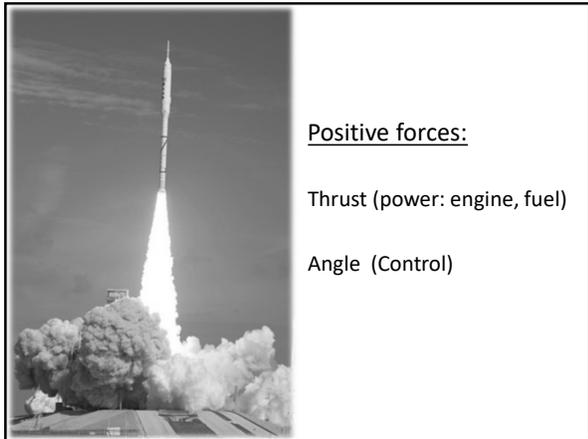
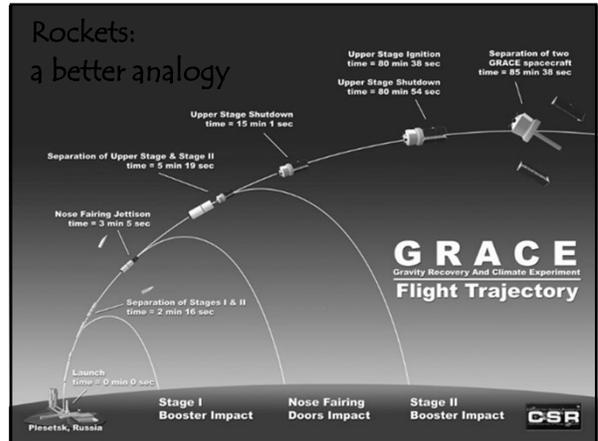
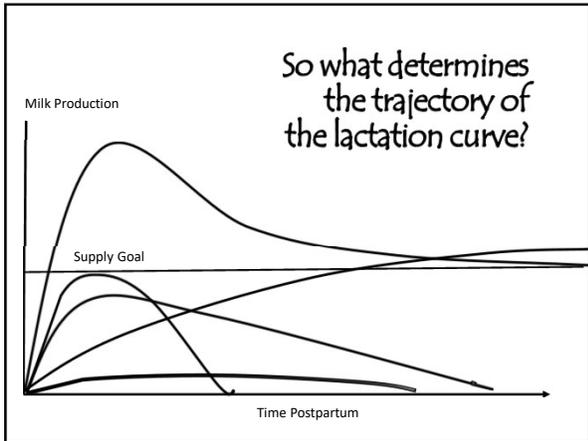


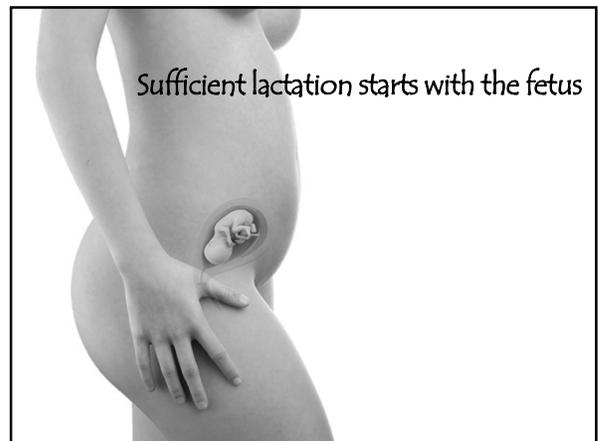


The Lactation Curve



Without positive force, gravity will take over:  
Negative feedback

Stage 1: Building a good rocket

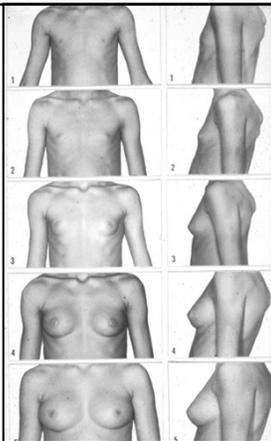


The Lactation Curve

Continues through Puberty

Development of fat pad  
Elongation of ducts into pad  
Skeleton team of alveoli

Tanner Staging



Marshall, W., & Tanner, J. (1969). Variations in pattern of pubertal changes in girls. Archives of Disease in Childhood, 44(235), 292.

...and finishes during pregnancy

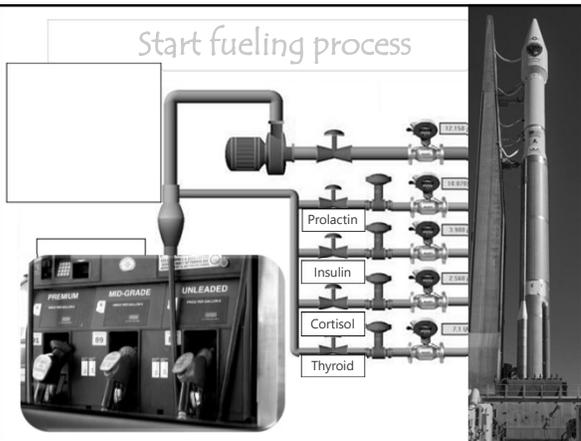
General signs of successful mammogenesis:  
Increased breast sensitivity, nipple changes, enlargement, expressible colostrum at end of pregnancy

Stage 2: A successful launch



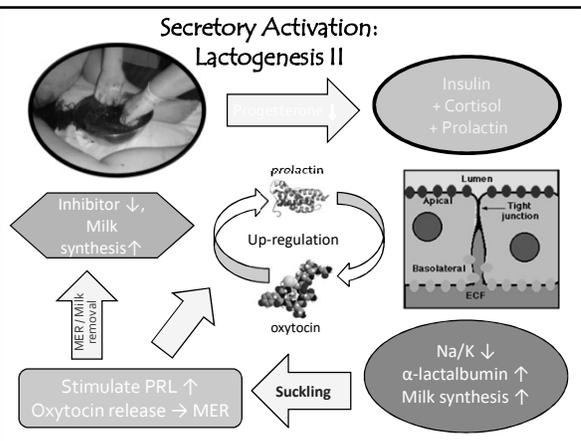
23

Start fueling process



Insulin shifts the gears via PTPRF  
*Should result in Lactogenesis II*

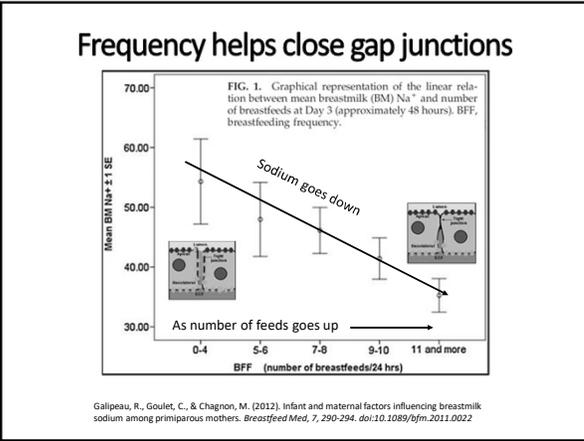
Secretory Activation:  
Lactogenesis II



The Lactation Curve

Stage 3: Transitioning to Autocrine Control

Calibration...  
Starts from birth with frequent milk removal

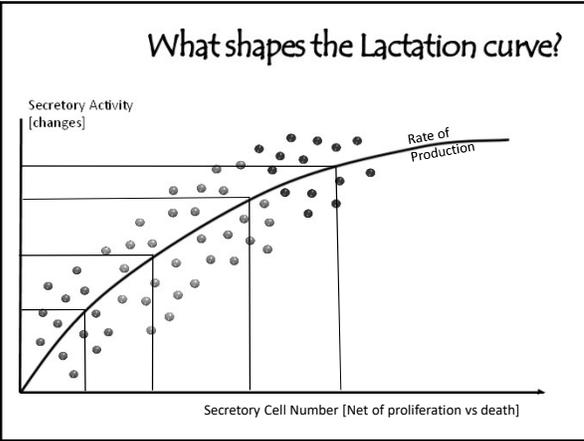


*“Increased milking frequency during early lactation may increase mammary growth (cell proliferation) and thus produce a carryover effect on milk production for the majority of lactation.” –Capuco2003*

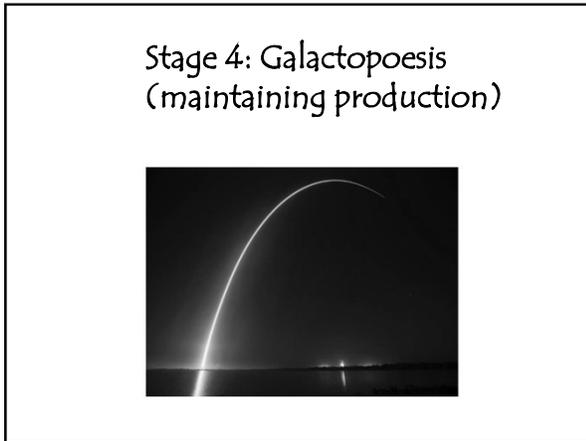
**What drives Secretory Activity?**

Sustained frequency and intensity leads to additional cell proliferation

Rate of proliferation vs Rate of apoptosis determines Growth vs Regression of glandular tissue

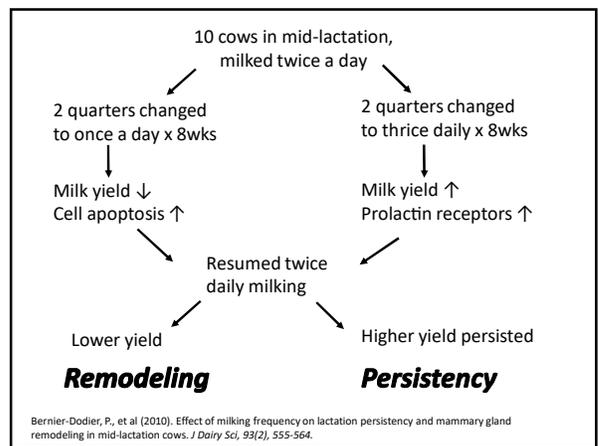
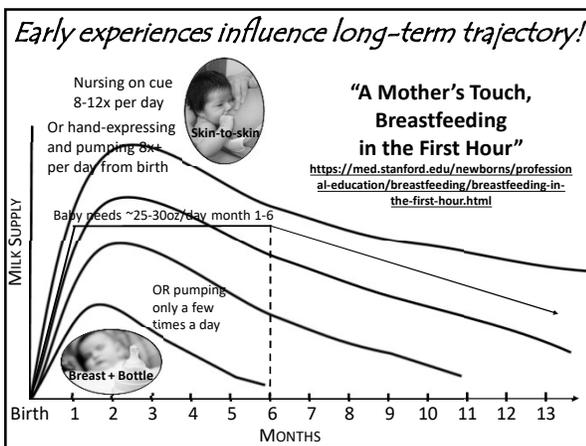
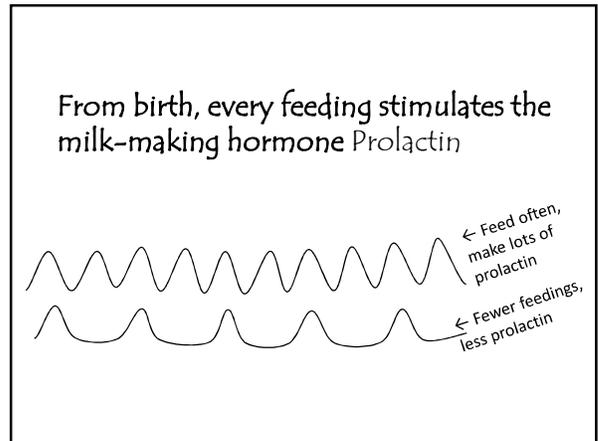


The Lactation Curve

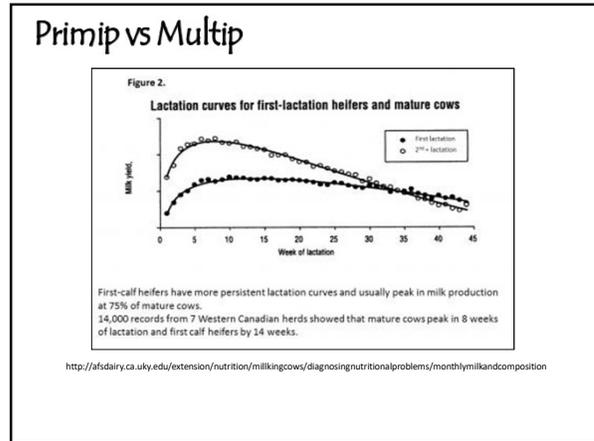
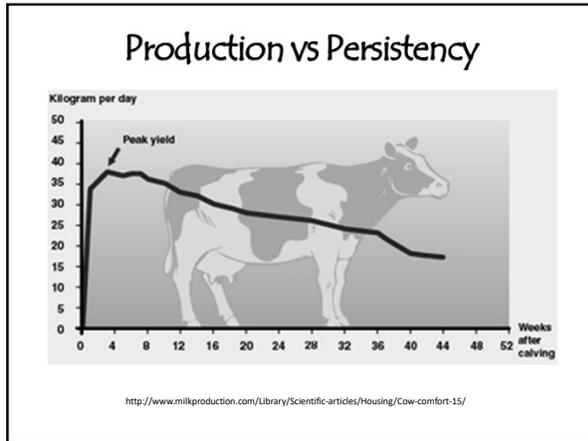


*Mom may own the equipment, but...*

**Baby Drives the Supply**



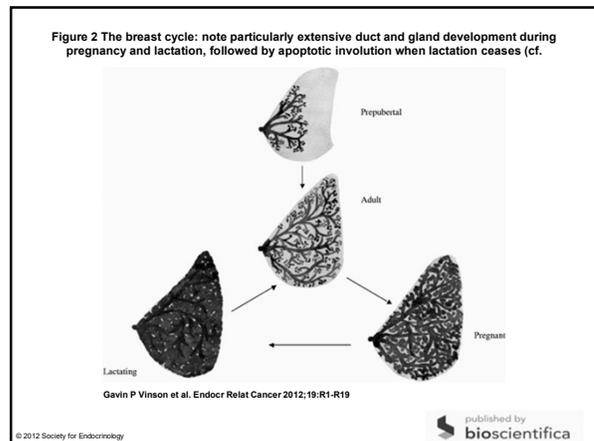
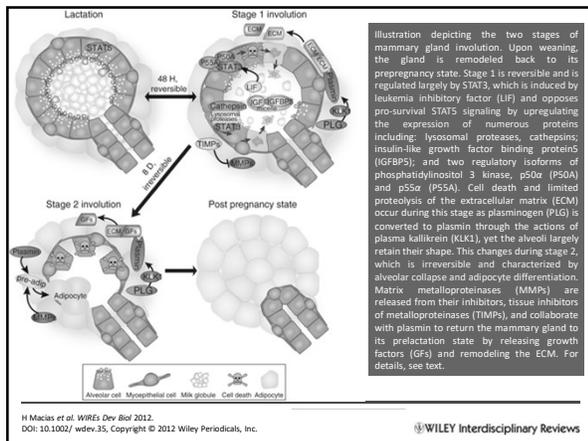
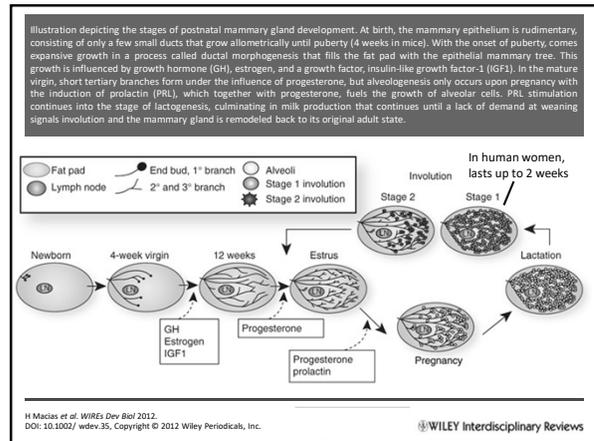
# The Lactation Curve



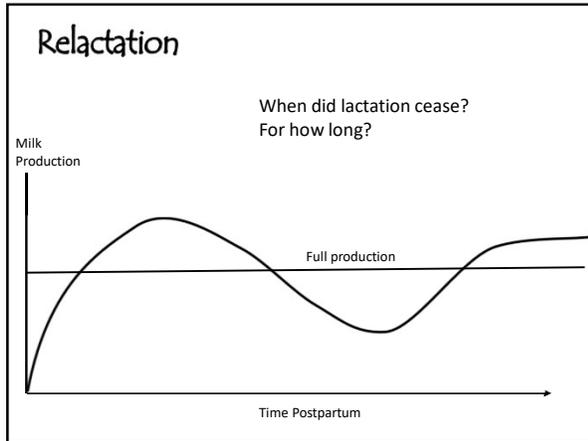
## Stage 5: Winding down the journey

More solids, less frequency....

...Less need for those cells.



# The Lactation Curve



## Relactation

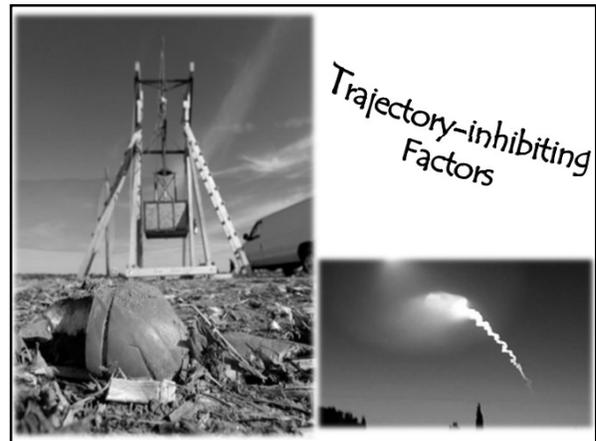
**Early Successful Relactation in a Case of Prolonged Lactation Failure**

This case:

- ✓ 2 wk process after 14 week gap
- ✓ First reappearance of milk @ 6d
- ✓ Discontinued at breast supplement
- ✓ Past experience of success <8wk gap
- ✓ Note success rate 60% > 3 wks

## How flexible is milk calibration?

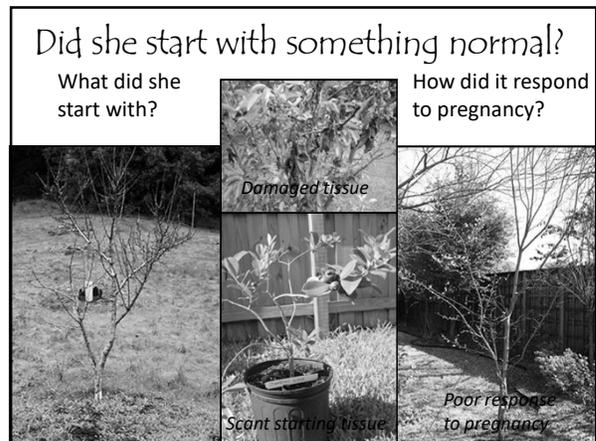
Woolridge: *“Where there has been substantial down-regulation, it is often difficult to shift back up; where there has been up-regulation from birth, the potential to carry on up-regulation is retained. Down-regulation, if excessive, can be a harmful process.”*



Is her rocket the right size for the job?

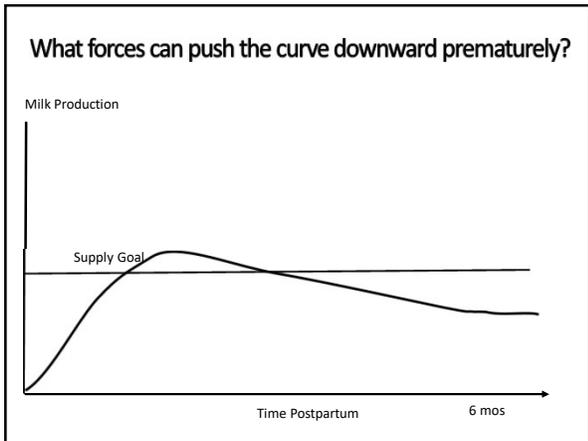
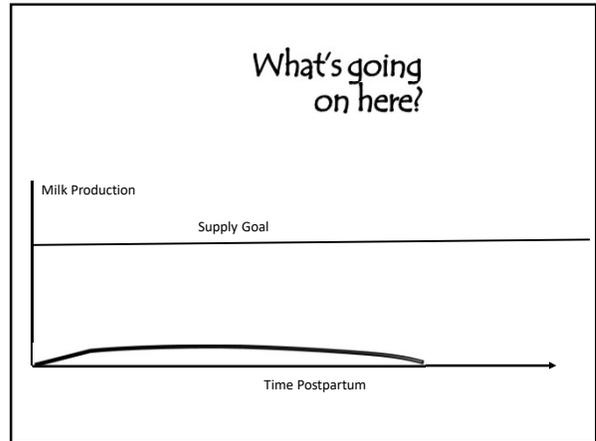
And her engine size?

“USSRC Rocket Park” by Ke4roh - Own work. Licensed under Public Domain via Wikimedia Commons - [http://commons.wikimedia.org/wiki/File:USSRC\\_Rocket\\_Park.JPG#/media/File:USSRC\\_Rocket\\_Park.JPG](http://commons.wikimedia.org/wiki/File:USSRC_Rocket_Park.JPG#/media/File:USSRC_Rocket_Park.JPG)



The Lactation Curve

Pregnancy history:  
Hypertension?  
Placental problems?



Diet- another concern?

*“Consumption of high fat diet impairs mammary parenchymal tissue and impedes its ability to synthesize and secrete milk...”*

Hernandez 2012. High Fat diet Alters lactation outcomes: Possible involvement of inflammatory and serotonergic pathways. PLoS ONE 7:3

## Endocrine Disruptors

May...

- Mimic endogenous hormones
- Antagonize endogenous hormones
- Alter synthesis & metabolism of natural hormones
- Modify hormone receptor levels
- Block normal binding of hormones to their receptors
- Bind preferentially to receptors

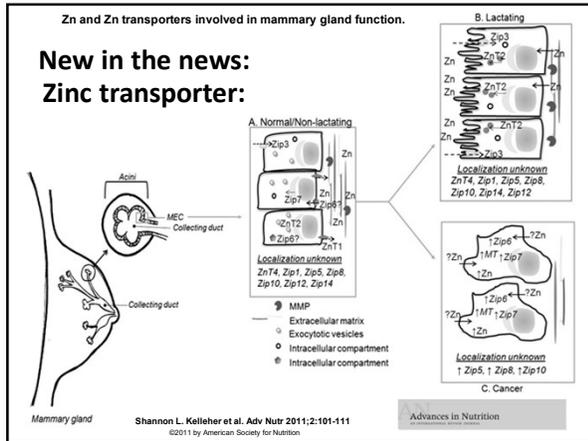
Markey 2002

## New in the news: PFOA

As exposure to chemical rises, so does risk of ending breastfeeding early

Romano, et al. (2016). Maternal serum perfluoroalkyl substances during pregnancy and duration of breastfeeding. Environ Res.

# The Lactation Curve

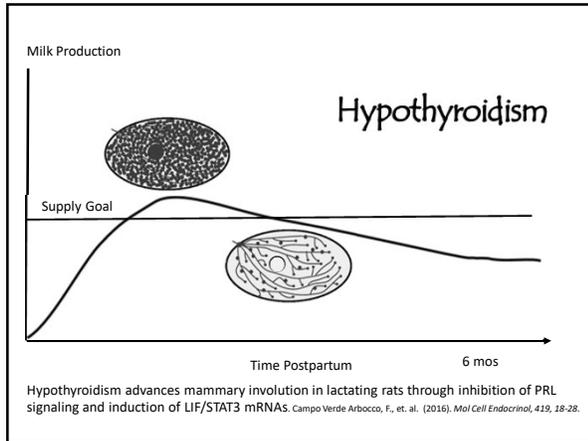


**Mastitis: bane of the dairy industry**

Apoptotic (programmed cell death) index increased during mastitis

Proliferation (creating new cells) may also increase in attempt to repair

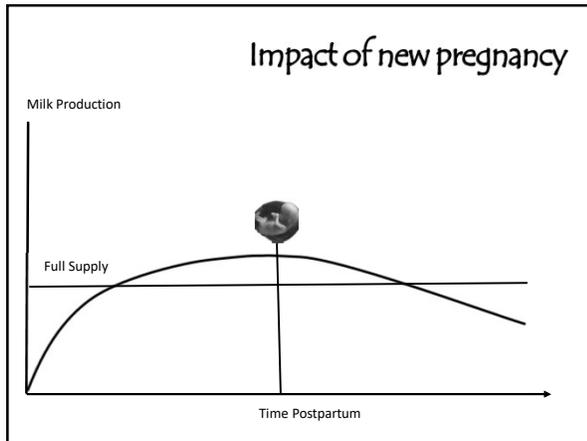
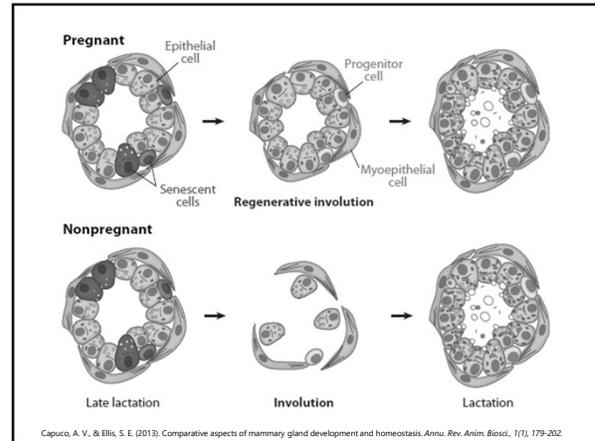
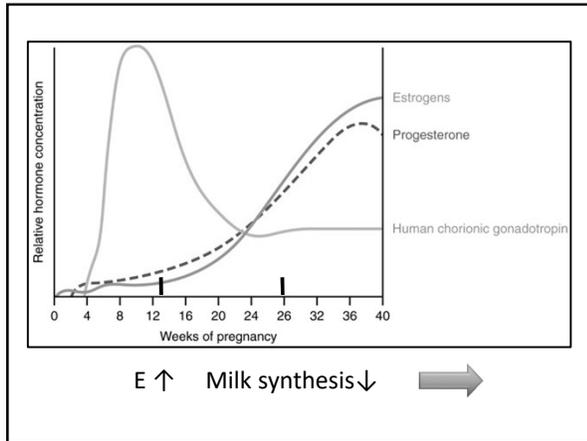
*Phagocytosing neutrophils could damage mammary epithelium*



What about a new pregnancy?

**Dairy industry "Best Practice" –  
Drying off period >40 days to maximize production**

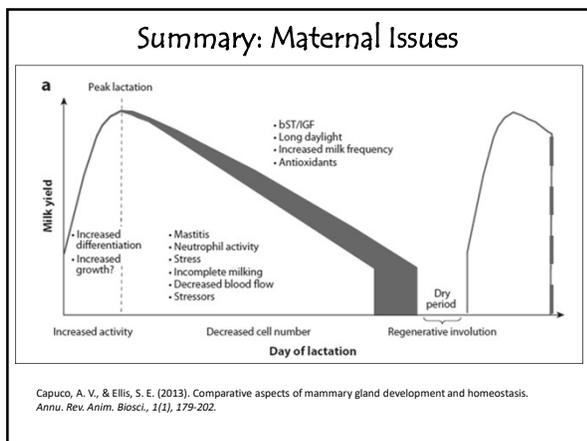
## The Lactation Curve



## When lactation and pregnancy overlap...

*15% decline in weight gain at 1 month*

Marquis, G. S., Penny, M. E., Diaz, J. M., & Marin, R. M. (2002). Postpartum consequences of an overlap of breastfeeding and pregnancy: reduced breast milk intake and growth during early infancy. *Pediatrics*, 109(4), e56.



## Beyond dairy science: Infant Factors

It's all about the suck—  
*quality and frequency*

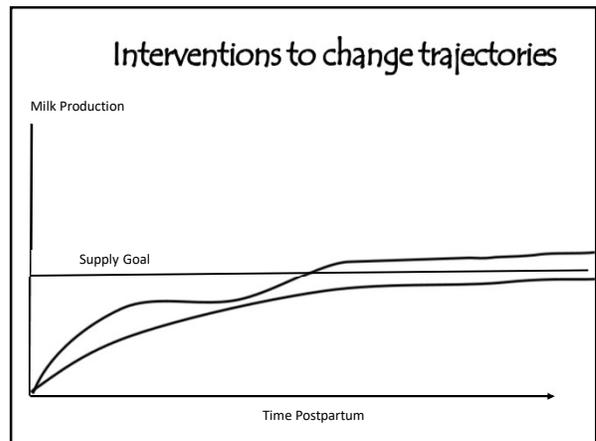
The Lactation Curve



**Mechanical Factors**

Pumps are not  
all created equal

Neither are women...  
physically  
psychologically  
culturally



Combining baby and pumping

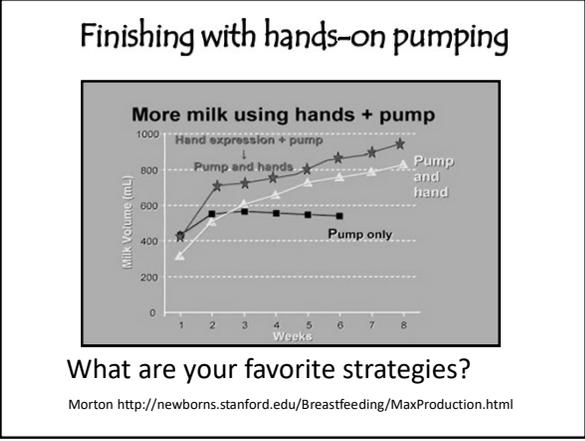
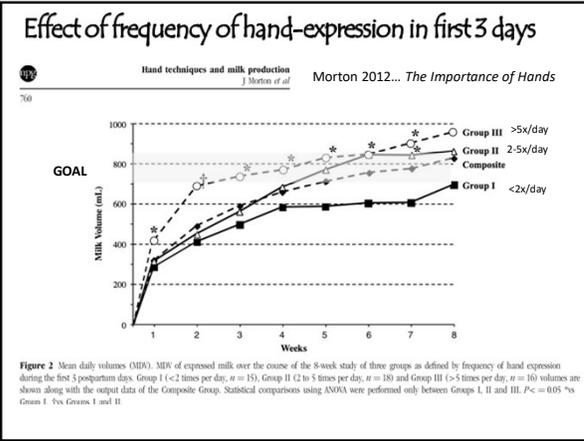
**Breast pumping patterns that mimic newborns**

Irregular cycles of 120, 90, 60 sucks per minute. Starting on day 4 milk started trending higher and remained higher... Meier 2012

# The Lactation Curve

**Women who hand-expressed bfd longer**

Flaherman 2011... Randomised trial comparing hand-expression with breast pumping for mothers of term newborns feeding poorly



### Insights on milk expression:

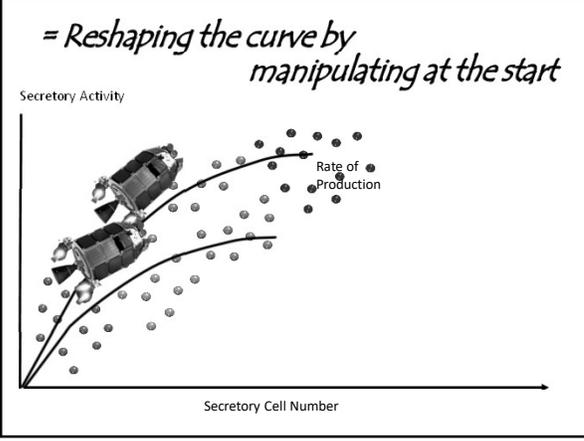
Jane Morton MD, Stanford University

### Intriguing pig study tries a novel approach to improve lactation

Dom given .4mg/kg (26mg for 145lb woman) during gestation days 90-110 to induce hyperprolactinemia

- Mammary differentiation accelerated
- Alveolar volume increased
- Piglets gained 21% more than controls

Vanklompenberg, M. K., Manjarin, R., Trott, J. F., McMichael, H. F., & Hovey, R. C. (2013). Late gestational hyperprolactinemia accelerates mammary epithelial cell differentiation that leads to increased milk yield. *J Anim Sci*, 91(3), 1202-1211. doi: 10.2527/jas.2012-5903



## The Lactation Curve



Where galactogogues fit in

They most likely

- Increase the number of milk-making cells, or
- Stimulate the rate they make milk, OR....

Mortel, M., & Mehta, S. D. (2013). Systematic Review of the Efficacy of Herbal Galactagogues. Capuco, (2003).

