



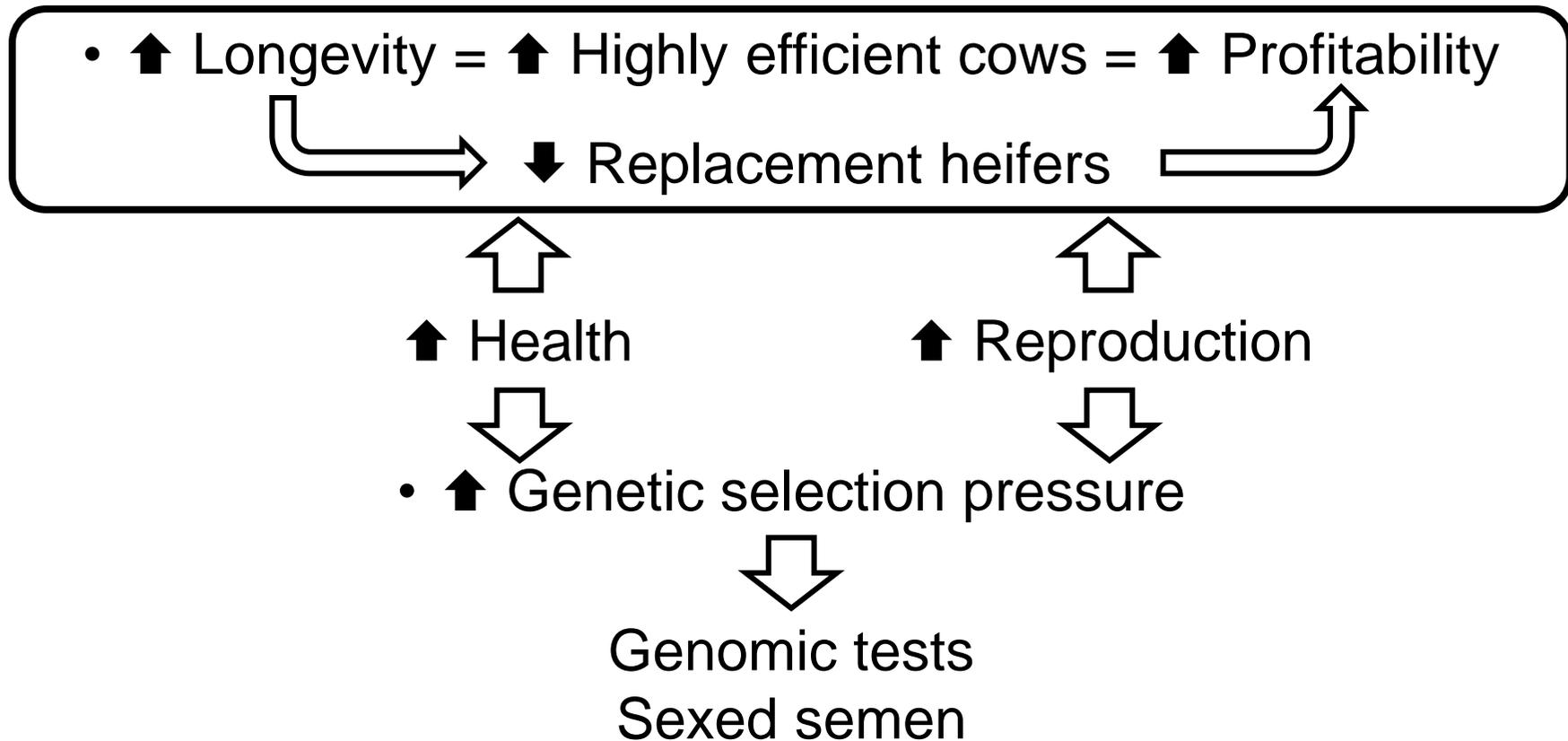
ASSOCIATION OF BCS CHANGE AND HEALTH STATUS ON FERTILITY AND PERFORMANCE

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Department of Animal Sciences*

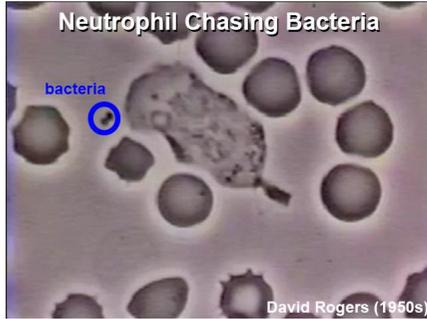
Health and Reproductive Efficiency are Imperative for Profitability

- Difference between the price of milk and cost of feed is the most important driver of profit in US dairies



Objectives of the Transition Period

Prevent immunosuppression



- Reduce morbidity
 - Mastitis
 - Retained placenta
 - Metritis
 - Hypocalcemia
 - Displac. abomasum

Survival (> 94% by 60 DIM)



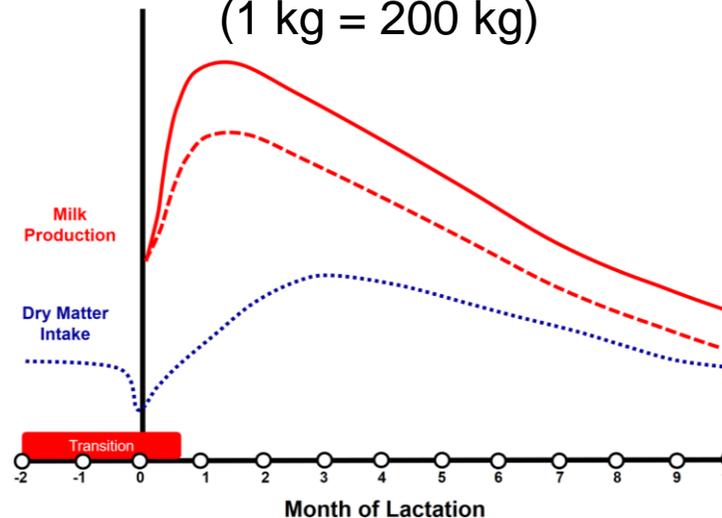
Colostrum (> 50 g/L IgG)



Live calf (≤ 5% of stillbirth)



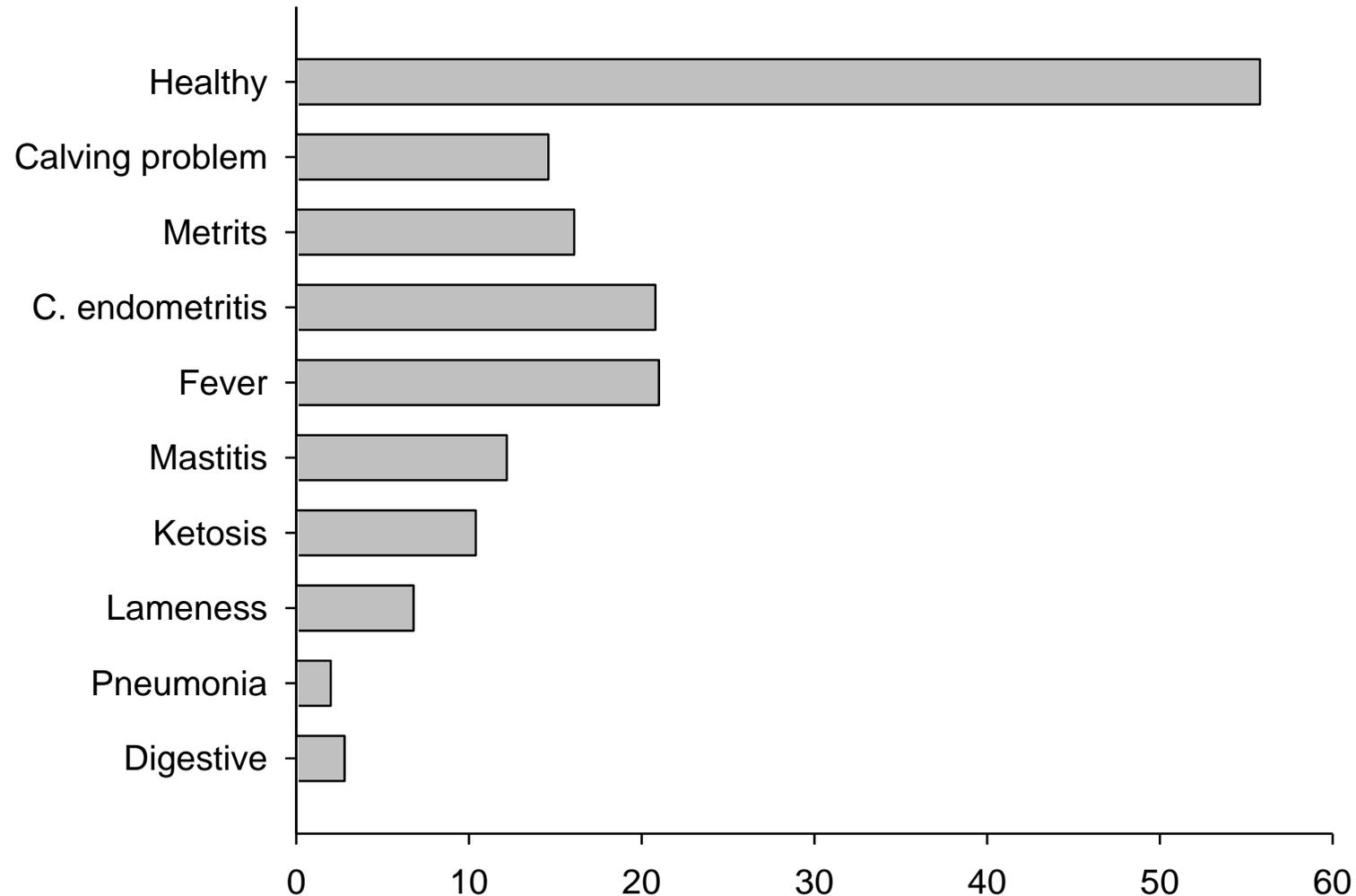
Peak milk yield (1 kg = 200 kg)



Pregnancy to 1st service



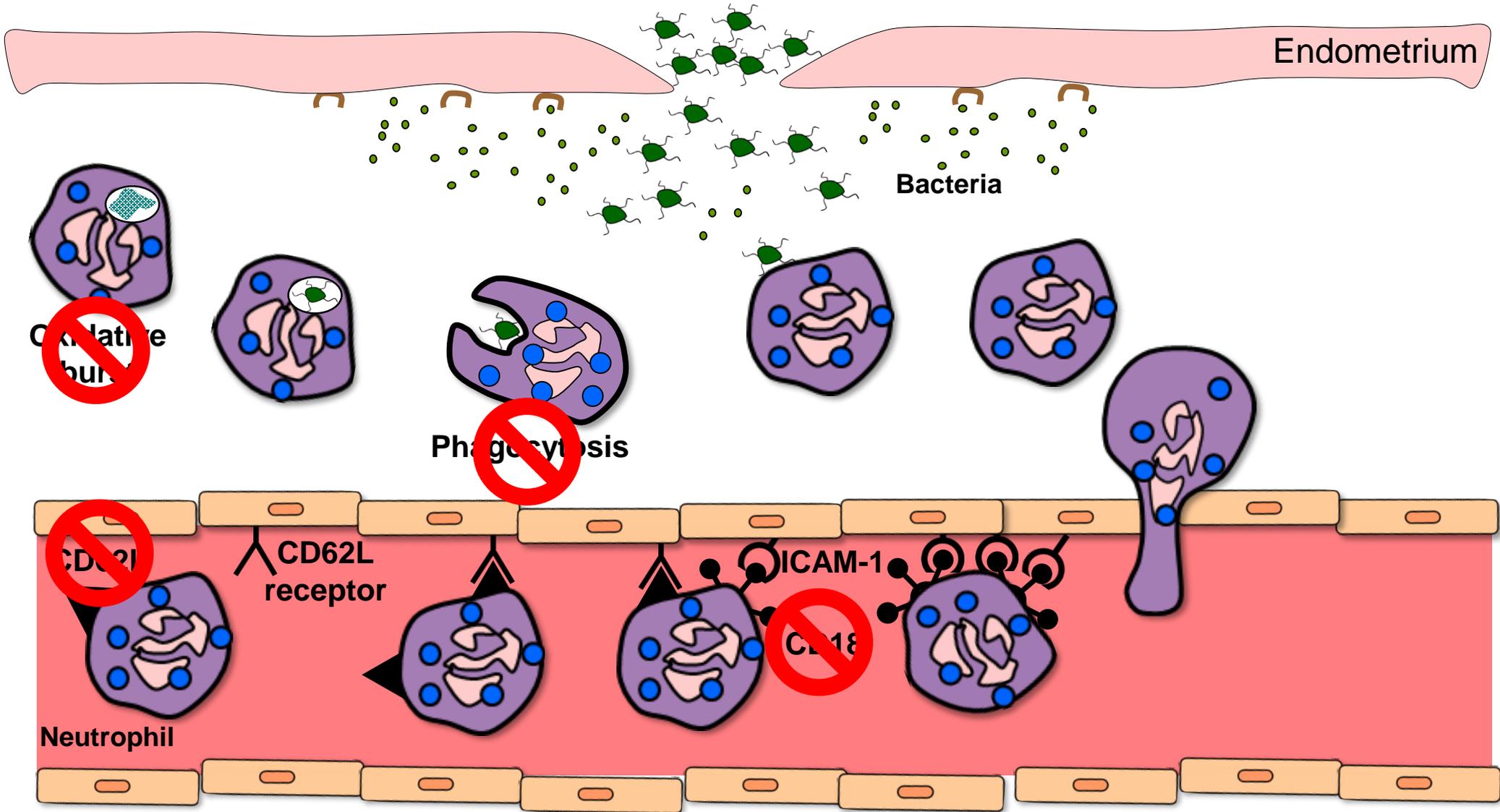
Incidence of Health Disorders in the First 60 DIM in High-Producing Holstein Herds



11,412 postpartum dairy cows from 16 farms from six regions of the US.



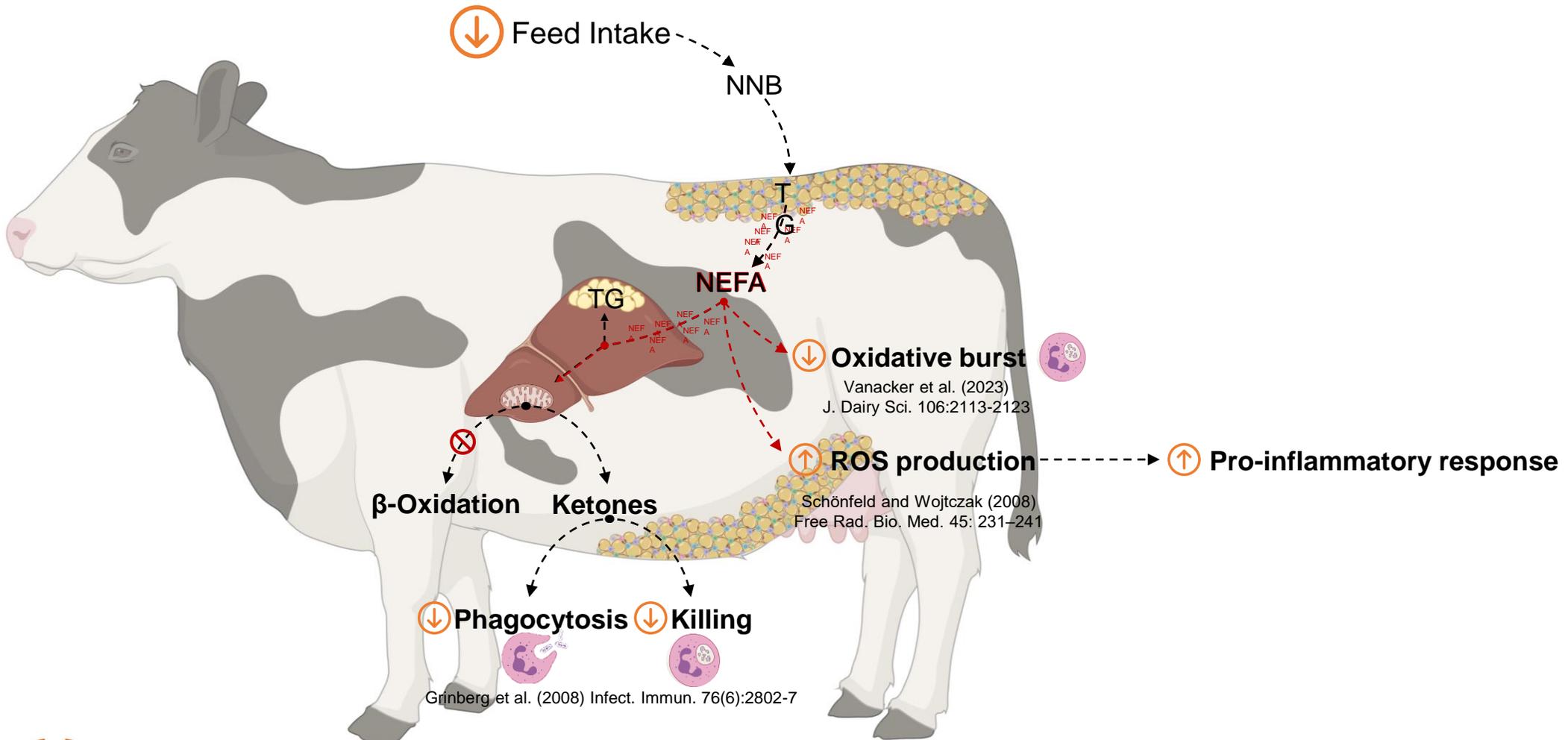
Immune Responses associated with Uterine Disease



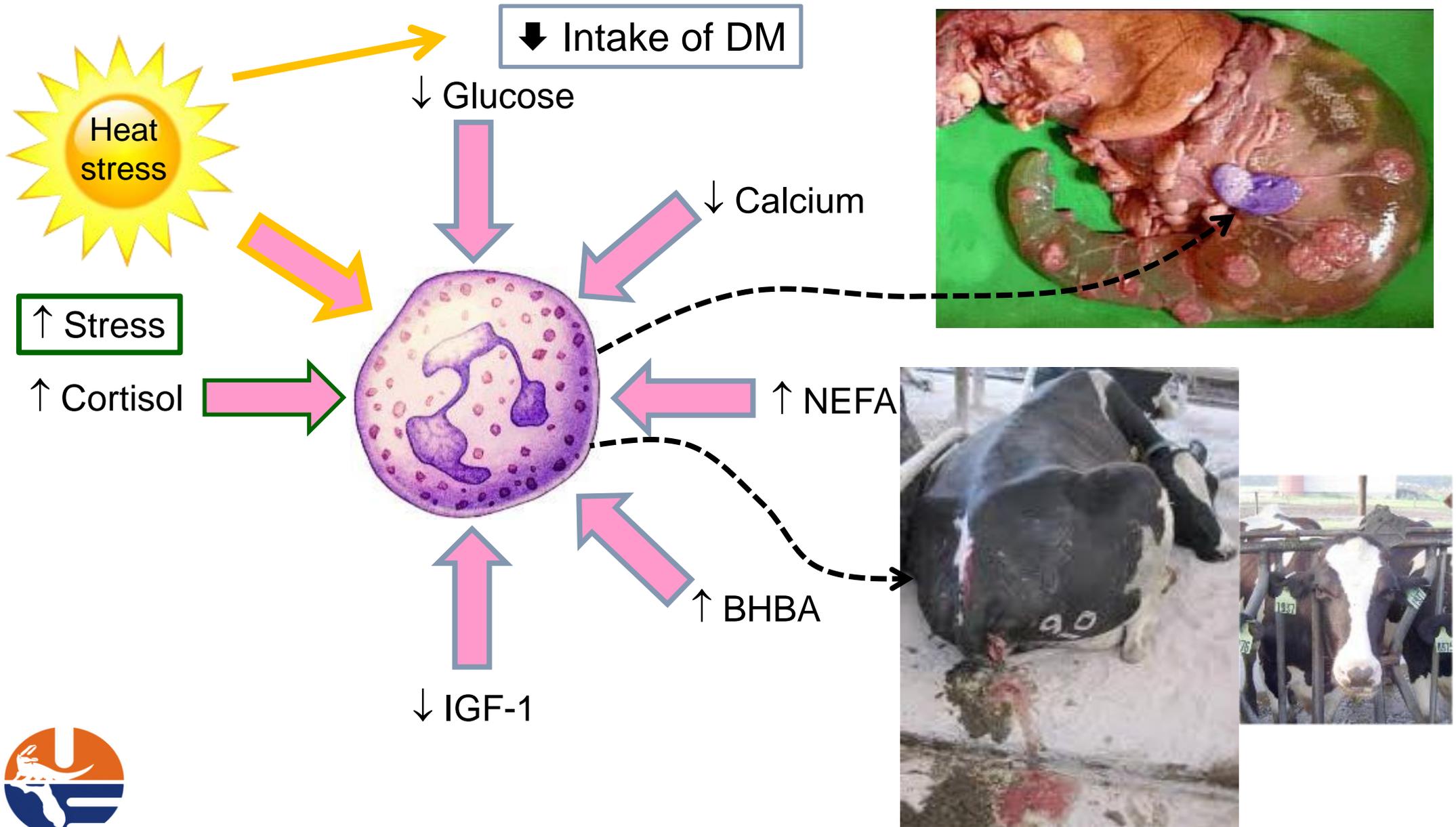
Neutrophils and Macrophages are the First Line of Defense



Decreased Leukocyte Function in the Transition Period



Causes of Infectious Diseases and Retained Placenta



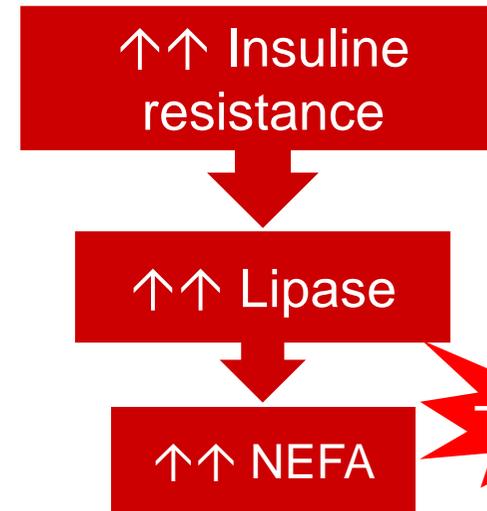
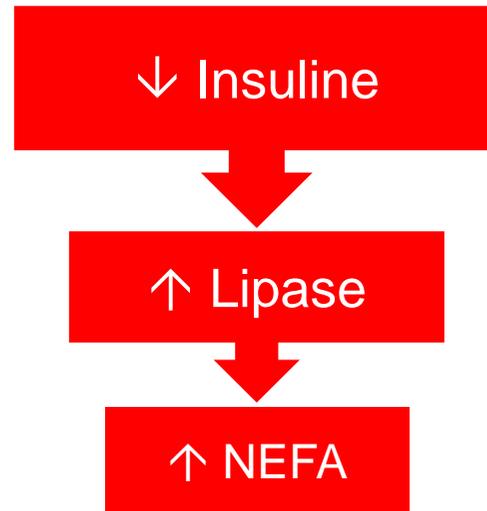
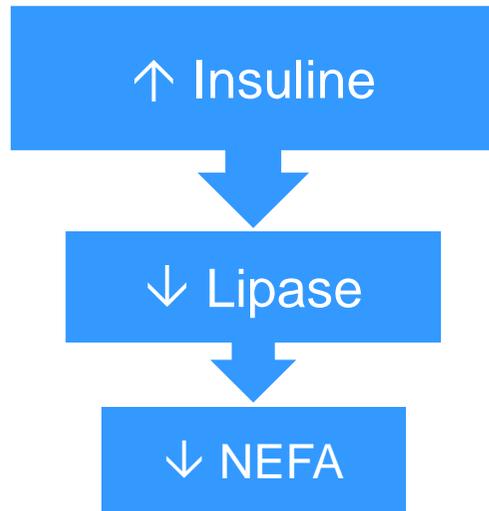
Relationship between Metabolic State and Inflammation

Homeostasis

Inflammation

Glucose

NEFA



Effects of Fasting and Pathogen Exposure on Inflammation and Nutrient Flux

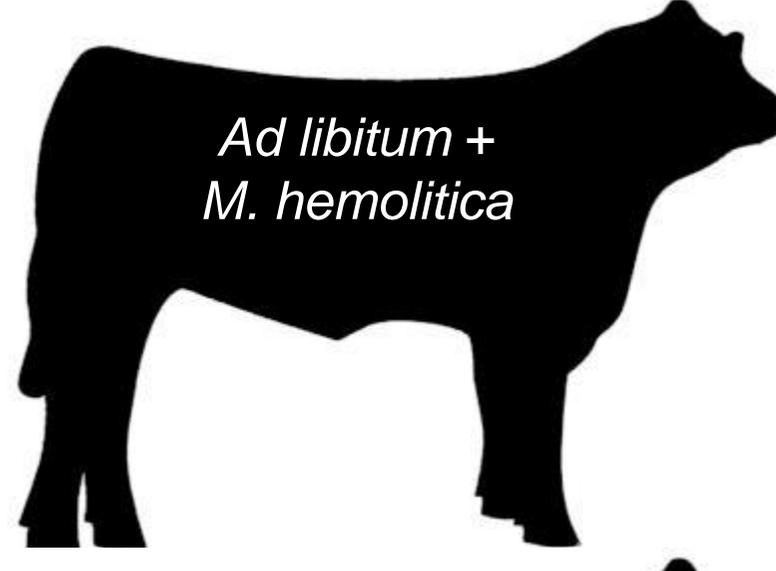


Ad libitum
no challenge

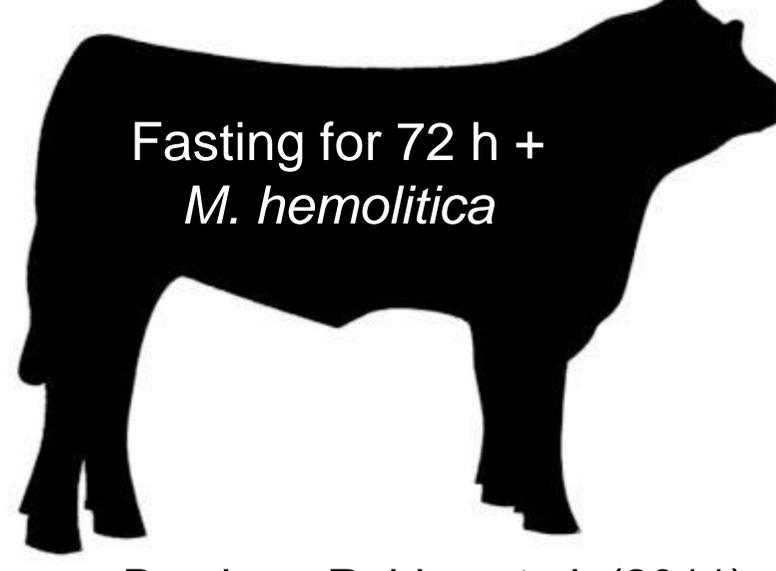


Fasting for 72 h
no challenge

- Responses:
 - DMI
 - N intake
 - N excretion
 - N retention
 - AA flow
 - Inflammatory responses



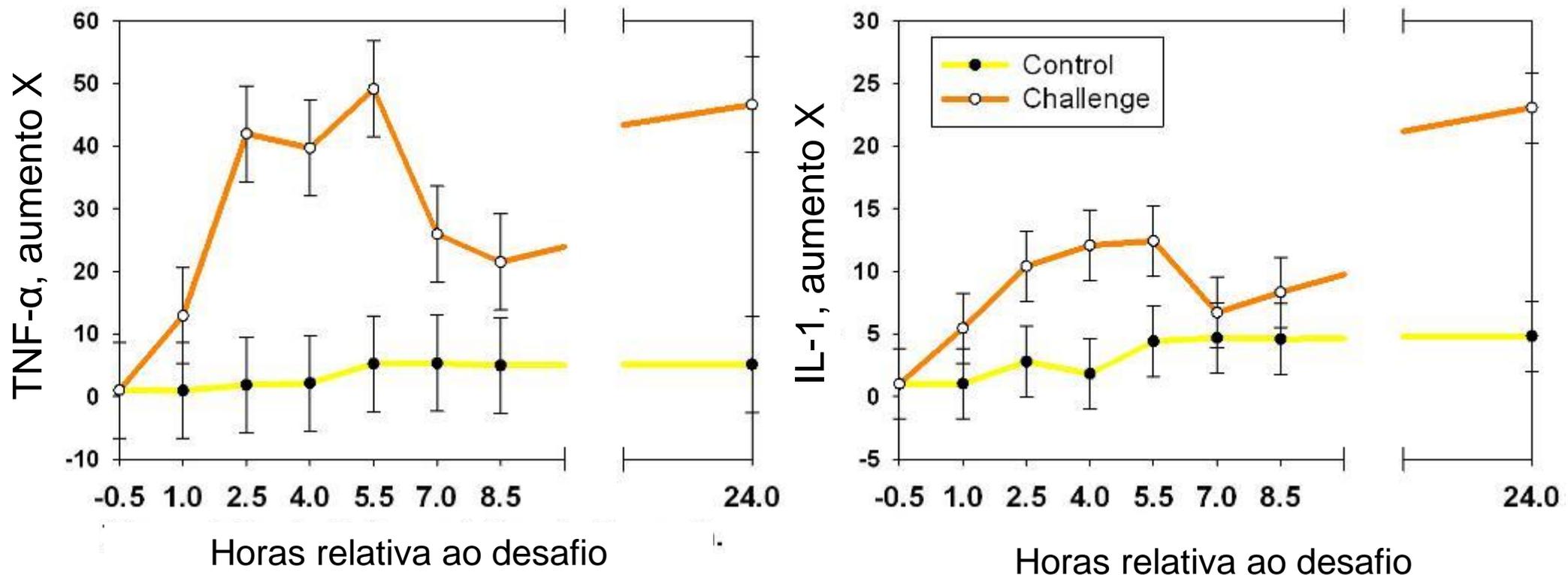
Ad libitum +
M. hemolitica



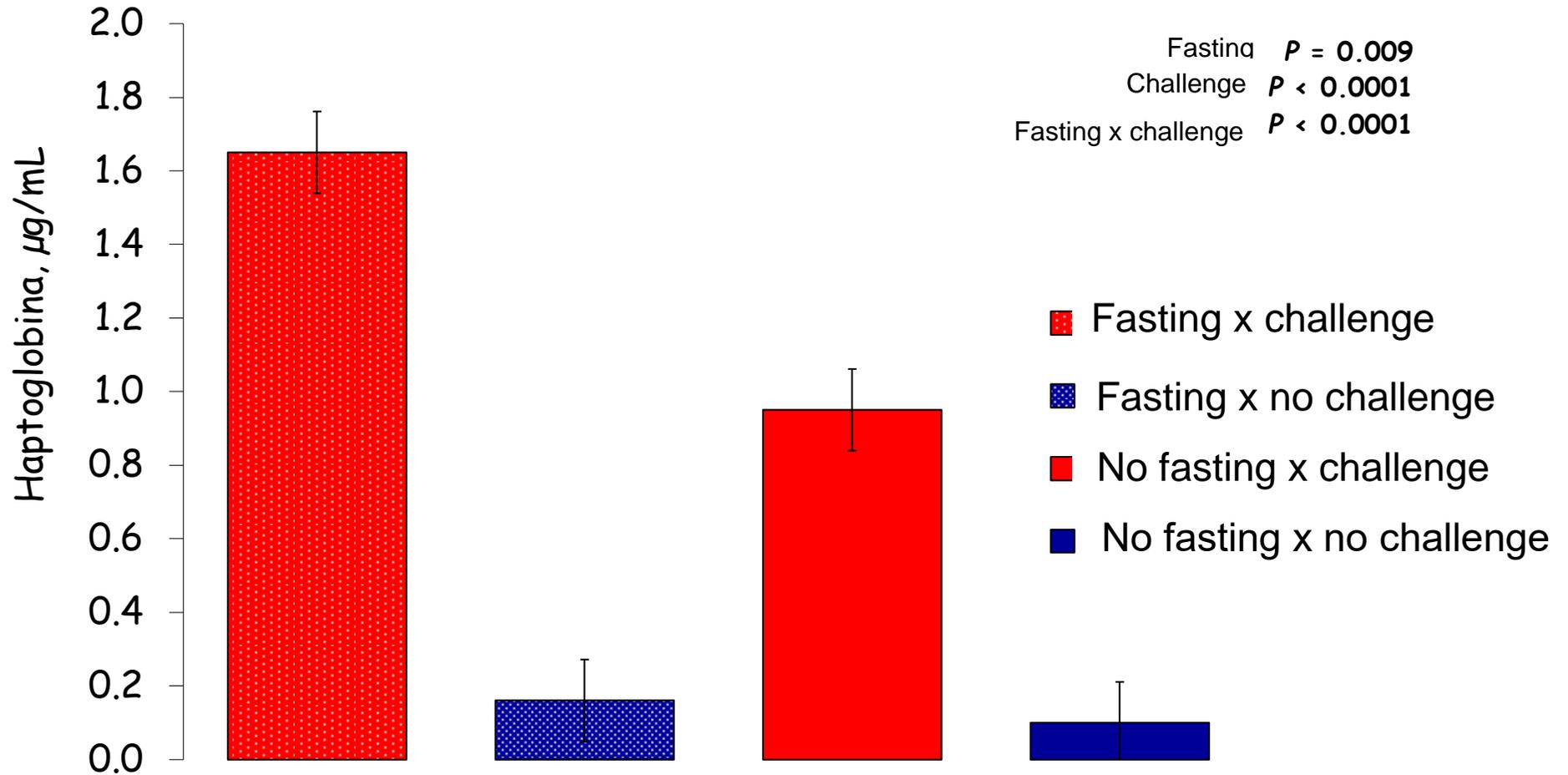
Fasting for 72 h +
M. hemolitica

Effect of *M. hemolytic* Challenge on Serum TNF- α and IL-1 Concentrations in Steers

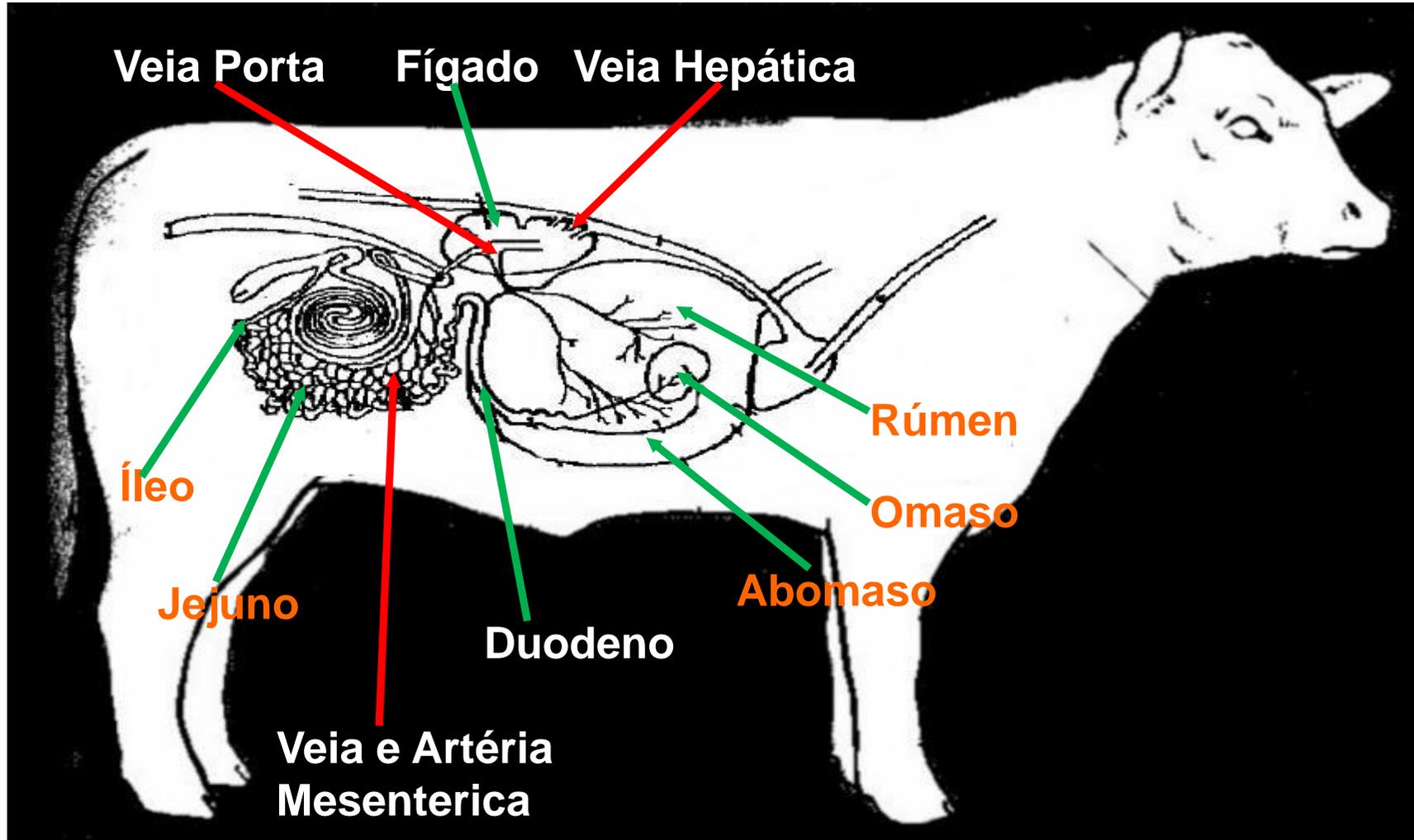
$P < 0.05$



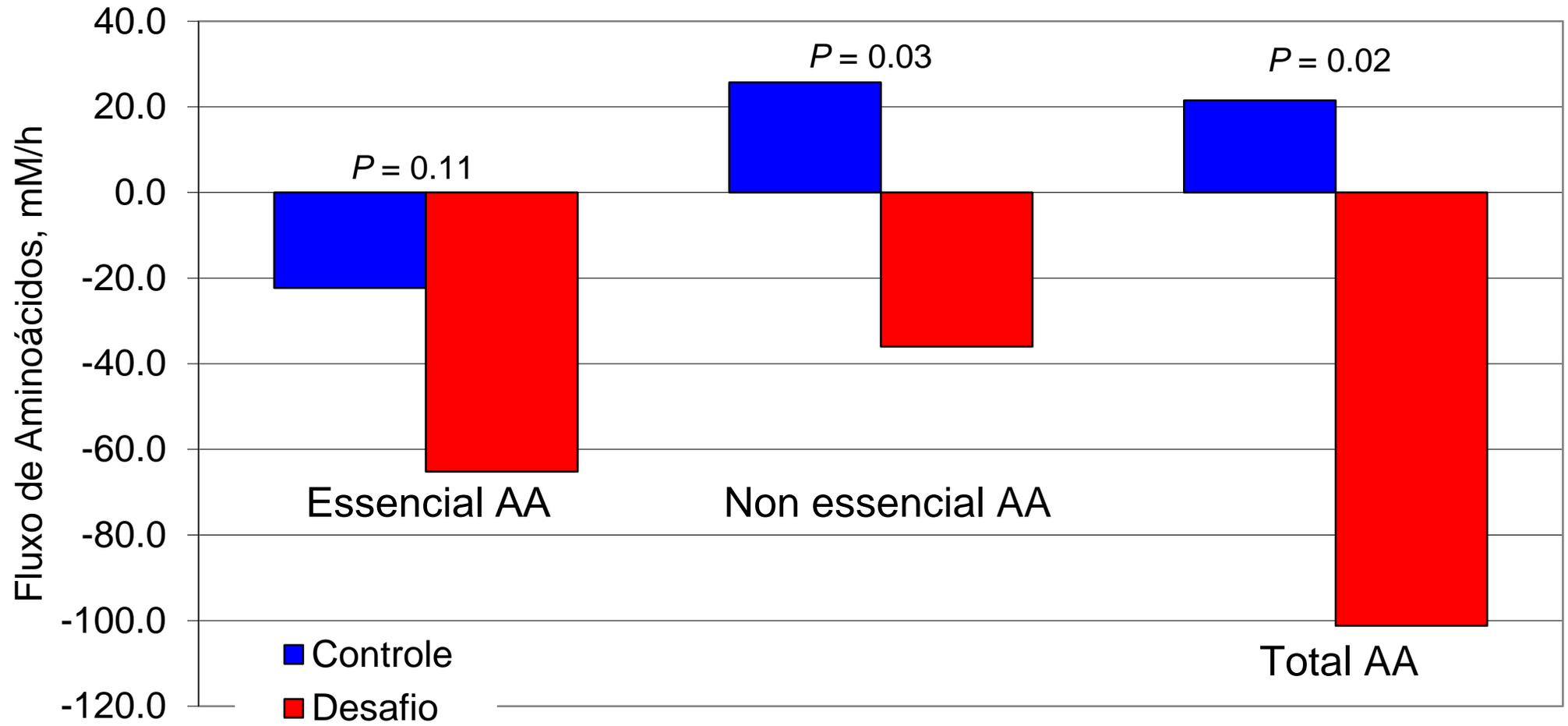
Haptoglobin Arterial Concentration in Fed or Fasted Calves, Challenged or Not with *M. haemoliticus*



Nutrient Flow



Hepatic Flow of Amino Acids in Fed or Fasted Calves and Challenged or Not with *M. haemolítica*

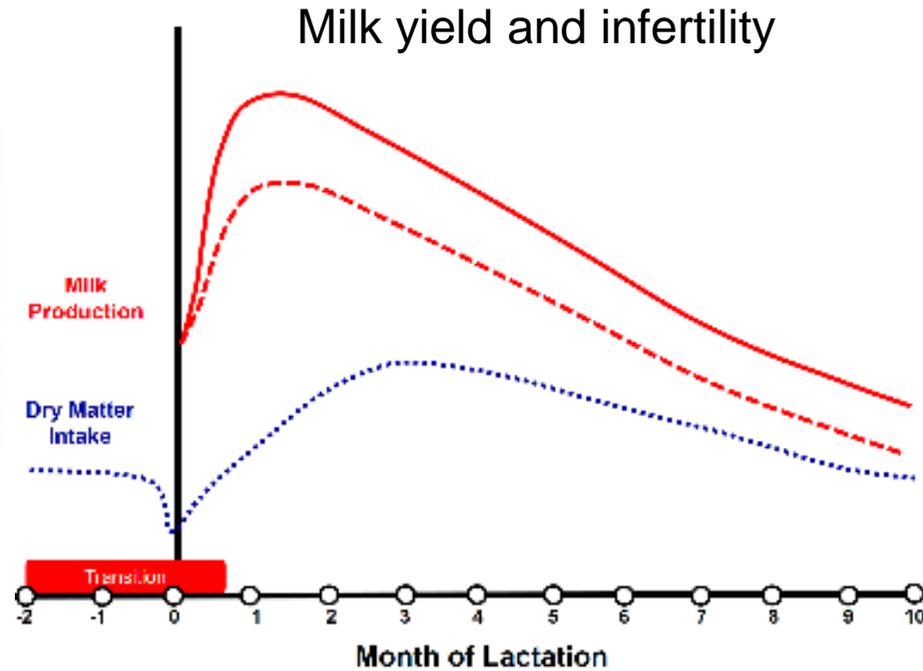


Diseases and Use of Nutrients

- Inflammation can alter appetite and influence nutrient partitioning
 - Amino acids are catabolized in peripheral tissues and directed to the liver for the acute phase response and for gluconeogenesis
- Evidence that acute stress (CRH challenge = acute ↑ in cortisol concentration) increases IL-6 concentration, stimulating haptoglobin secretion (Cooke and Bohnert, 2011)
- During inflammatory processes, the use of nutrients favors survival rather than production and growth.

Economic Losses due to Diseases

Milk discarded



\$\$\$ Feeding



Additional installations



\$\$\$ Replacement



\$\$\$ Labor

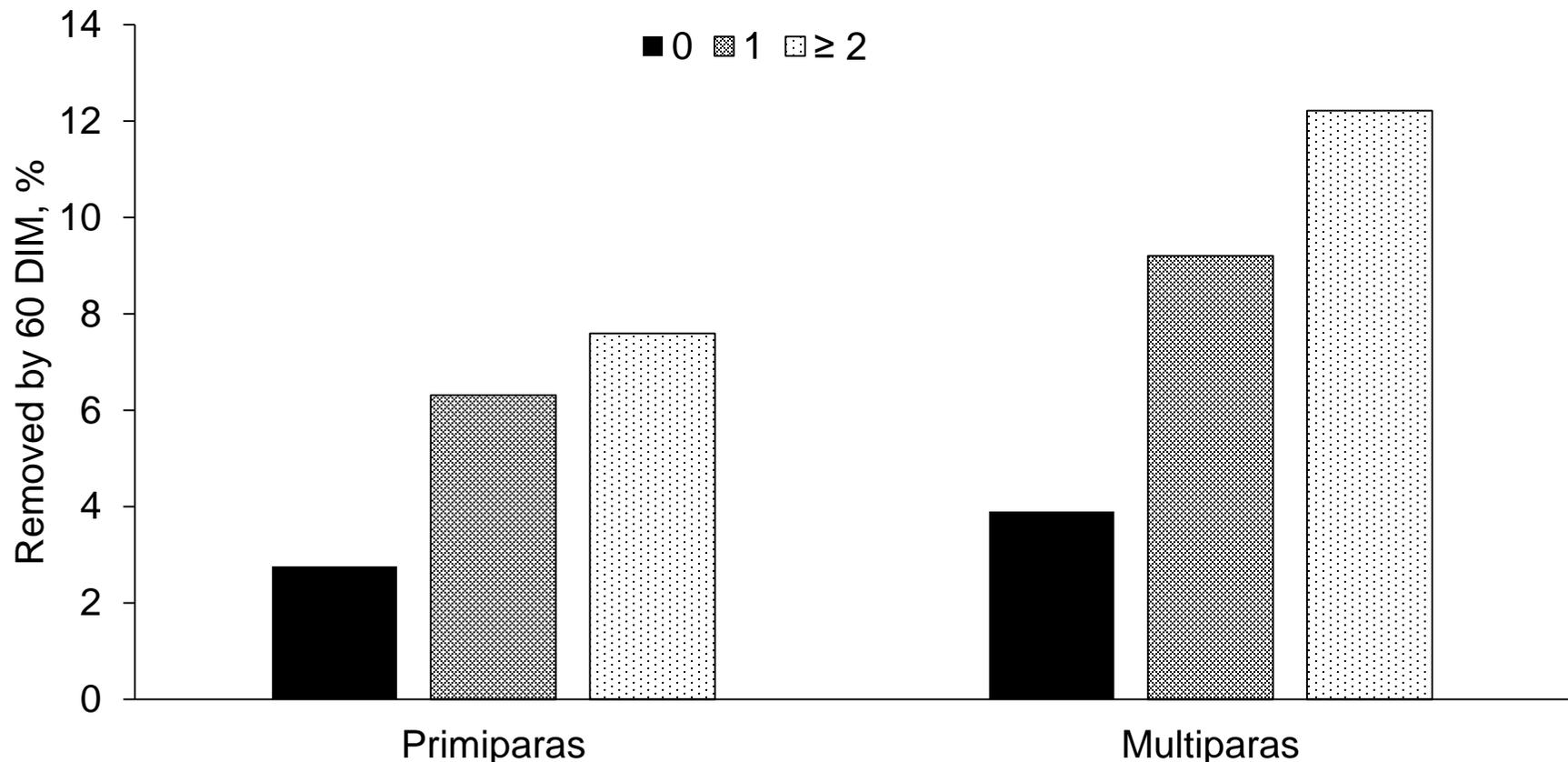


\$\$\$ Treatment



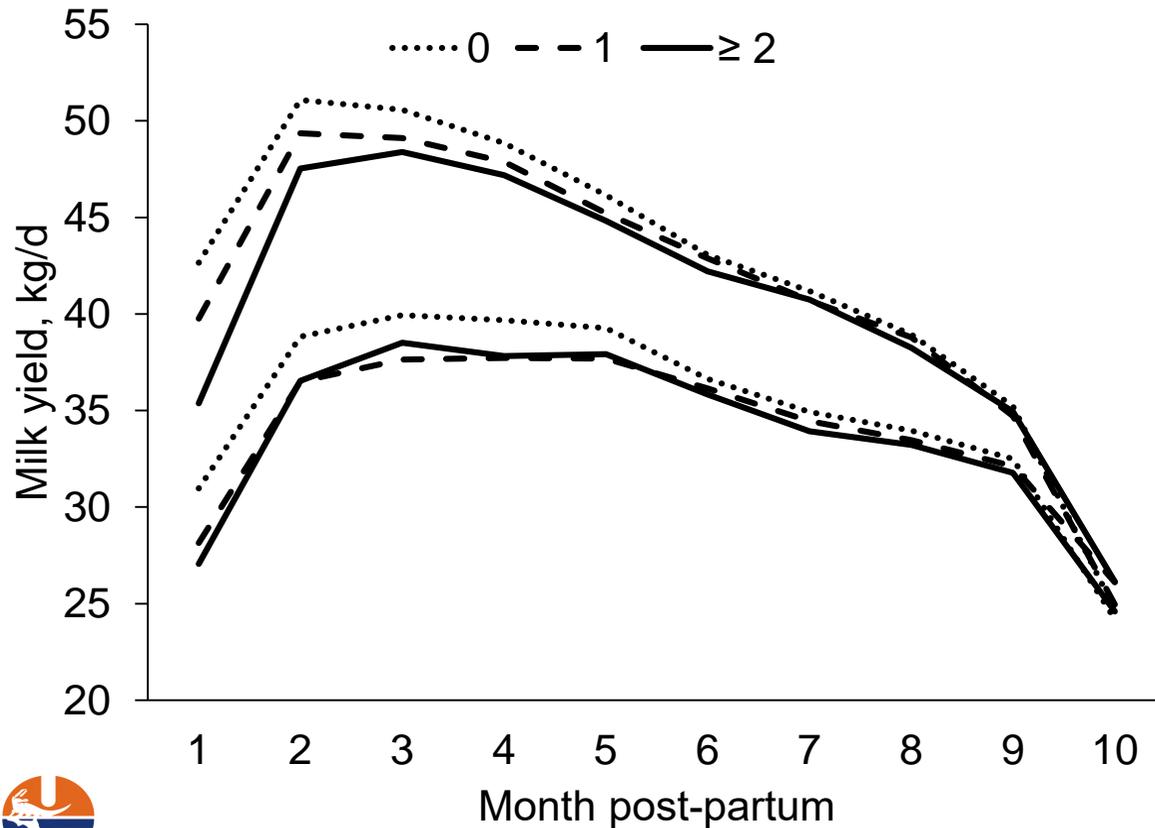
Health Disorders and Premature Exit

- Data from 68,090 lactations of cows from 3 dairy in the SE US
- Clinical diseases (retained placenta, metritis, mastitis, lameness, indigestion, displaced abomasum, trauma) and sub-clinical (ketosis)



Health Disorders and Milk Yield

- Data from 68,090 lactations of cows from 3 dairy in the SE US
- Clinical diseases (retained placenta, metritis, mastitis, lameness, indigestion, displaced abomasum, trauma) and sub-clinical (ketosis)



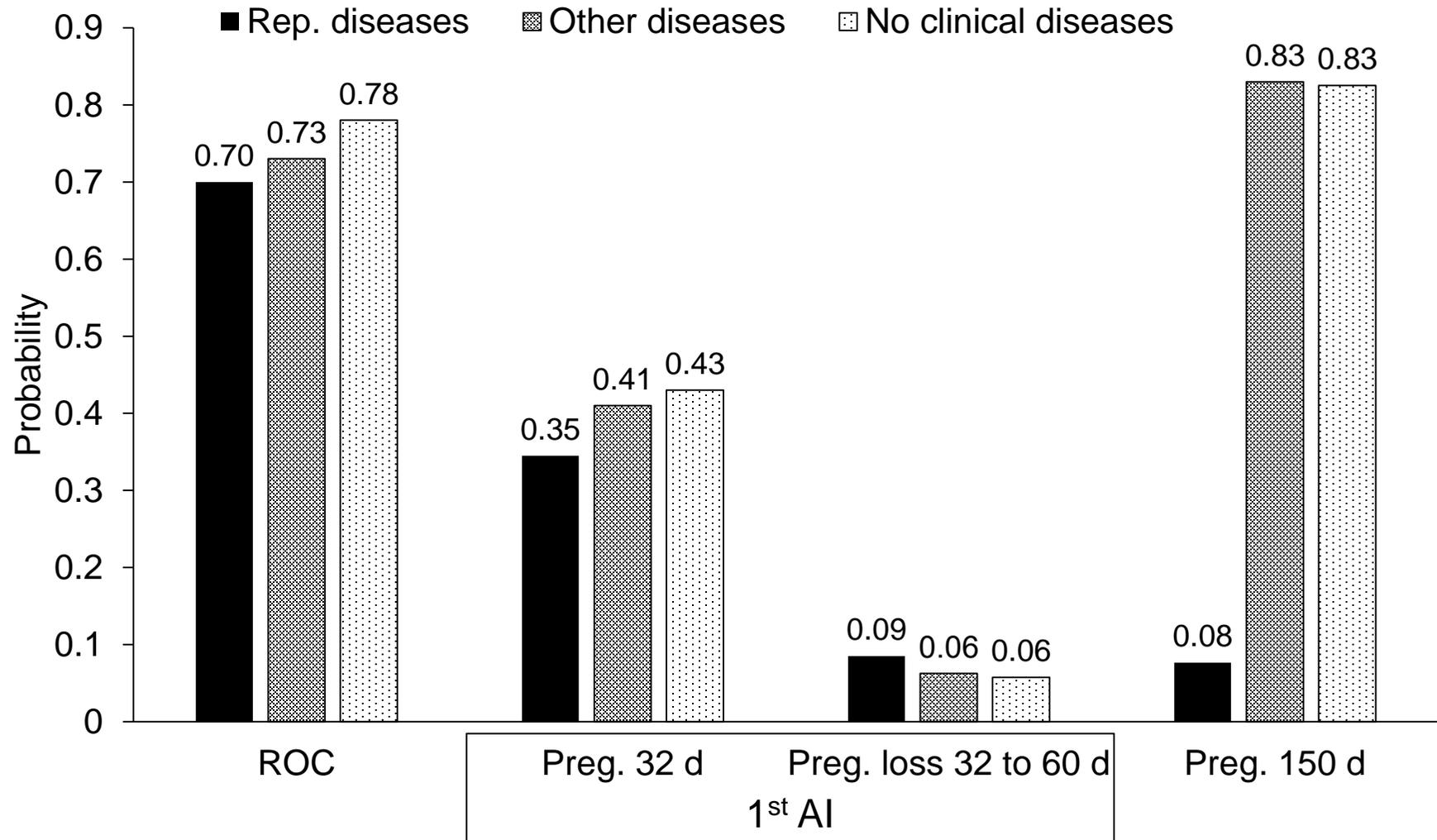
# Diseases	Milk yield, kg/d	
	Primiparus	Multiparus
0	35.2	42.7
1	34.1	41.9
≥ 2	33.8	40.9

# Diseases	Milk yield 305 d, kg	
	Primiparus	Multiparus
0	10.736	13.024
1	-336	-244
≥ 2	-427	-549



Health Disorders are Associated with Cyclicity and Pregnancy

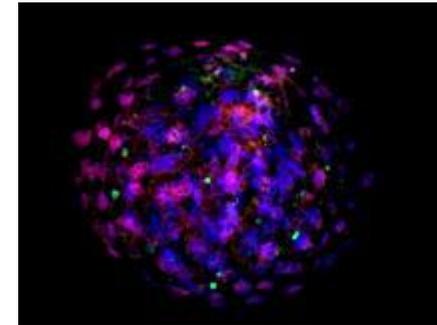
- Data from 11,729 cows from 16 herds, across 9 US states



Estimates of Pregnancy at Different Stages after AI according to Occurrence of Disease

- Data from 476 embryo-oocytes from non-superovulated cows at 6 days after AI evaluated for:

- Fertilization
- Quality of embryos
- Cell population



- Data from 145 lactating cows collected at 15 d after AI evaluated for:

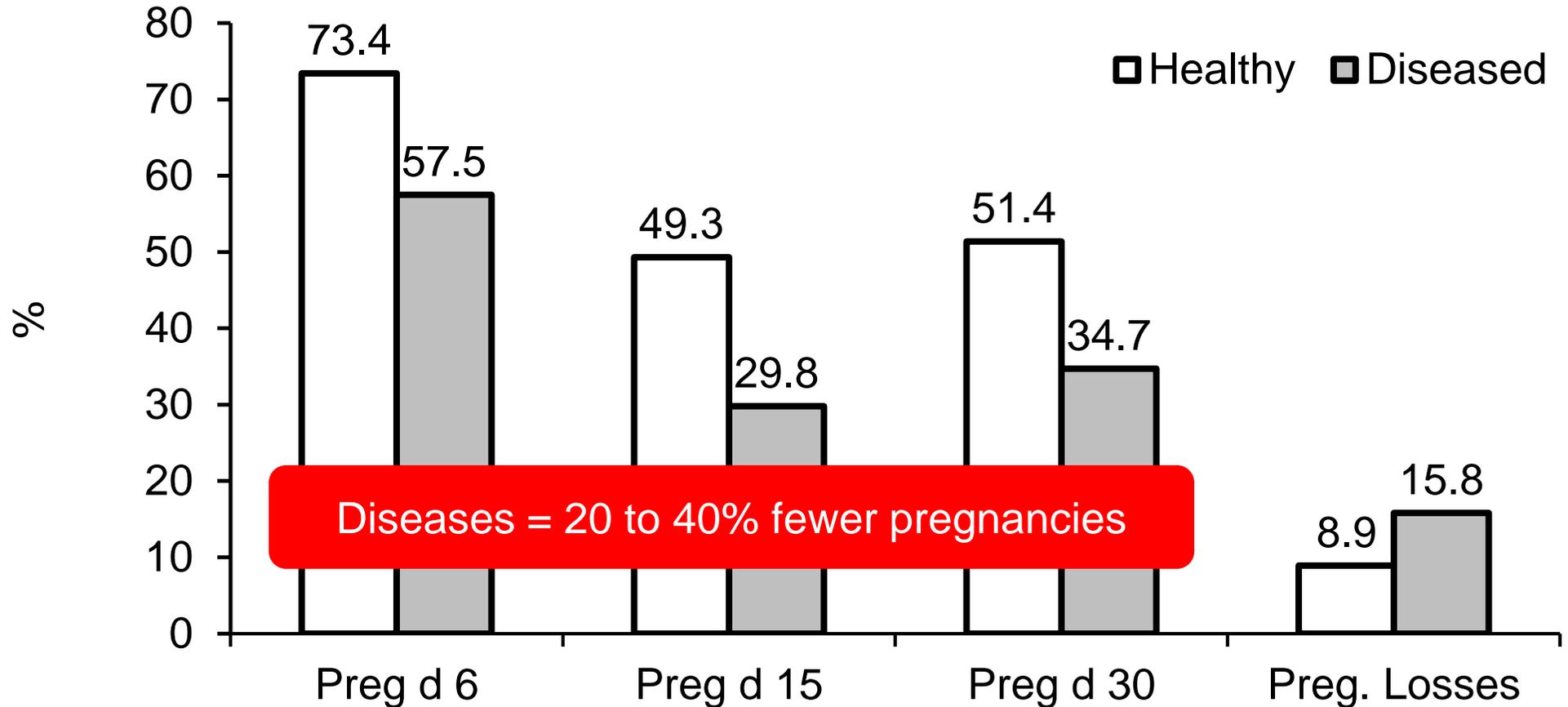
- Pregnancy
- Shape and length of embryos
- Interferon-tau concentration



- Pregnancy data for 5,719 cows from 7 US farms

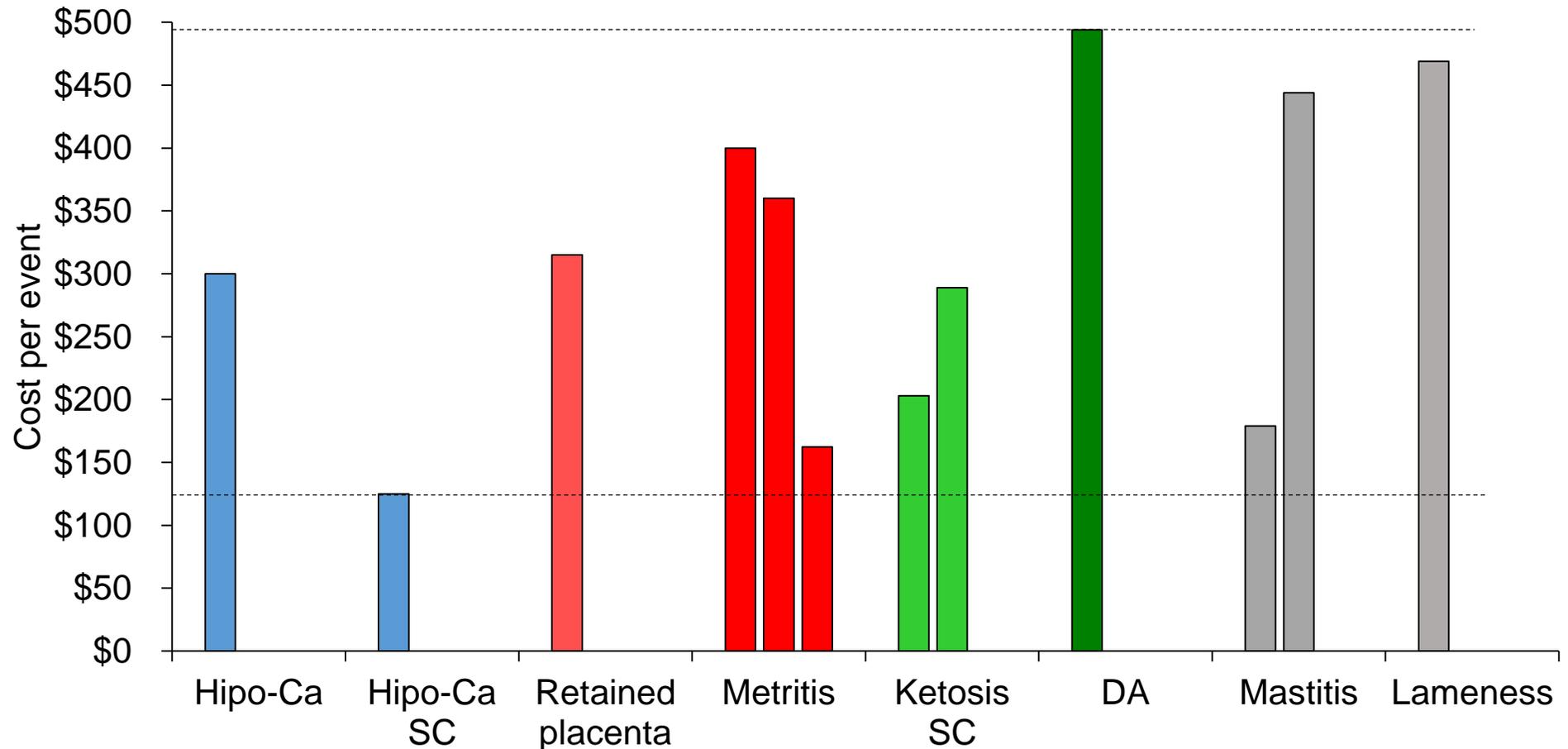


Estimates of Pregnancy at Different Stages after AI according to Occurrence of Disease



How Much Do Diseases Cost?

- The cost includes losses due to: incidence, treatment, death, production, predisposition to other diseases, reproduction, replacement



DA: Displaced abomasum; Hipo-Ca: Hipocalcemia; SC: Sub-clinic



How to Achieve the Goals of the Transition Period?

↓ Heat stress

↓ BCS at dry-off

↓ Stress

Pre-partum

Preventive antimicrobial

Vaccinations

Projected DMI

Mineral balance

↓ Morbidity

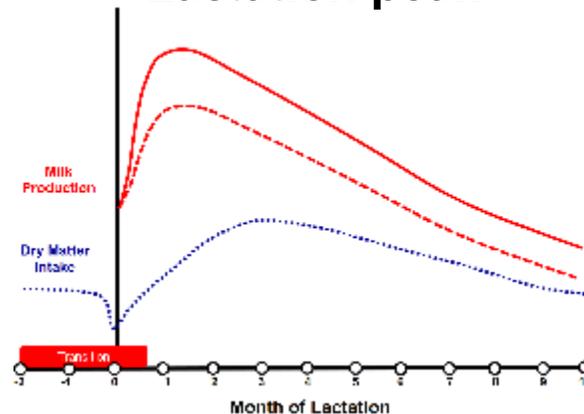
Projected DMI

↓ Somatic cell count

Survival



Lactation peak



Pregnancy



Post-partum



Association between Body Condition Score Loss in the Dry Period and Performance

Association between Body Condition Score Loss in the Dry Period and Performance

- Data from 16,104 lactations (9,950 cows) of parous cows from 2 herds
- Cows scored for body condition at dry-off and at calving
- Evaluation of:
 - Association between BCS change in the dry period and health, reproduction and production
 - Risk factors for BCS change in dry period
 - Factors associated with BCS at dry-off



Association between Body Score Change and Postpartum Diseases and Treatments

Item, %	BCS Change				P - value
	≤ -0.75 (n = 1,604)	-0.5 to -0.25 (n = 6,430)	0 (n = 4,819)	≥ 0.25 (n = 3,251)	
Uterine diseases	15.8 ^a	13.6 ^b	13.3 ^{b,c,A}	12.2 ^{c,B}	< 0.001
Indigestion	2.7 ^A	3.4 ^{a,B}	2.8 ^X	2.2 ^{b,Y}	0.01
Antimicrobial	14.1 ^{a,x}	12.4 ^a	11.8 ^y	10.1 ^b	< 0.001
Anti-inflammatory	13.7 ^{a,A}	10.0 ^{B,X}	7.9 ^{b,Y}	6.9 ^{b,Y}	< 0.001
Supportive therapy	8.1 ^a	8.4 ^a	7.6 ^a	5.9 ^b	< 0.001

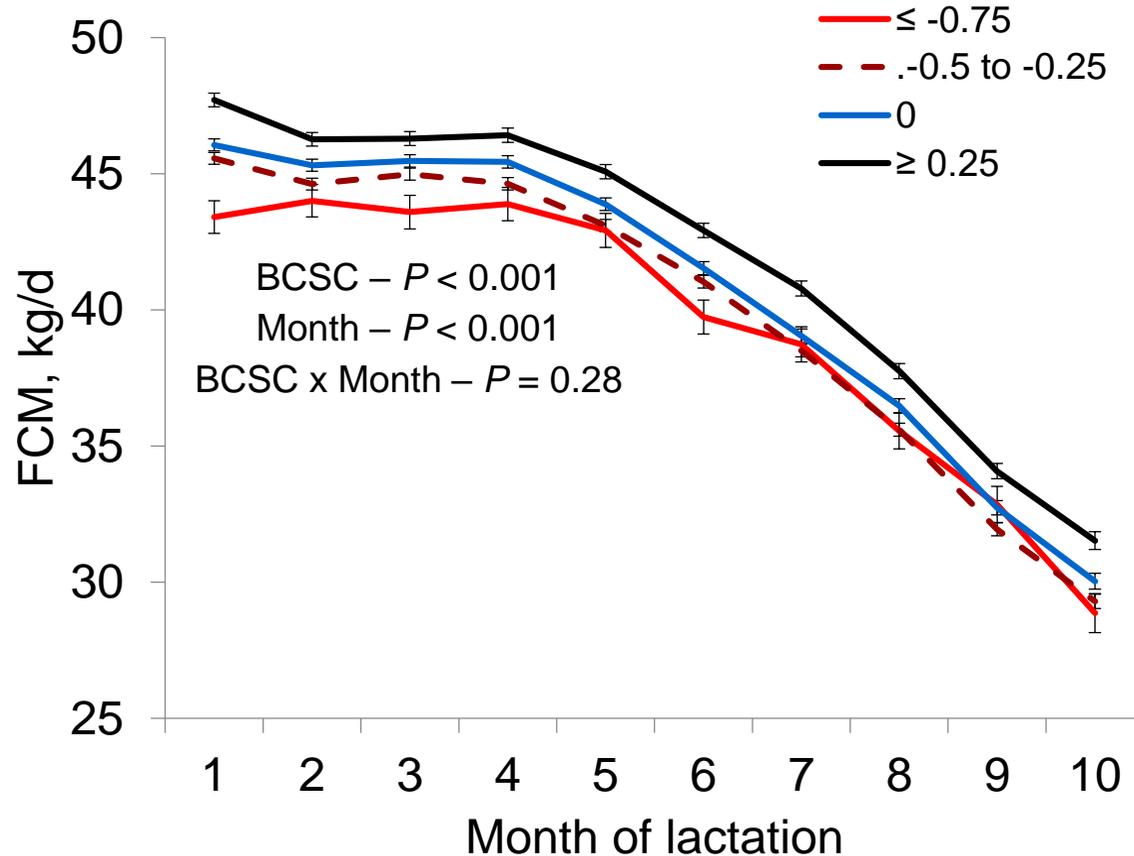


Association between Body Score Change and Reproductive Performance

Item	BCS Change				P - value
	≤ -0.75	-0.5 to -0.25	0	≥ 0.25	
1 st AI	1,540	5,812	4,258	2,955	---
Pregnancy at 75 d, %	20.8 ^a	28.3 ^b	33.1 ^c	41.9 ^d	< 0.001
Pregnancy loss (38 to 75 d), %	15.6 ^{a,A}	10.5 ^{a,A}	7.4 ^B	4.5 ^b	< 0.001
2 nd IA	1,213	4,081	2,717	1,669	---
Pregnancy at 75 d, %	22.1 ^a	26.8 ^{x,A}	28.9 ^{b,B}	36.4 ^{c,y}	< 0.001
Pregnancy loss (38 to 75 d), %	11.0 ^{a,A}	8.9 ^{a,A}	6.4 ^B	4.4 ^b	< 0.001
Hazard of pregnancy up to 305 DIM (95% CI)	0.88 ^a (0.79, 0.99)	0.76 ^b (0.70, 0.83)	0.70 ^b (0.64, 0.77)	Referent	< 0.001



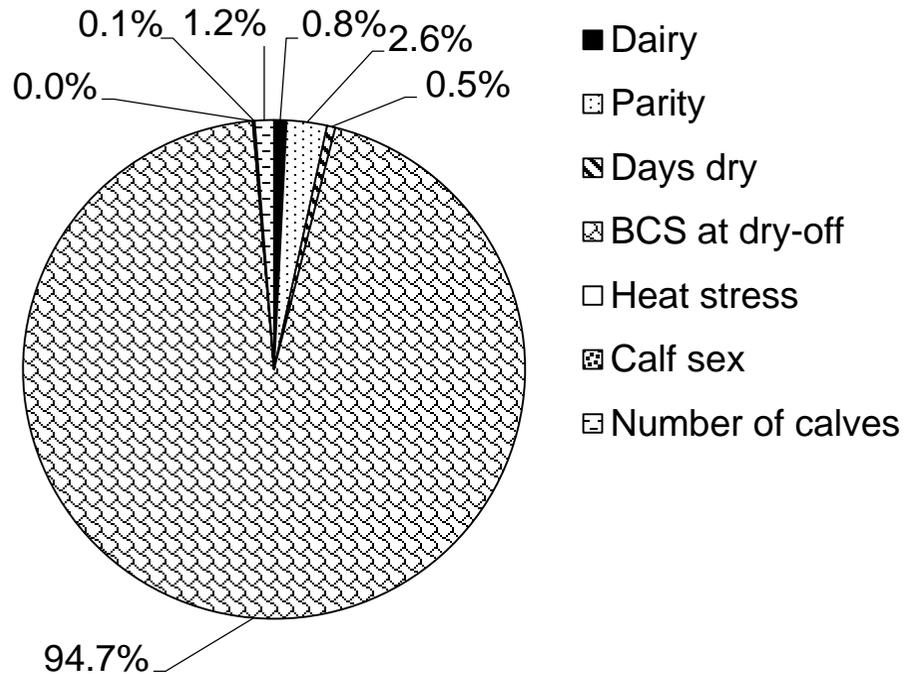
Association between Body Score Change and Milk Production



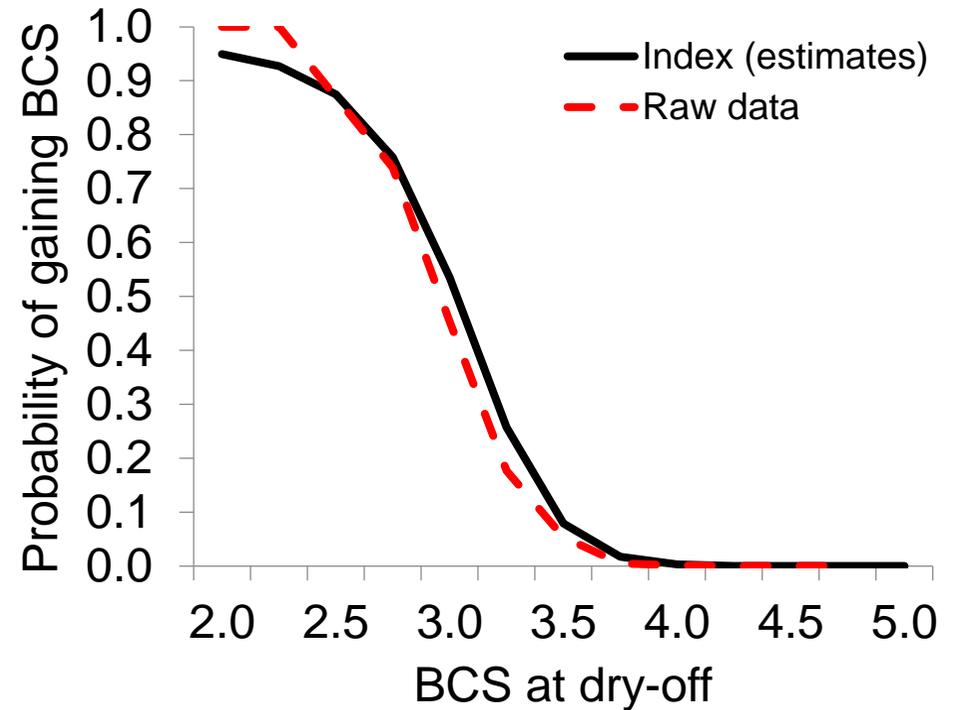
	Fat corrected milk (kg)	
	305-d	30 DEL
≤ -0.75	39.3 ± 0.3	43.4 ± 0.6
$-.5 \text{ to } -0.25$	39.9 ± 0.1	45.6 ± 0.2
0	40.6 ± 0.2	46.1 ± 0.2
≥ 0.25	41.9 ± 0.2	47.7 ± 0.3



Factors Associated with Body Condition Score Change



$R^2 = 0.57$



Probability of gaining BCS

Criterion ≤ 3.25

Sensibility = 70.0%

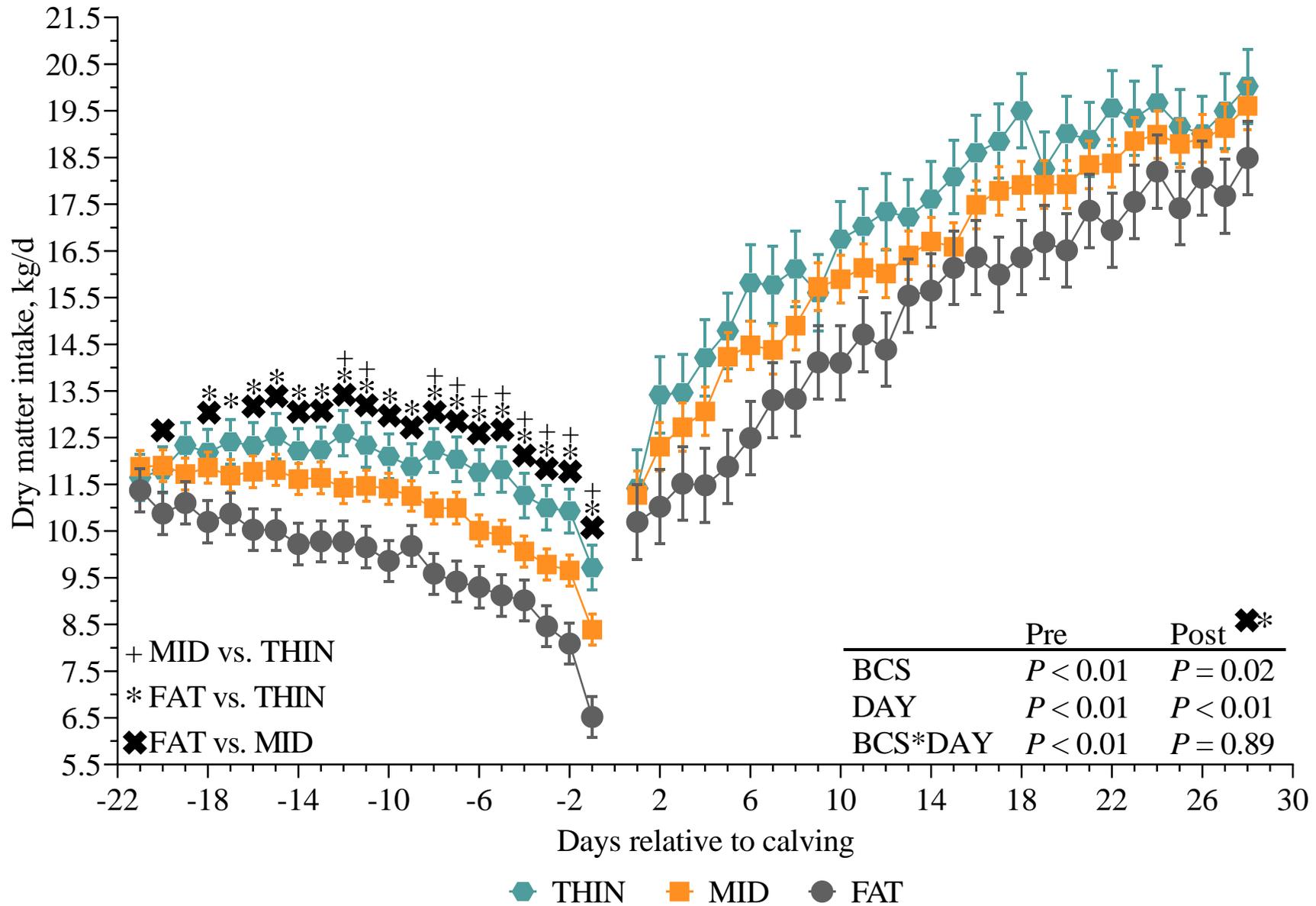
Specificity = 85.1%



Estimated energy cost of changing BCS during a 60-day dry period

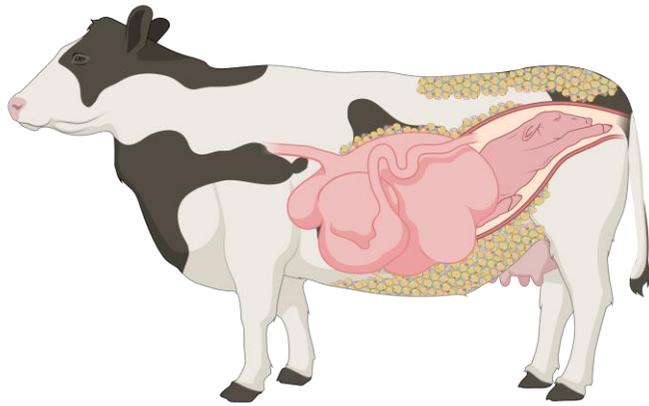
BCS at dry-off	Δ BCS	Δ BW (Kg)	Energy cost (Mcal)	Daily energy cost (Mcal/d)	Dry cow diet with 1.46 Mcal of NE _L /kg of DM
2.75	+0.35	24.5	134.8	2.25	+1.54 kg/d
3	+0.09	6.3	34.7	0.58	+0.40 kg/d
3.25	0	0	0	0.00	
3.5	-0.15	-10.5	-57.8	-0.96	-0.66 kg/d
3.75	-0.30	-21	-115.5	-1.93	-1.32 kg/d
4	-0.41	-28.7	-157.9	-2.63	-1.80 kg/d
4.25	-0.59	-41.3	-227.2	-3.79	-2.60 kg/d

How much Less do Fat Cows Eat???



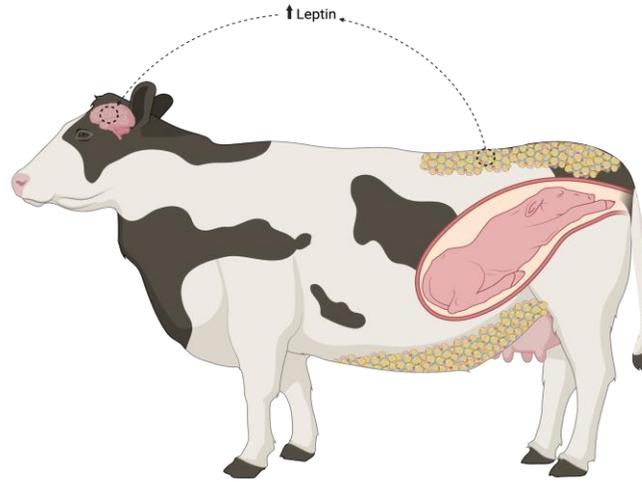
Possible Mechanisms Associated with Decreased DMI in Fat Cows

Physical limitation



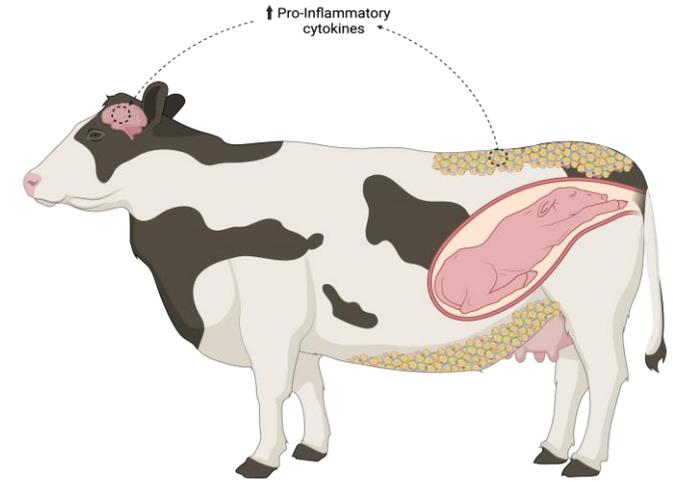
Khan et al. (2009) Mol Cell Biol 29:1575–1591

Metabolic



Riosa et al. (2022) J Dairy Sci 105:6327–6338

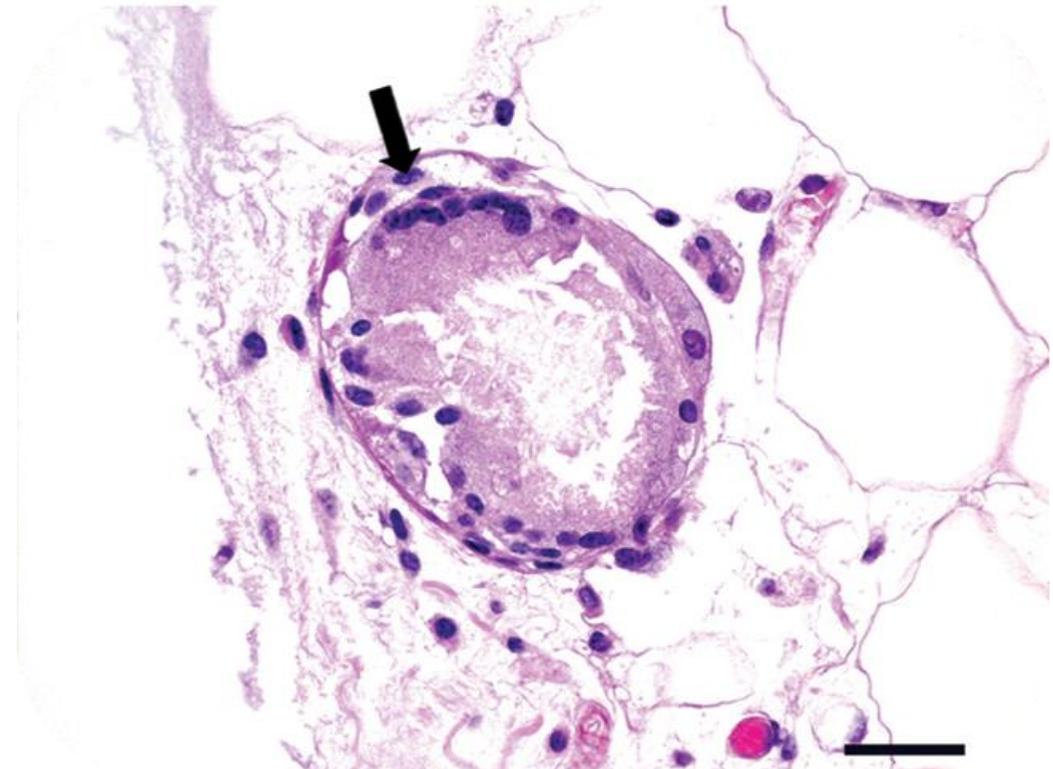
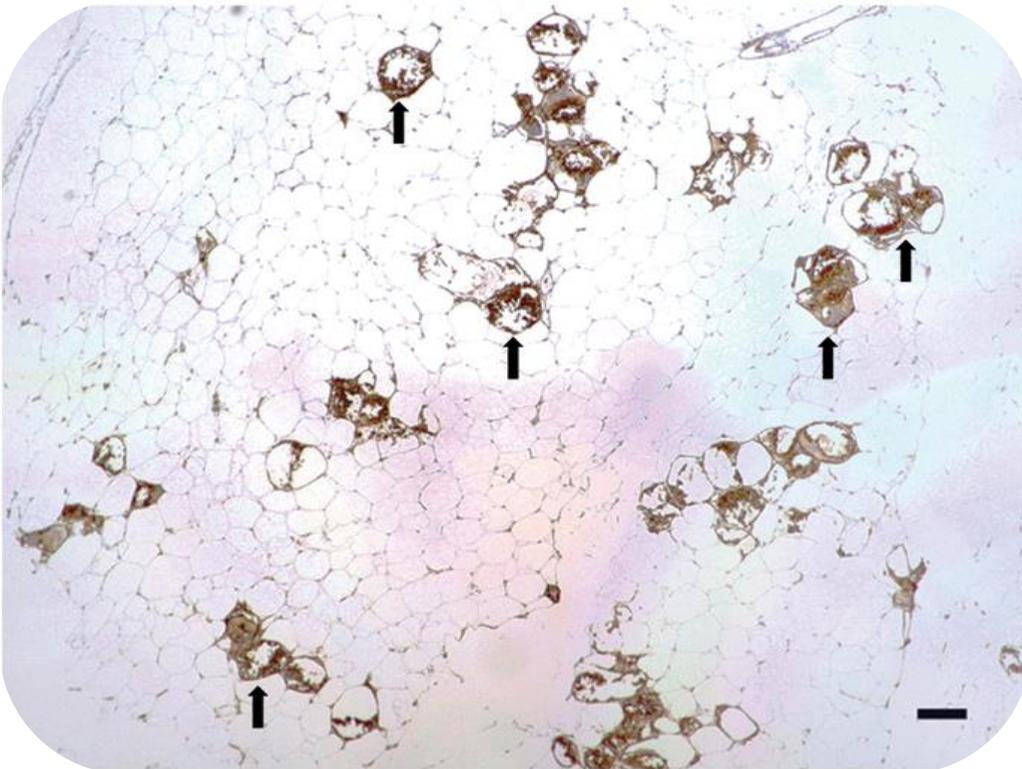
Inflammatory



Kuhla et al. (2020) Animal 14:S65–S77

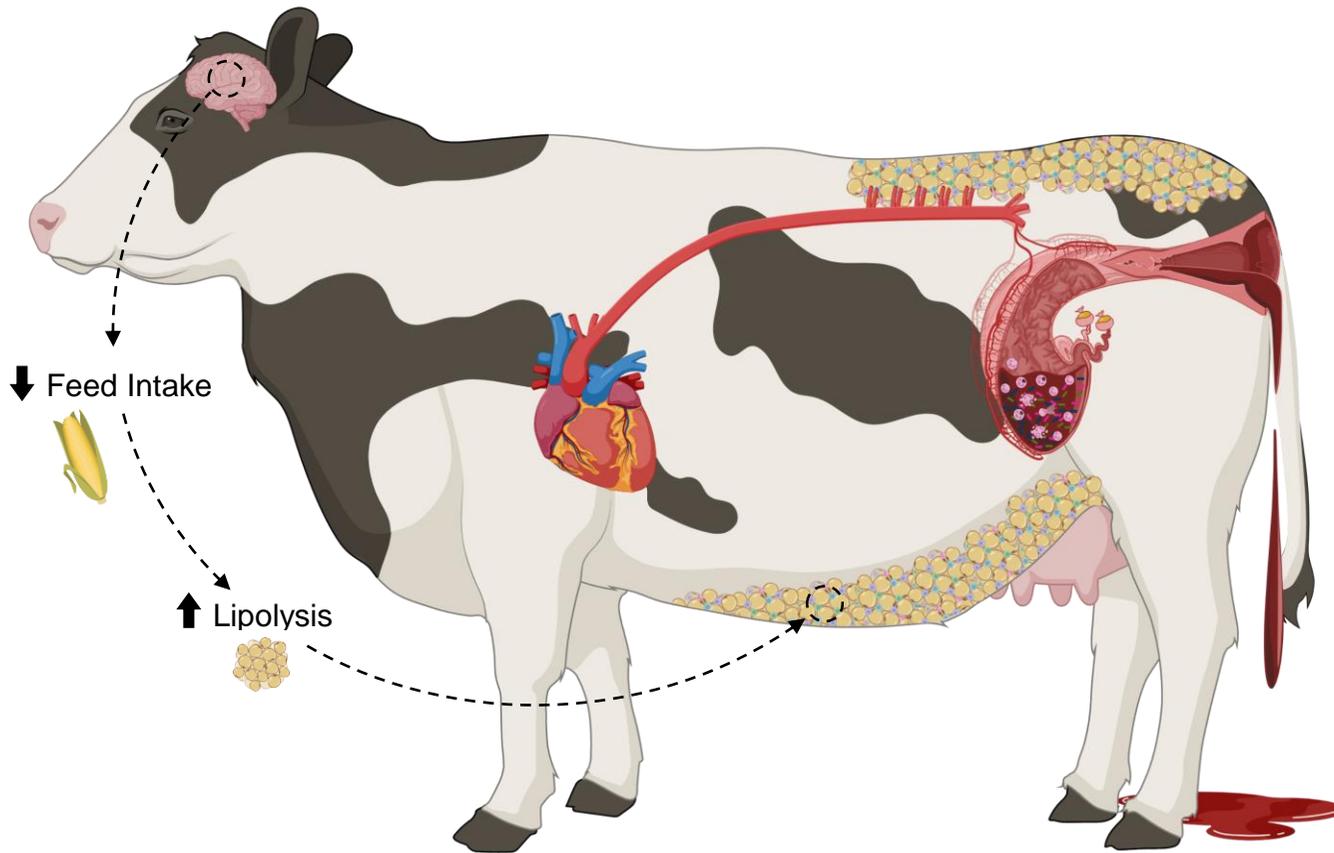
What Triggers Prepartum Immune Cell Activation?

Crown-like structures with macrophage infiltration

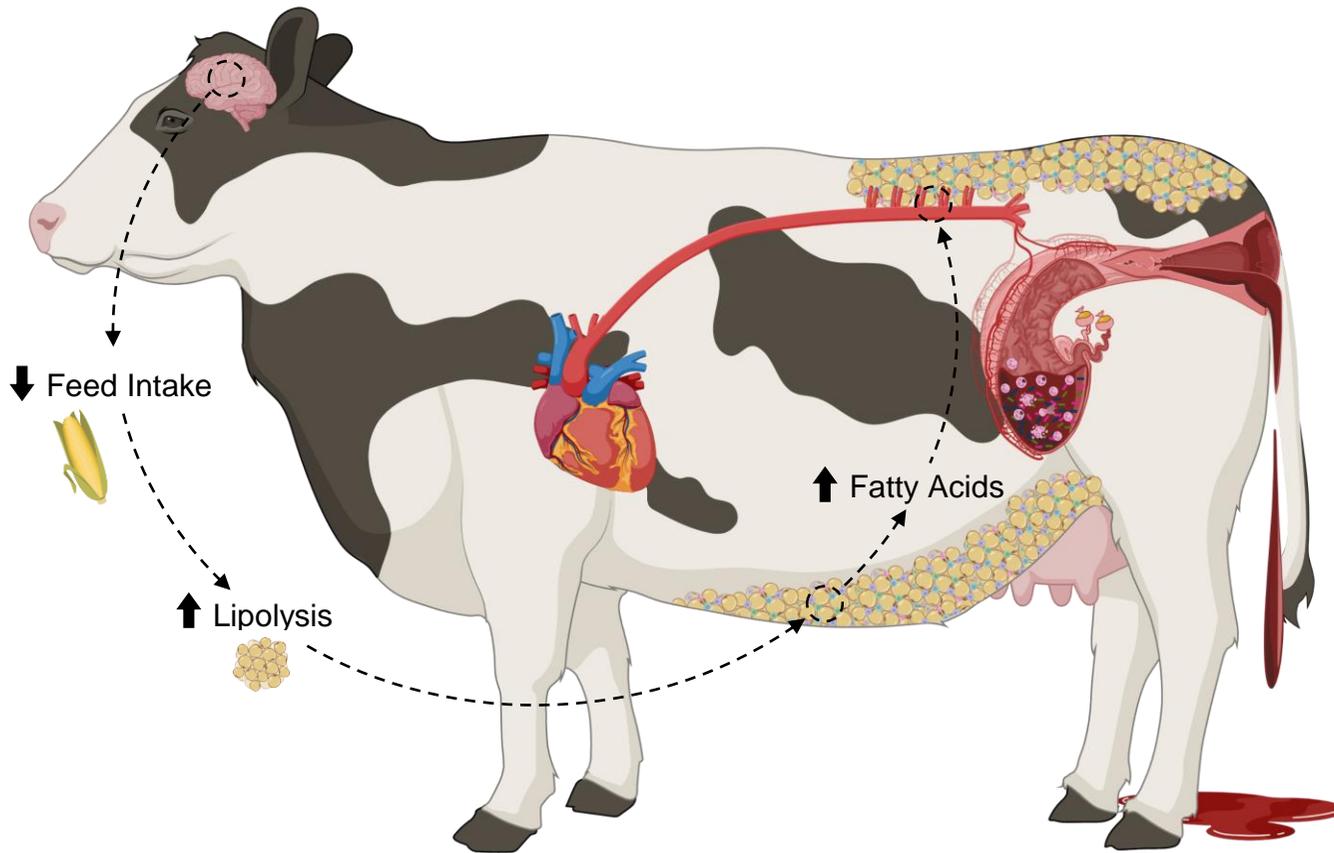


Lipolysis associated adipose tissue inflammation?

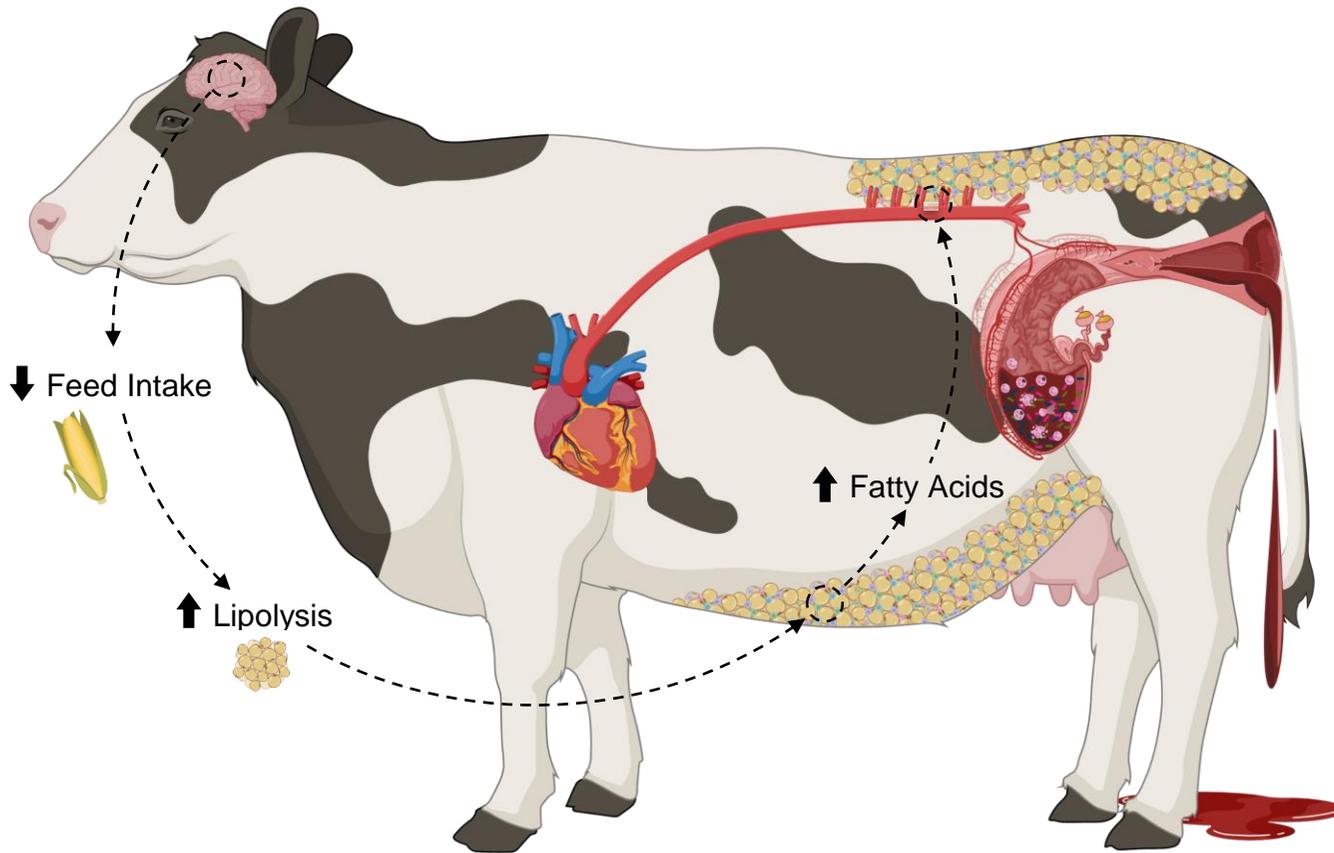
Possible Mechanisms Associated with Decreased DMI in Fat Cows

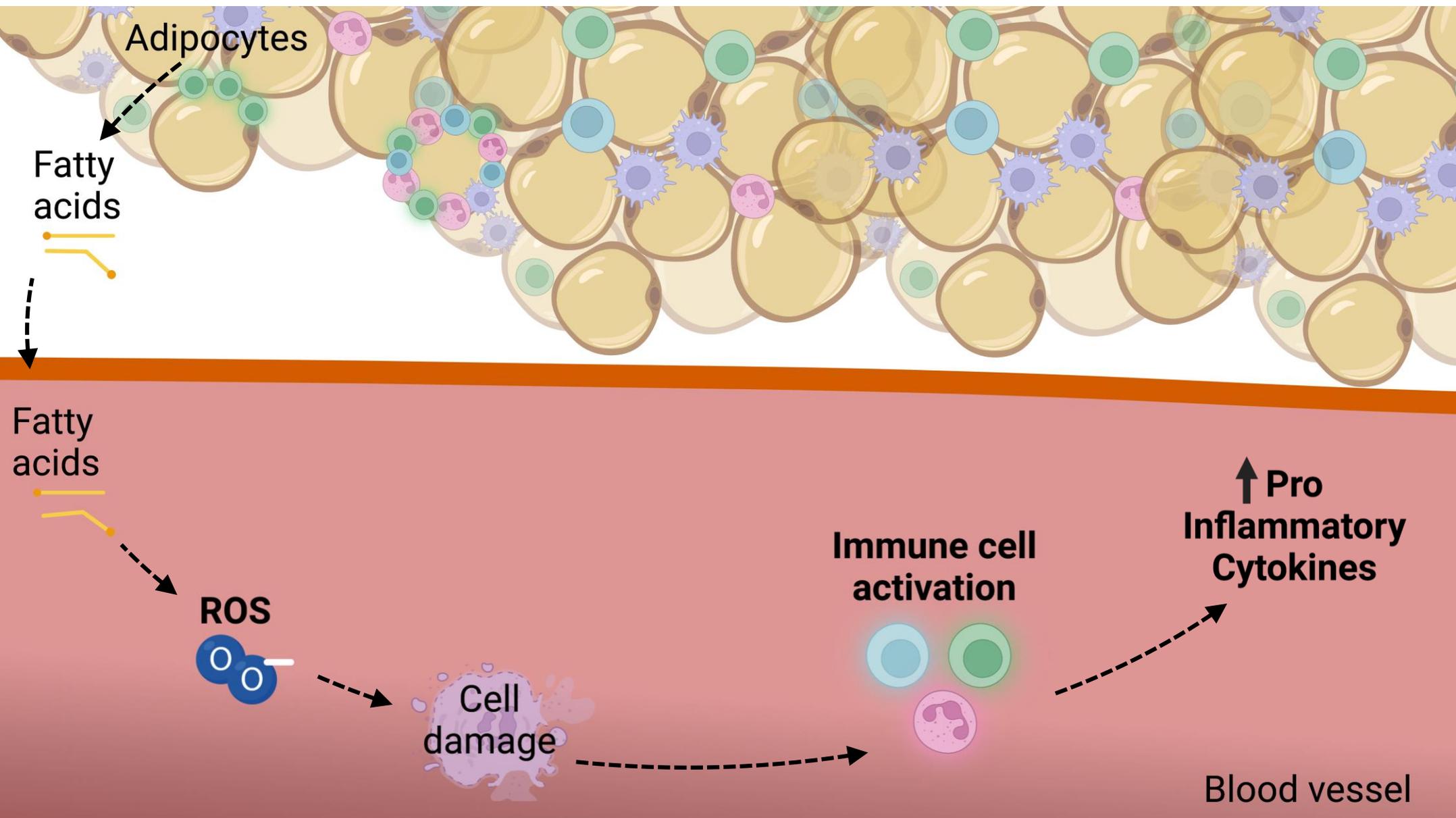


Possible Mechanisms Associated with Decreased DMI in Fat Cows

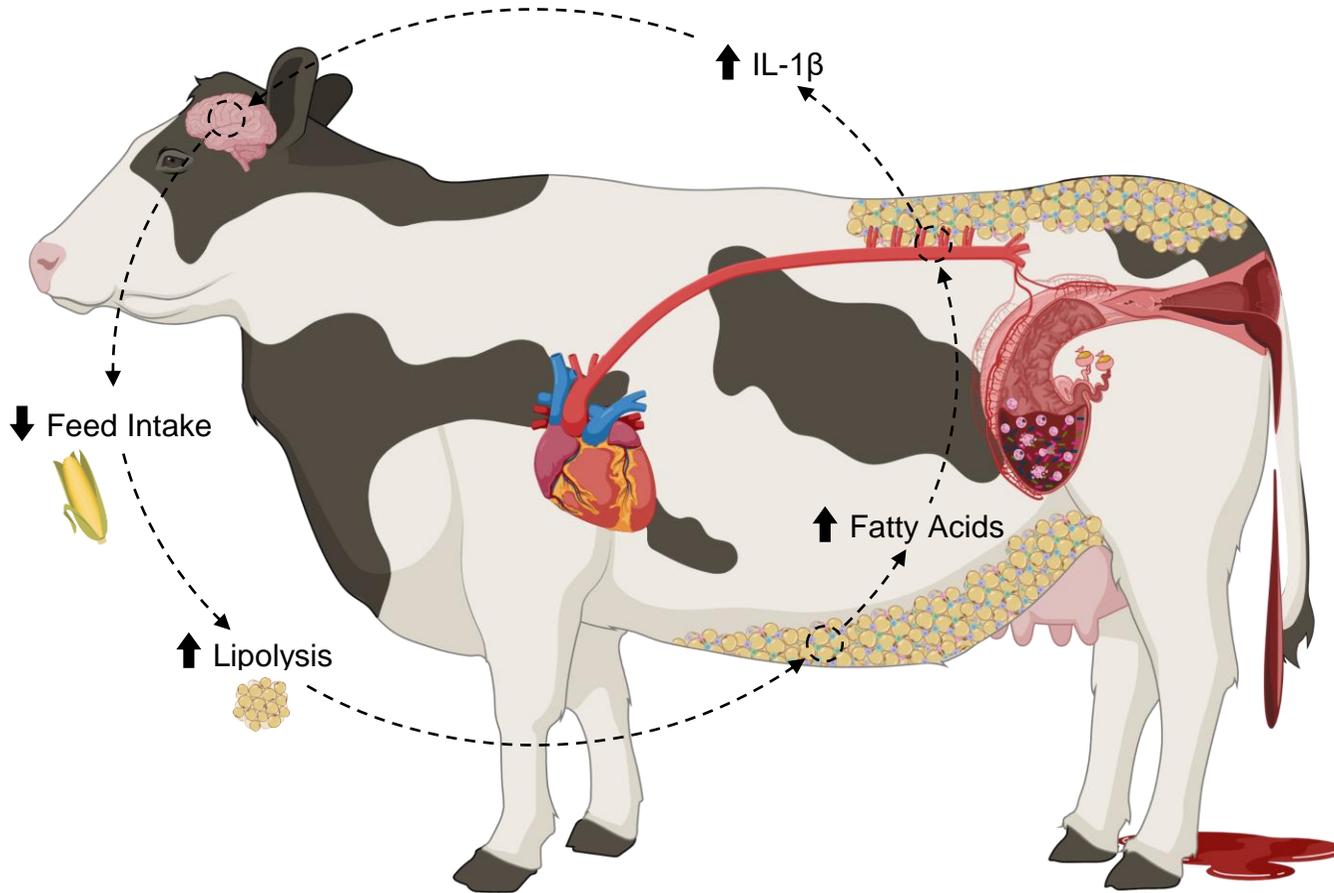


Possible Mechanisms Associated with Decreased DMI in Fat Cows





Possible Mechanisms Associated with Decreased DMI in Fat Cows



The Fat Cow!!!

Dry-off



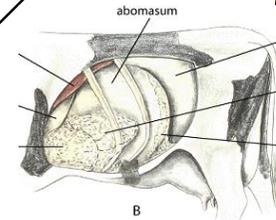
↑ Δ BCS

Dry-period

Calving



Post-partum



↑Mortality
 ↑Culling
 ↓\$\$\$ /cow

↓Pregnancy per AI
 ↓21-d pregnancy rate
 ↓Milk production
 ↓\$\$\$ /cows

↑Calving interval
 ↓Milk yield at dry-off
 ↑Premature dry-off

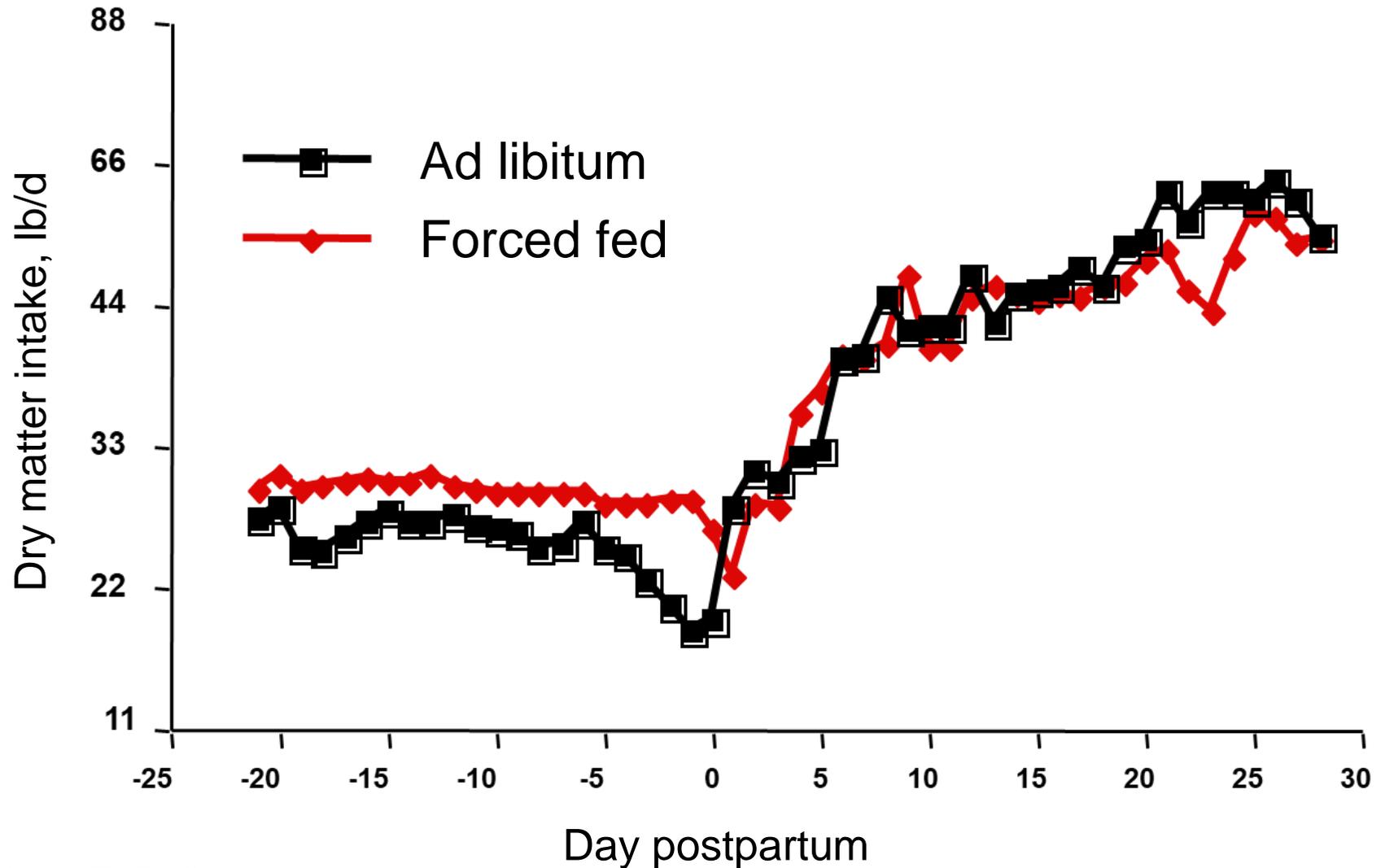
• Prevention

- ↑ Production
- ↑ 21-d pregnancy rates

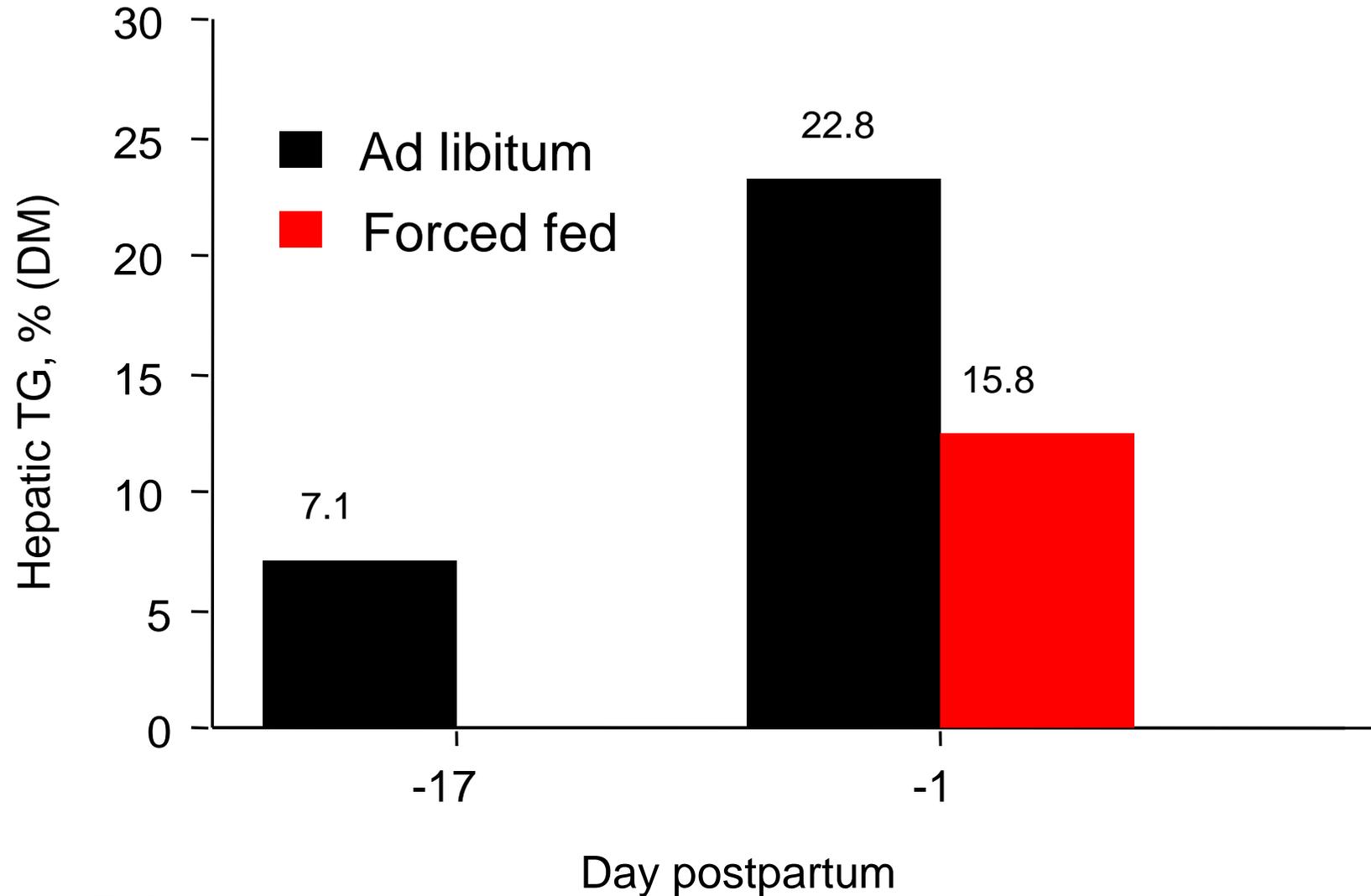
• Treatment ???

- Choline (25 g/d; pre- & post-partum)
- Monensina (200 to 300 mg/d, pre- & post-partum)
- High fiber diets to prevent ↓CMS pre-partum

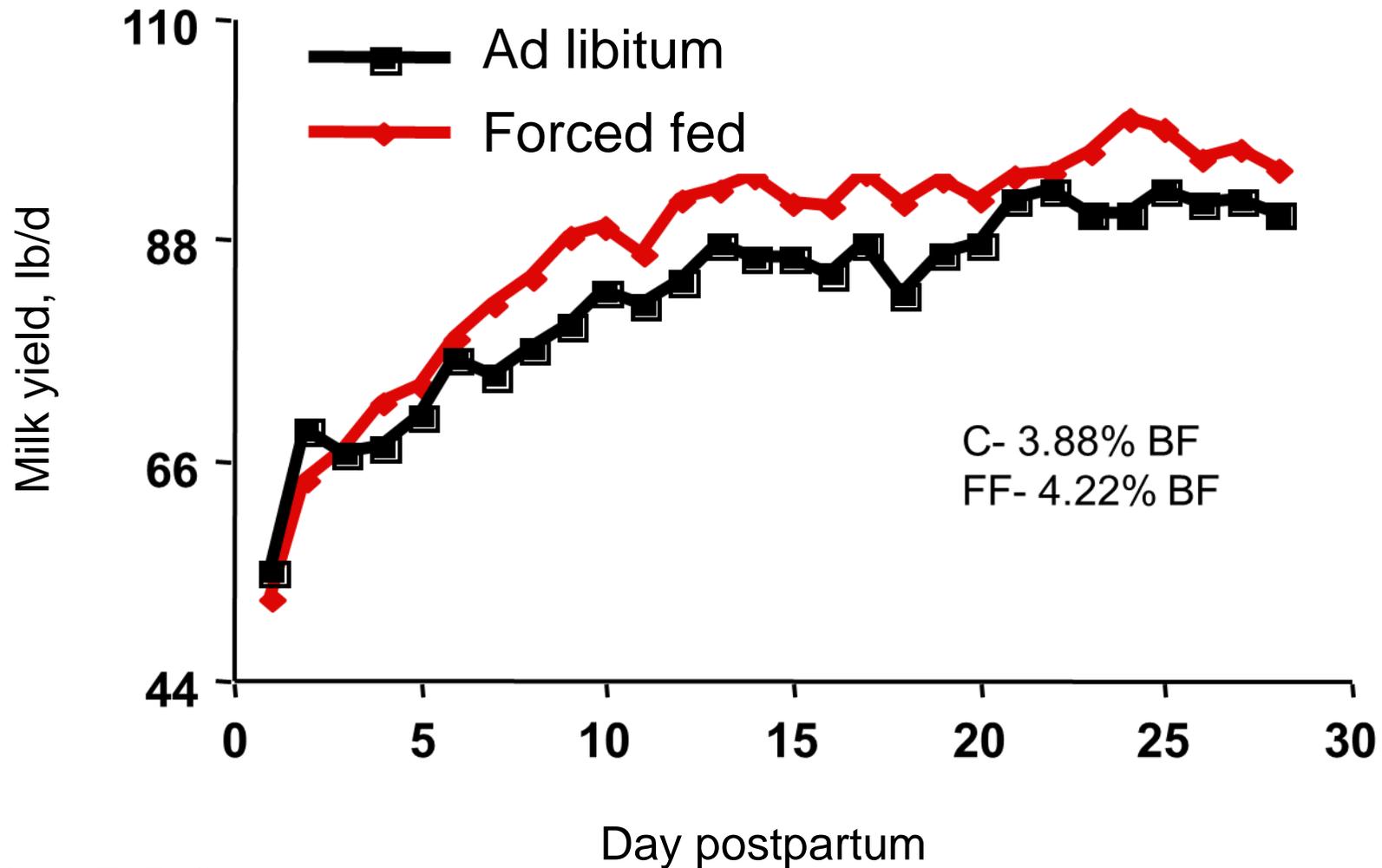
Effects of Force Feeding on Metabolic Responses and Milk Production



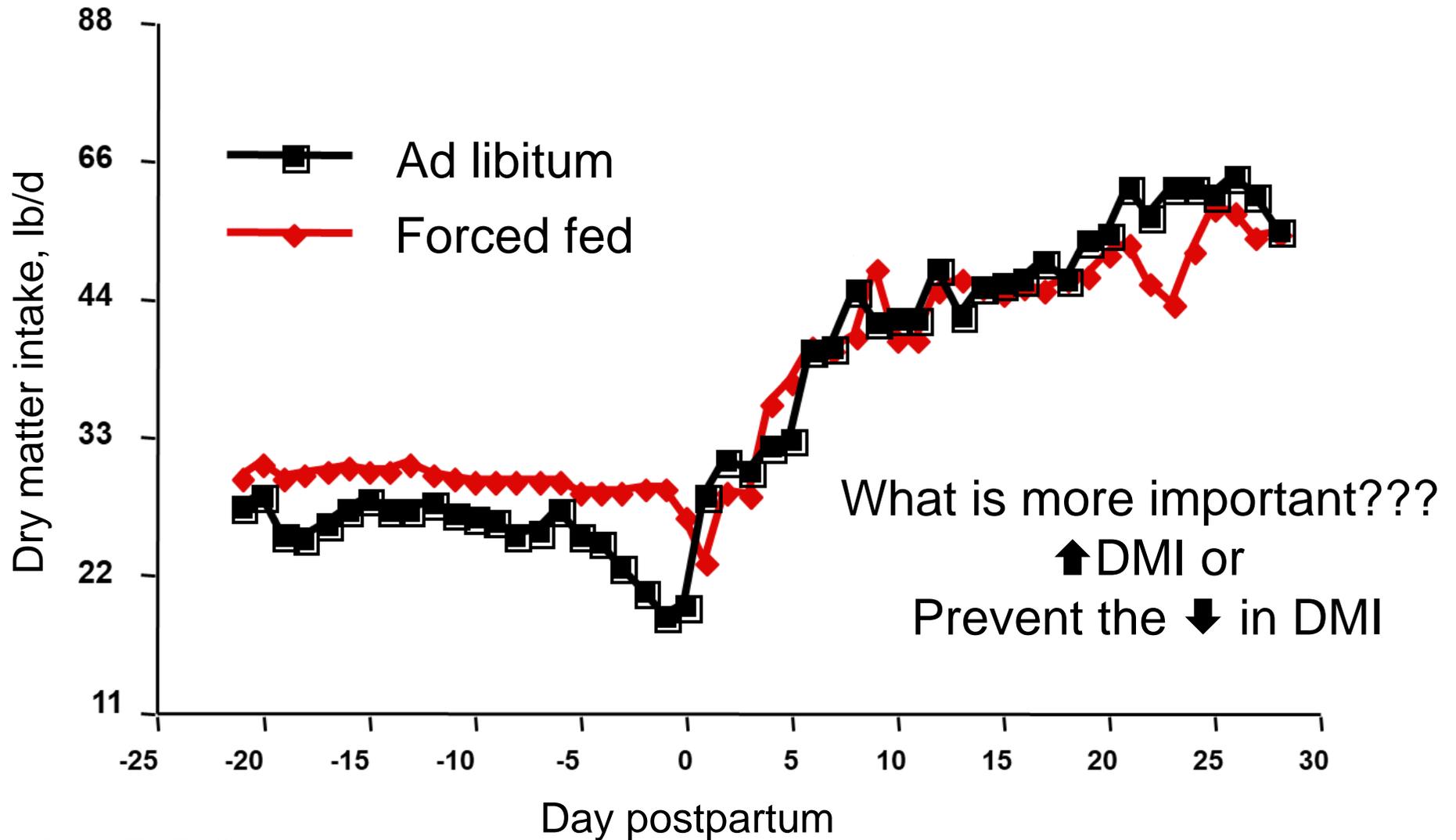
Effects of Force Feeding on Metabolic Responses and Milk Production



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Effects of Force Feeding on Metabolic Responses and Milk Production



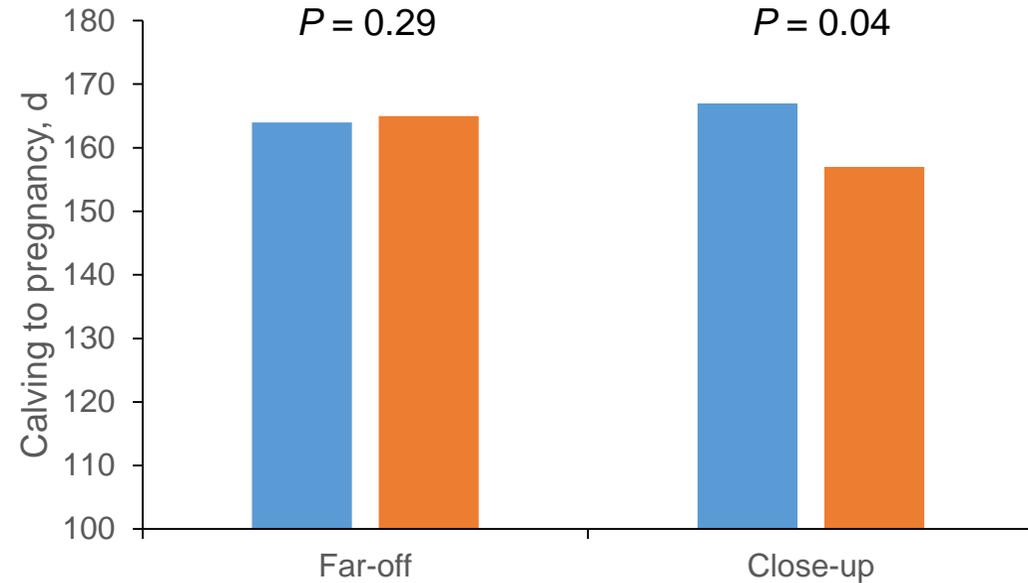
Low Energy, High NDF Diets

- Suggestion that rumen filling prevents sudden drops in DMI prepartum and metabolic disorders
- Cardoso et al. (2013)
 - Using data from 7 experiments, he evaluated the effects of low energy/high NDF diets on metabolic responses, reproduction and production
 - 354 cows and 54 heifers
 - HE = ad libitum access to moderate energy diets (19.8 ± 6.8 Mcal/d)
 - PSSB = 6.4 ± 1.3 (> 19 mm), 43.1 ± 1.3 (8-19 mm), 50.5 ± 3.1 (< 8 mm)
 - EC = ad libitum access to low-energy/high-fiber diets (12.1 ± 4.7 Mcal/d) or dietary restriction (NEL = 80% of requirement)
 - PSSB = 21.8 ± 2.6 (> 19 mm), 35.2 ± 1.7 (8-19 mm), 43 ± 1.4 (< 8 mm)

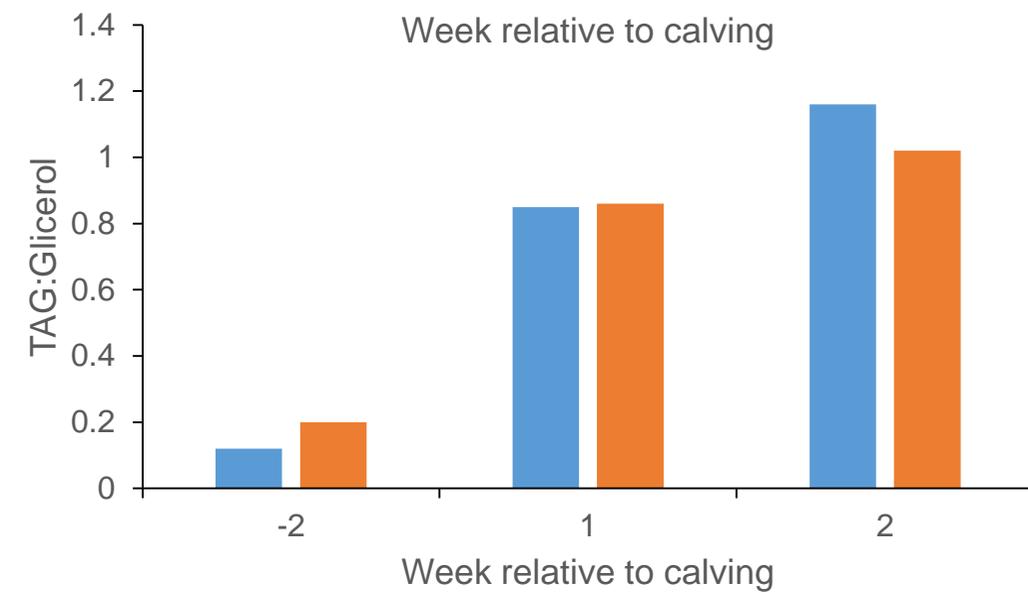
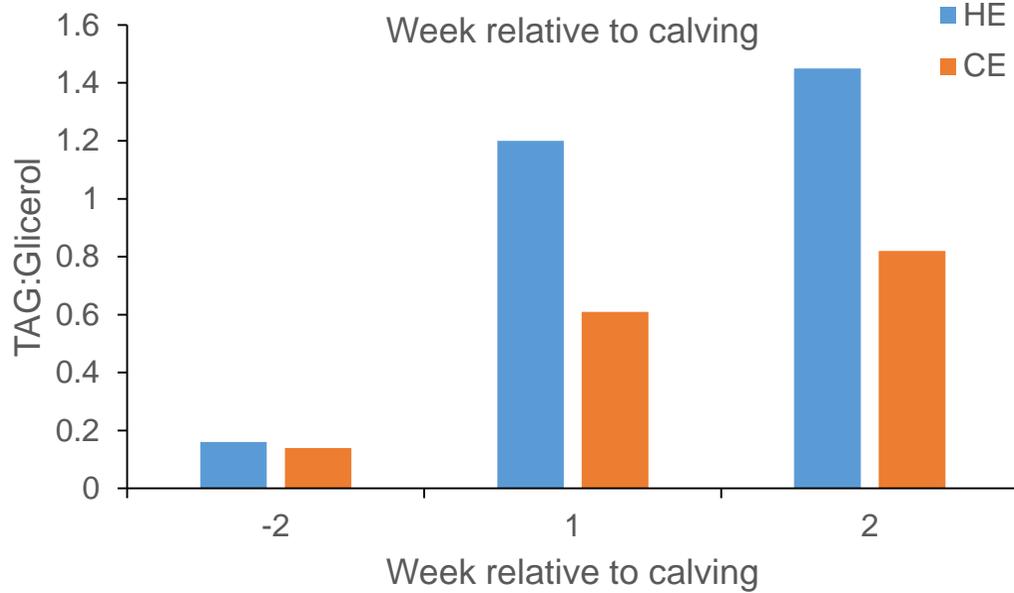
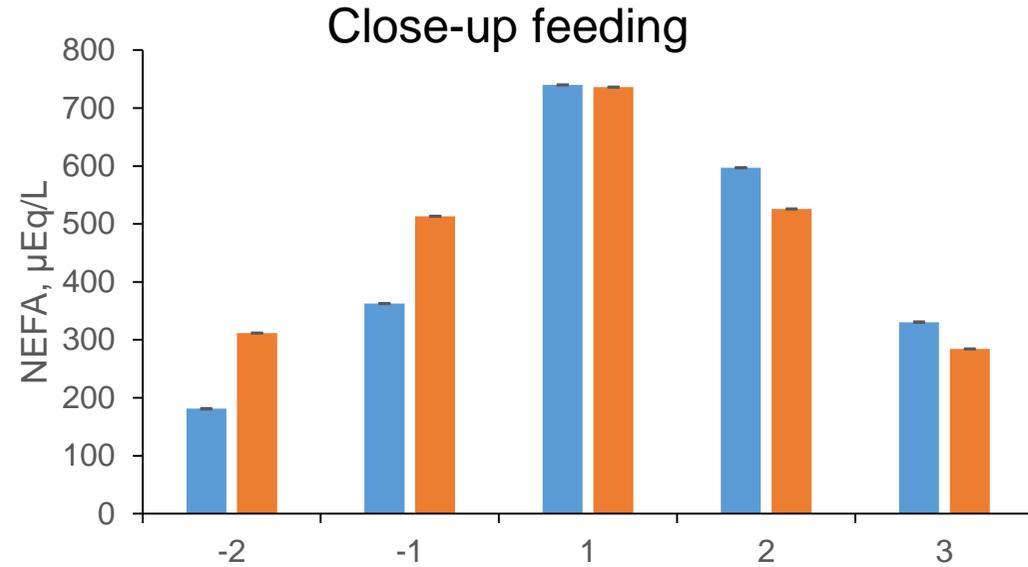
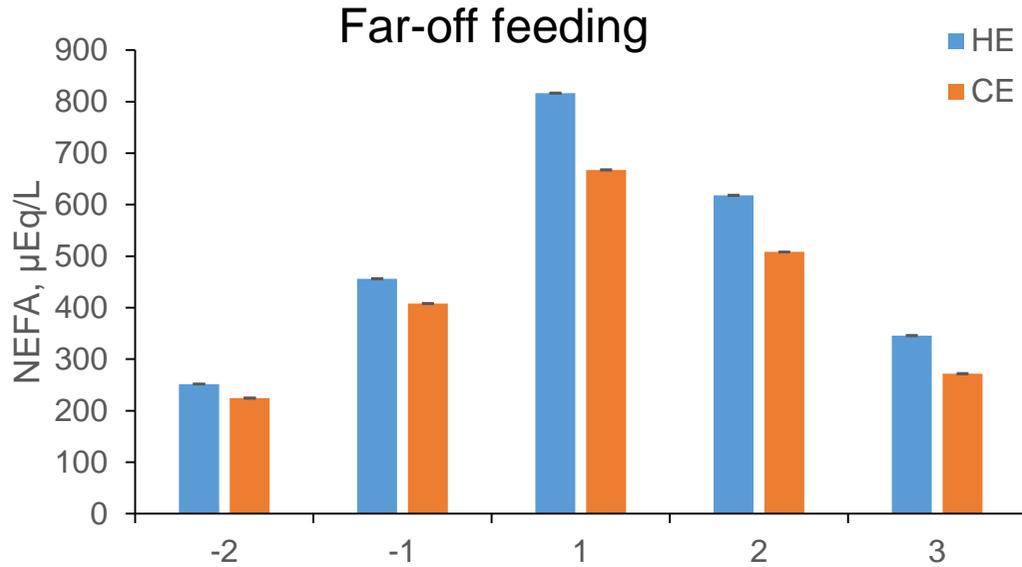
Low Energy Diets/Feed Restriction and Performance

- Authors described positive effects of low energy/feed restriction during the close-up on reproductive performance

Cardoso et al., 2013 (JDS 96:5859–5871)



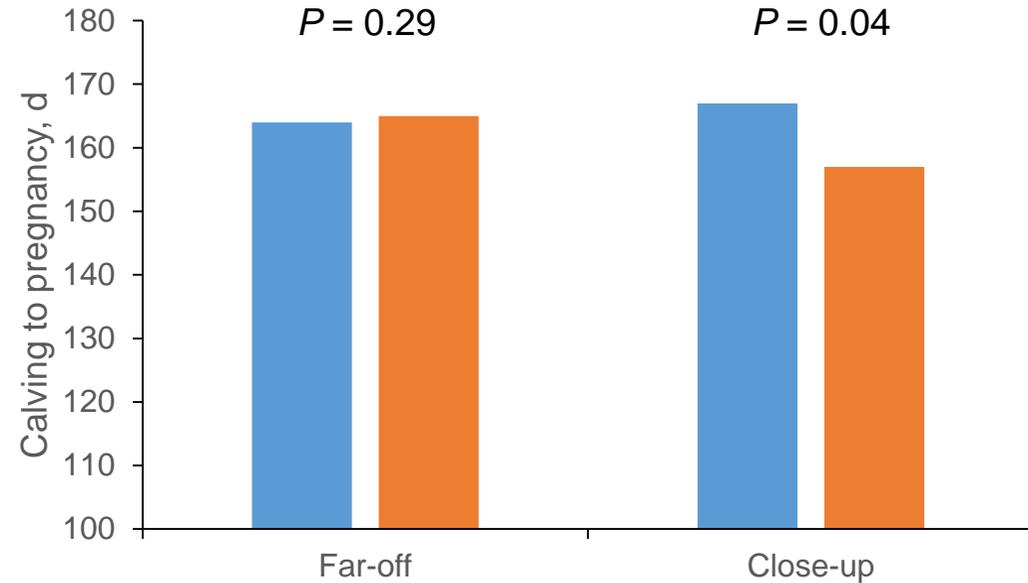
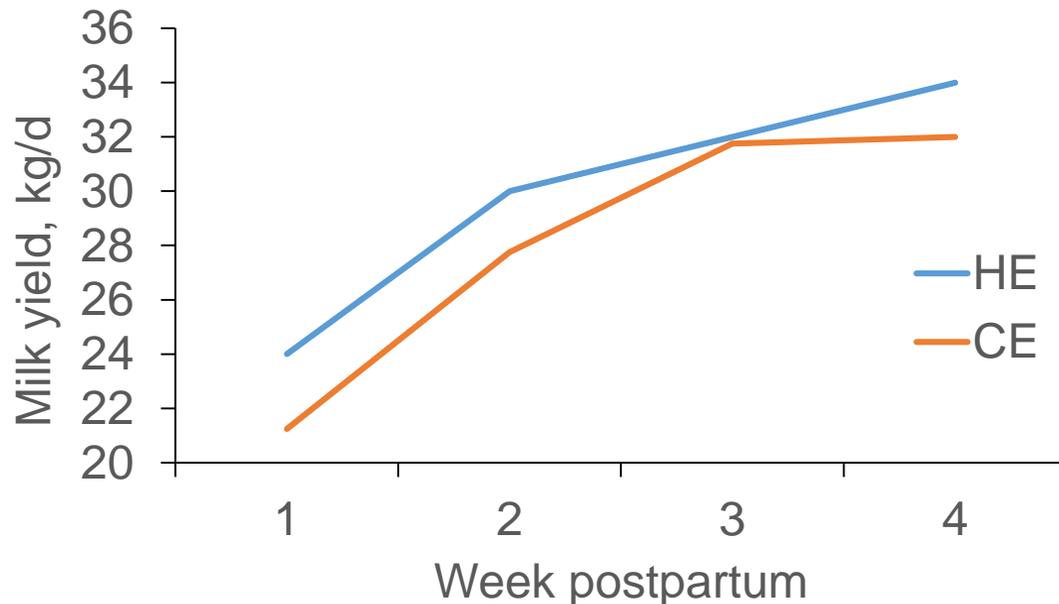
Low Energy Diets/Feed Restriction and Metabolic Responses



Low Energy Diets/Feed Restriction and Performance

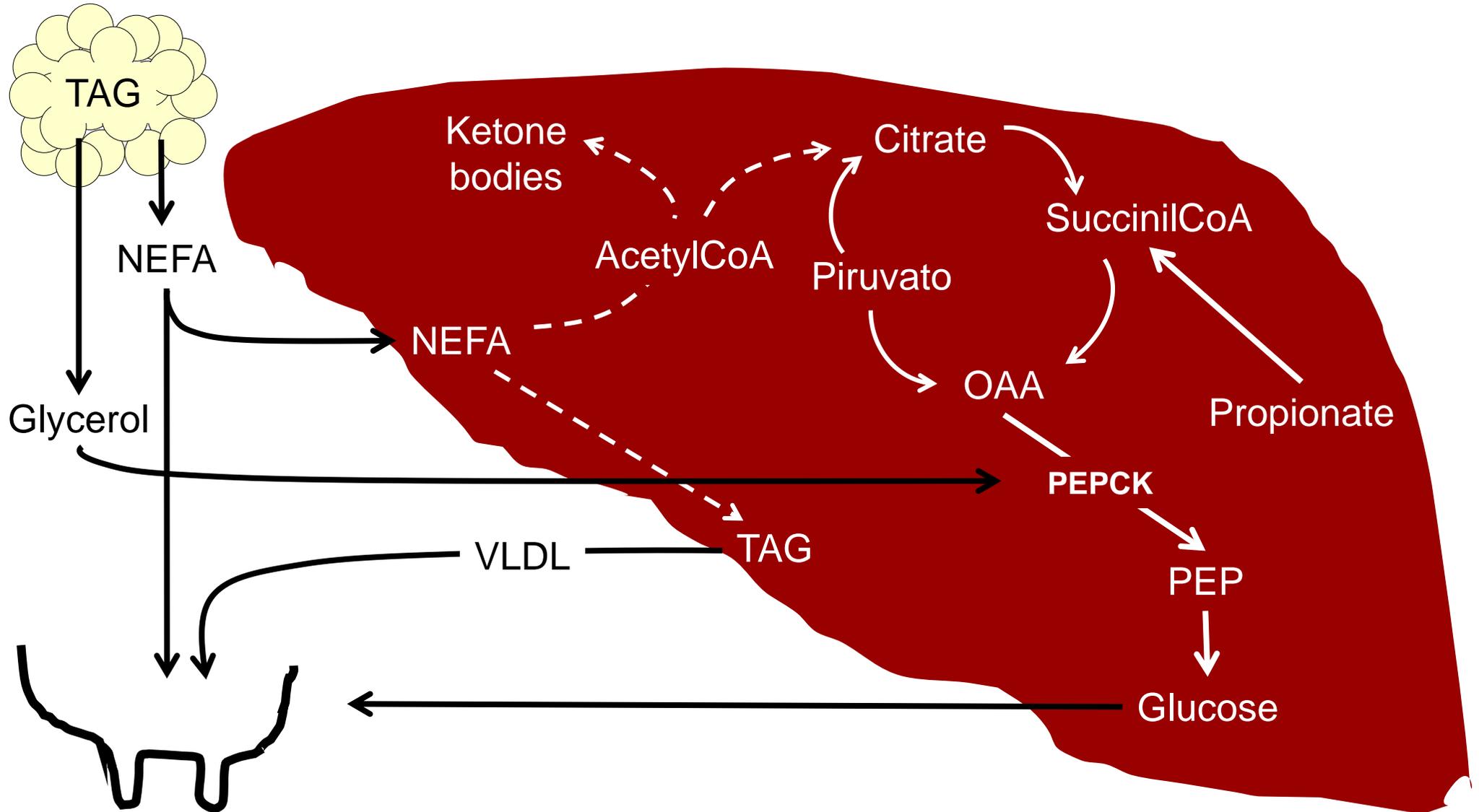
- Authors described positive effects of low energy/feed restriction during the close-up on reproductive performance

Cardoso et al., 2013 (JDS 96:5859–5871)

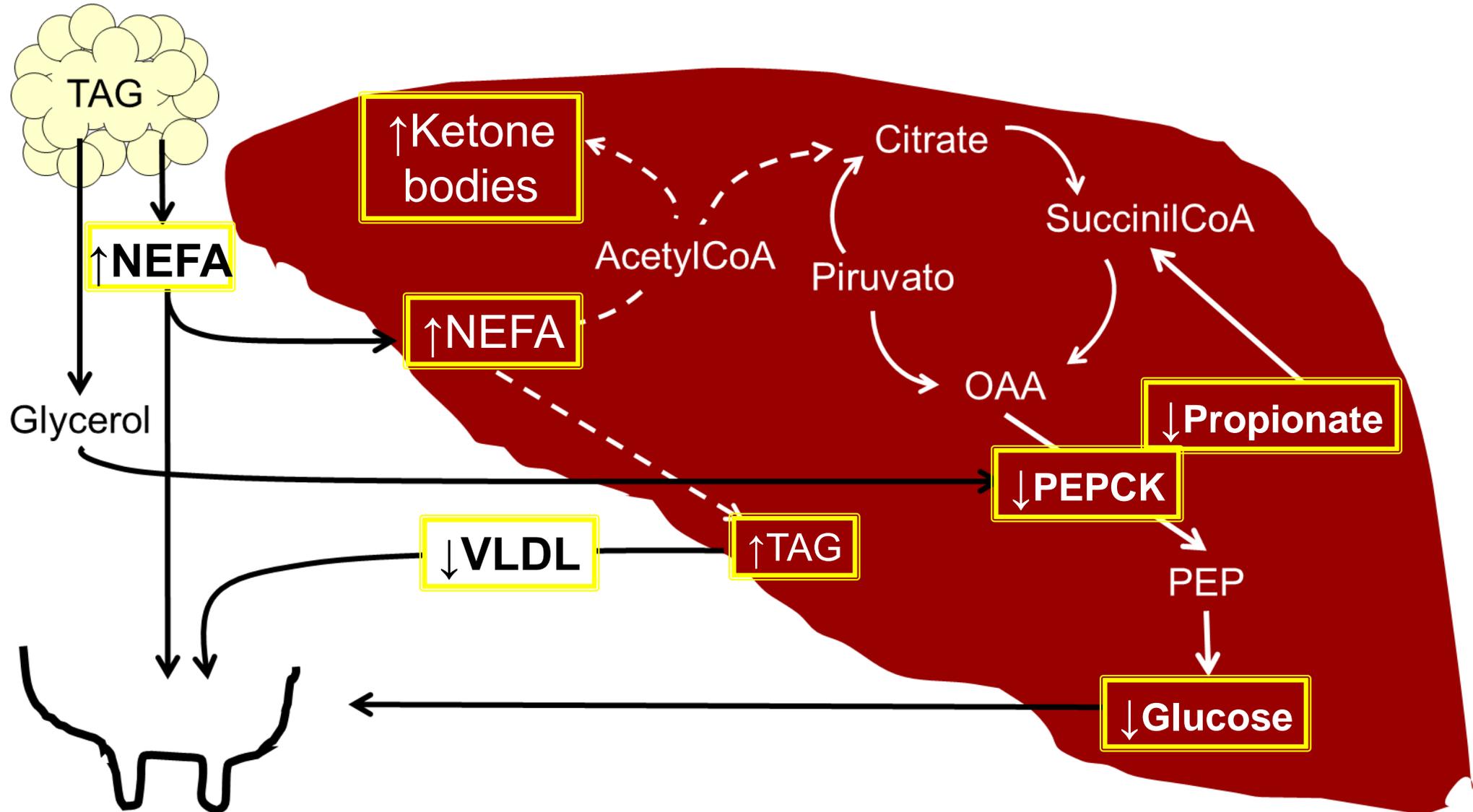


- Authors failed to report that cows in the low energy/feed restriction produced less in the first 4 weeks postpartum (↓1.8 kg/d)

Lipolysis and Lipid Metabolism during Postpartum



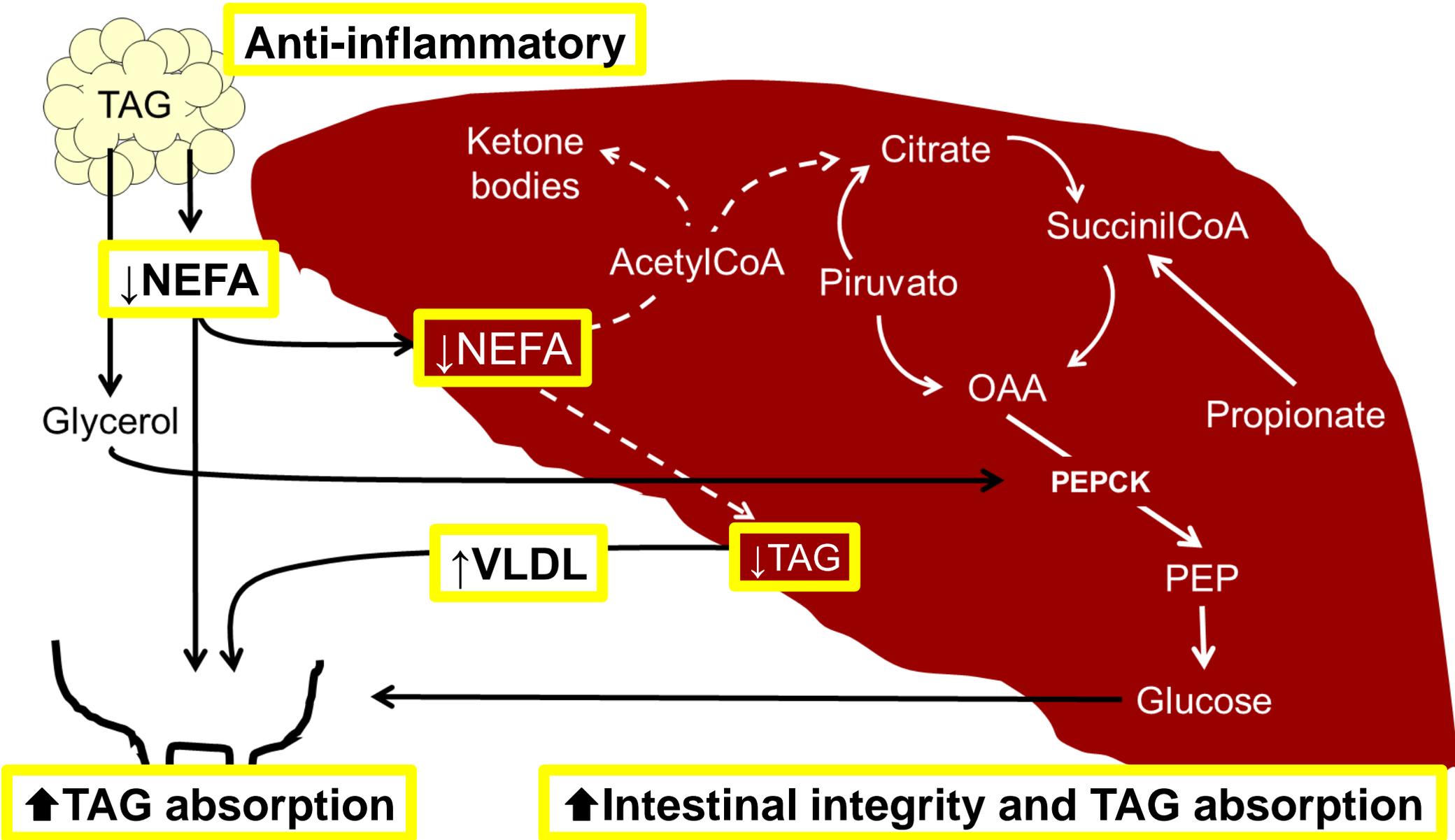
Lipolysis and Lipid Metabolism during Postpartum





Supplementation of Choline Transition Cows: Effects on Health

Possible Effects of Choline on Lipid Metabolism



Choline: Effects on Production and Health

- Meta-analysis:
 - 21 experiments, 66 treatments and 1,313 cows
 - Pre- and postpartum supplementation
 - Treatments: no-choline (0 g/d) vs. choline (5.6 to 25.2 g/d)
 - Pre-partum feeding duration = 22.0 ± 6.0
 - Post-partum feeding duration = 57.5 ± 42.2 d, respectively

Choline: Effects on Production and Health

- With amount of choline fed increased from 0 to 12.9 g/d
 - ↑DMI post-partum = 0.5 kg/d
 - ↑BCS post-partum = 0.09 unidade quando
 - ↑ECM = 1.7 kg/d
 - Dependent on methionine concentration, indicating that part of the effect is due to increased availability of C donors for cellular metabolism
 - ↓Hepatic glycogen, no effect on triglycerides
 - ↓Incidence of RP and mastitis
- RPC supplementation had a linear effect on most productive responses – maximum evaluated supplementation = 25 g/d

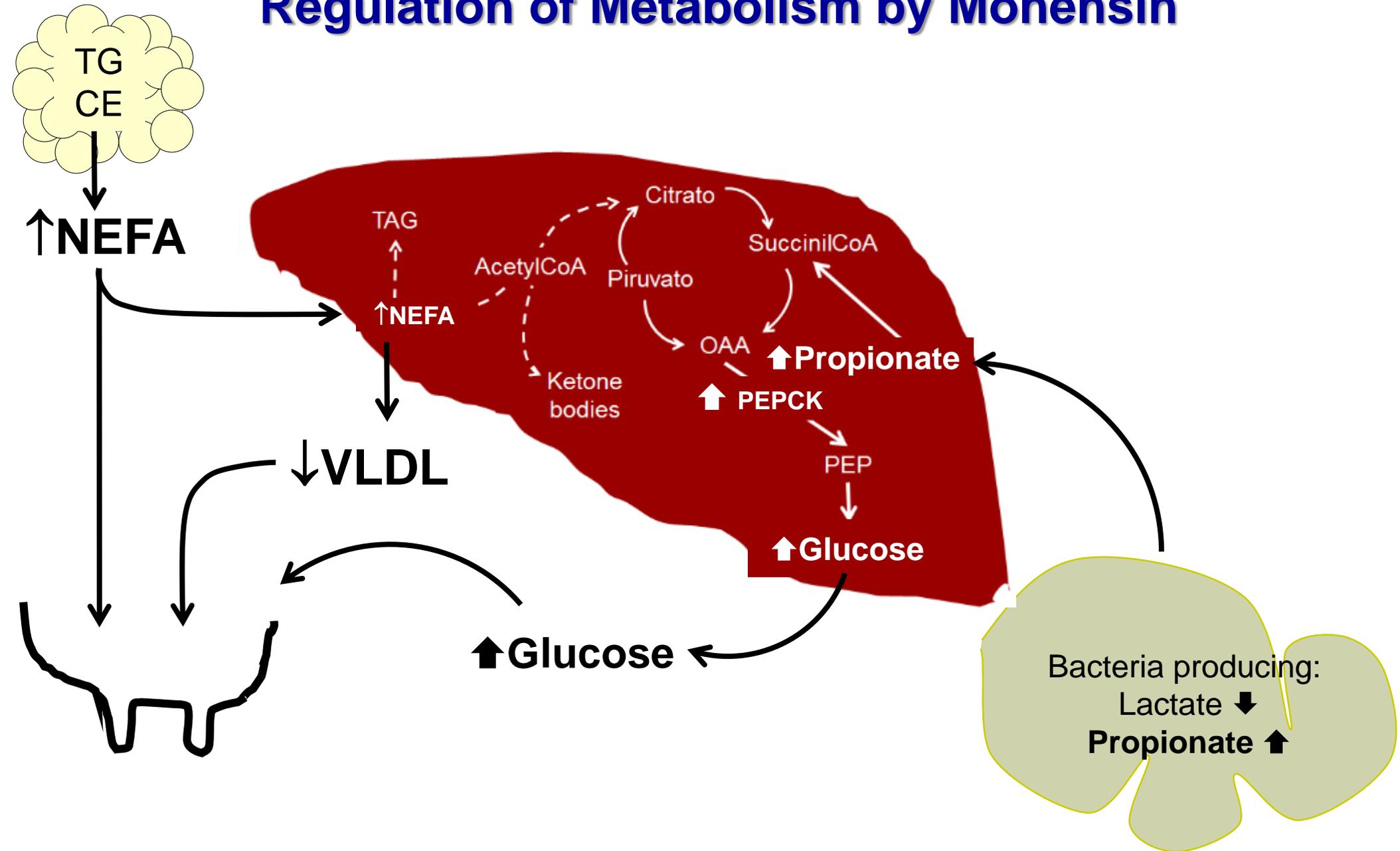
Arshad et al. 2019 (JDS 103:282–300)

- Effects of choline supplementation are independent of BCS in the prepartum (Bollatti et al., 2020)



Effects of Monensin Sodium Supplementation on Metabolic Responses, Health and Performance

Regulation of Metabolism by Monensin



Effects of Monensin during Transition on Metabolic Responses and Performance

- Meta-analyses to assess the effects of monensin (200 to 300 g/d) on metabolic responses, health and performance
- Metabolic responses
 - BHBA (↓13.4%), NEFA (↓7.1%) and acetoacetate (i↓14.4%)
 - Glucose (↑3.2%) and urea (↑6.2%)
 - BHBA: better results when monensin was included in the total ration, supplemented up to 30 days of lactation
 - NEFA: better results when monensin was supplemented during pre and postpartum



Effects of Monensin during Transition on Metabolic Responses and Performance

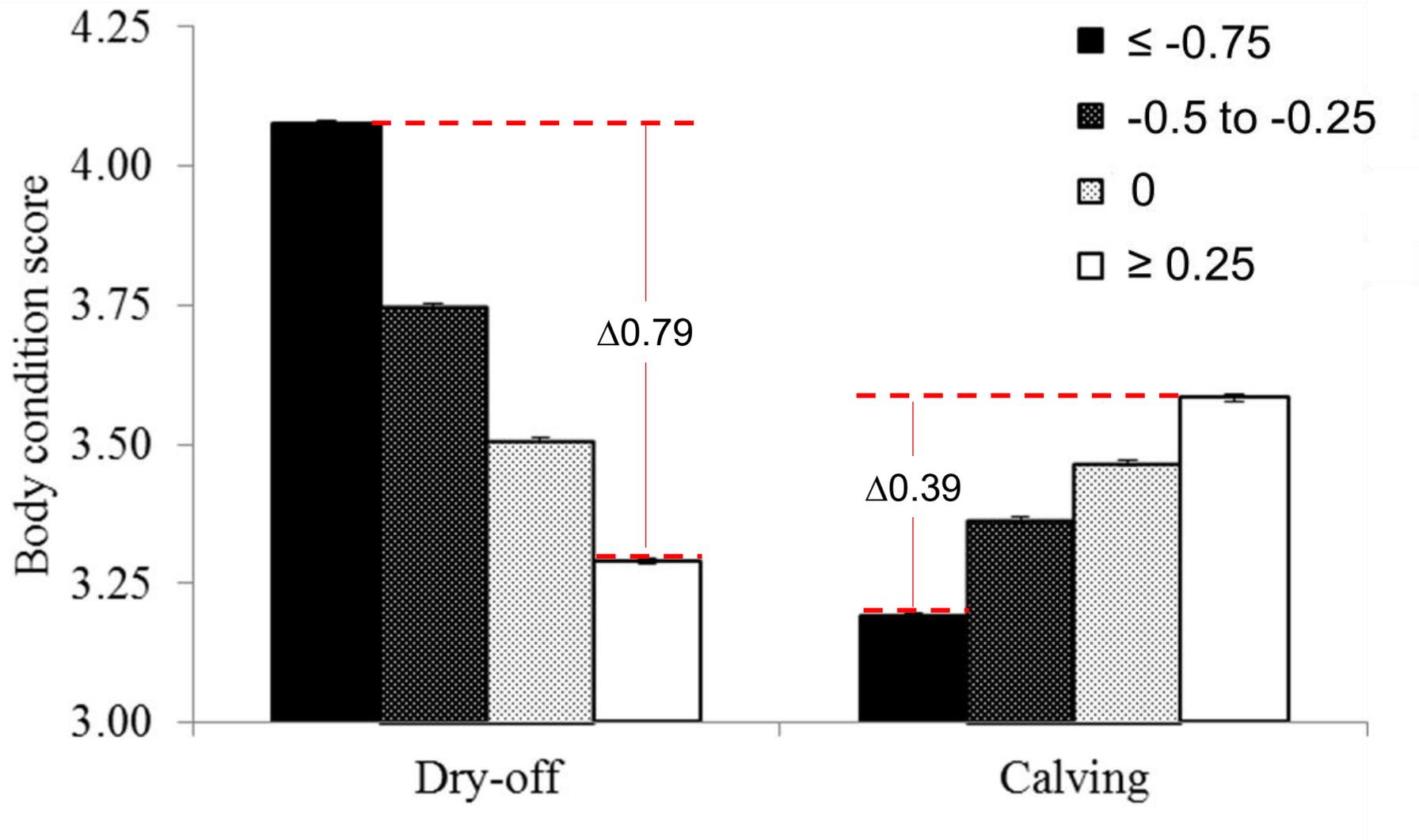
- Meta-analyses to assess the effects of monensin (200 to 300 g/d) on metabolic responses, health and performance
- Health
 - Displaced abomasum (↓25%), ketosis (↓25%) and mastitis (↓9%)
 - No effects on metritis, endometritis, pregnancy to 1st AI or culling
- Performance
 - Increase in milk production (↑2.3%)
 - Decrease DMI (↓2.3%)
 - Production efficiency (↑2.5%)





Do Holstein Cows Seek an 'Ideal' BCS at Calving?

Do Holstein Cows Seek an 'Ideal' BCS at Calving?



Do Holstein Cows Seek an 'Ideal' BCS at Calving?

- 2,573 cows (3,251 lactations) gained BCS during the dry period

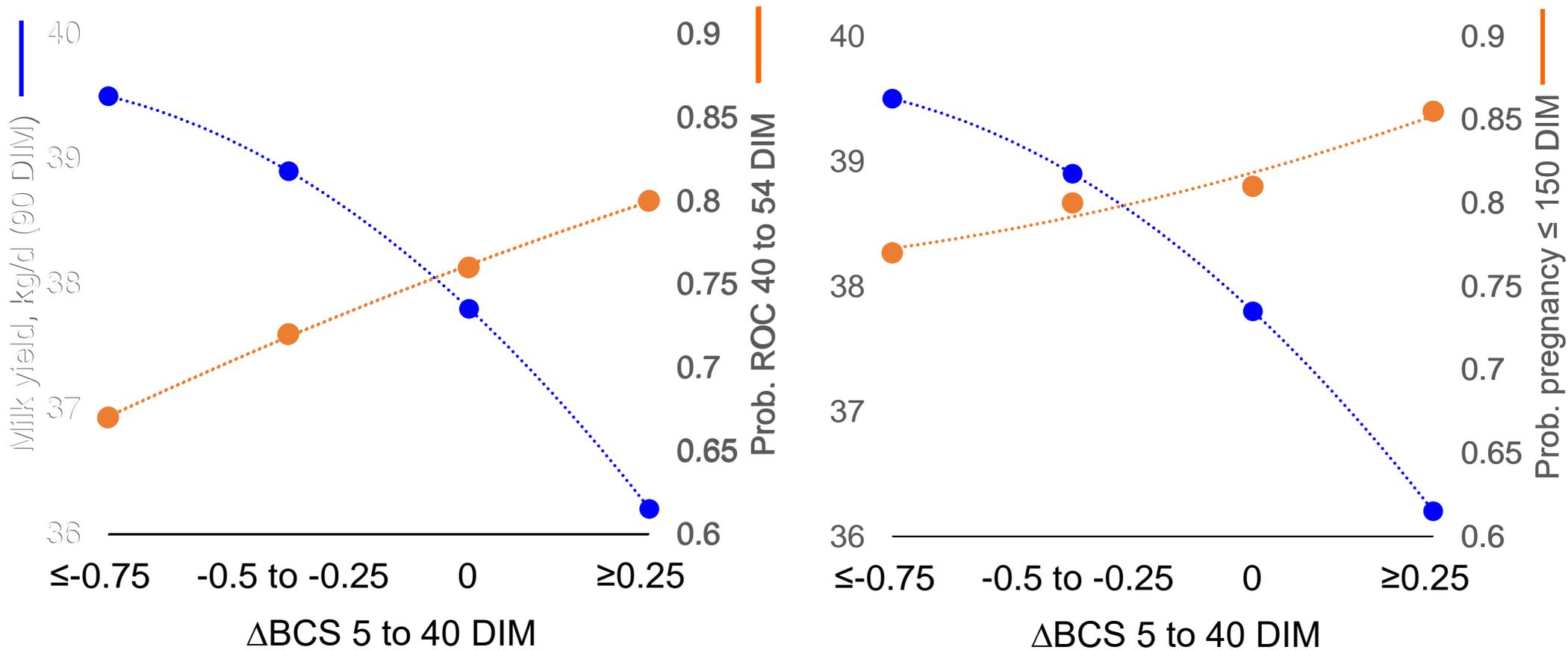
Outcome	BCS at fresh				P - value
	≤ 3.25 (n = 502)	3.5 (n = 1,386)	3.75 (n = 997)	≥ 4.0 (n = 366)	
Morbidity, %	54.7 ^a ± 4.1	44.1 ^b ± 3.7	43.1 ^b ± 3.8	41.5 ^b ± 4.6	< 0.001
Removal 60 DIM, %	5.5 ^a ± 0.01	3.5 ^b ± 0.01	3.1 ^b ± 0.01	4.2 ^{a,b} ± 0.01	0.09
Pregnancy (305 d), AHR	0.83 ^a (0.71, 0.98)	1.01 ^b (0.88, 1.16)	1.06 ^b (0.92, 1.21)	Ref. ^b	0.003
Milk yield (305 d), kg/d	39.0 ^a ± 0.3	40.3 ^b ± 0.2	40.9 ^b ± 0.3	39.2 ^a ± 0.4	< 0.001

- As long as cows gained BCS during the dry period, BCS = 3.5 to 3.75 at calving was associated with improved performance



Gain of BCS Postpartum is “Incompatible” with Maximum Milk Yield

- Data from 11,729 cows from 16 herds, across 9 US states



- +ΔBCS postpartum = **↑** reproductive efficiency and **↓** milk yield



Summary of Key Management Points



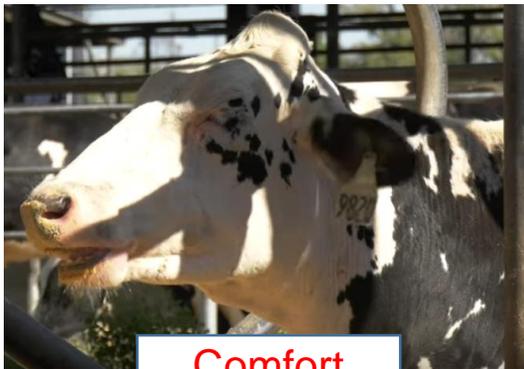
Sire selection, size at calving, monitoring



Access to feed and water



Balanced diets



Comfort



↓ Heat stress



Simple and objective monitoring



Group by parity



Aggressive reproduction



Data analyses



Thank you!!!

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