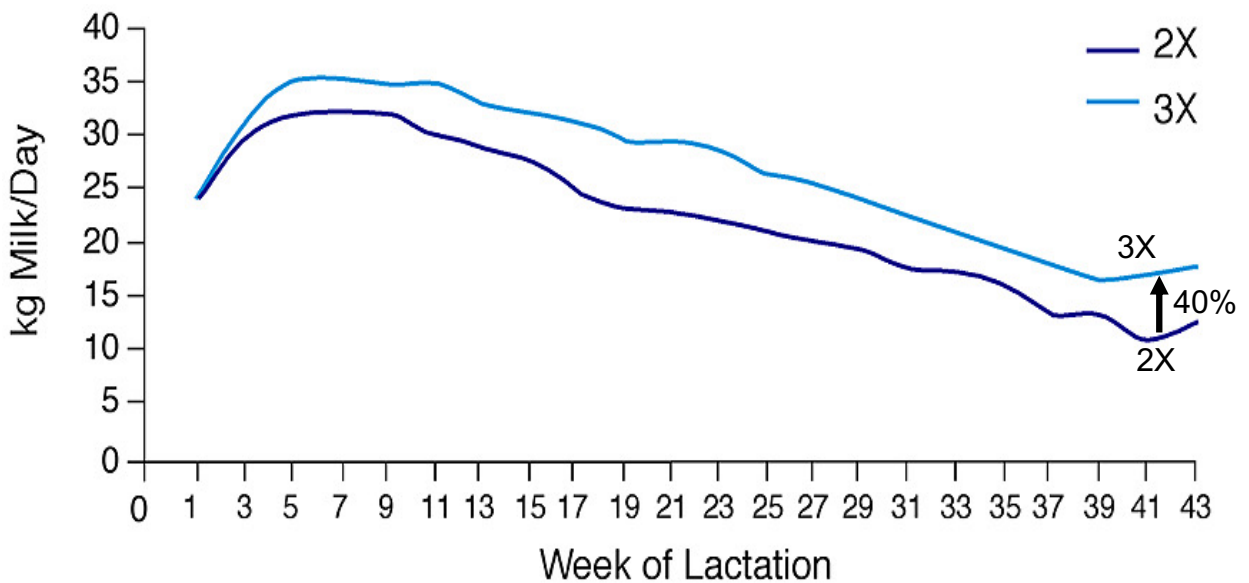
Dairy cow



Milking Frequency -

Upward shift of lactation curve \pm \uparrow persistence

Dairy cows



Adapted from Amos et al., 1985