

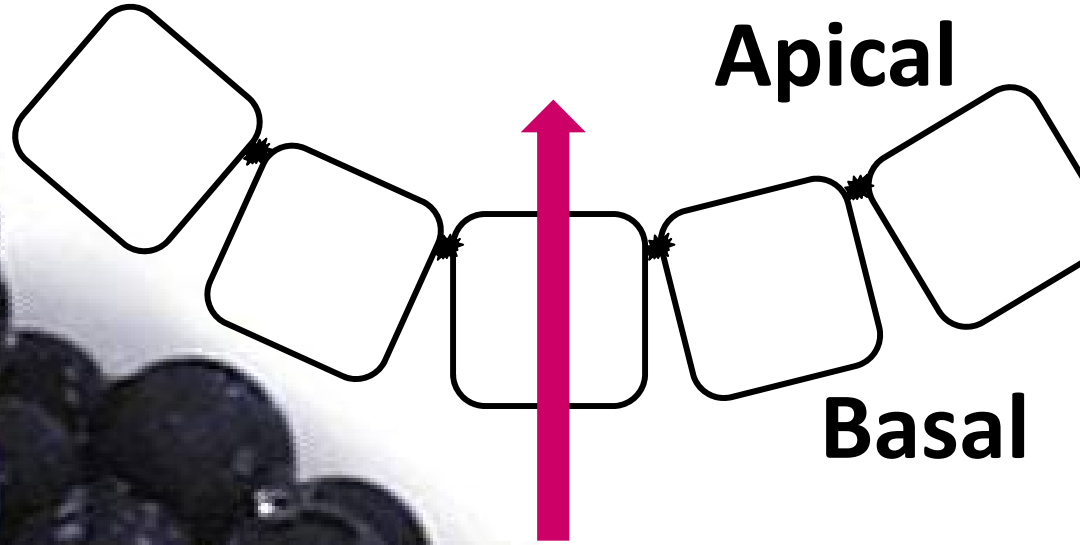
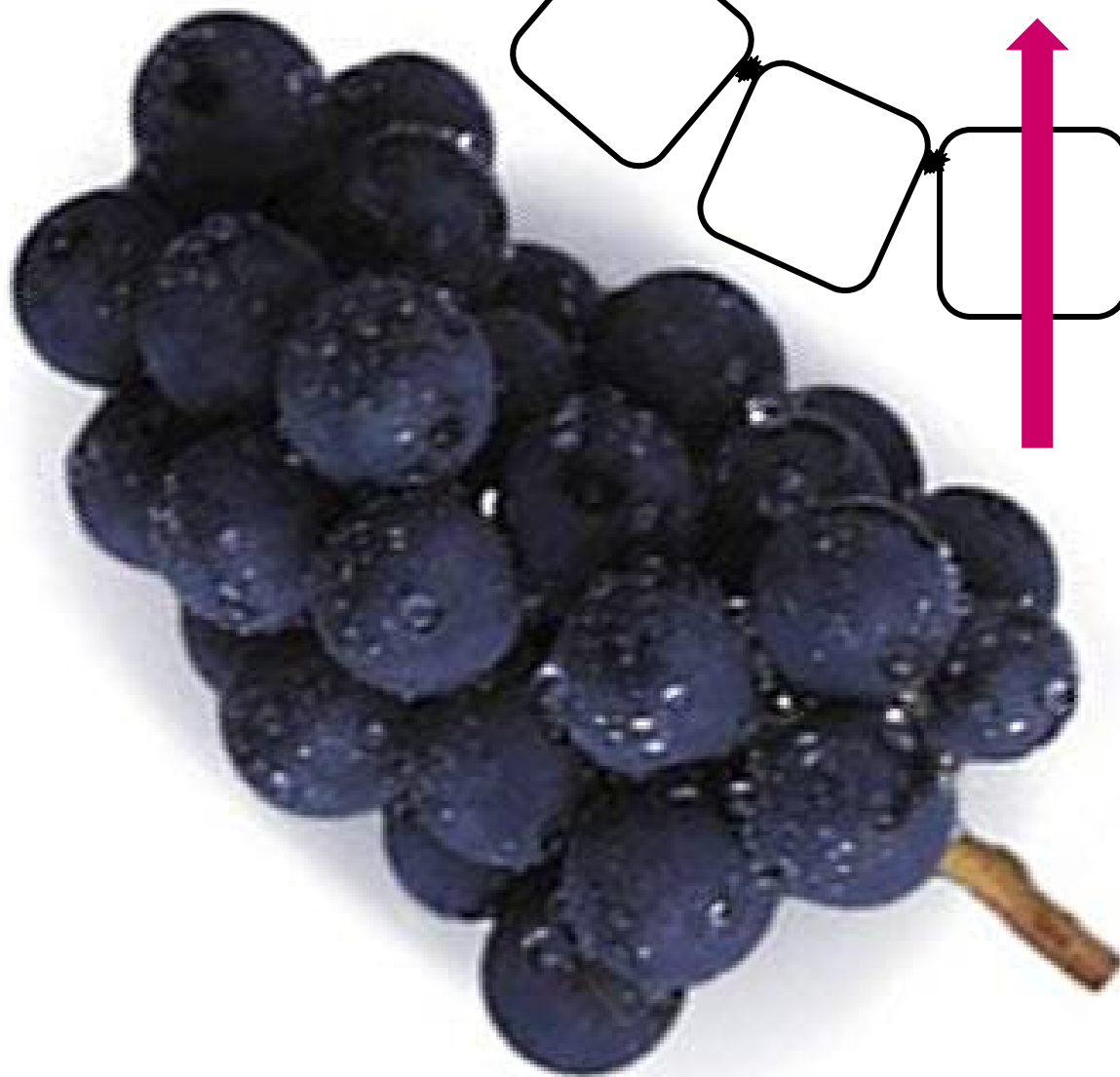
Control of milk protein synthesis in the mammary gland and the interaction with the supply of energy yielding nutrients

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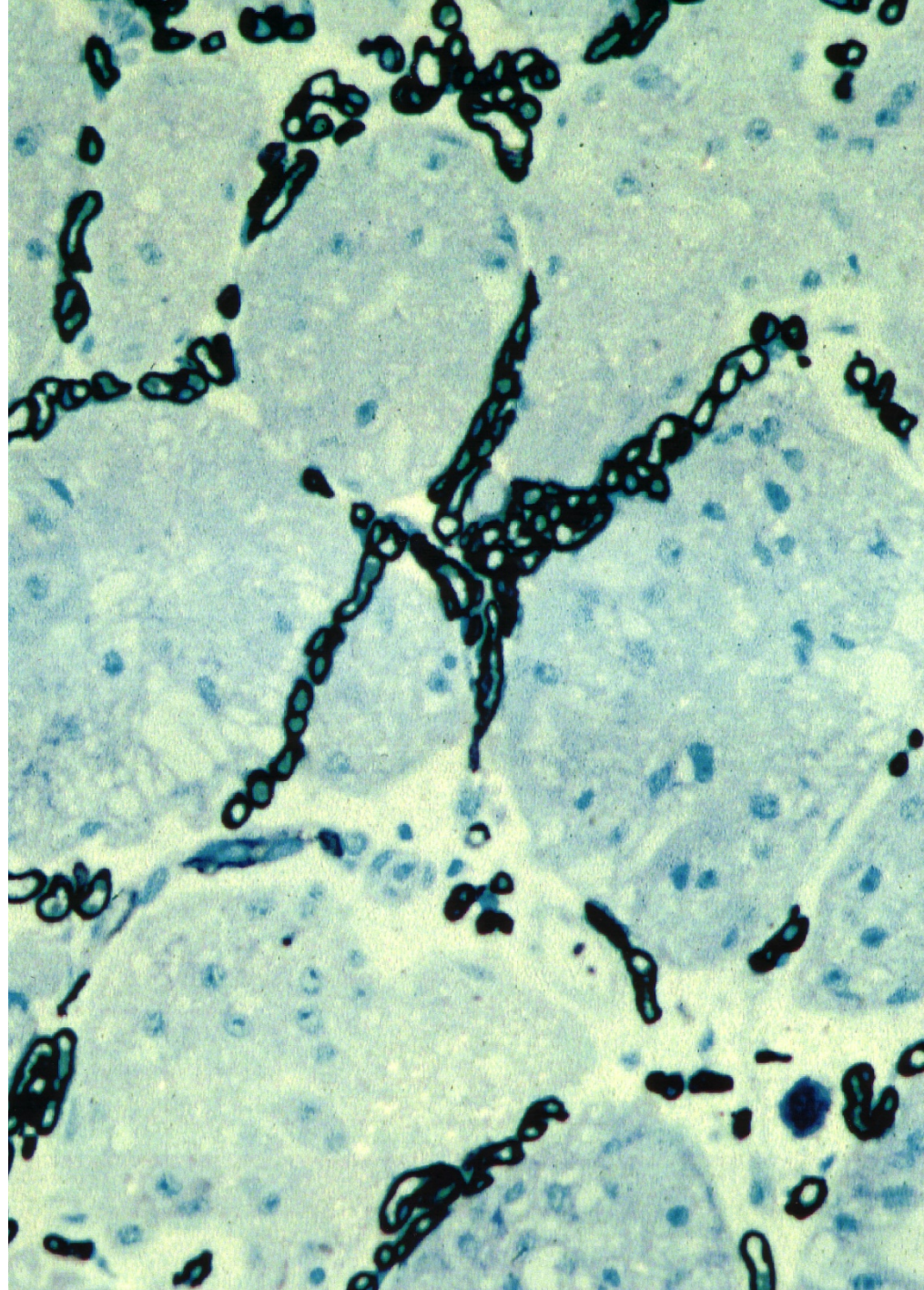


Apical

Basal



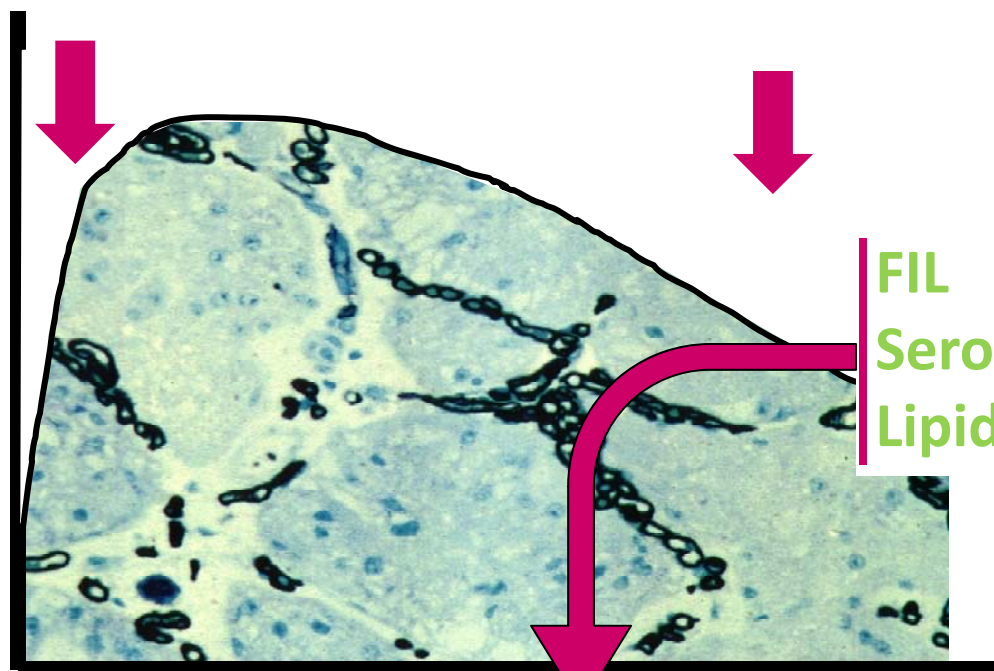




Stage of lactation

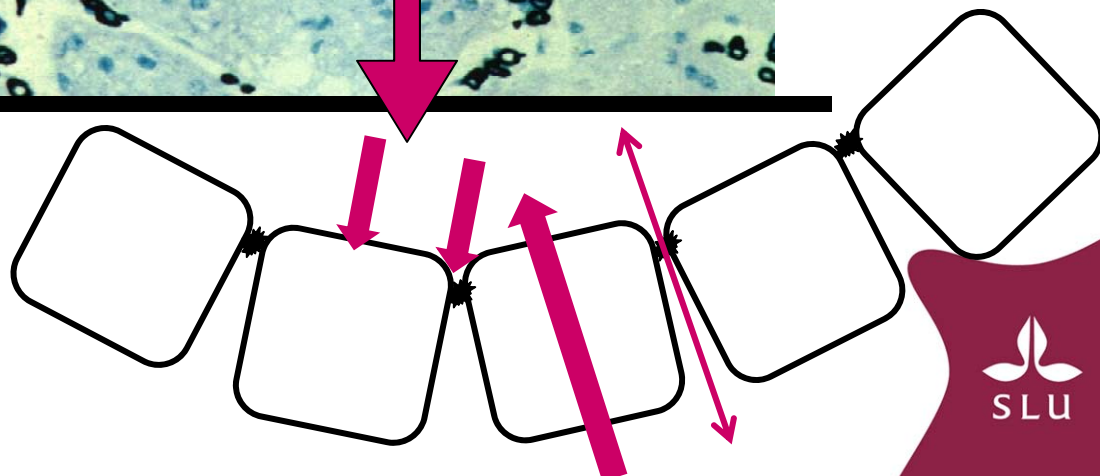
differentiation
and apoptosis

apoptosis



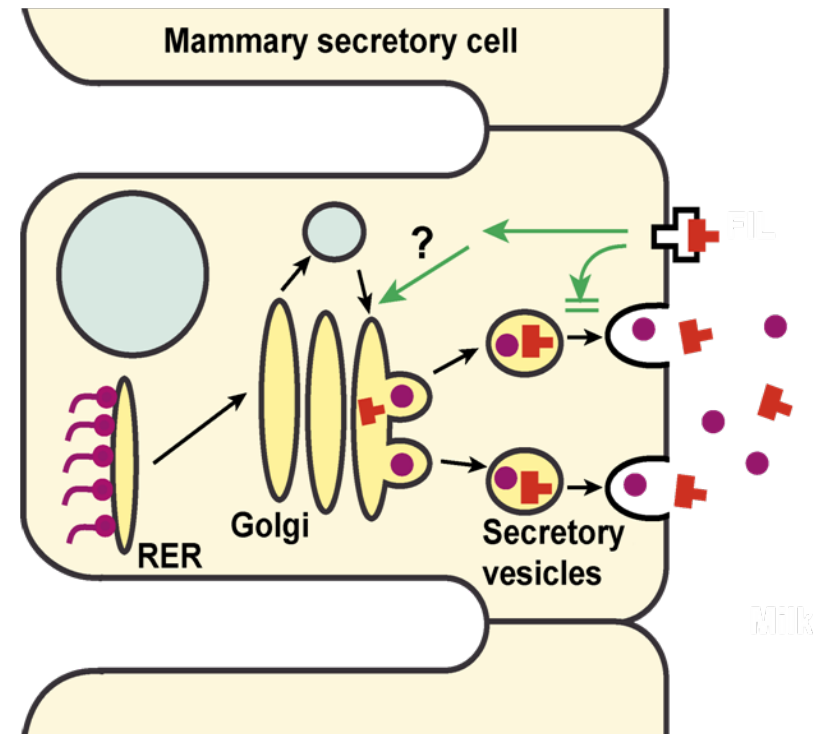
FIL
Serotonin?
Lipid fractions?

↑
proliferation



How FIL works

- FIL disrupts the Golgi (secretory) apparatus of the milk-producing cell
- FIL causes breakdown of the endoplasmic reticulum
- FIL acts by blocking milk secretion within the mammary cell



Stage of lactation

differentiation
and apoptosis

apoptosis

Progesterone

Estrogens

Thyroid
hormones

Prolactin

Growth
hormone

IGF-1

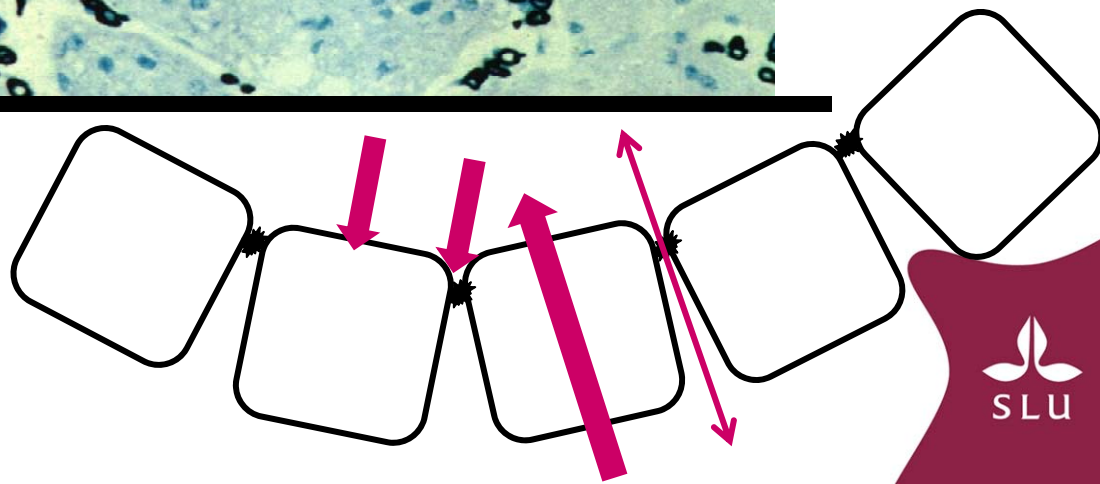
Cortisol

Insulin

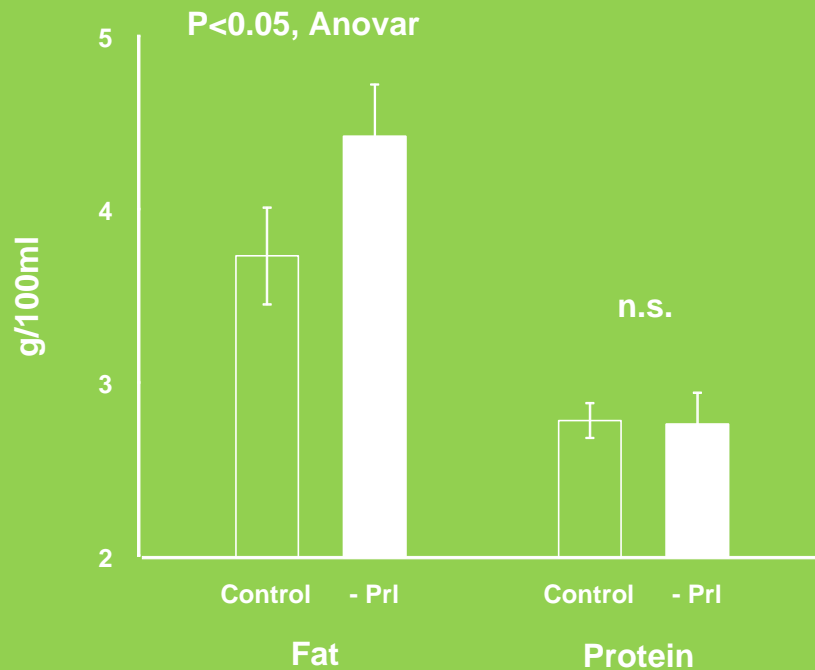
Oxytocin



proliferation



Basic endocrine control



- Goats treated with bromocriptine to reduce prolactin
- Milk yield reduced by 15%
- Protein output decreased
- Fat % increased, output unchanged

Same pattern during water- and feed deprivation

Milk protein = many different types!

- **CASEINS**

alpha-1, alpha-2, beta, kappa

- **WHEY PROTEINS**

beta lactoglobulin , alpha-lactalbumin ,
serum albumins, immunoglobulins

- **OTHER PROTEINS**

Lactoferrin , lactoperoxidase ,
lysozymes and more





Amino acid metabolism in the mammary cells

- **Milk protein synthesis**

essential and non-essential amino-acids
+ ATP!

- **Metabolic reactions**

CO₂, Urea, Polyamines

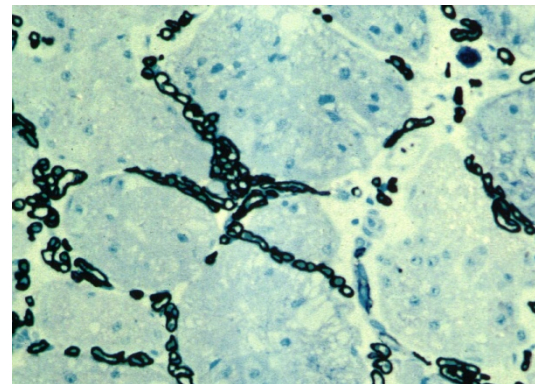
- **Synthesis of enzymes**

- **Pass unchanged into blood, milk and lymph**

Amino acid uptake in the mammary glands depends on

- Arterial concentration of amino acids
- Mammary blood flow
- Mammary perfusion
- Transport across the basal membrane

Carrier proteins and Channels, Specific for each amino acid



Secretion

- Transferred from RER to Golgi apparatus
- Processed for transport out of cell in Golgi
- Secretory vesicles bud off the Golgi
- Vesicles transported to apical membrane via microtubules
- Vesicles fuse with apical membrane and release contents into alveolar lumen

Proteolysis after synthesis

- Bacterial proteases
- Plasmin (a serum proteinase)

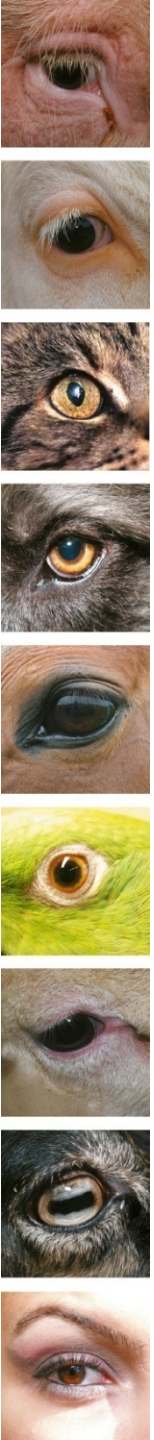
high SCC and mammary infections
cause increased proteolysis

Late lactation (=late pregnancy)



Types of variation in milk composition

- **Concentration/Dilution**
- **Synthesis of specific components** (in the mammary gland *or in the liver*)
- **Secretion of specific components**
- **Intracellular or extracellular degradation of specific components**

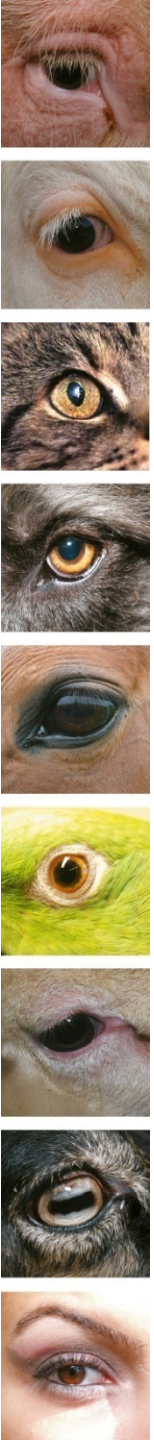
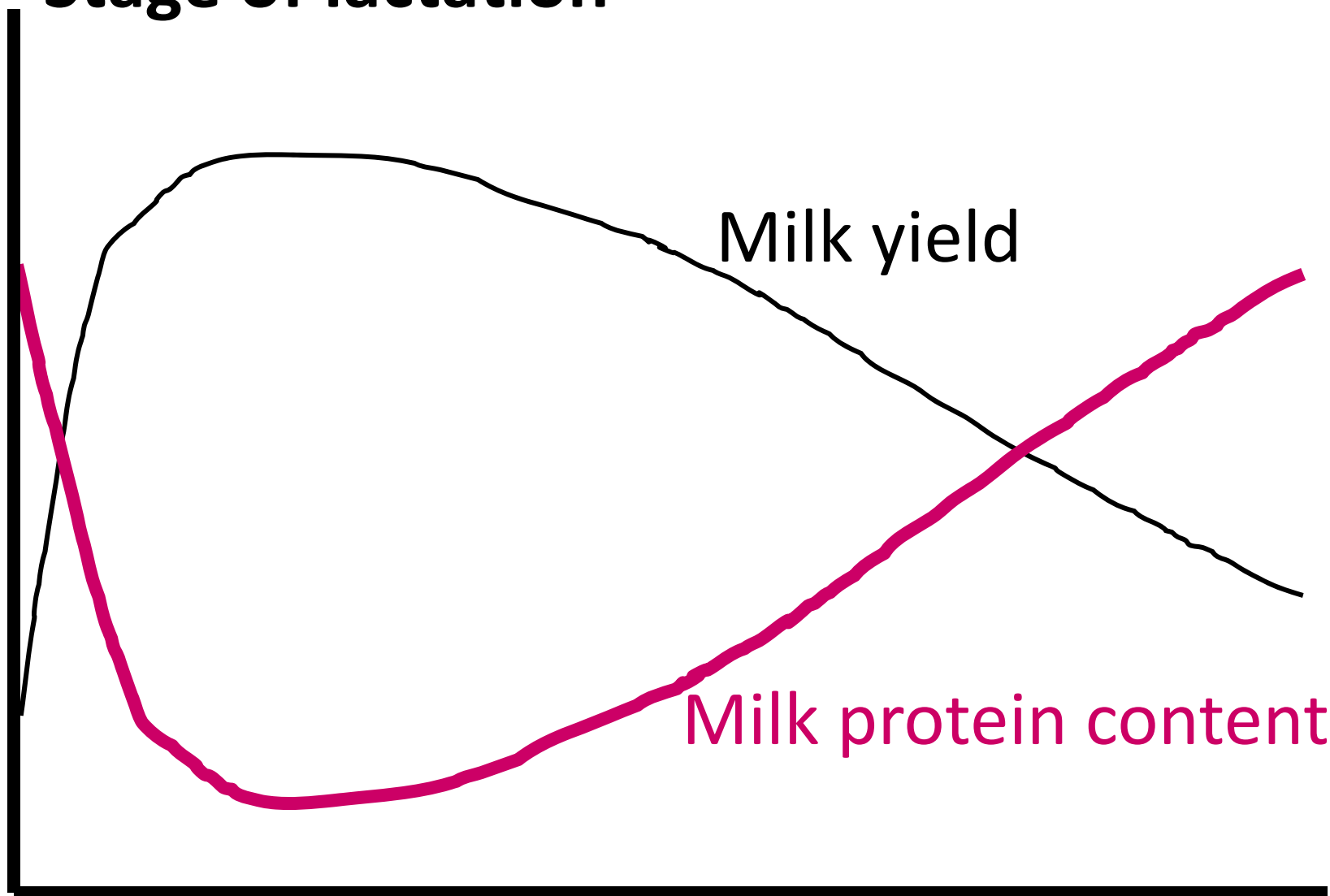


Causes of variation

- Genetic
- Physiologic
- Environmental
- Milking routines
- Pregnancy, stage of lactation, calving interval
- Nutrition



Stage of lactation

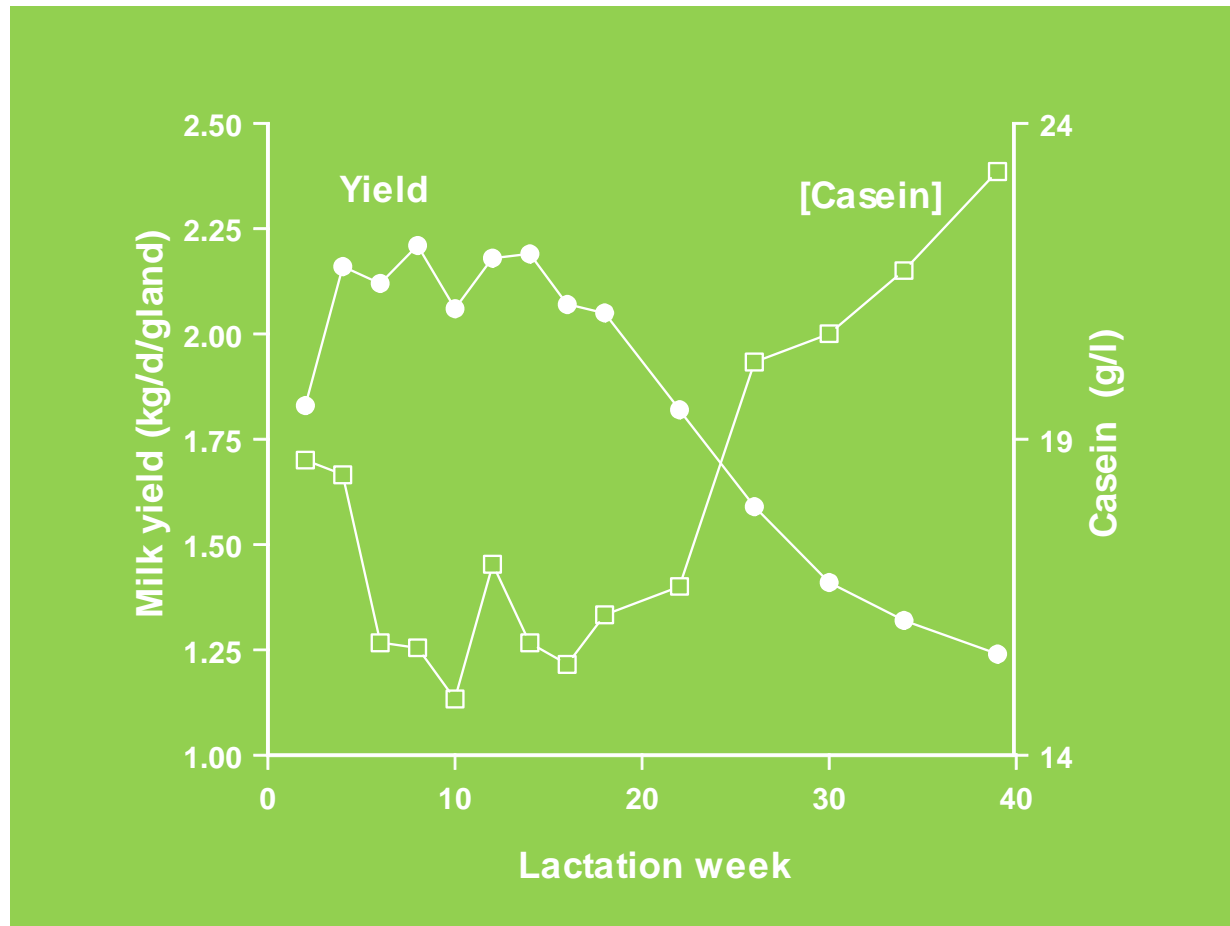


Stage of lactation

As yield declines,
casein increases

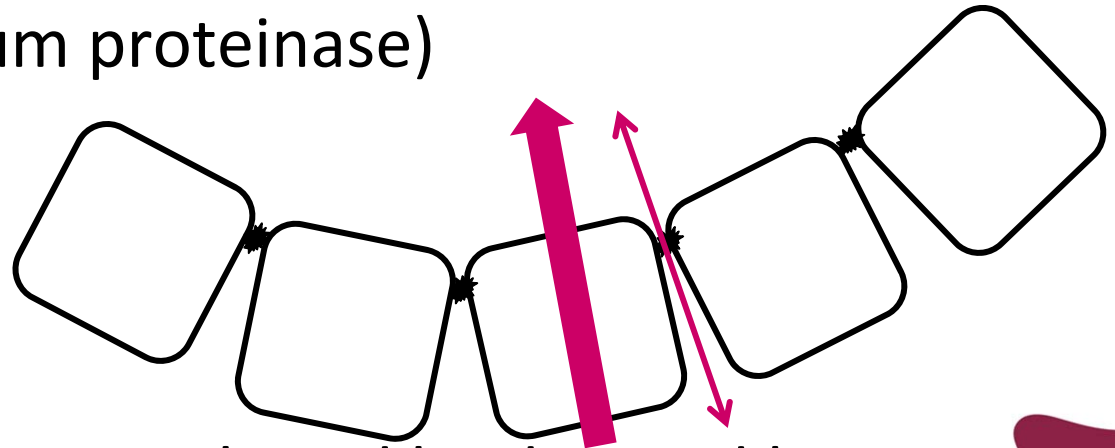
However, proteolytic degradation also increases...

...and the proportion of useful caseins decreases



Milk protein quality and stage of lactation

- Late lactation milk has poor processing quality
- This is largely due to a low casein:non casein protein ratio (casein number)
- Casein proteolysis occurs through the action of a plasmin (a serum proteinase)



- The problem is exacerbated by diet and by infrequent milking



Effect of milking frequency (MF)

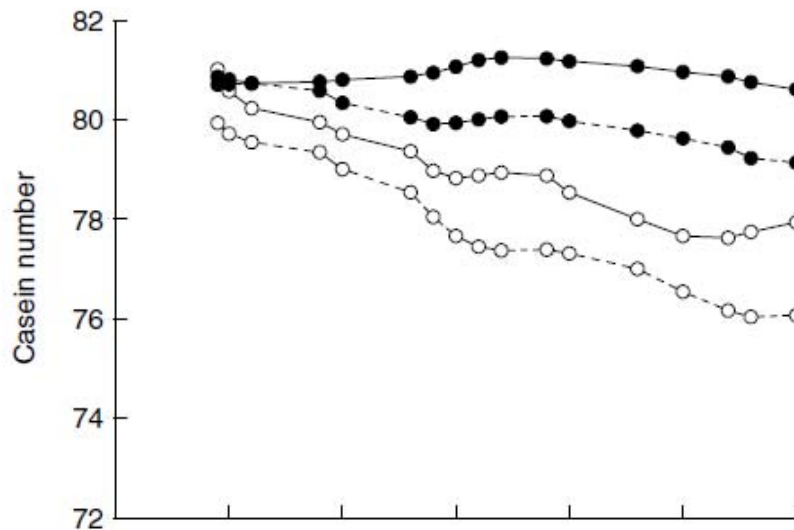
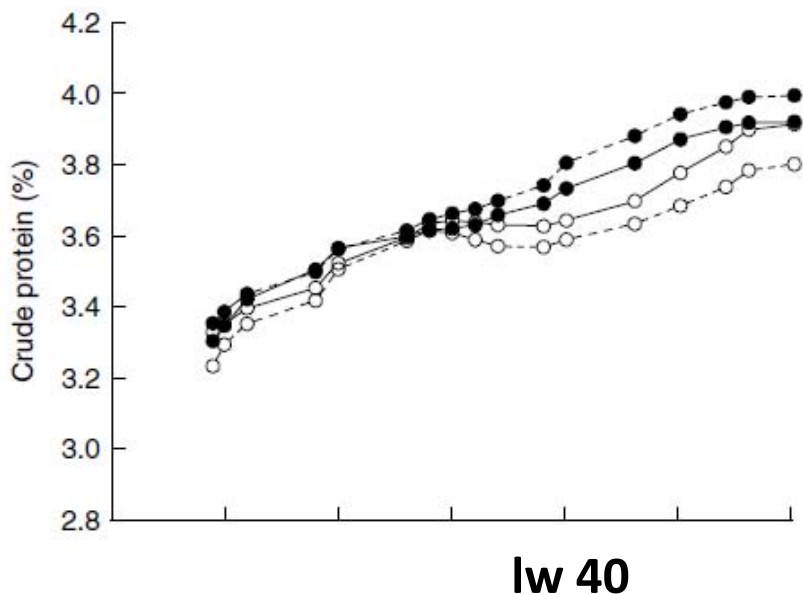
Influence of Milking Three Times a Day on Milk Quality¹

LINDA R. KLEI,² JOANNA M. LYNCH,² DAVID M. BARBANO,²
PASCAL A. OLTENACU,³ ANTHONY J. LEDNOR,³ and DAVID K. BANDLER²
Cornell University, Ithaca, NY 14853

1997 J Dairy Sci 80:427–436

- 3X gave 10.4% more milk, 4.7% more fat and 7.3% more protein
- Casein number was improved by 3X, but not consistently

Stage of lactation × nutrition × MF



● Higher concentrate --- 2x daily milking — 3x daily milking

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doi:10.1017/S0022029907002944 First published online 29 January 2008 Printed in the United Kingdom

Extended lactation in dairy cows: effects of milking frequency, calving season and nutrition on lactation persistency and milk quality

Annette Sorensen¹, D Donald Muir² and Christopher H Knight^{3*†}

Experimental manipulation of protein supply

Table 1. The chemical composition (% of DM, unless stated otherwise) of the fish meal cube, feather meal cube and sugar beet pulp used in the experiments.

	Fish meal cube	Feather meal cube	Sugar beet pulp
DM, %	86.9	88.4	87.2
Organic matter	87.8	91.7	88.2
Total N	4.73	4.82	1.79
Starch	27.7	26.6	0.5
Sugars	6.1	7.6	21.9
Neutral-detergent fiber	26.9	26.5	35.0
Acid-detergent fiber	6.9	8.6	20.0

Experimental diet deficient in histidine, methionine and lysine

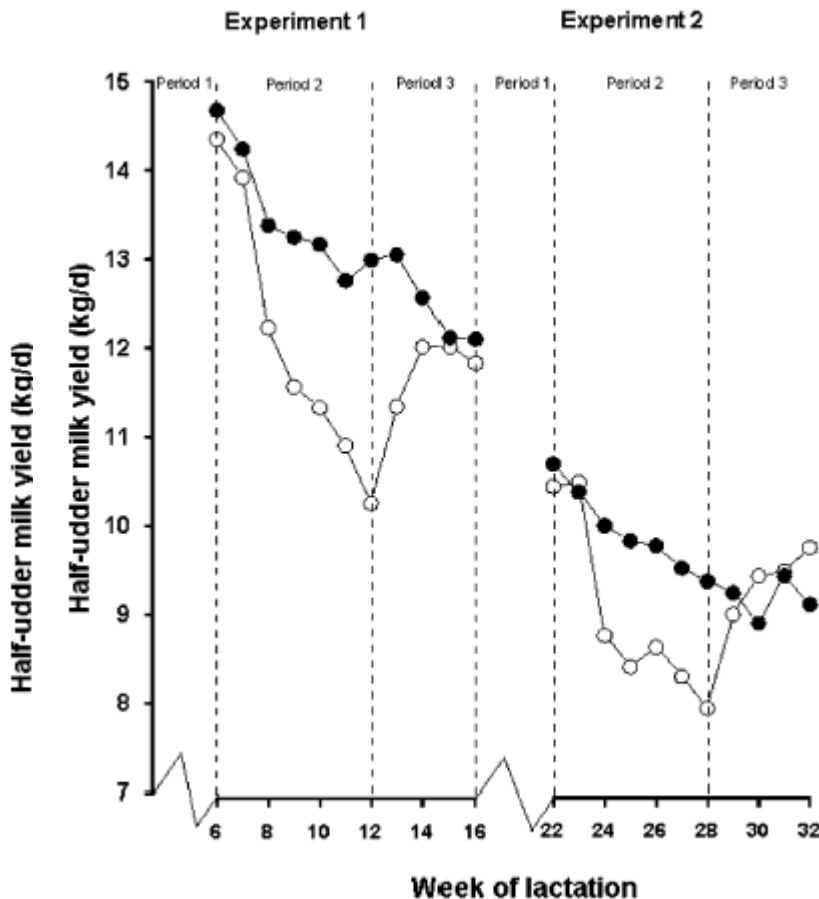
J. Dairy Sci. 86:1436–1444

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Effects of Changes in Dietary Amino Acid Balance on Milk Yield and Mammary Function in Dairy Cows

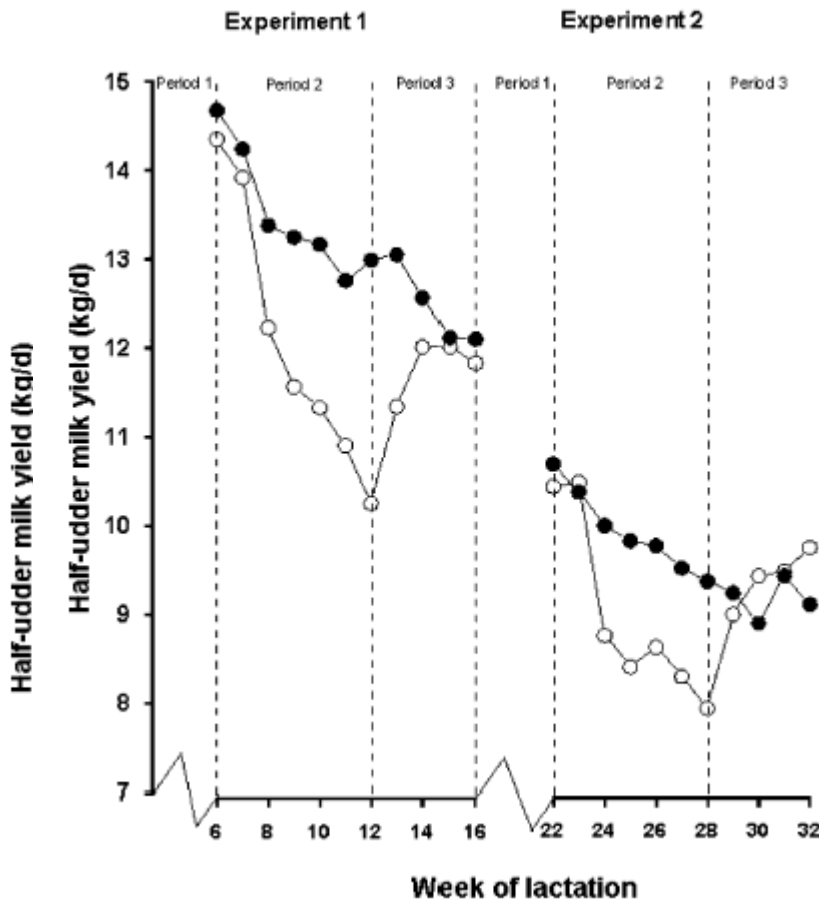
J. -M. Yeo, C. H. Knight, and D. G. Chamberlain
Hannah Research Institute, Ayr, KA6 5HL, UK

Recovery from amino acid deficiency



- In early lactation amino acid deficiency compromised milk yield
- There was complete recovery when deficiency ended
- The responses were independent of stage of lactation

Recovery from amino acid deficiency



- In early lactation amino acid deficiency compromised milk yield
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Management factors

- Heifer management
- Calving season
- Milking frequency
- Milking efficiency
- Organic production
- Robotic milking
- Concurrent pregnancy
- Extended lactation
- Transition management

Summary

- Breeding
- Short-term lactation inhibition caused by protein inadequacy is reversible
- Supply of essential aa (when limiting) increases milk protein
- Milking frequency and udder health to avoid proteolysis post secretion
- Avoid late lactation



What's going on?

- Specific effects of milk proteins on the human consumer
- Immunomodulatory properties of specific milk proteins and proteins in milk as indicators of infection and inflammation
- Effects of milk proteins on milk secretion
- Expression studies (RT-PCR), microdissection
- Timing of mammogenesis and angiogenesis
- Lactation dynamics
- Comparative lactation biology



CoLact: Nordic researcher network on comparative lactation (www.colact.net)

CRU: Center for Reproductive Biology in Uppsala, The mammary gland in health and disease (www.slu.se/en/collaborative-centres-and-projects/cru-home/)

The Swedish Livestock Research Centre