



**Barry Bradford**

Barry Bradford completed dual bachelor's degrees at Iowa State University and a doctorate in animal nutrition at Michigan State University. In 2006 he joined Kansas State University as an assistant professor, and was promoted to associate professor in 2011. Bradford oversees an active research program and has published more than 50 peer-reviewed papers on the interactions of inflammation and metabolism, use of alternative feedstuffs in dairy cattle, and physiological regulation of carbohydrate and lipid metabolism. In addition, he teaches over 180 students per year in several undergraduate and graduate courses in animal nutrition and physiology.

## How transition cow nutrient metabolism influences the immune system

**Barry Bradford**  
Kansas State University

22 October 2015

**Barry Bradford - How transition cow nutrient metabolism influences the immune system**

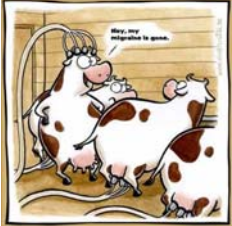
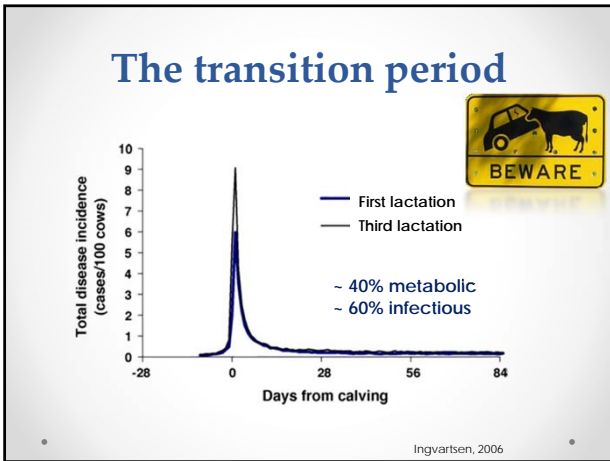
## How transition cow nutrient metabolism influences the immune system

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## Overview

- The problem with transition cows
- Nutrient effects on immune function
- Interacting mechanisms
- Take-home points


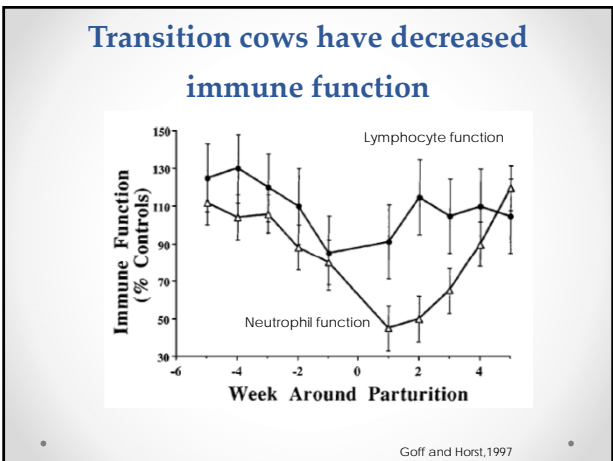
## The bar is being raised

- Diagnostic tools now give us the ability to detect disruptions that we would not have noticed a few decades ago.
- Example: transition dairy cows have worse lactation outcomes following:
  - Subclinical hypocalcemia
  - Subclinical ketosis
  - Subclinical metritis



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## How important is immunity?

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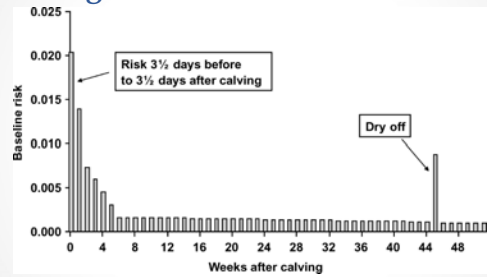
**Transition immune cells**

- Enhanced inflammatory response
- Impaired chemotaxis
- Decreased phagocytosis
- Reduced killing ability



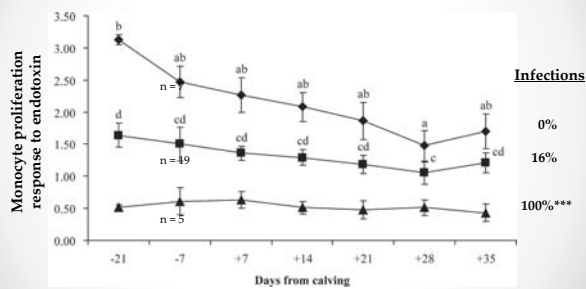
Sordillo et al., 1995; Contreras et al., 2012; Kehrl et al., 1989; Nonnecke et al., 2003

**Immunosuppression coincides with greater risk of infection**



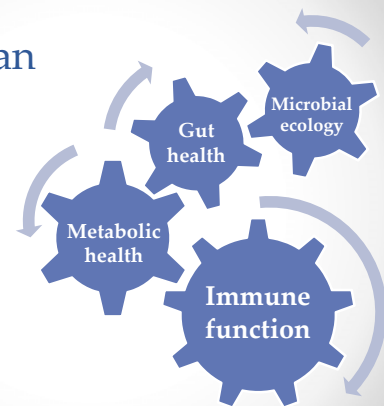
Ostergaard et al., 2005

**Immune function predicts infection risk**



Catalani et al., 2013

Nutrition can directly influence:



**Nutrients implicated**

- Vitamins
- Minerals
- Fatty acids
- Carbohydrates
- Amino acids

Yup, that's pretty much all of them.



**Assessing adequacy**

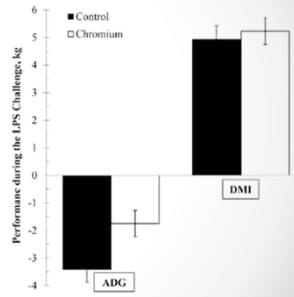
- Nutritional support of health can be difficult to assess
- Requirements are altered by physiological state
- Suboptimal nutrition may only cause problems during challenging scenarios



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Responses may appear during a challenge

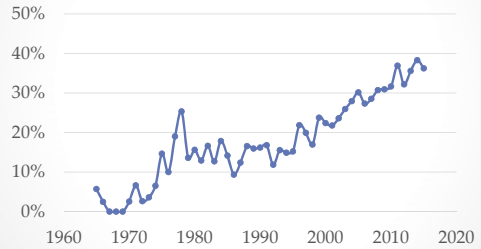
- Chromium limited weight loss due to endotoxin challenge
- Also enhanced feed efficiency in newly-received feedlot cattle



Bernhard et al., 2012

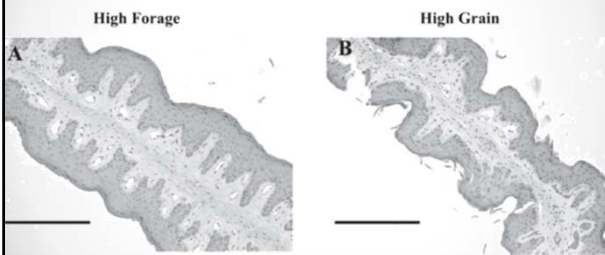
A long-term trend

Dairy nutrition studies incorporating a challenge model



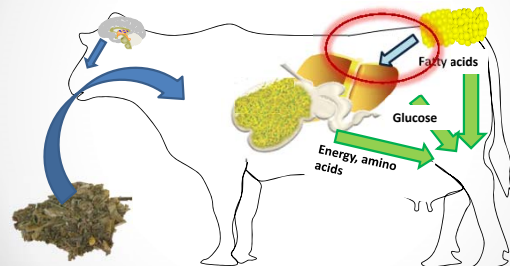
PubMed: (dairy or Holstein) AND (cow or cattle) AND (dietary or diet or TMR or ration or feed or feeding) AND (health or challenge or stress or disease or transition)

Diet → gut health

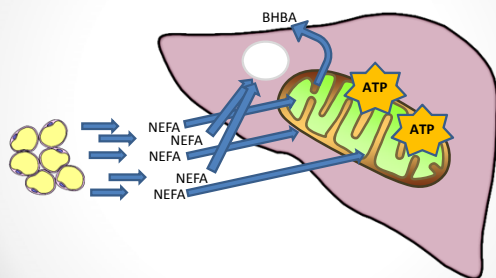


Steele et al., 2011

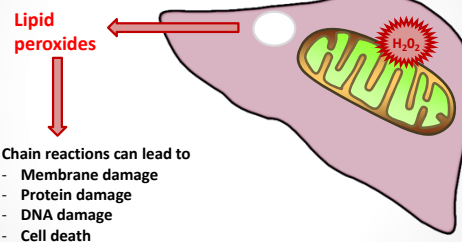
Metabolic function



Fatty acids in transition cows

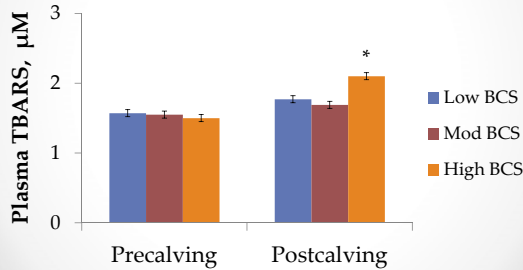


Lipid peroxide formation



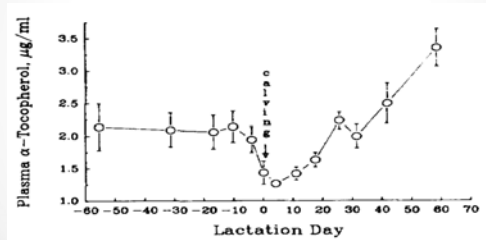
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**Increased lipid peroxides in overweight transition cows**



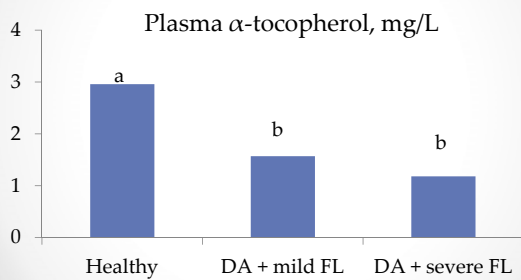
Bernabucci et al., 2005

**Vitamin E status declines during the transition period**



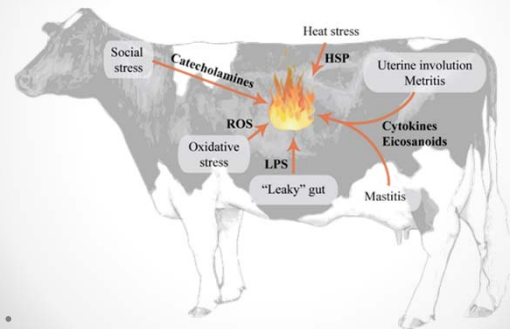
Weiss et al., 1990

**Vitamin E status is decreased in cows with metabolic disorders**



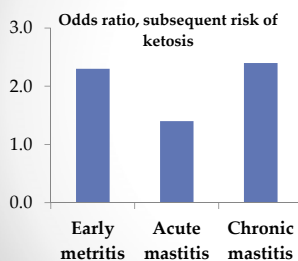
Mudron et al., 1997

**Many factors may contribute to systemic inflammation**



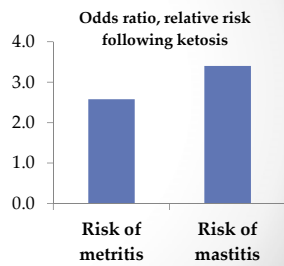
**Interacting mechanisms**

**Infection → Metabolic**



Gröhn et al., 1989

**Metabolic → Infection**



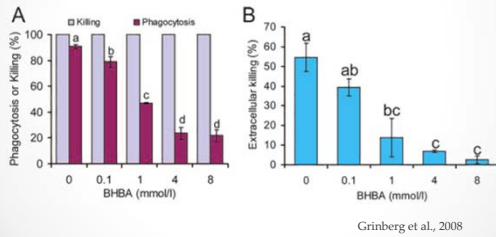
Duffield et al., 2009; Doohoo and Martin, 1984

**The chicken or the egg?**



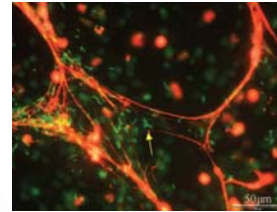
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BHBA decreases neutrophil function



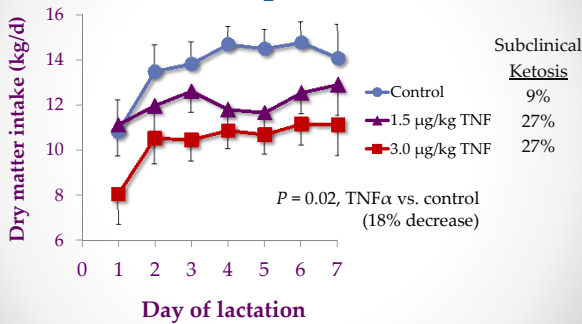
Grinberg et al., 2008

BHBA inhibits extracellular trap formation



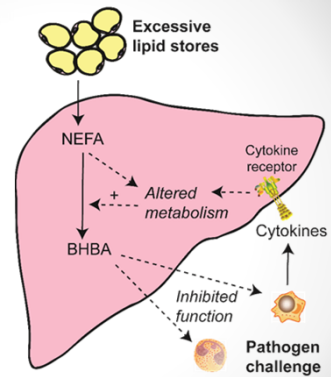
Grinberg et al., 2008

Inflammation promotes ketosis

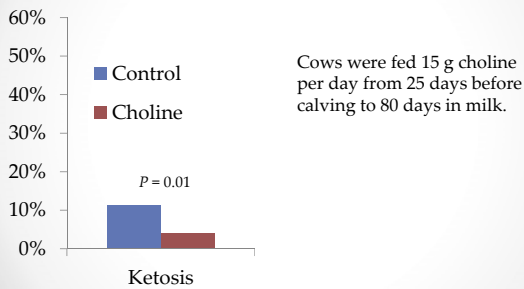


Yuan et al., 2013

It's the chicken AND the egg...

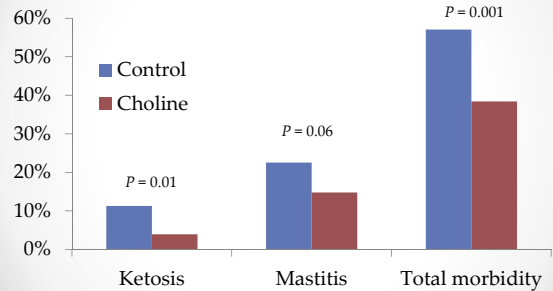


Unexpected benefits?



Lima et al., 2012

Unexpected benefits?



Lima et al., 2012

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## Balancing for optimal health

- Example: Fiber for gut health vs. starch for glucose supply in lactating cows
- Fiber: Prevention of acidosis, more robust to dietary fluctuation
- Starch: Supports glucose production, helping to limit metabolic disease and support immune function



## Balancing for optimal health

- Example: Omega-3 fatty acids to support metabolic and immune function
- Evidence in nonruminants and limited data in ruminants suggests benefits of omega 3 supplementation, but...
- Delivering enough of these lipids without disrupting ruminal function is a challenge.



## Take-home points

- Nutrients can influence gut health, metabolic health, and immune function, with overlapping roles.
- Requirements vary with physiological state of the animal, and nutrients may have no effect until a challenge is encountered.
- Creative approaches are possible, but effects on all aspects of health must be considered.

## Thank you!

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