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aka, what we did during COVID!

New Insights from University of Wisconsin Transition Cow Research

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Peripartum Challenges and Opportunities

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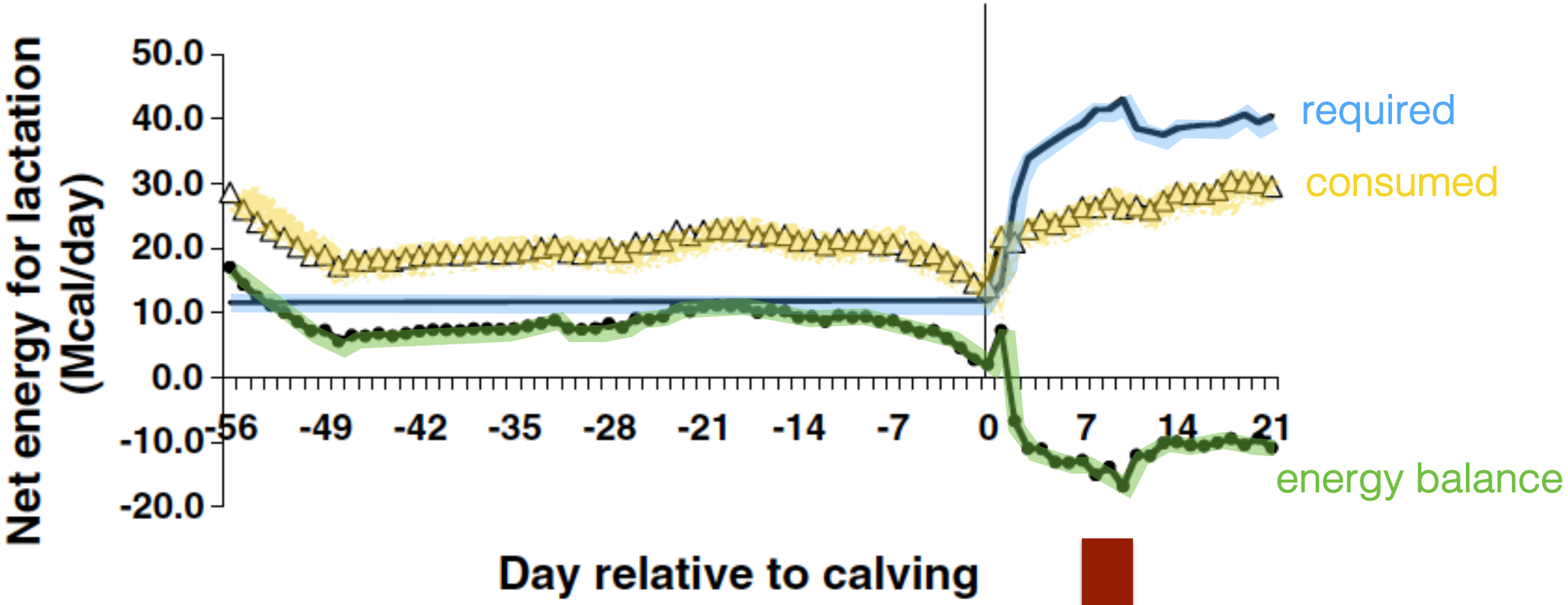
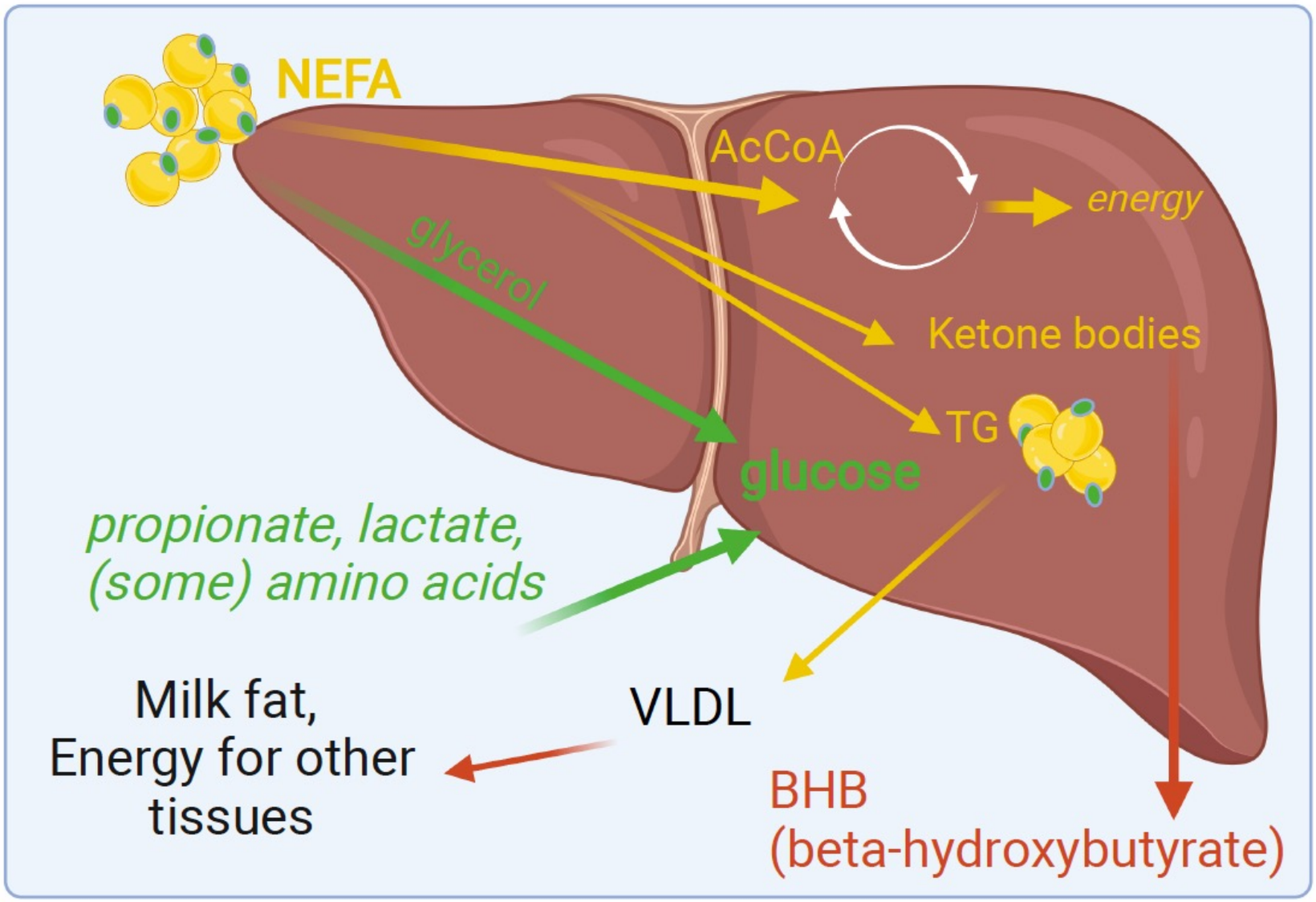


Negative Energy Balance
Negative Macronutrient balance
Negative Micronutrient balance

Grummer, 2008

Peripartum Challenges and Opportunities

Nutrients that modulate these pathways can be beneficial.



Negative Energy Balance
Negative Macronutrient balance
Negative Micronutrient balance

Nutrition Can Propagate our Impact

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- Impact of RP Choline supplementation on lactation performance
- Mechanism of action to support production
- Impact of supplementing cows with RP Choline on offspring growth and health

Choline as a Nutritional Intervention

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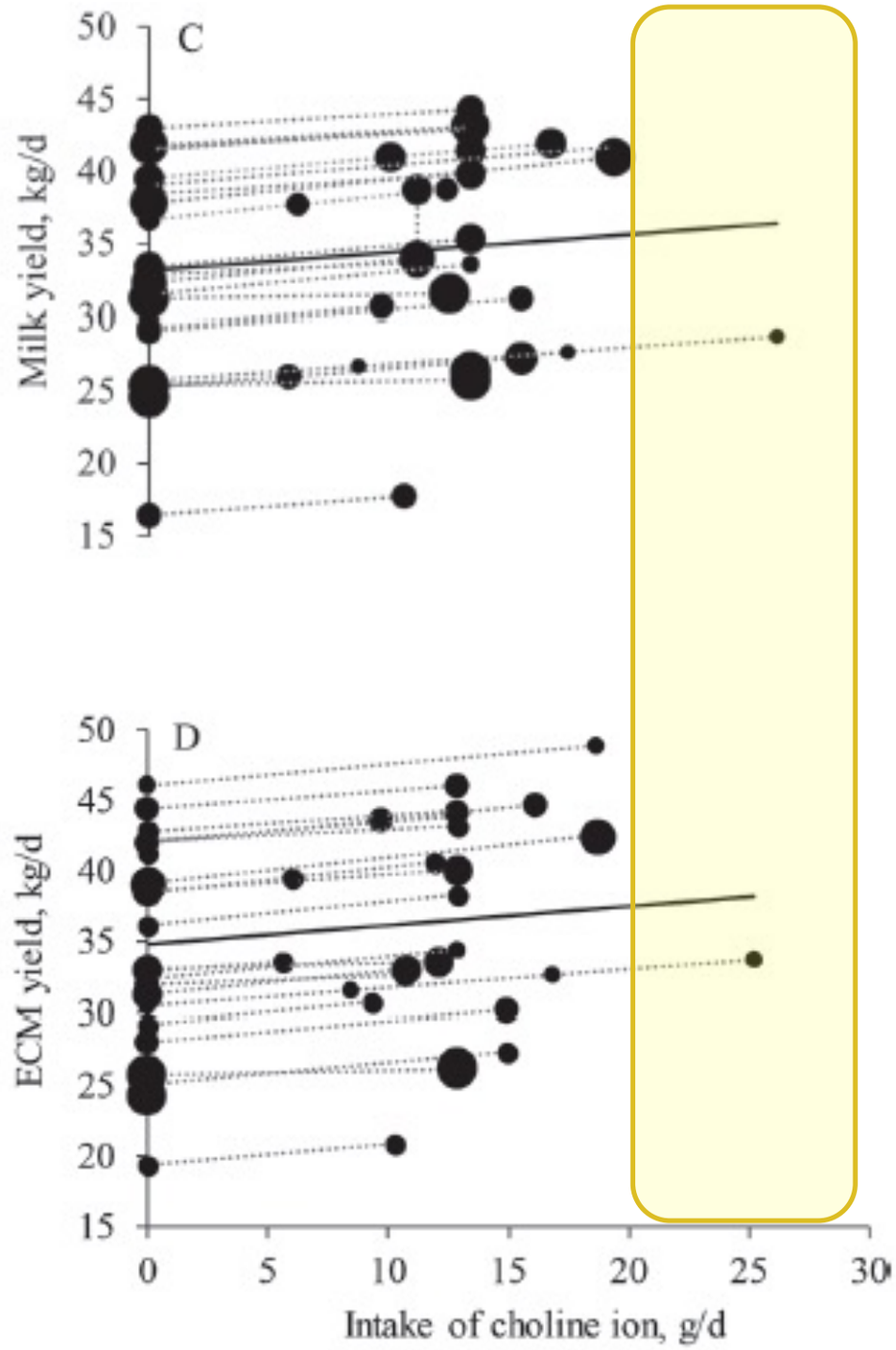
Choline meta-analysis of
23 transition cow studies;
74 treatment means; 1,938 cows

- Energy-corrected milk: Increased 1.61 kg/day
- Milk fat yield: Increased 0.08 kg/day
- Milk protein yield: Increased 0.06 kg/day
- DMI: Increased pre- and postpartum 0.28 and 0.47 kg/d



Arshad et al, 2020

Effects of Prepartum RPC Dose on Postpartum Performance

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- Multiparous cows (n=116) enrolled 21 days prior to calving and fed in electronic feeding gates
- Treatment additives were balanced for non-choline nutrients and amount, and mixed into the TMR

- **Control:** no RPC
- **$RPC1_{RD}$:** recommended dose (15 g choline ion; ReaShure, Balchem, Corp)
- **$RPC2_{RD}$:** recommended dose (15 g choline ion; concentrated RPC prototype, Balchem, Corp)
- **$RPC2_{HD}$:** high dose (22 g choline ion; concentrated RPC prototype, Balchem, Corp)

Prepartum:

Individual Cow DMI

Increasing prepartum RPC

Effects of Rumen Protected Choline Supplementation on Cow and Calf Performance

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Prepartum:

Individual Cow DMI

Increasing prepartum RPC

Postpartum *(1 to ~21 DRTC):*

Pens of 8, RD of treatments maintained

Lactating *(~21 DRTC to 100 DRTC):*

Mixed pens of 16, common diet

Effect of RPC Supplementation on Milk Yield

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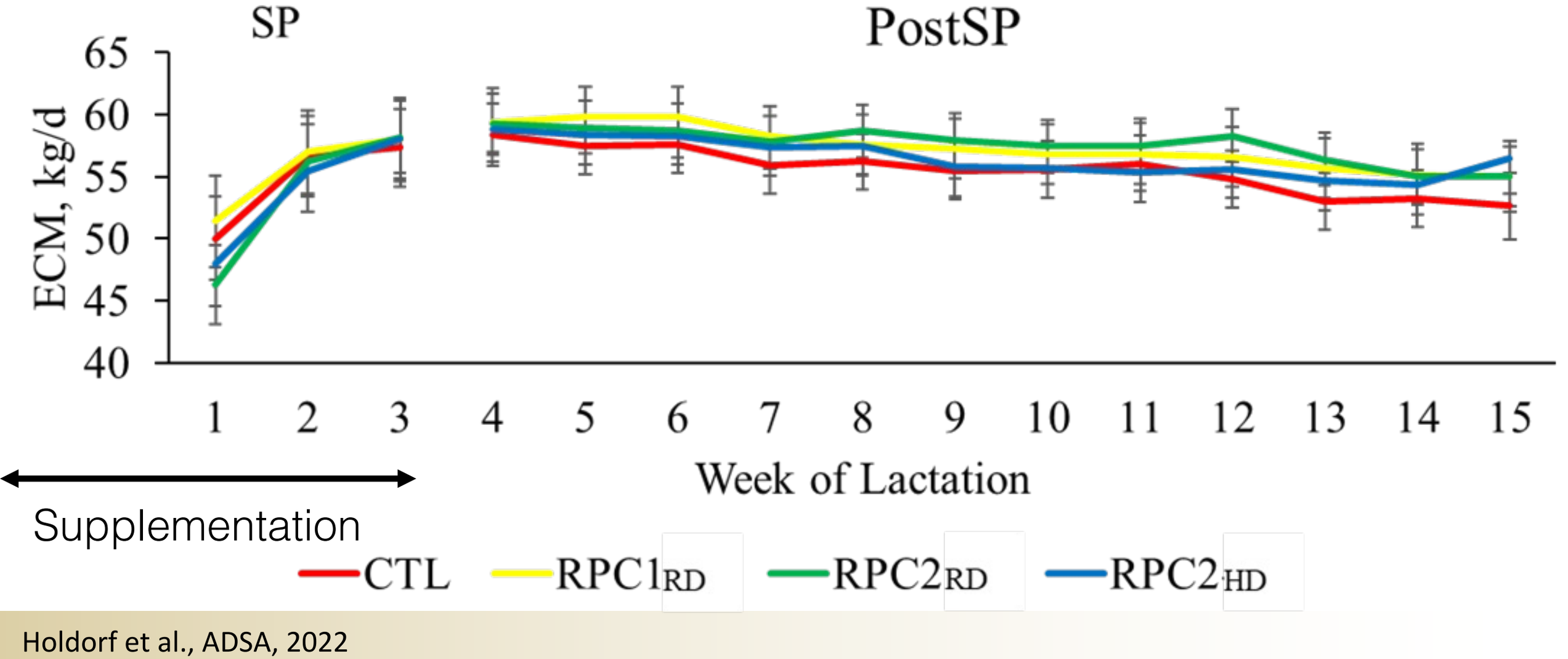
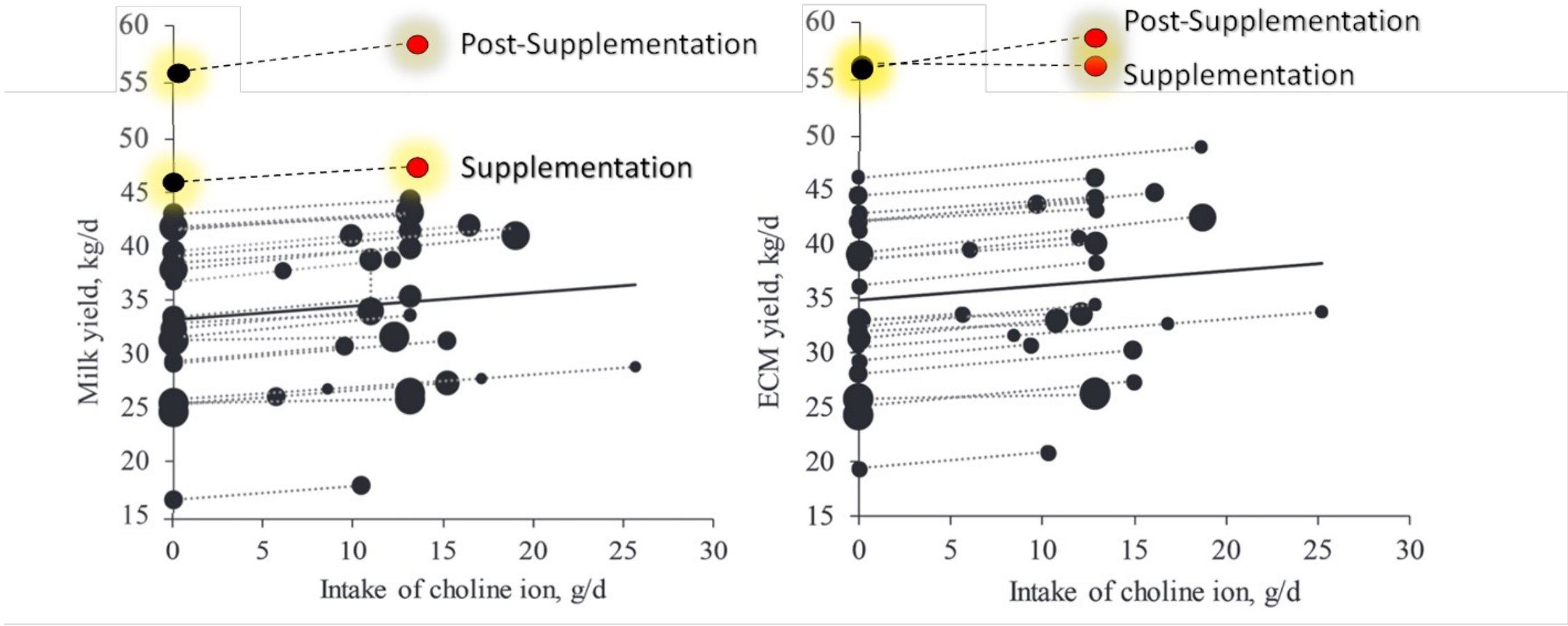
Ctl 122.1 lb/d
$RPC1_{RD}$ 126.3 lb/d 4.6 lb/d advantage
$RPC2_{RD}$ 126.7 lb/d *(2 kg/d)*
$RPC2_{HD}$ 124.3 lb/d

Ctl vs. $RPC1_{RD}$ and $RPC2_{RD}$ *P*-value = 0.10



Holdorf et al., ADSA, 2022

Milk Production compared with Meta Analysis



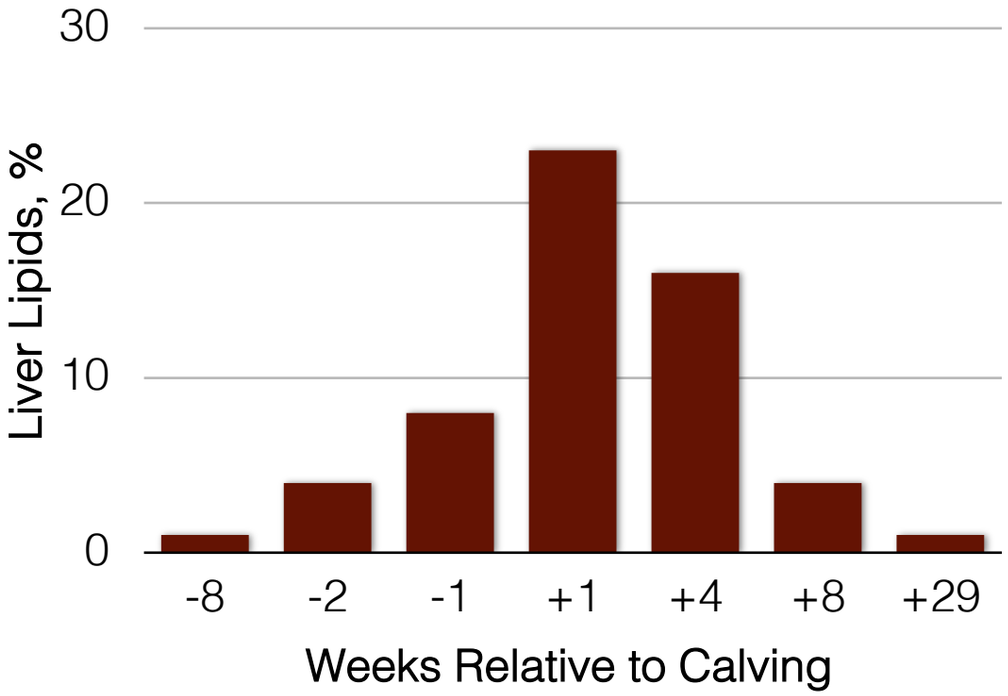
Overall Production Perspective:

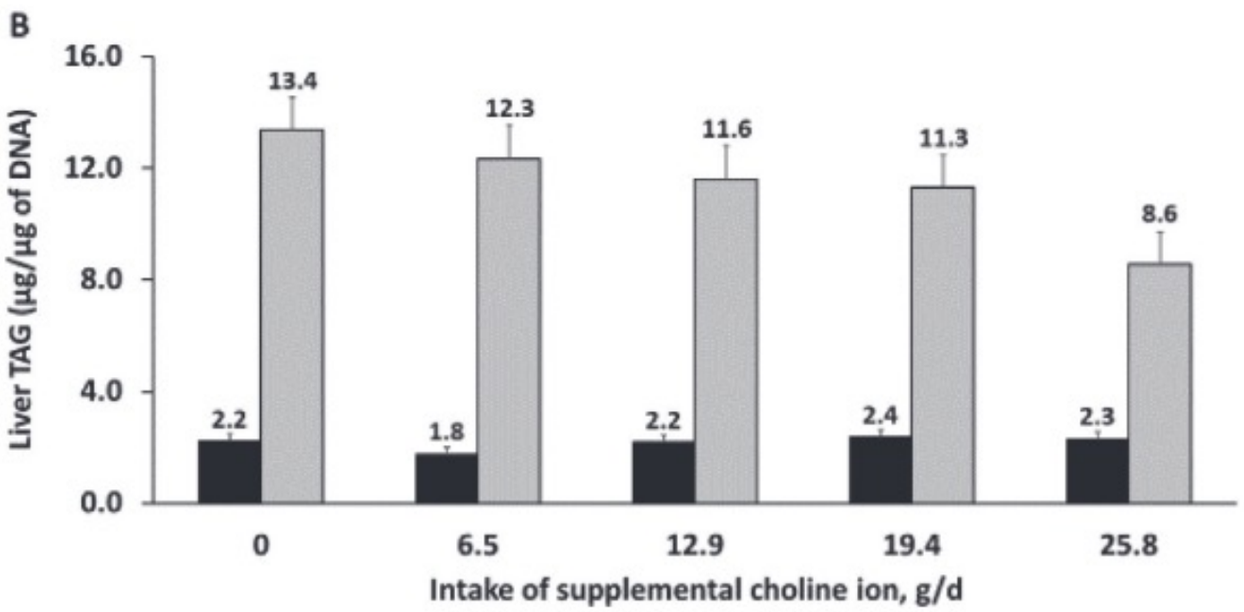
During and after supplementation,
Milk yield and ECM were ~30 to 37% greater
than Meta-Analysis average

Arshad et al, 2020; Holdorf et al., ADSA, EAAP, 2022

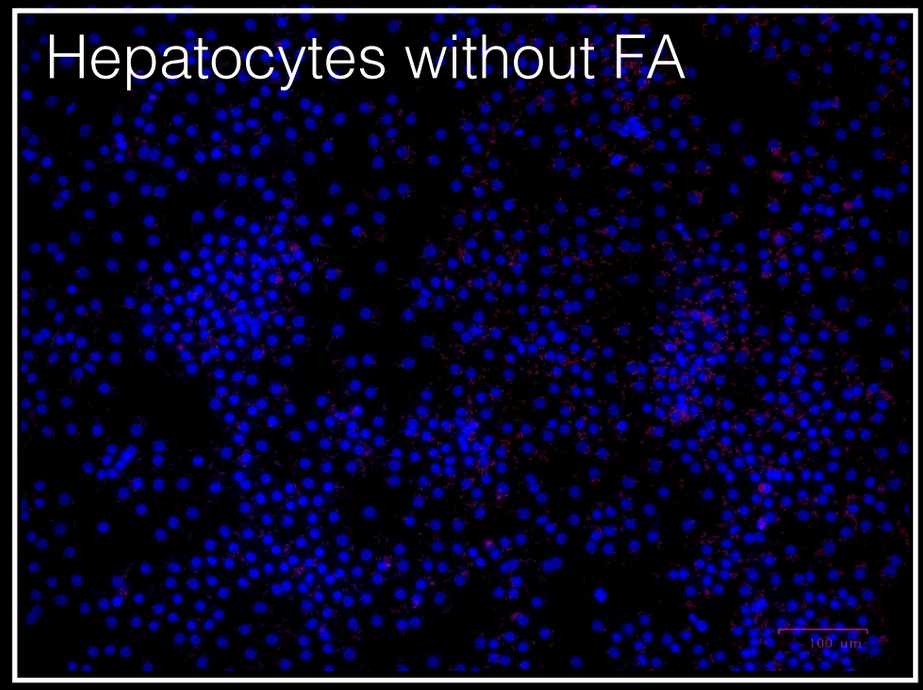
What is the mechanism of choline's effects during, and AFTER, supplementation of RP choline??

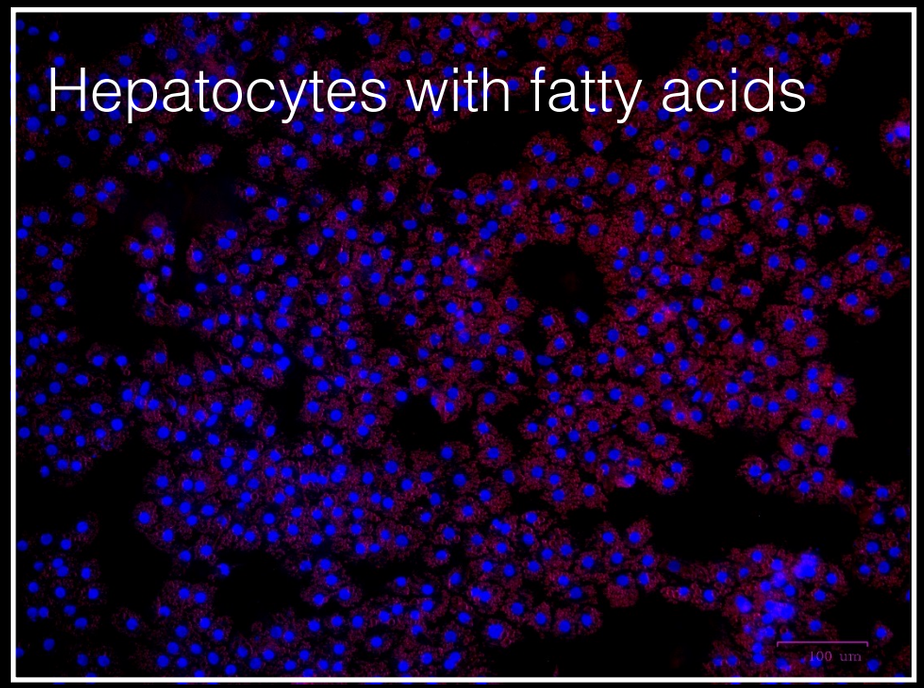
Fatty Liver and Cellular Lipids





Zenobi et al, 2018





Choline Shifts Pathways in Liver Cells

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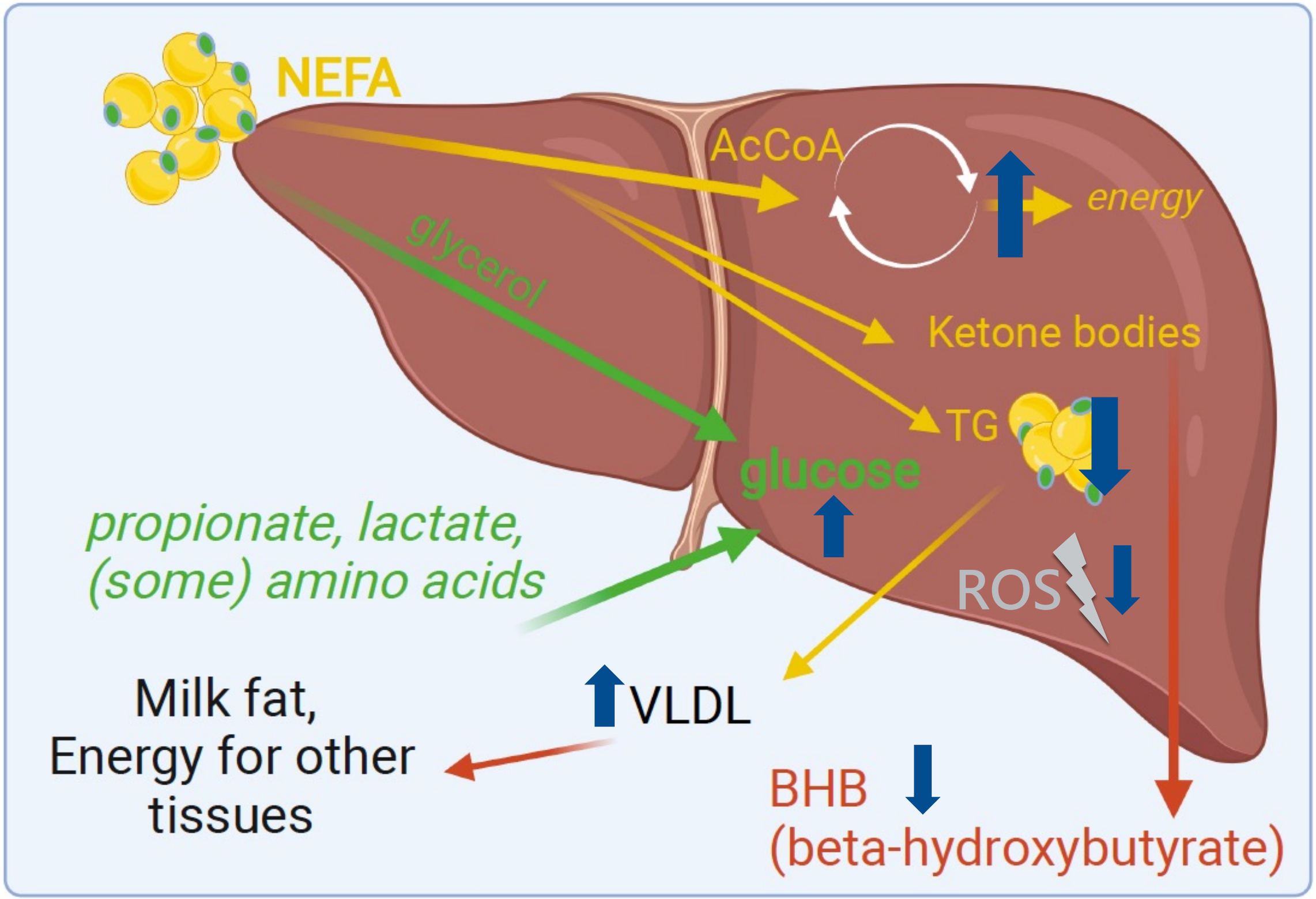
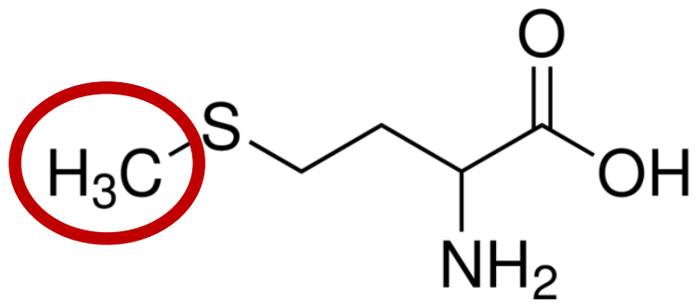
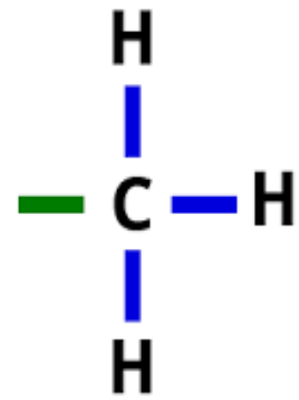


Chandler and White, 2017; Chandler et al, 2020

Methyl Group Metabolism

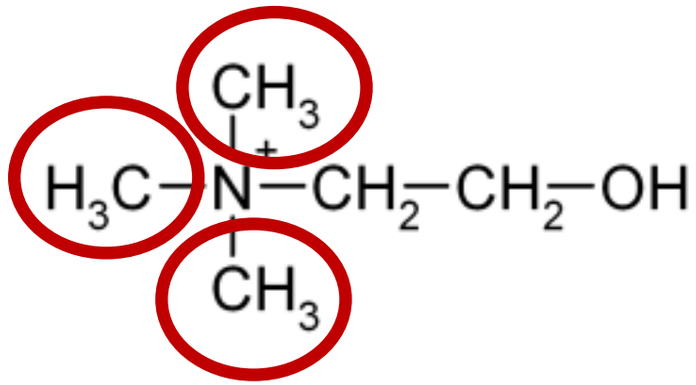
- Methyl groups come from methyl donors
  - methionine (1)



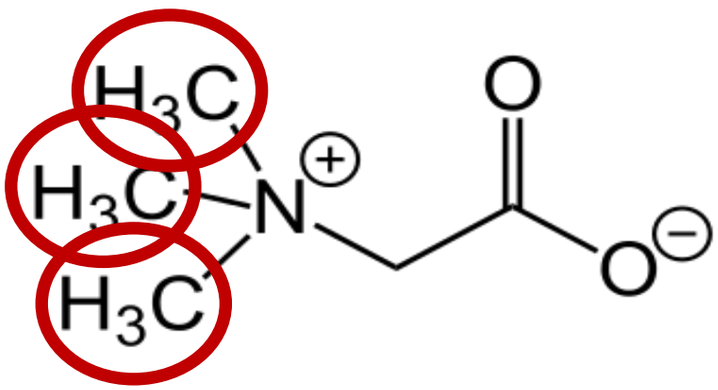


Methyl group

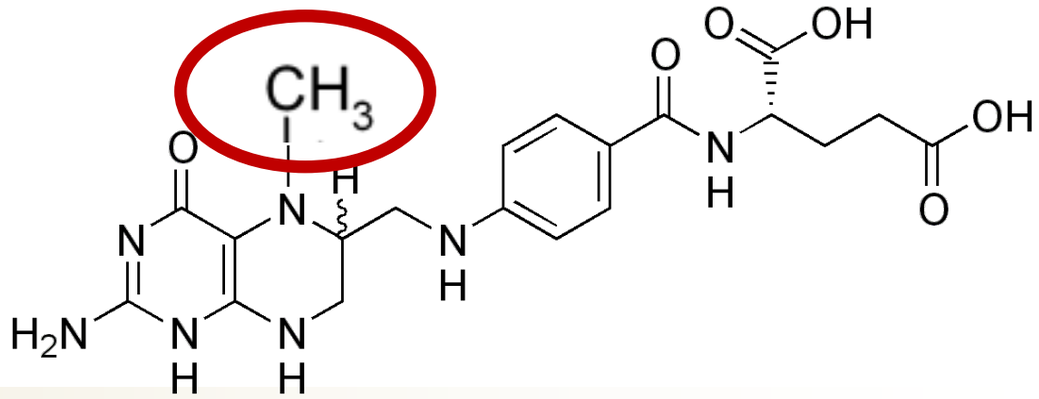
  - choline (3)



  - betaine (3)



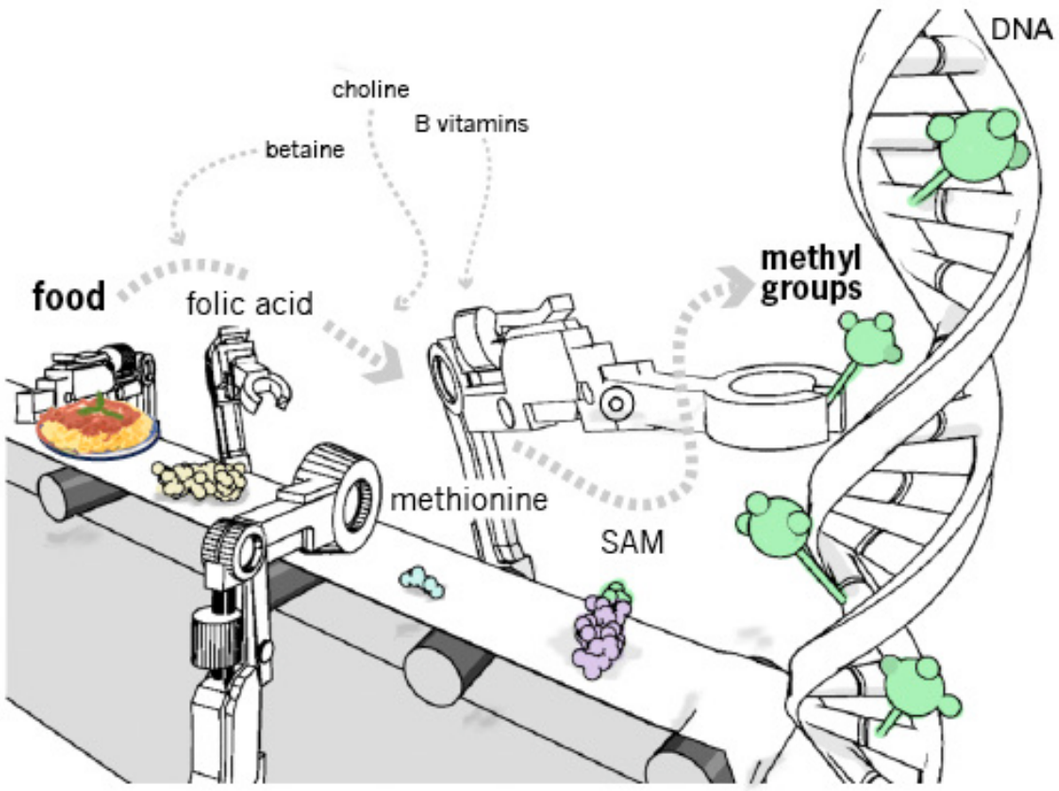
  - folate (5-methyltetrahydrofolate; 1)



Lack of methyl donors across species

=

increased liver inflammation,
decreased liver oxidation,
and
decreased methylation of DNA



http://learn.genetics.utah.edu/content/epigenetics/nutrition/

What does this mean to the calf in utero?

Calves born to Cows fed RP Choline have increased average daily gain (ADG)

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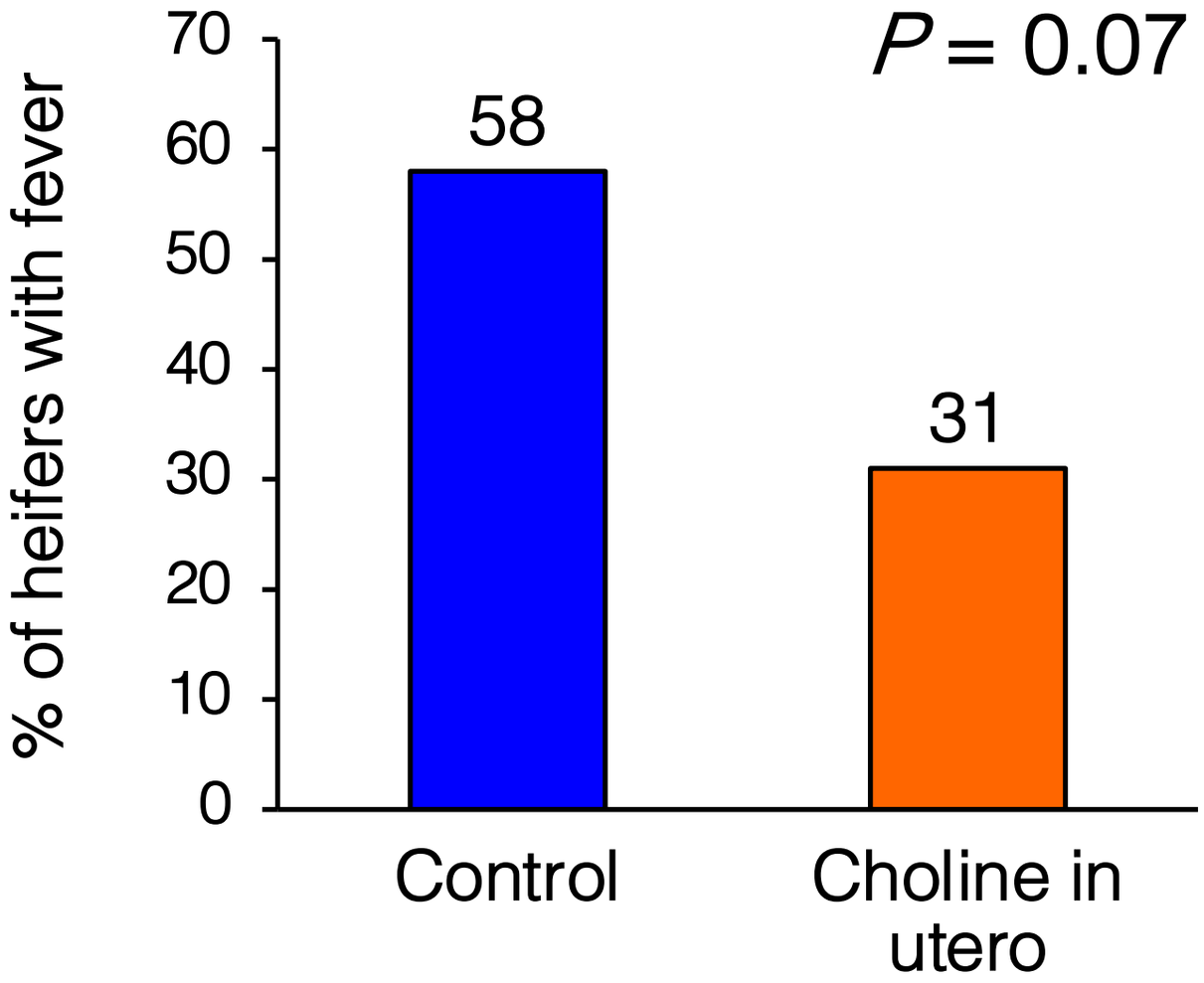
Birth to ~50 weeks of age by heifers		Birth to 5 weeks of age by bulls (given LPS)
2015	**2017**	**2017**
0.80 vs. 0.85 kg/d	0.77 vs. 0.82 kg/d	0.44 vs. 0.56 kg/d
P = 0.06	*P* = 0.09	*P* = 0.06
n = 35	n = 46	n = 38

Zenobi et al., 2018, JDS; Zenobi et al., 2018 abstract; JDS 2022

UF IFAS Research
UNIVERSITY of FLORIDA

Performance of Choline Calves



Immune Maturation & Function

Lung Development & Maturation

Rectal temperatures measured daily.

Fever: >103.1°F; >39.5°C

Zenobi et al., 2018 abstract; JDS 2022

Impact of In Utero Supplementation on Calf Growth

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OR

Female Holstein Calves

Male and Female Angus x Holstein Cross Calves

Impact of In Utero Supplementation on Holstein Calf Growth

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	Ctl	$RPC1_{RD}$	$RPC2_{RD}$	$RPC2_{HD}$	*P*-value
Birth Weight, lb	87.6	86.7	89.1	86.5	
1 to 2 week					
ADG, lb	0.4	0.6	0.5	0.7	*0.08* *Ctl vs* $RPC2_{HD}$
3 to 8 weeks					
ADG, lb	1.9	1.8	2.0	1.8	

Holdorf et al., ADSA, 2022

Challenges happen on farm, even during research studi es…

Impact of In Utero Supplementation on Holstein Calf Health

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- There was no evidence for an effect of treatment ($P \geq 0.12$) on bloat, respiratory, or fecal score
- No interaction of maternal trt x bloat on ADG

Impact of In Utero Supplementation on Calf Growth

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	Ctl	$RPC1_{RD}$	$RPC2_{RD}$	$RPC2_{HD}$	*P*-value
Birth Weight, lb					
Female	85.4	92.0	84.7	92.4	
Male	100.1	99.9	104.1	97.0	
1 to 2 week					
ADG, lb	0.6	0.6	0.6	0.4	
3 to 8 weeks					
ADG, lb					*0.01 trt x time* *0.08 Ctl vs $RPC2_{HD}$*
Female	2.2	2.0	2.2	2.1	
Male	2.1^{b}	2.2^{ab}	2.4^{ab}	2.6^{b}	

Holdorf et al., ADSA, 2022

Was DNA methylation increased with in utero choline exposure?

Yes . . .
in male Holstein x Angus calves

But . . .
There are also differences in energy, growth, and gut integrity markers

Impact of In Utero Supplementation on Beef x Dairy Calves

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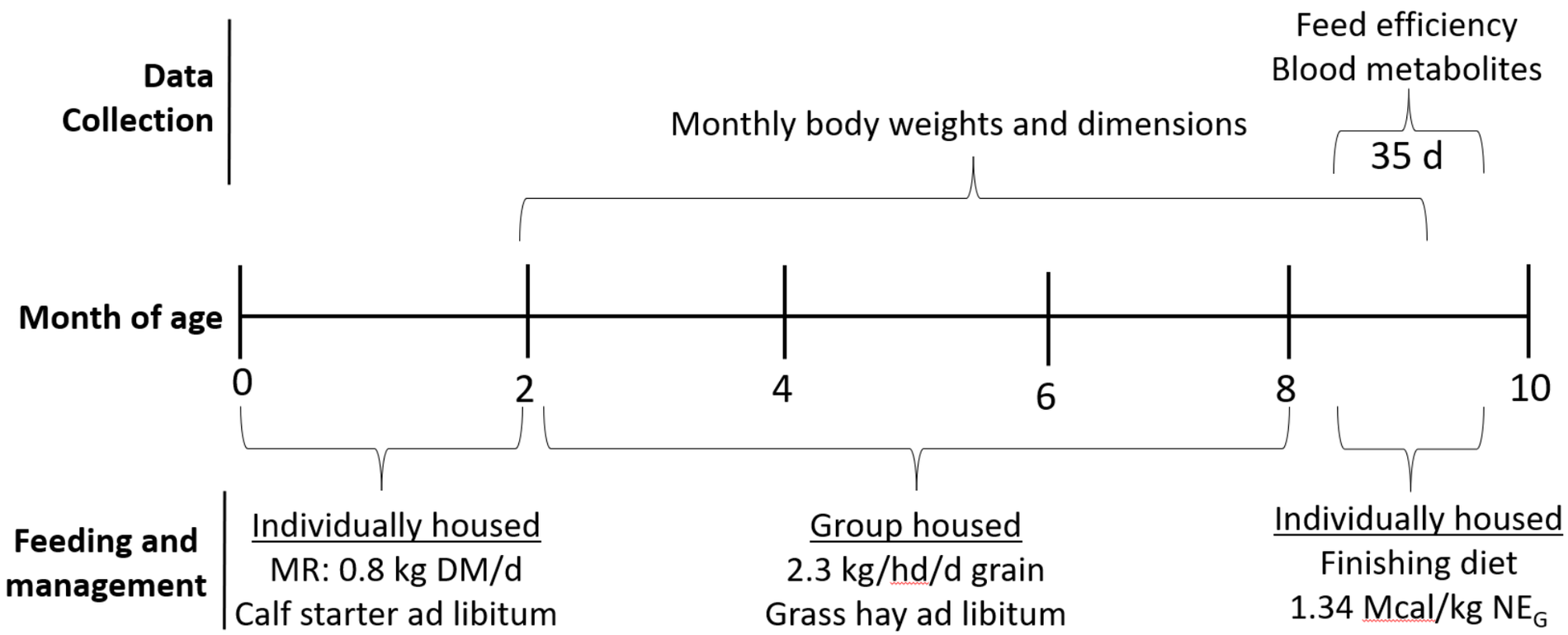
- Group housed and fed 2.3 kg grain/h/d (42% CP) and ad libitum access to grass hay and stepped up to a complete finishing diet from 7 month (12% CP; 1.4 Mcal/kg NE_g)



Impact of In Utero Supplementation on Beef x Dairy Calves (2 to 9 months)

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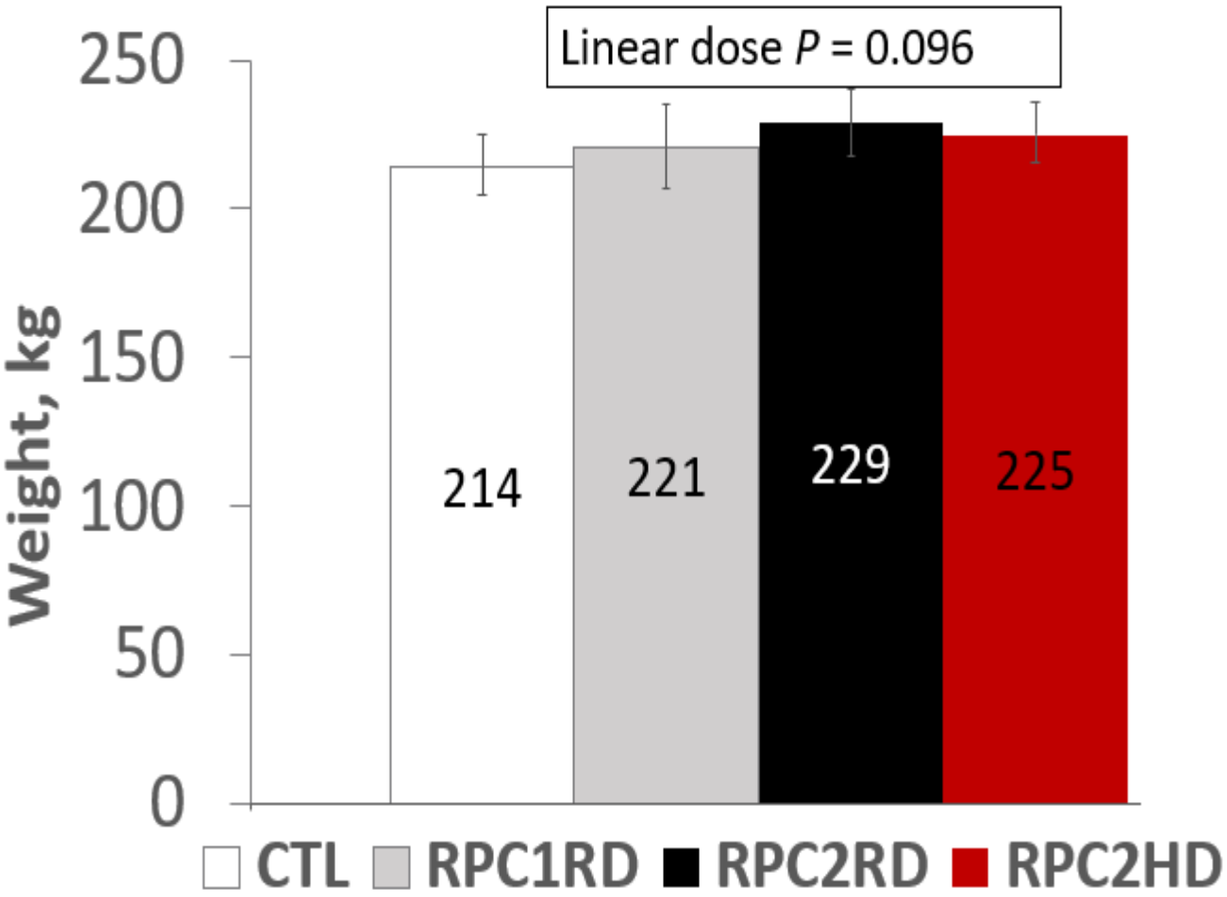

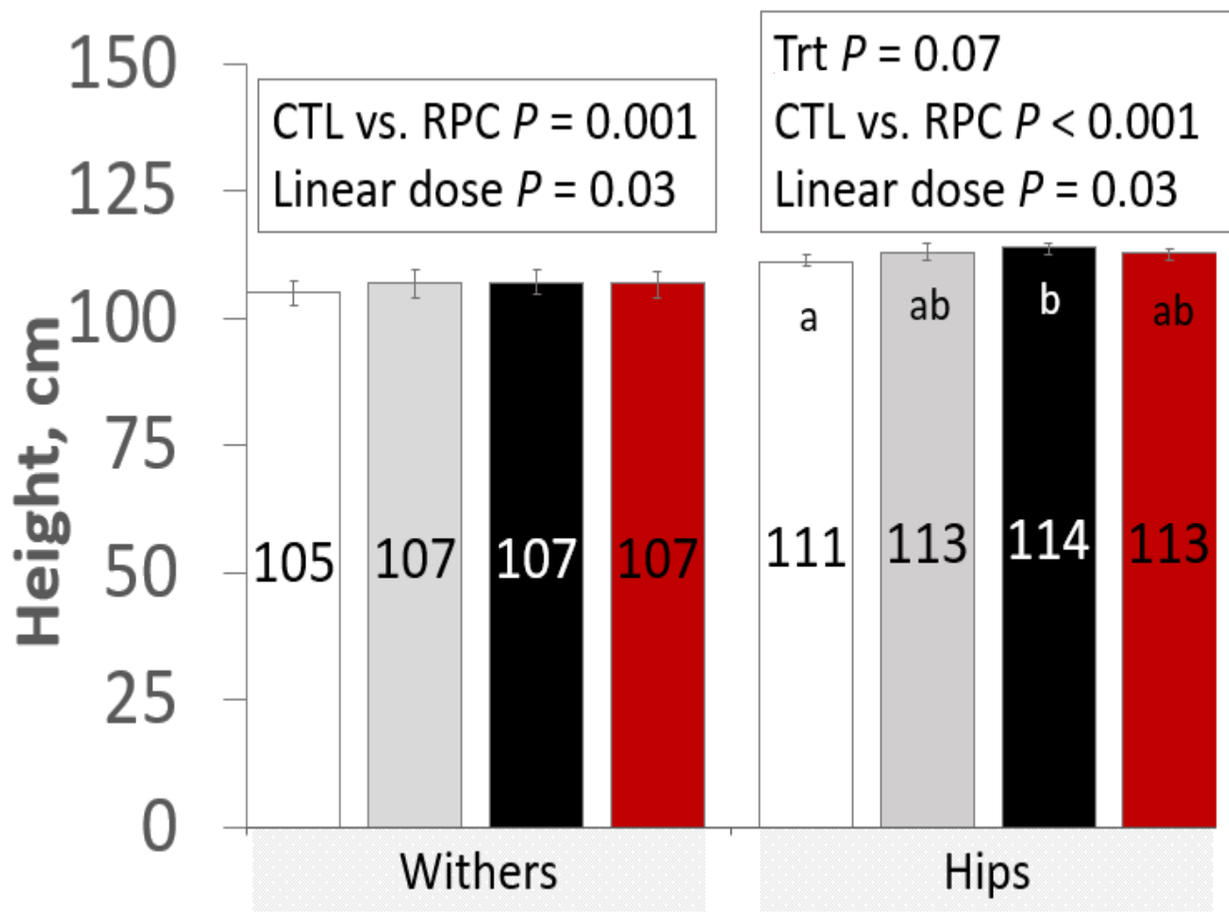

Impact of In Utero Supplementation on Beef x Dairy Calves (at 9 mths)

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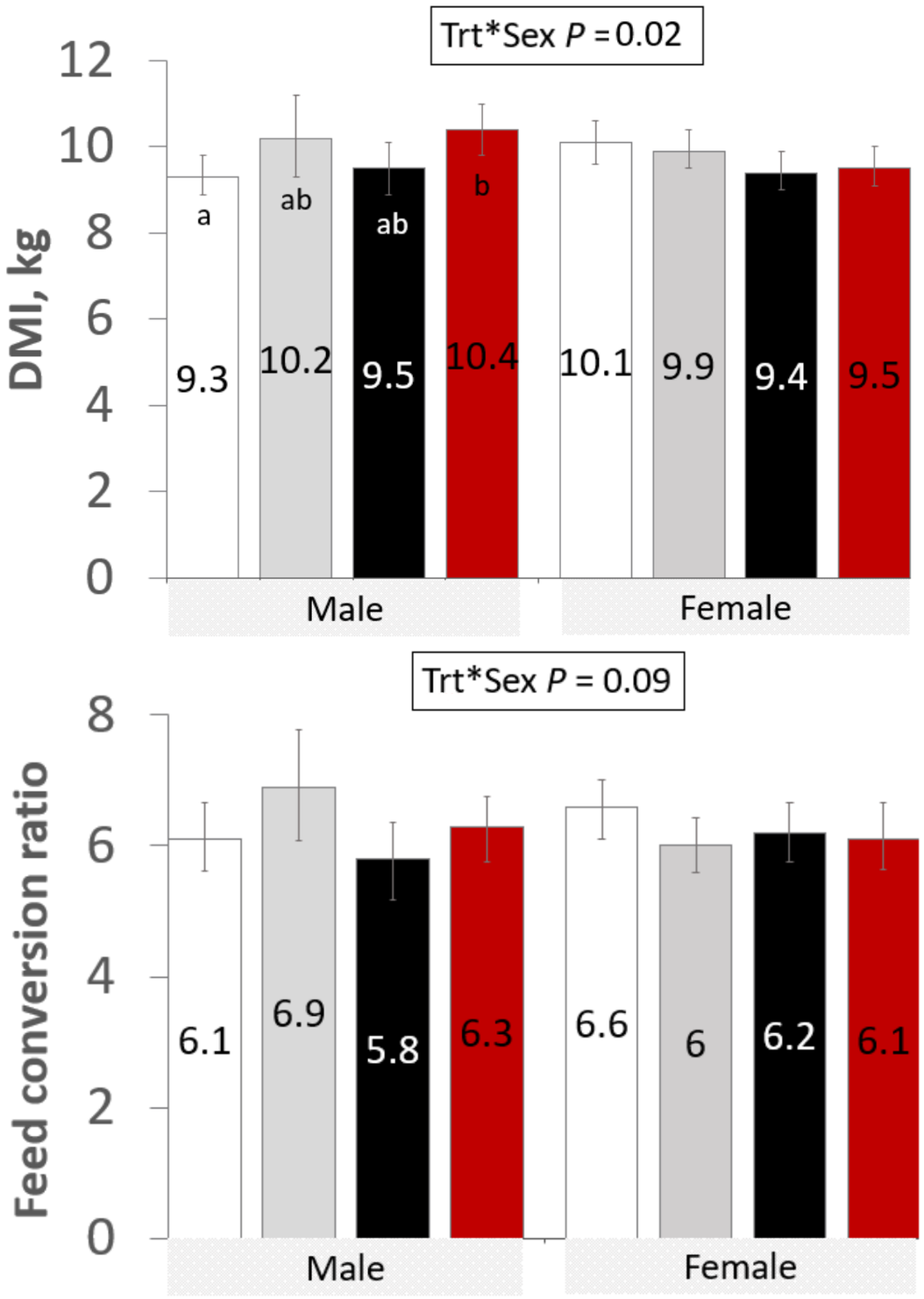

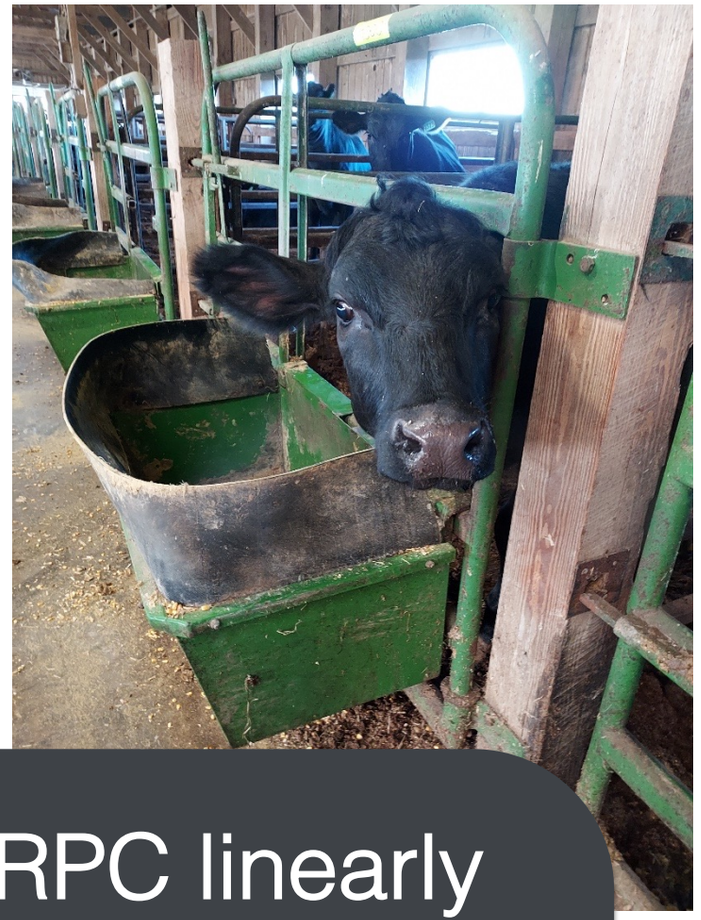

Increasing RPC linearly decreased plasma insulin ($P<0.01$) and tended to decrease glucose ($P=0.06$)

Brown et al., ADSA, 2022

Impact of In Utero Supplementation on Beef x Dairy Calves (at finish)

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- Finish live weights (sex $P < 0.001$) at 16 months
  - Male: 700 kg
  - Female: 640 kg
  - no treatment effect

- RPC increased marbling score (linear P=0.04)

USDA Quality Grade	Control (n=12)	RPC1-18 (n=10)	RPC2-18 (n=12)	RPC2-27 (n=13)
Prime	1 (8%)	2 (20%)	1 (8%)	3 (23%)
Choice	10 (83%)	8 (80%)	11 (92%)	10 (77%)
Select	1 (8%)	0 (0%)	0 (0%)	0 (0%)

Brown et al., ADSA, 2022; in preparation

Impact of In Utero Supplementation on Beef x Dairy Calves (at finish)

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- Marbling score at processing (16 mth) was not different by sex
  - Male: 539
  - Female: 546
- RPC linearly increased marbling score (linear *P*=0.04)

	Control (n=12)	RPC1-18 (n=10)	RPC2-18 (n=12)	RPC2-27 (n=13)
Marbling Score	489	554	561	571

Brown et al., ADSA, 2022; in preparation

A Long-Lasting Impact from Choline Supplementation

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- Strategic nutritional interventions during the transition period can have long-term impacts on cow and calf
- Mechanism of RP Choline action is through improved liver function
- Supplementing RP Choline during the transition period tended to increase energy-corrected milk yield even at higher production levels
  - Postpartum production relative to prepartum intake, together with long-lasting effects, suggests changes in metabolism or nutrient use efficiency
- Supplementation of cows with RP Choline also improves calf growth, immune function, and metabolic health and supported carcass quality in beef x dairy calves
- Higher supplementation rates (higher than recommended dose) of RPC resulted in further benefits to calves, but not cows

Take-Home Messages

- **Consistent postpartum production benefits are observed**
  - Even in very high producing cows and with cows with high genetic merit for milk
  - Regardless of BCS
  - **How?** Shifts in metabolism and nutrient partitioning to support increased production and maintained or improved health
- **In utero programming provides added benefits to the calf**
  - Benefits on calf growth and health are observed with maternal choline supplementation
  - Improved feed efficiency to finish weight and improved marbling in Angus x Holstein
  - **How?** Increased colostrum yield, increased global methylation, and changes in calf metabolism

Acknowledgments

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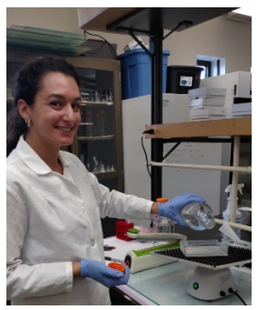

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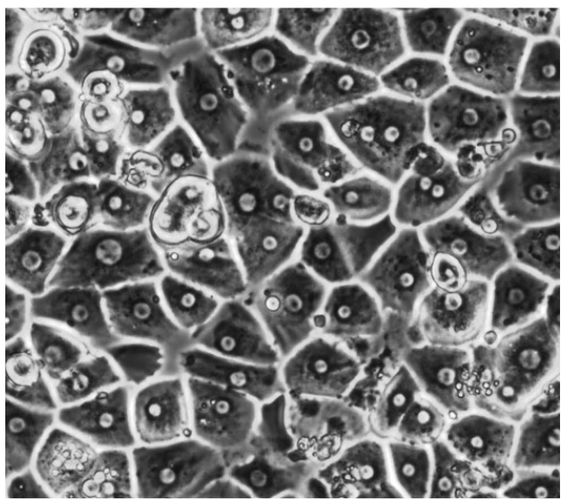
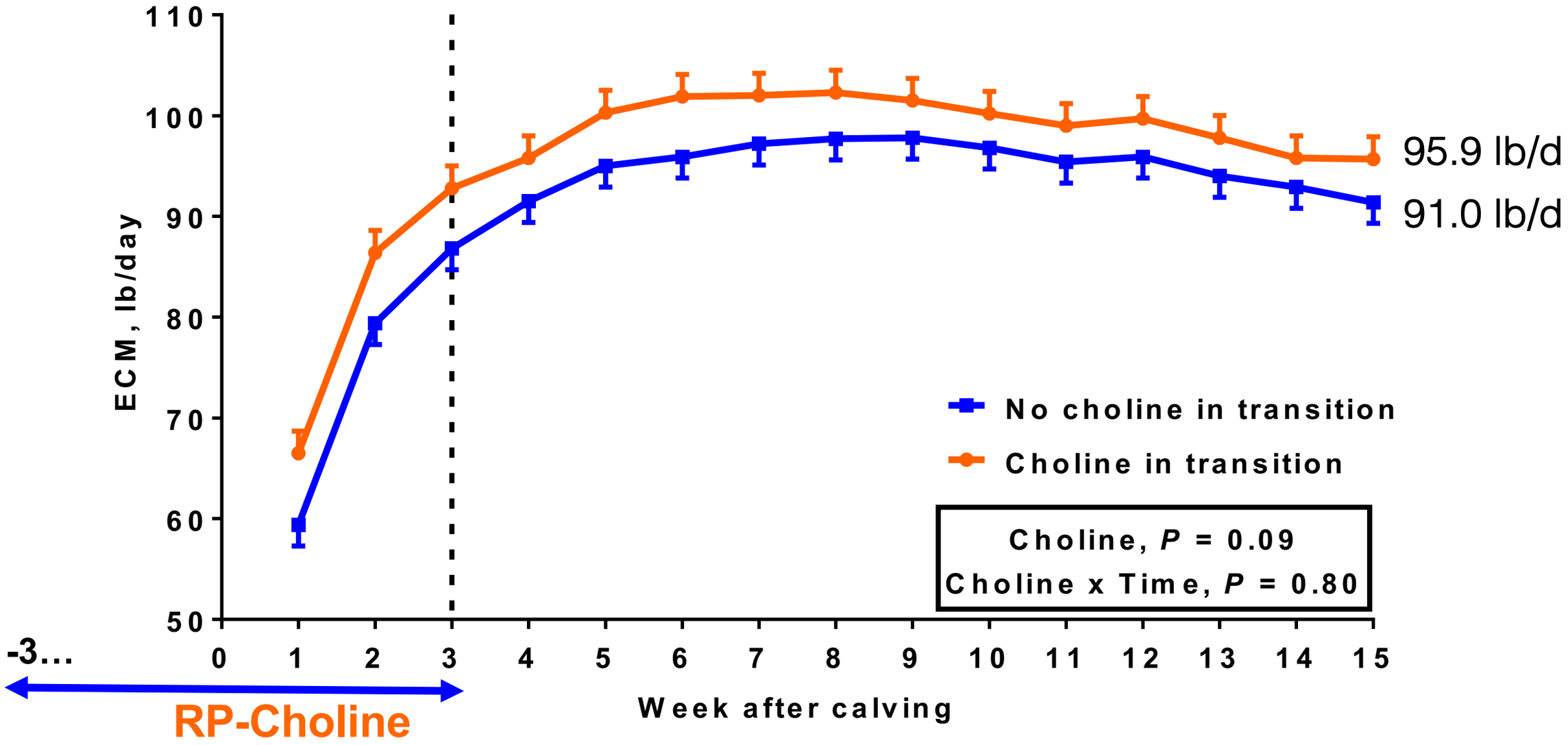
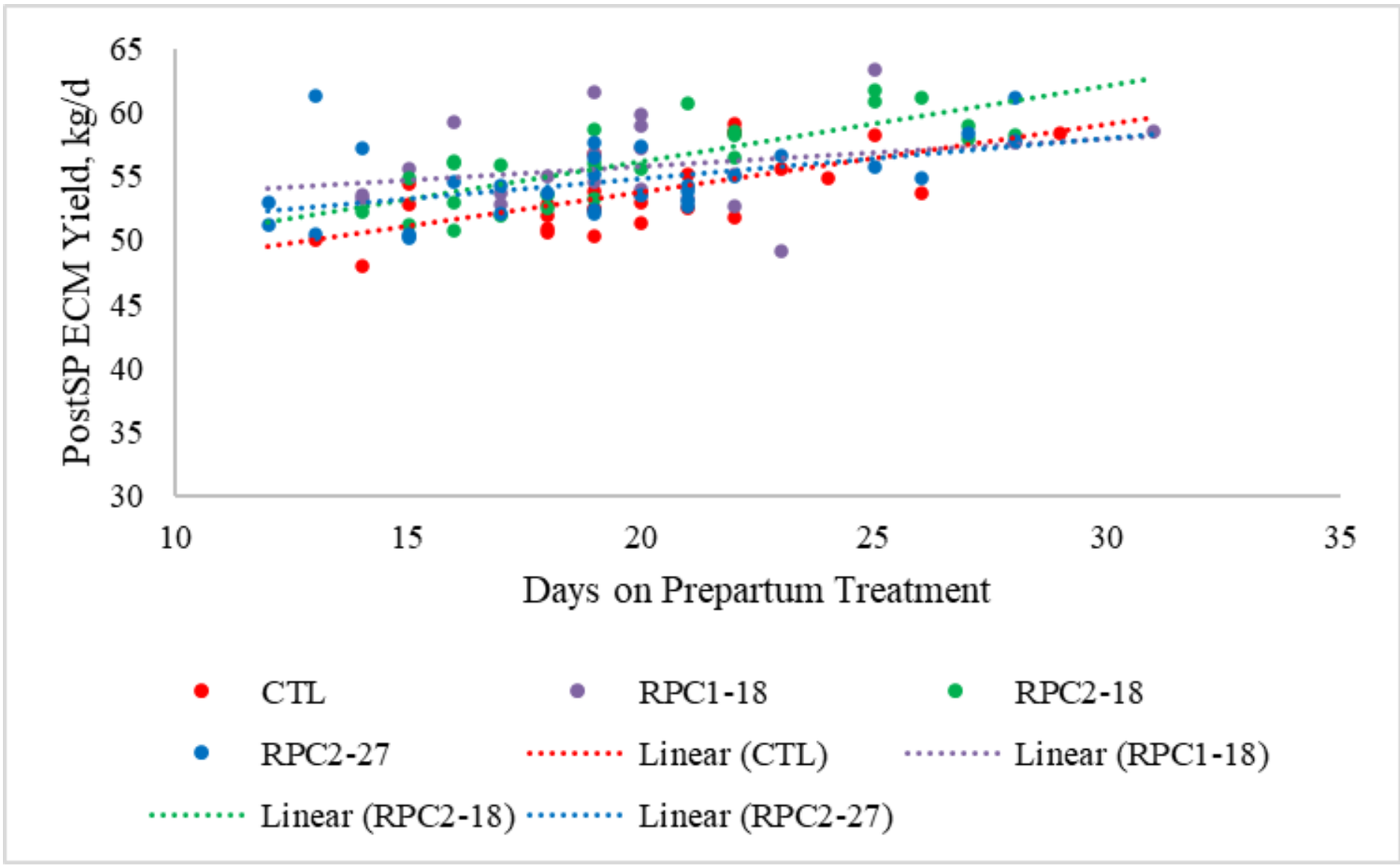


Long-Lasting Benefits of Peripartum Supplementation



Zenobi et al., 2018, JDS 101:1088-1110; 93 Holstein cows


PostSP ECM Yield, kg/d
65
60
55
50
45
40
35
30
10
15
20
25
30
35
Days on Prepartum Treatment
CTL
RPC1-18
RPC2-18
RPC2-27
Linear (CTL)
Linear (RPC1-18)
Linear (RPC2-18)
Linear (RPC2-27)