Immunity in Dairy Cattle: What is a Healthy Cow?

Derek McLean, Ph.D.
Phibro Animal Health Corporation
The theme for today – Broad impact of immune system

The maintenance of health

- Requires interaction of physiological systems
- Dynamic shifts in tissue and organ function
- Stable immune function during shifts
- Provides the animal the foundation for health and optimal performance

What could go wrong?

**Immune system - Extraordinary Challenge**

- Decreased feed intake
- Lower milk production
- Decreased feed efficiency
- Gastroenteritis
- Intestinal hemorrhages
- Impaired rumen function
- Diarrhea
- Ketosis
- Milk contamination
- Decreased milk production
- Mastitis
- Laminitis
- Mobility
- Irregular heats
- Low conception rates
- Embryonic loss
- Ovarian cysts
- Embryonic loss
- Ketosis

Broad impact of immune system

- Inflammation
- Reproduction
- Ruminal Acidosis/Laminitis

What is the link?

What are common elements of these physiological systems?

How to measure health?
Impact on the Immune system – physiological systems need energy

- Decreased feed intake
- Lower milk production
- Decreased feed efficiency
- Gastroenteritis
- Intestinal hemorrhages
- Impaired rumen function
- Diarrhea
- Ketosis
- Irregular heats
- Low conception rates
- Ovarian Cysts
- Embryonic Loss

Milk contamination
- Decreased milk production
- Mastitis
- Laminitis
- Mobility

Energy Related Disorders
- Decline in feed intake
- Impaired calcium homeostasis
- NEFA
- Ketone body

Significant energy is required for immune response

Feed Efficiency – Dairy

- Fraction of feed energy or dry matter captured in products
- Feed efficiency – doubled in the last 50 years
- Genetic selection and management for productivity
- Goes to products – energy for maintenance is lost
- Undesirable side effects from selection

Energy Related Disorders
- Significant energy is required for immune response

Glucose requirements of an activated immune system

Kvidera et al., JDS 2017
Glucose requirements of an activated immune system

Acutely activated immune system uses > 1kg of glucose
Maintaining euglycemia did not rescue milk synthesis

Kvidera et al., JDS 2017

Resource Allocation Decision

↑1°C: 7-15% increase metabolism
Infection: 7-29% increase

Gastroenteritis
Intestinal hemorrhages
Impaired rumen function
Diarrhea
Ketosis
Decreased milk production
Mastitis
Laminitis

Resource Allocation Decision

How to think about resource allocation in cows differently?
Tolerance

Predict cows that have tolerance to resource drain

Moyes et al., 2013
Physiologic Imbalance Index
urea nitrogen, albumin, cholesterol, NEFA, glucose, and BHBA

Predictor of disease
one week after calving

Trevisi et al., 2012
Bertoni & Trevisi, 2013
Liver Functionality Index
albumin, cholesterol, bilirubin

Higher liver function may produce more milk
Provide a means for cows to resist or tolerate resource challenge

Link between immune cells and dairy cow health, reproduction and productivity

Banos, et al., 2012; Denholm et al., 2017

Higher ratios of CD4+:CD8+ cells associated with lower somatic cell counts

Negative correlation between percentage of eosinophils and milk yield, feed intake, dry matter intake and metabolizable energy intake

CD335+ natural killer cells were positively correlated with the incidence of mastitis

Banos et al., 2012; Denholm et al., 2017

Hypothesis: OmniGen-AF supplementation will regulate memory immune response

Evaluate humoral and cell mediated immune responses to BHV-1 and BVDV type 1 and 2 viruses as components of a MLV BRD vaccination program in dairy heifers

David Hurley & Steve Nickerson – U. of Georgia

Immune System – Metabolism and Tolerance

Healthy Immune Function

↑ Herd Health
↑ Milk Yield
↑ Milk Quality
↑ Longevity
↑ Sustainability
↑ Profitability

Antigen Recall – OmniGen-AF

OmniGen-AF Heifers:

- IL-4 induced (P < 0.04) by:
  - BHV-1 (D42 & 60)
  - BVDV type 1 (D42)
  - BVDV type 2 (D60)

- IL-17A induced (P=0.02) by:
  - BVDV type 1 on D60

OmniGen-AF enhanced booster vaccine response
What is a healthy cow?

Support Immune Function

Thank You

David Hurley
Steve Nickerson