

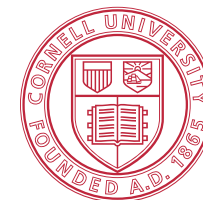


# **MILK, MILK FAT, AND HUMAN HEALTH: CAN WE ALTER MILK FAT COMPOSITION ON FARM? DO WE WANT/NEED TO ALTER IT?**

**Adam L. Lock & Dale E. Bauman**



**67<sup>th</sup> Annual Meeting**  
**European Federation of Animal Science**  
*Waterfront Conference and Exhibition Centre*  
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*August 31, 2016*

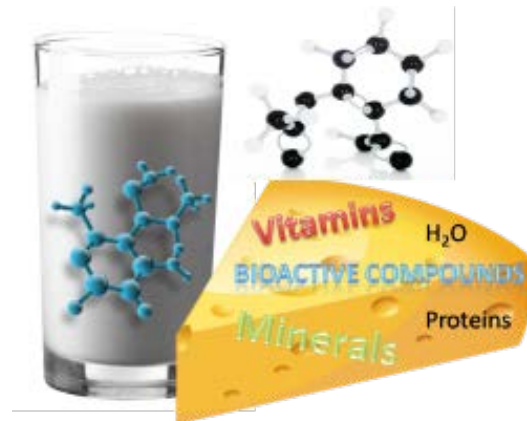
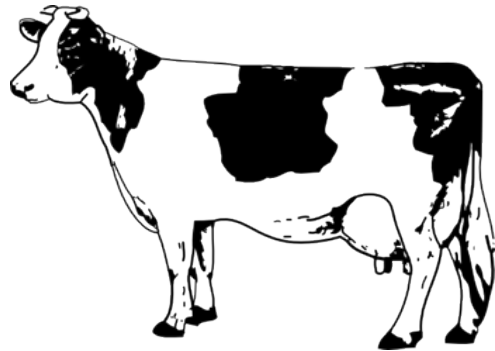
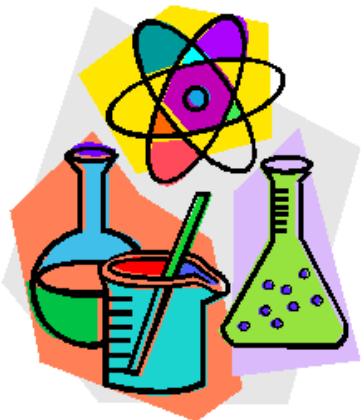


**Cornell University**



# What Does the Science Show?

- Do milk and other dairy products promote health maintenance and disease prevention?  
or
- Do milk and other dairy products have adverse effects on the maintenance of good health and is their consumption the cause of chronic diseases in humans?
  
- Should we look at altering milk/milk fat composition?  
or
- Should we focus on promoting the unique role of dairy products in supplying essential nutrients and identifying the role of bioactive components in dairy products?



# Dairy Products as Foods

## Key Components of a Balanced Diet

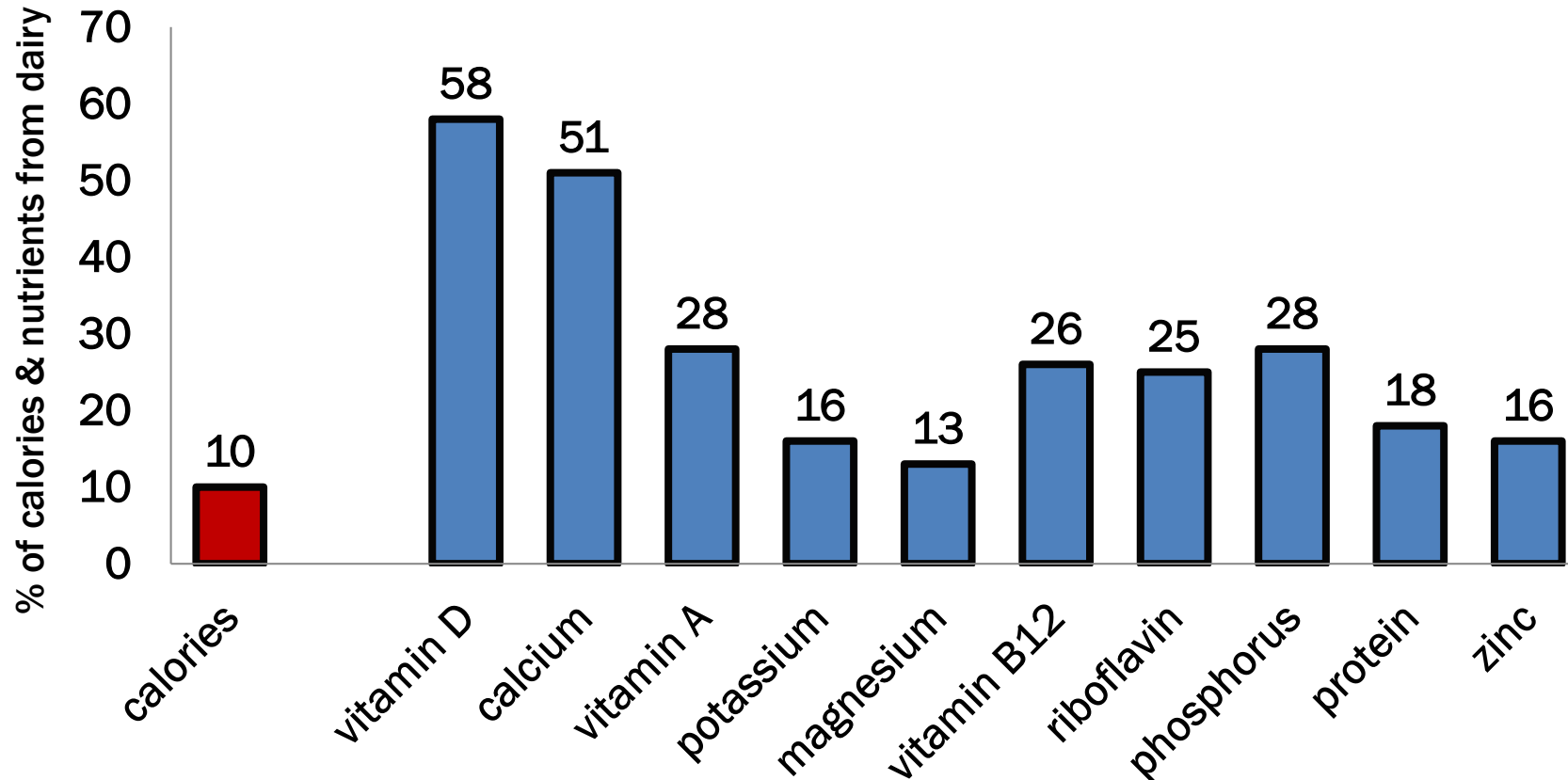


- Dairy products are included in dietary recommendations by Public Health Organizations around the world
- Studies consistently demonstrate that milk consumption improves health maintenance and reduces risk of chronic diseases
- Available evidence indicates there is an overall survival advantage from the consumption of milk and dairy foods
- This is increasingly reflected in lay articles for dietitians and health professionals



# Dairy's Unique Nutrient Package

- Milk and milk products are nutrient-rich foods
- They provide a higher level of essential nutrients compared to their calorie content





# Nutrition & Human Health

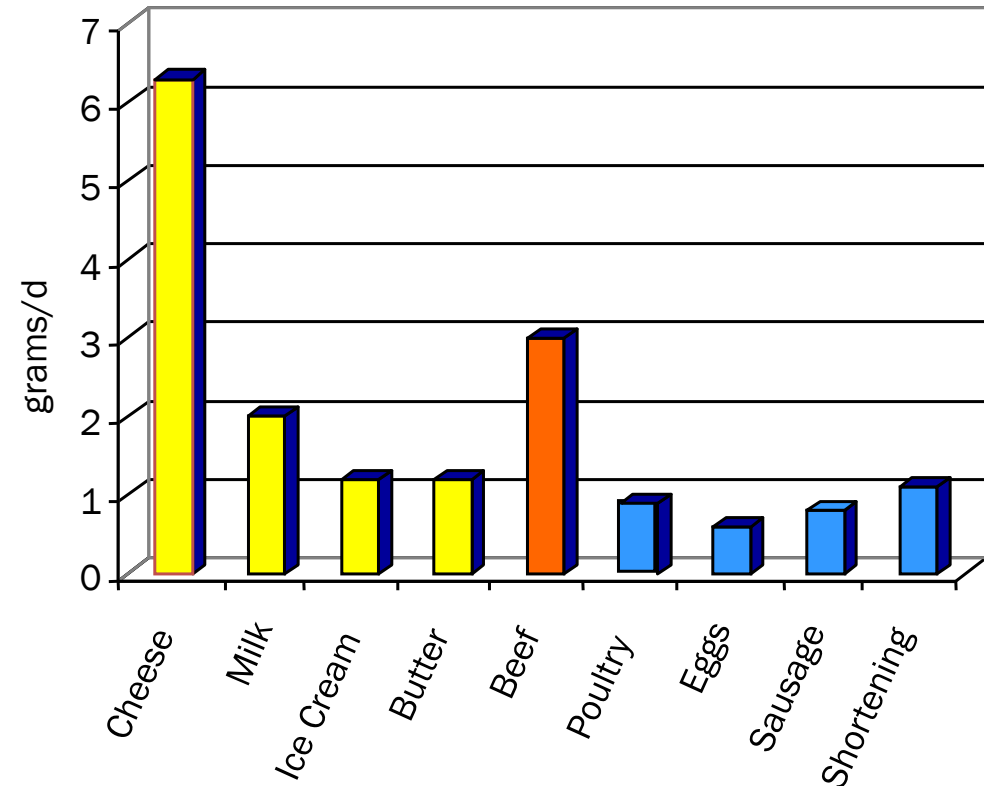
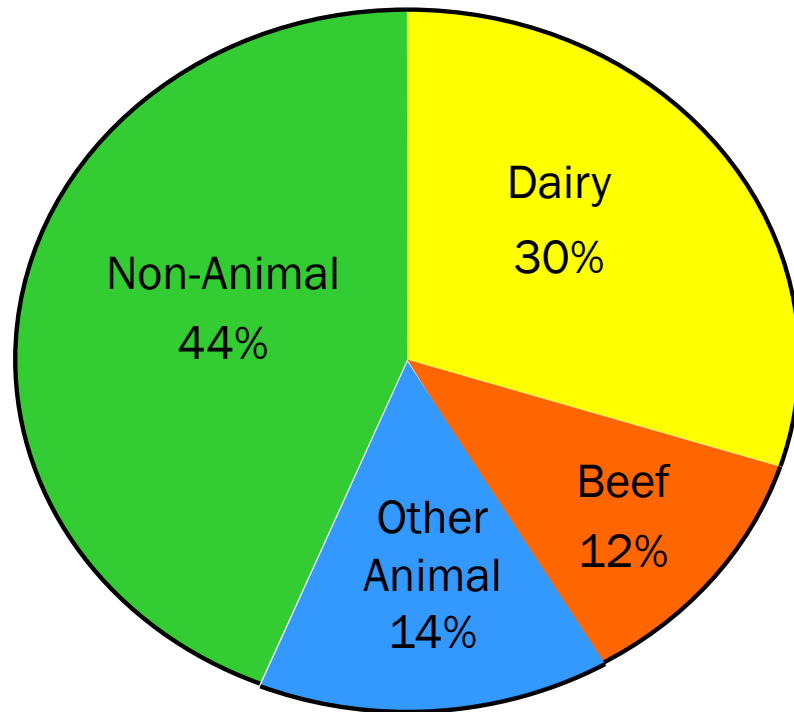
- For over 50 years, the concept of eating healthy has become synonymous with avoiding dietary fat, especially saturated fat





# Contribution of Animal Products to SFA Intake in the United States

Do we need to alter milk fat composition?





# Modifying Milk Fat

- 100's of studies have have examined the effect of modified dairy cow diets on milk FA composition
- Most have involved studies in which whole-scale changes have been the objective, whereby large shifts in SFA to MUFA or PUFA ratio have been the goal
- Modest changes have been achieved, but have often led to problems relating to product quality and stability and dairy cow production

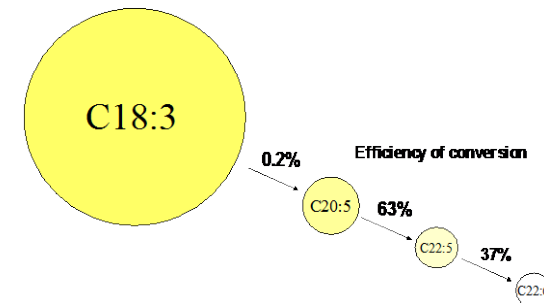
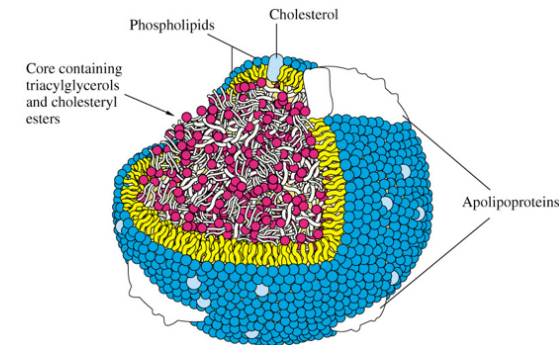
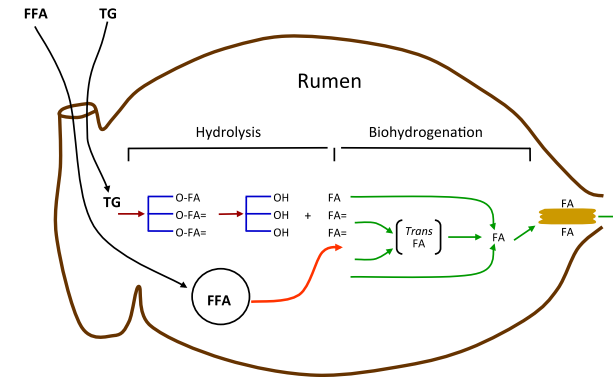




# 3 Challenges (to altering milk FA composition)



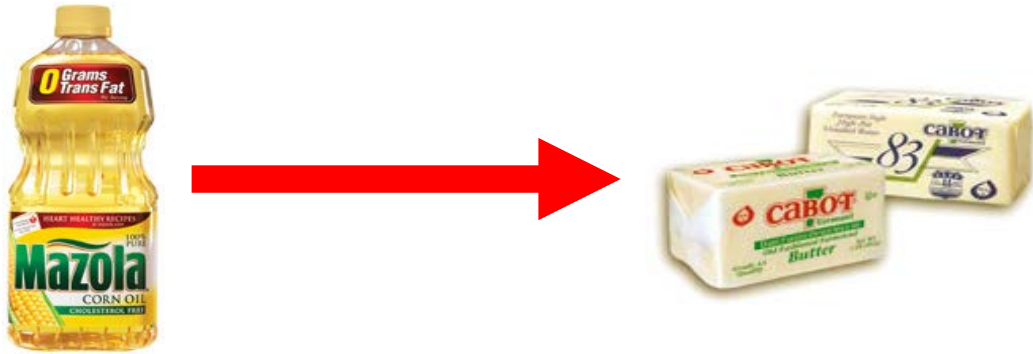
- Rumen metabolism of FA
- Post-absorptive packaging & transport of specific FA
- Limited conversion of EFA to LCPUFA





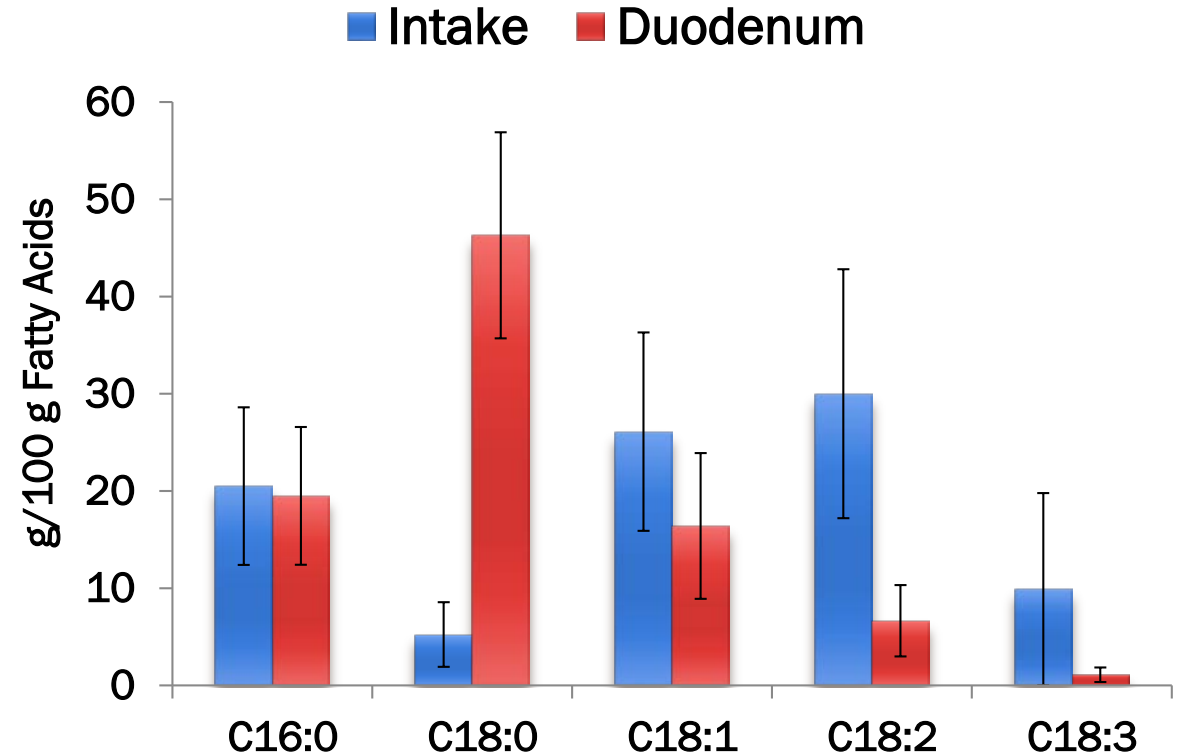


# Ruminal Bacteria Change Dietary Unsaturated FA Into *Trans* & Saturated FA



## ➤ Unsaturated FA are Toxic to Rumen Bacteria

- Hydrolysis
- Biohydrogenation

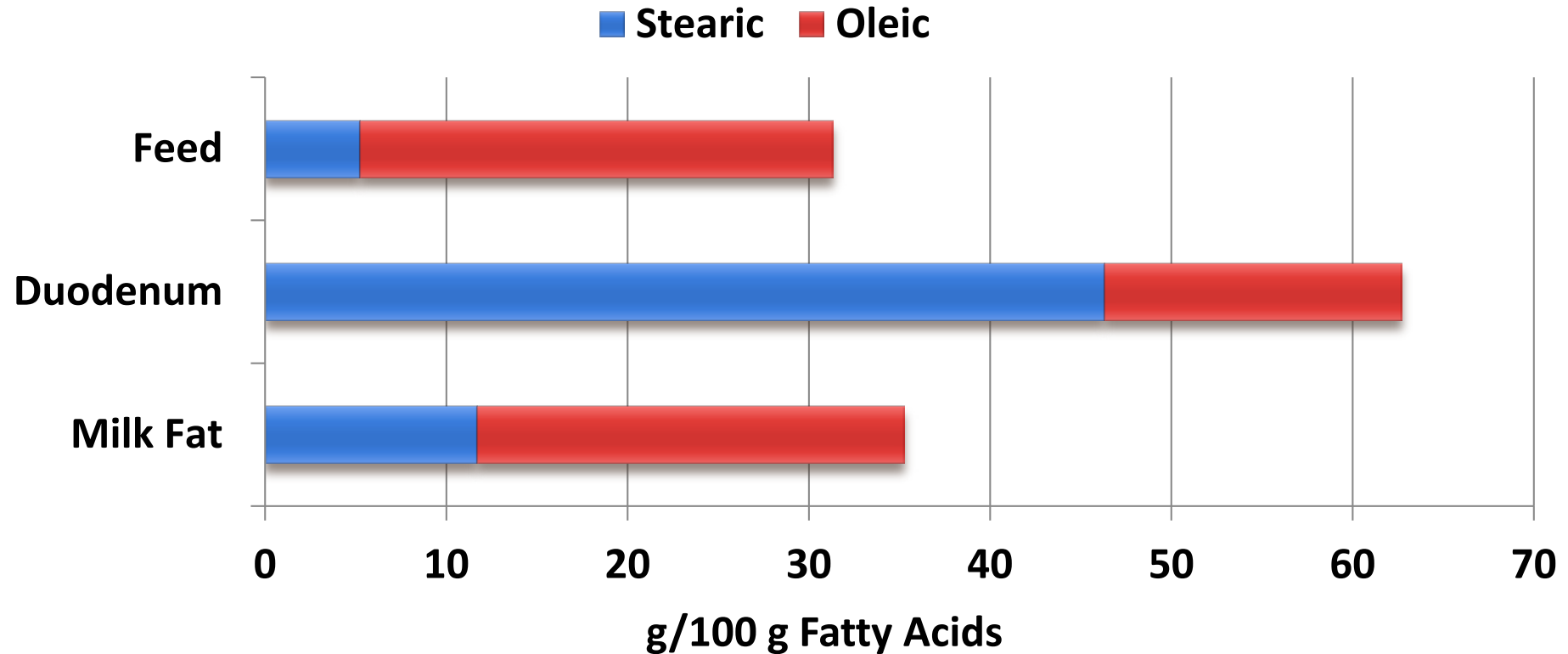


Boerman et al. 2015. J Dairy Sci. 98:8889–8903

Stearic acid (C18:0), under typical feeding situations, is the predominant FA available for absorption by the dairy cow



# Changes from Diet to Milk

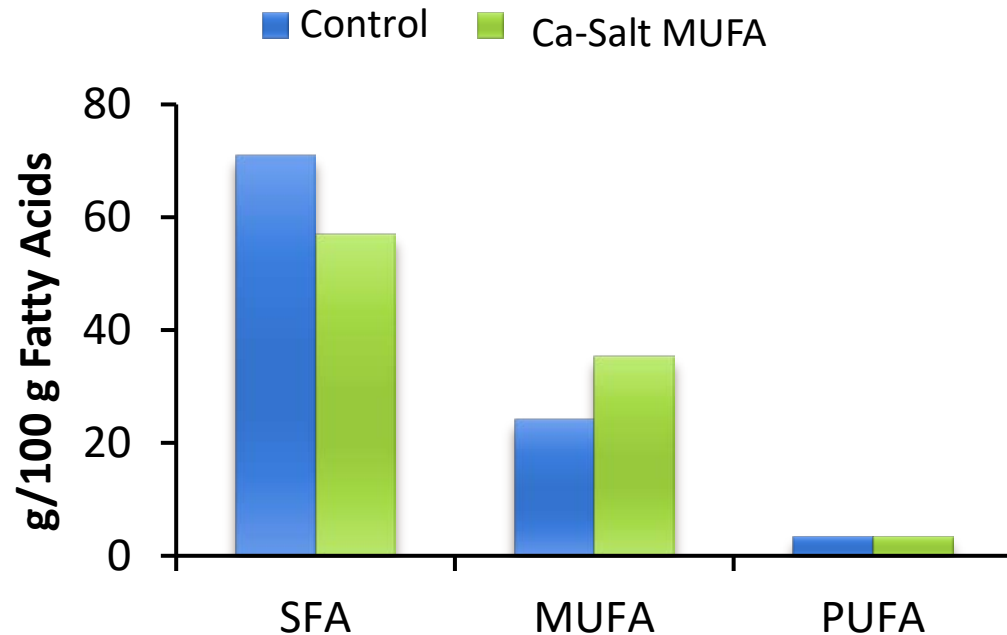


- Feed → Duodenum = Biohydrogenation by rumen bacteria
- Duodenum → Milk Fat = Desaturation by mammary  $\Delta^9$ -desaturase



# Feeding Ca-Salt of MUFA

- Ca-Salt MUFA fed at 4% DM increased oleic acid intake ~ 450 g/d
- 8.4 g/100 g increase in oleic acid



	Control	Ca-Salt MUFA
<b><i>cis</i>-9 18:1</b> (g/100 g FA)	15.4	23.8
<b>Total <i>trans</i> 18:1</b> (g/100 g FA)	3.4	7.9
<b><i>trans</i>-10 18:1</b> (g/100 g FA)	0.37	0.88
<b><i>trans</i>-10, <i>cis</i>-12 18:2</b> (mg/100 g FA)	2.5	8.8

	Control	Ca-Salt MUFA	No MFD
Oleic acid (g/100 f FA)	15.4	23.8	20.8



# n-3 FA Concentrations in Milk

(from control diets reported in the literature)

n-3 PUFA	Average Concentration (g/100 g)	Range (g/100 g)	# Studies
$\alpha$ -Linolenic (ALA; 18:3)	0.48	0.05–0.99	29
Eicosapentaenoic (EPA; 20:5)	0.05	0.00–0.12	24
Docosapentaenoic (DPA; 22:5)	0.07	0.00–0.15	15
Docosahexaenoic (DHA; 22:6)	0.02	0.00–0.08	20

van Valenberg et al. 2013. J. Dairy Sci. 96:4173–4181

Plasma Lipid Fraction	% Total Fatty Acids	18:3 n-3	20:5 n-3	22:5 n-3	22:6 n-3	Total n-3
—— % fatty acids within lipid fraction ——						
Phospholipids	53	1.24	0.31	0.79	0.03	2.36
Cholesterol esters	43	5.89	0.40	ND	ND	6.29
Triglycerides	2.9	1.73	0.15	0.18	0.01	2.07
NEFA	1.4	0.86	0.04	0.16	ND	1.06

- < 2% of total EPA, DPA, & DHA present in plasma TAG

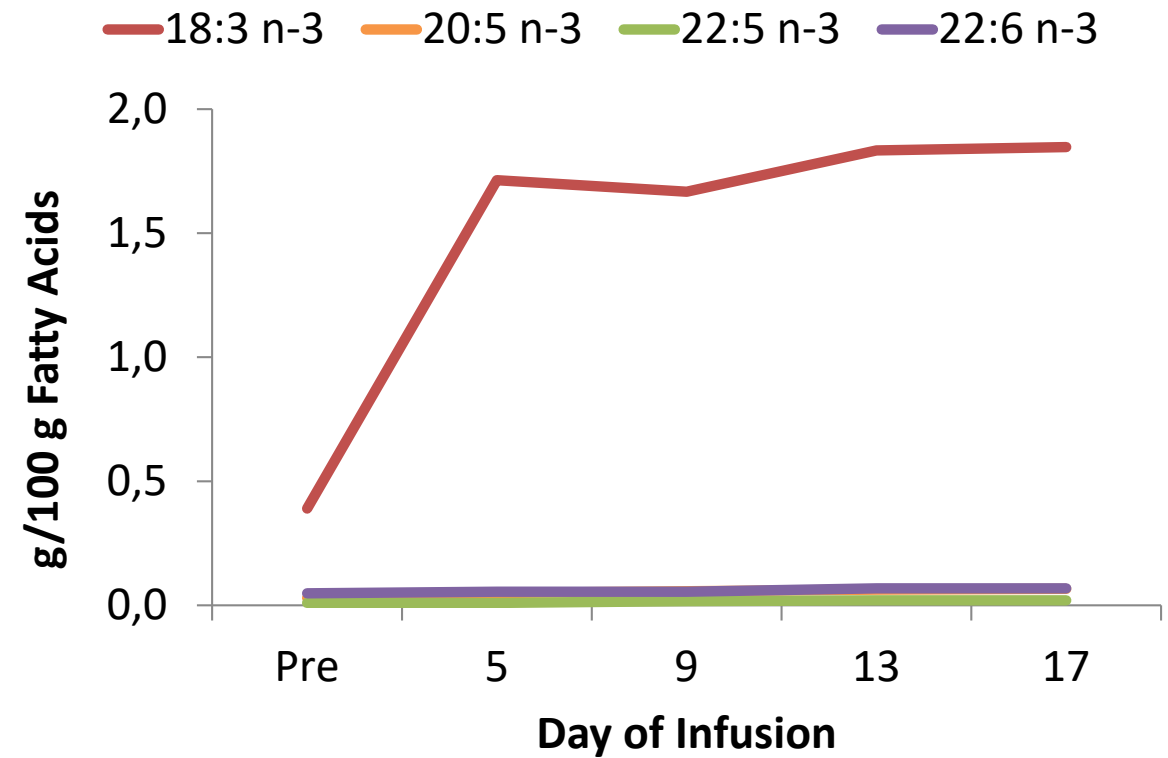
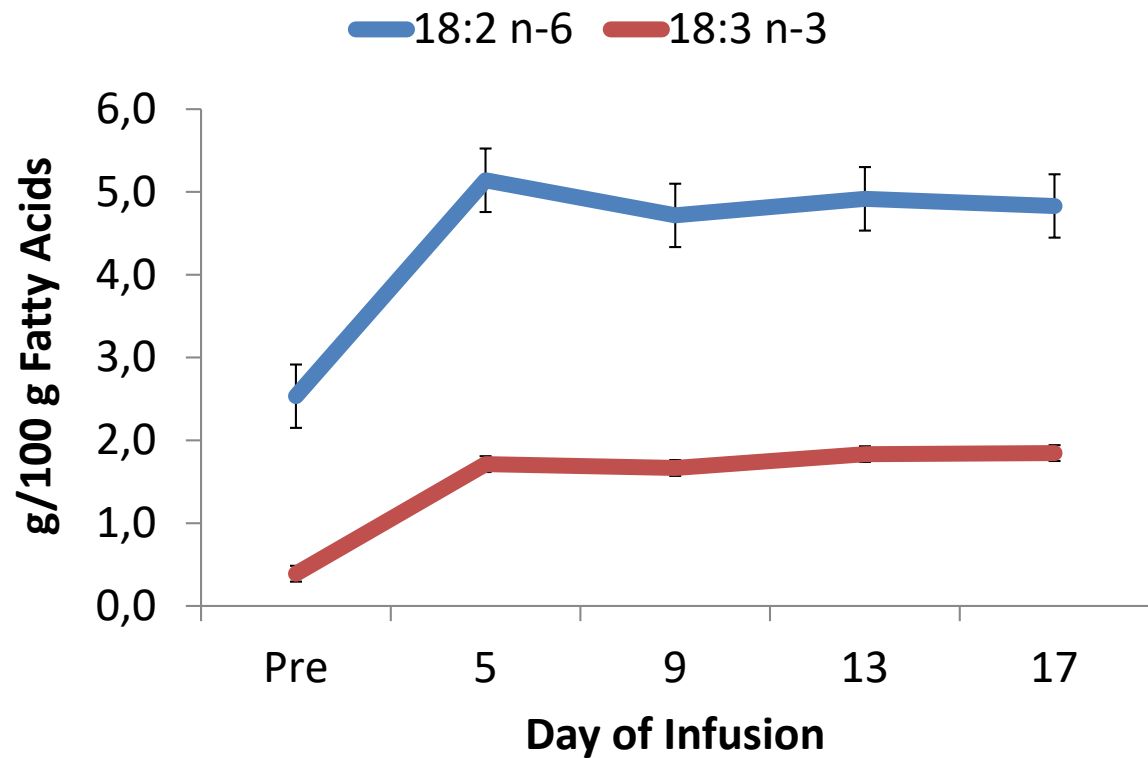


Preseault et al. 2013. J. Dairy Sci. 96 (Suppl. 1): 658



# n-6 and n-3 FA in Milk Fat

(Following ~ 45 g/d Abomasal Infusions of Linoleic and Linolenic Acids)



- Infusions increased 18:2 n-6 and 18:3 n-3 by 2.3 and 1.5 g/100 g



# FA Profile of Milk from Different Production Practices

Telegraph.co.uk

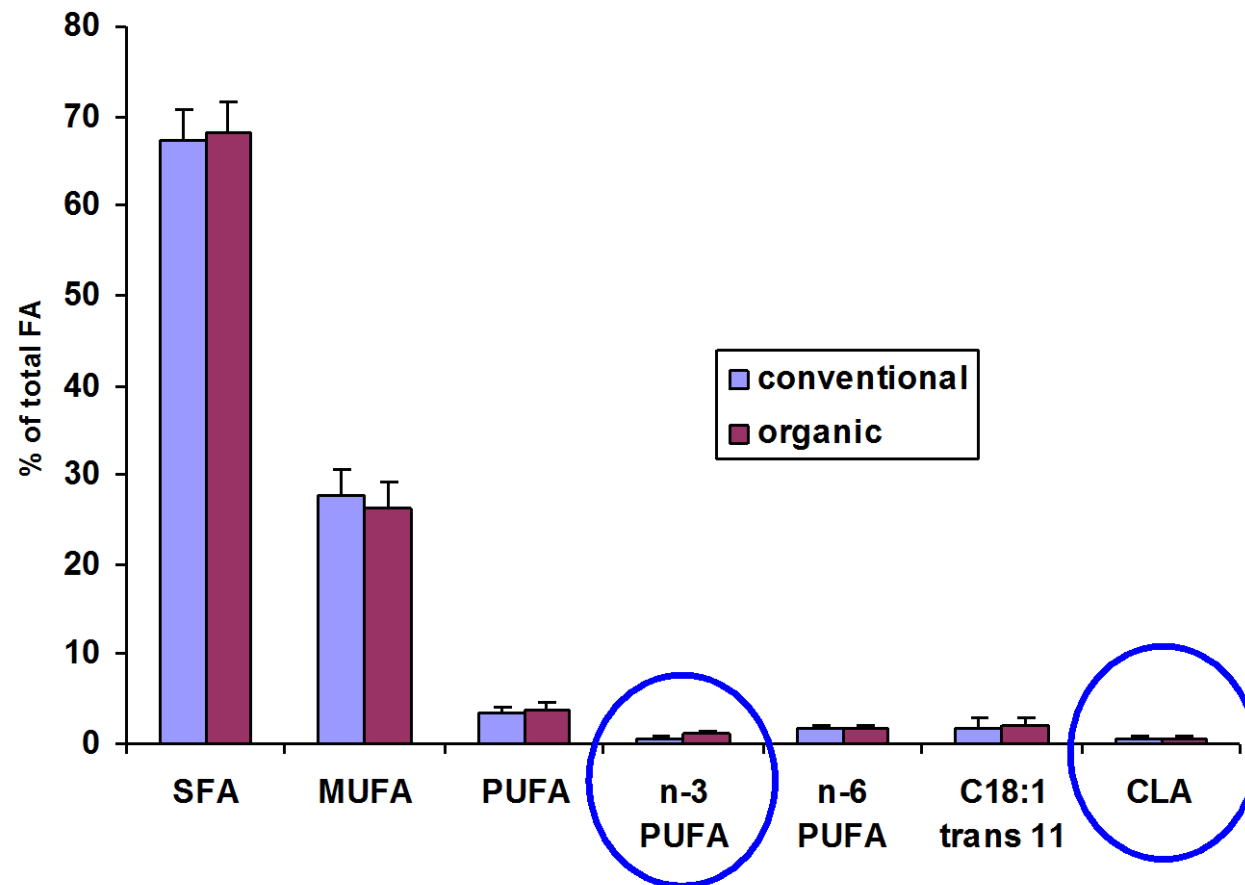
Organic milk: it looks good, it tastes good and by golly they've proved it does you good

By David Derbyshire, Consumer Affairs Editor

(Filed: 30/08/2006)

"A group of scientists called on the Food Standards Agency yesterday to acknowledge that organic milk is healthier than the conventional pint.

The 14 veterinary and public health researchers have written to the FSA claiming that there is compelling evidence that organic milk is a richer source of Omega 3 essential fatty acids and that official advice should reflect this."



Ellis al. 2006. J Dairy Sci. 89:1938–1950

Typically, actual change in oleic acid ~ 10-fold (g/100 g) more compared to the actual change in linolenic acid in conventional vs. organic milk



# Saturated Fatty Acids





# Saturated Fatty Acids

- “A meta-analysis of prospective epidemiologic studies showed that there is no significant evidence for concluding that dietary saturated fat is associated with an increased risk of CHD or CVD.”  
[Siri-Tarino et al. 2010. Am. J. Clin. Nutr. 19:91:535–546](#)
- After adjustment for demographics, lifestyle, and dietary cofounders, a higher intake of dairy SFA was associated with lower CVD risk. Associations between SFA and incident CVD depend on the food source; the consumption of dairy SFA is inversely associated with risk  
[de Oliveira Otto et al. 2012. . Am. J. Clin. Nutr. 96:397–404](#)
- Available evidence from randomized controlled trials shows that replacement of saturated fat in the diet with linoleic acid effectively lowers serum cholesterol but does not support the hypothesis that this translates to a lower risk of death from coronary heart disease or all causes  
[Ramsden et al. 2016. BMJ. 353:i1246](#)

**Due to a focus on the small rise in blood cholesterol with milk drinking, the debate on milk has never achieved a reasonable balance in the evaluation of risks and benefits**





# Dairy Foods & Human Health

Individuals do not consume fatty acids (or any other single nutrient) as a dietary entity, but rather as components of food

➤ This is an important consideration in evaluating health implications

“.... no biochemical measurement can represent the effect of various nutrients, it is important to examine the direct relationship between consumption of the food item and the risk of disease.” (Hu et al., 1999)





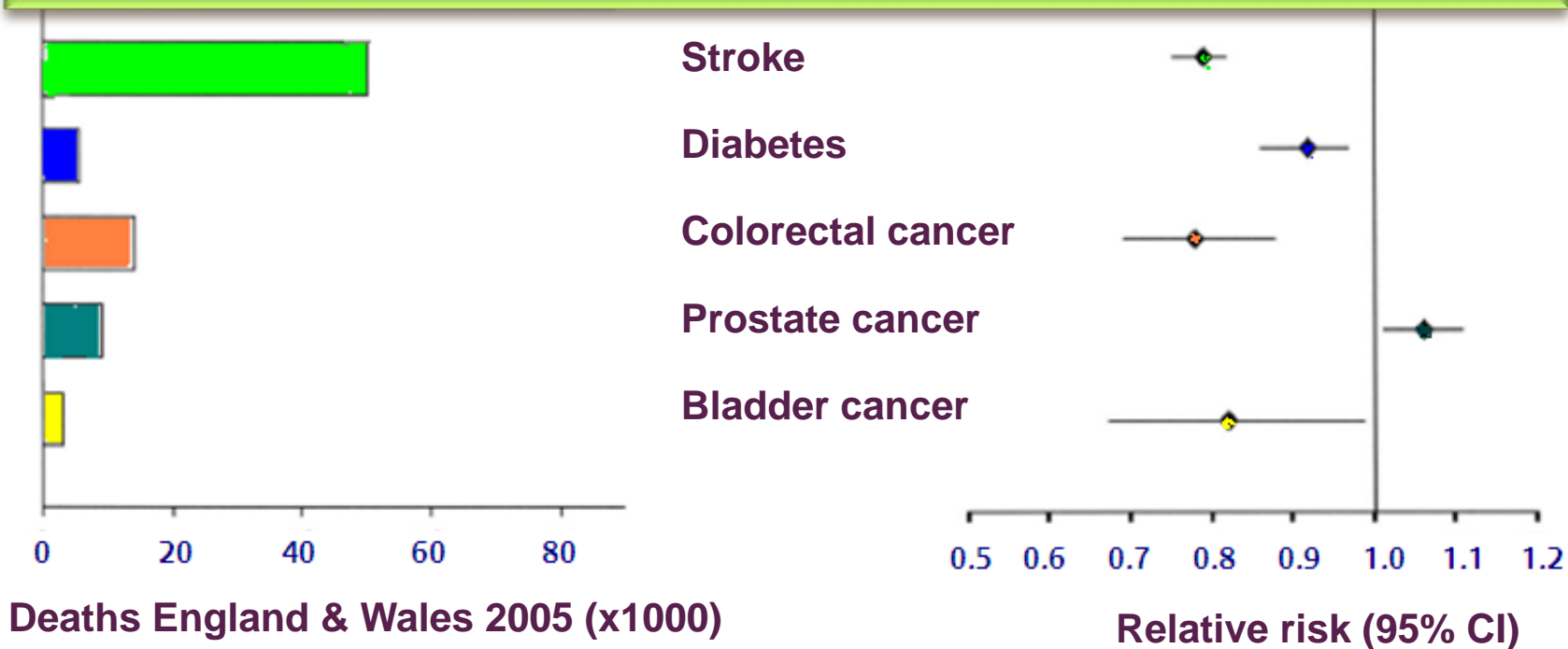
## The Survival Advantage of Milk and Dairy Consumption: an Overview of Evidence from Cohort Studies of

**In 2 large prospective cohorts, circulating biomarkers of dairy fat were not significantly associated with stroke**

Yakoob et al. 2014. *AJCN*. 100:1437–1447

**In two prospective cohorts, higher plasma dairy fatty acid concentrations were associated with lower incident diabetes**

Yakoob et al. 2016. *Circulation*. E-Pub Ahead of Print



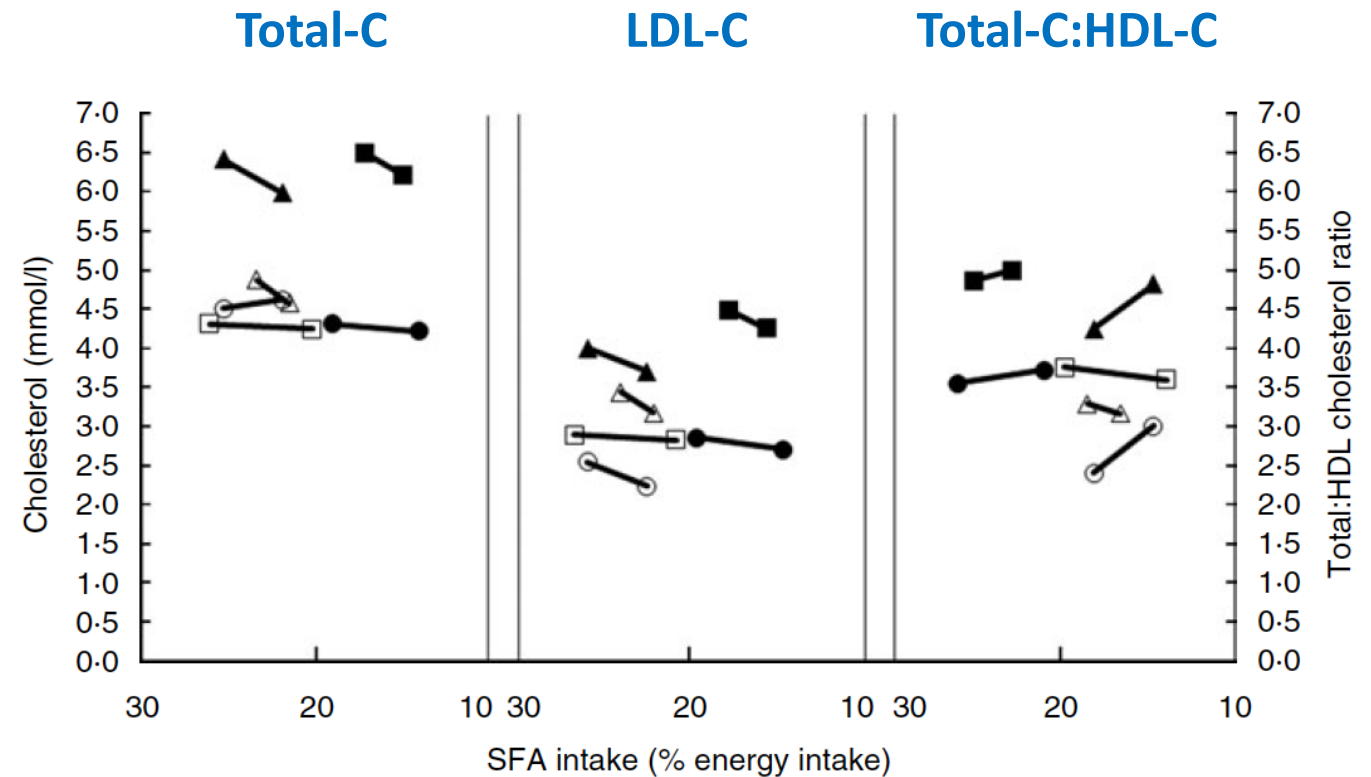
### Conclusion:

“Set against the proportion of total deaths attributable to the life-threatening diseases in the UK, vascular disease, diabetes and cancer, the results of meta-analyses provide evidence of an overall survival advantage from the consumption of milk and dairy foods.”



# Impact of Substituting SFA in Dairy Products with MUFA or PUFA on CVD Risk: Evidence From Human Intervention Studies

- Studies based on biomarkers rather than disease
- Majority utilized modified butter
- Provide no evidence on disease and no convincing evidence of a beneficial effect based on biomarkers
- 1 study reported a reduction in both the total:HDL and LDL:HDL ratios but 2 studies increased these ratios
- Compare this to the role of dairy in health maintenance and disease prevention
- The pendulum has starting to swing from the idea that milk fat is a negative to the idea it is beneficial





# What about Fat-Reduced Milk & Dairy Foods

- There are a number of studies that report disease rates in subjects who consume natural dairy foods, and in those who consume reduced fat dairy foods
- But... the data are hopelessly confounded due to the adoption of other health-related behaviours by subjects on low-fat milk
- The appropriate question to ask however is:
- Do fat-reduced milks and dairy foods provide any additional advantage... or does the reduction in fat reduce the benefits of whole milk?
- “A high daily intake of regular-fat cheese for 12 wk did not alter LDL cholesterol or MetS risk factors differently than an equal intake of reduced-fat cheese or an isocaloric amount of carbohydrate-rich foods”



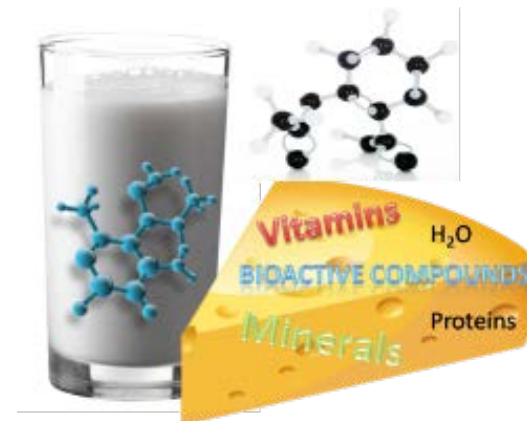
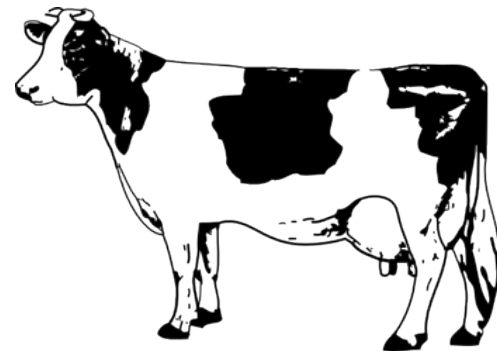
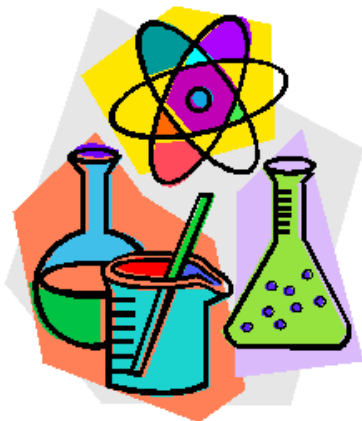
# Looking Forward

- Focus needs to move away from looking at large scale changes in SFA, MUFA, PUFA (bovine milk fat will always be a source of SFA in our diet)
- Focus should be on individual FA and the food source (matrix) that they are delivered in
- Especially the impact of minor FA in milk fat which we often did not previously identify
- Milk has a variety of unique FA
  - May be bioactive in unique ways (positive and negative)
    - e.g. CLA isomers (anticarcinogenic; antilipogenic)
    - Odd and branch chain FA
- Microbiome – human health interactions



# What Does the Science Show?

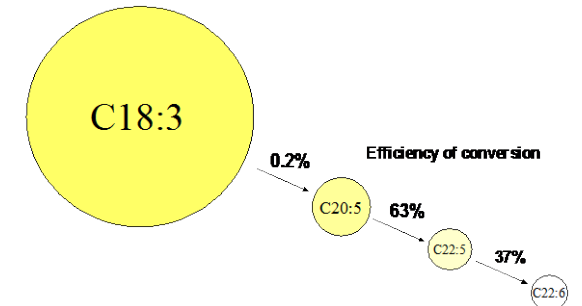
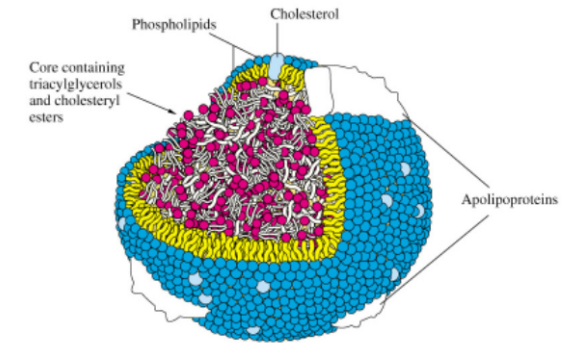
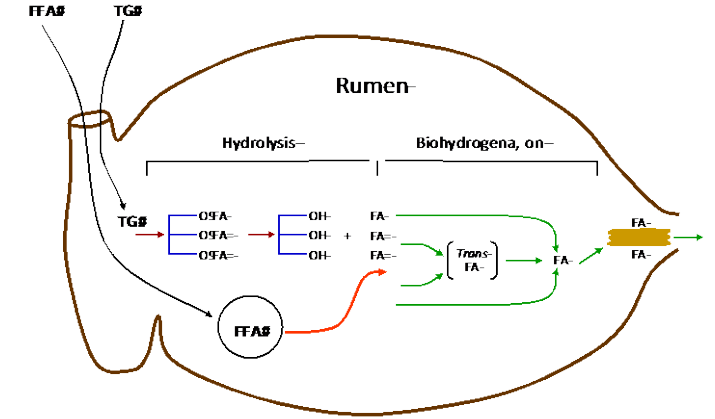
- Milk and other dairy products promote health maintenance and disease prevention
- Focus should be on promoting the unique role of dairy products in supplying essential nutrients and identifying the role of bioactive components in dairy products?





## Take Home Messages

- Milk fat synthesis is highly coordinated
- In large part, presence of numerous FA in milk fat is due to rumen biohydrogenation of PUFA
- Overall, pattern of milk FA can only be very modestly changed:
  - Rumen metabolism of FA
  - Post-absorptive packaging & transport of specific FA
  - Limited conversion of EFA to LCPUFA
- Important to consider effects on animal production/efficiency and product quality





## Take Home Messages



- Milk and dairy products are a source of dietary saturated FA
  - Earlier efforts that demonized milk fat were inaccurate and inappropriate
  - Will take time for this message to work its way through educators, medical community, and consumers
- Milk is an excellent source of oleic acid, a FA increasingly recognized for its potential beneficial effects
- Milk fat provides minimal n-3 FA especially in the forms of most interest (EPA, DHA)
- Disservice to industry and consumers and of questionable ethics to imply significant changes in milk fat composition are important when they are quantitatively very small and unlikely to have human health implications
- Milk and dairy products have beneficial effects on health and despite concerted efforts there is little evidence that anyone has meaningfully changed FA composition to an extent that would have any further impact





**Sustainable food security to feed the worlds rapidly expanding population represents the major global challenge of the 21<sup>st</sup> century**

**Animal source foods, especially dairy products including milk fat, will play an important role in meeting this challenge**





**ALL MILK SHOULD BE PROMOTED  
FOR ITS SIGNIFICANT CONTRIBUTION  
TO OUR NUTRIENT SUPPLY AND IT'S BENEFITS  
ON HUMAN HEALTH**





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