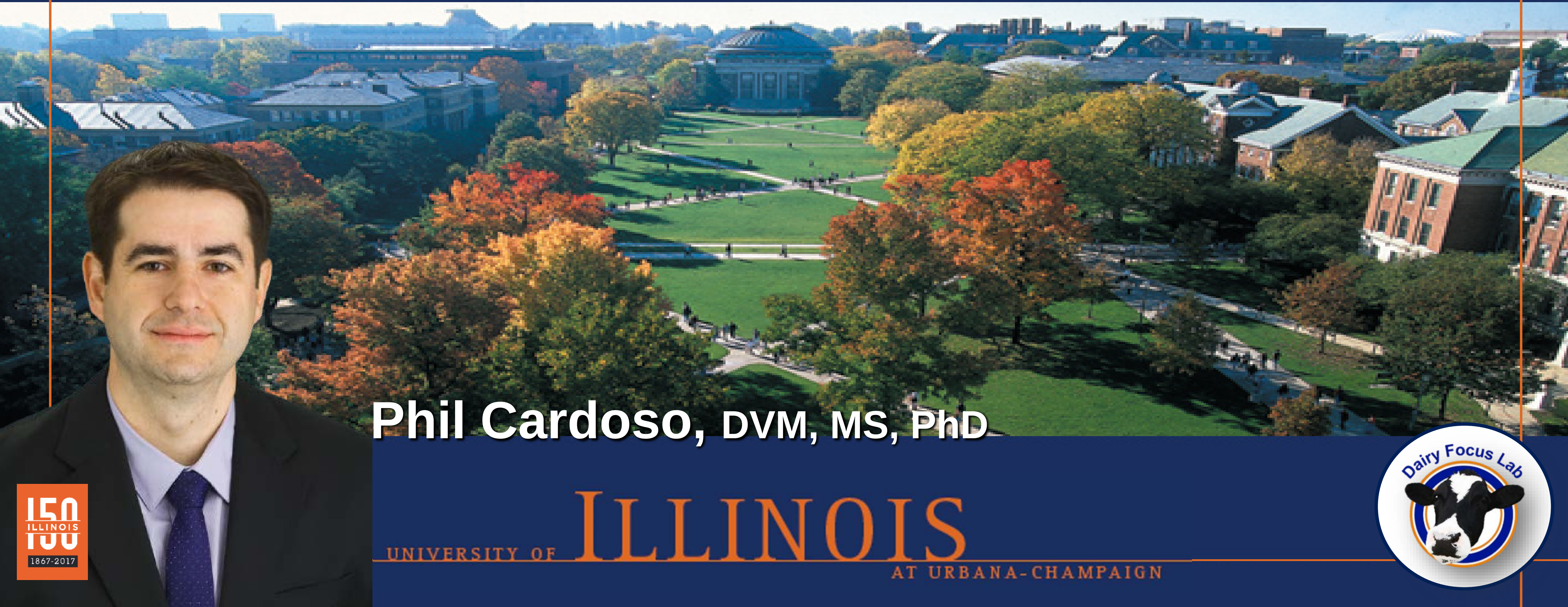
Applied Research into Amino Acid Nutrition



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ILLINOIS 150 1867-2017

Dairy Focus Lab

So, What do we want from this cow?

We should feed and manage dry and transition cows to:

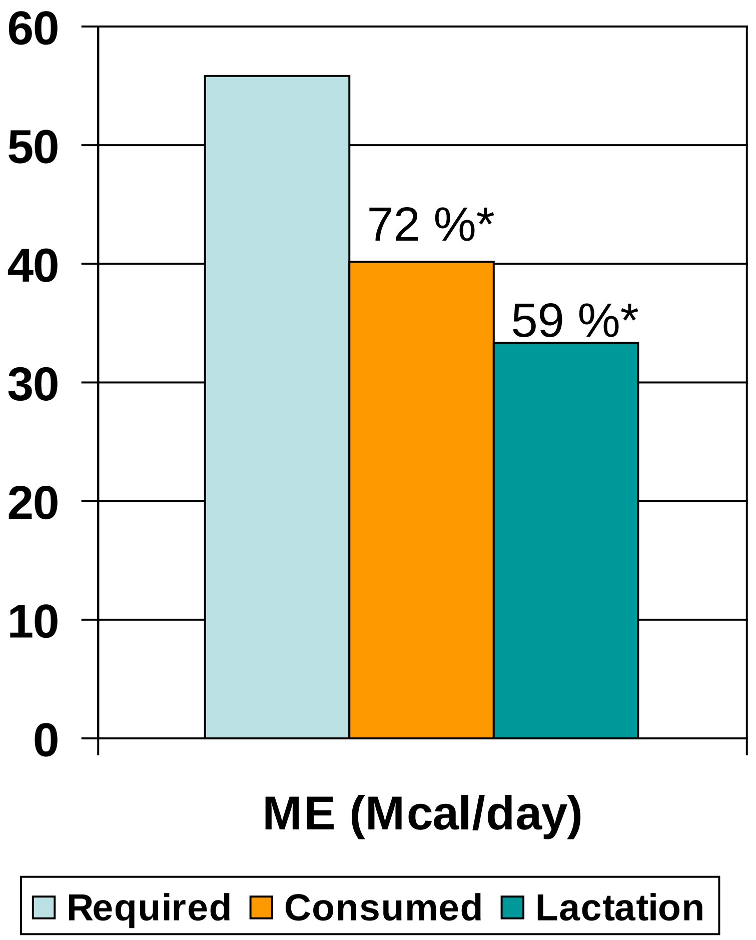
1. minimize health disorders,
2. maximize production and reproduction

Net energy (NE_L) requirements 2 days before and 2 days after calving

	725-kg Cow		570-kg Heifer	
Units	Pre	Post	Pre	Post
Total (Mcal/d)	14.5	28.8	14.0	25.1
Typical intake	**14-17**	**19-21**		

Calculated from NRC (2001). Assumes milk production of 25 kg/d for cow and 20 kg/d for heifer, each containing 4% fat.

Courtesy of J.K. Drackley

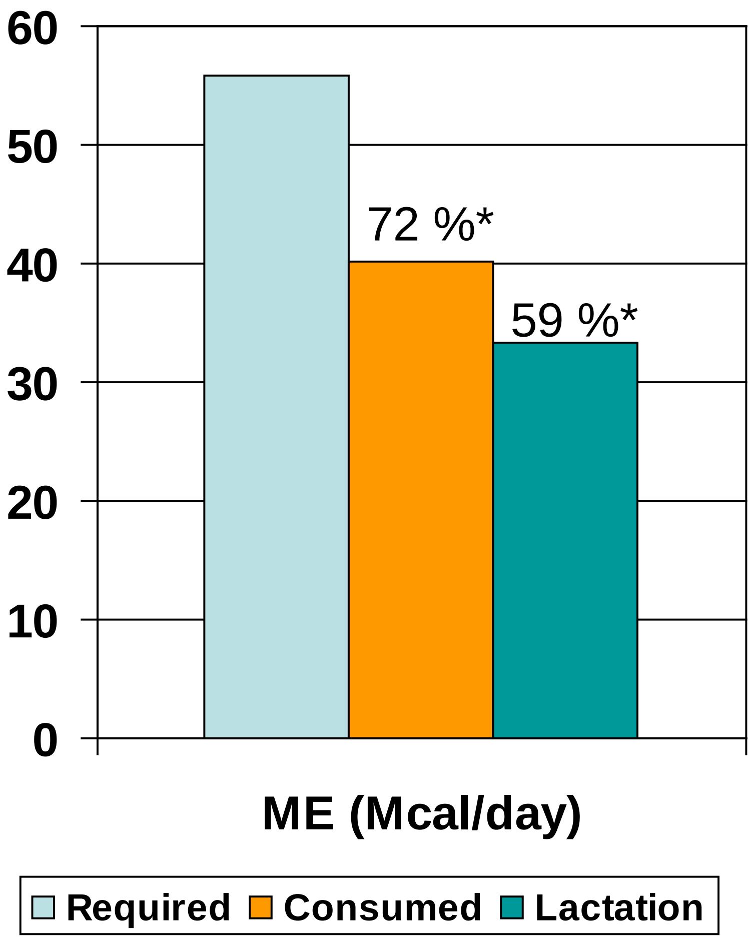


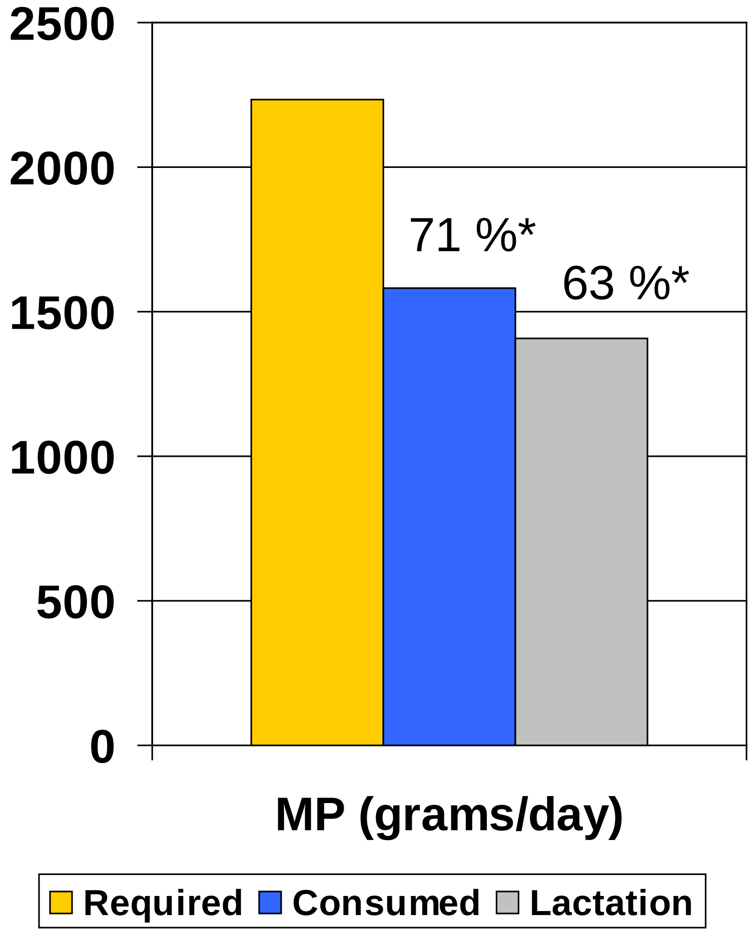
Metabolizable Energy (*ME*; Mcal/day) required and consumed at 7 days in milk

From CNCPS V6 – Assumes BW 700 kg, 15.5 kg DMI, 30 kg milk 3.8% fat, 3.2% prot.; * Percent of required; ** Percent of consumed

Adapted from J.K. Drackley

ME and metabolizable protein (MP; g/d) required and consumed at 7 days in milk





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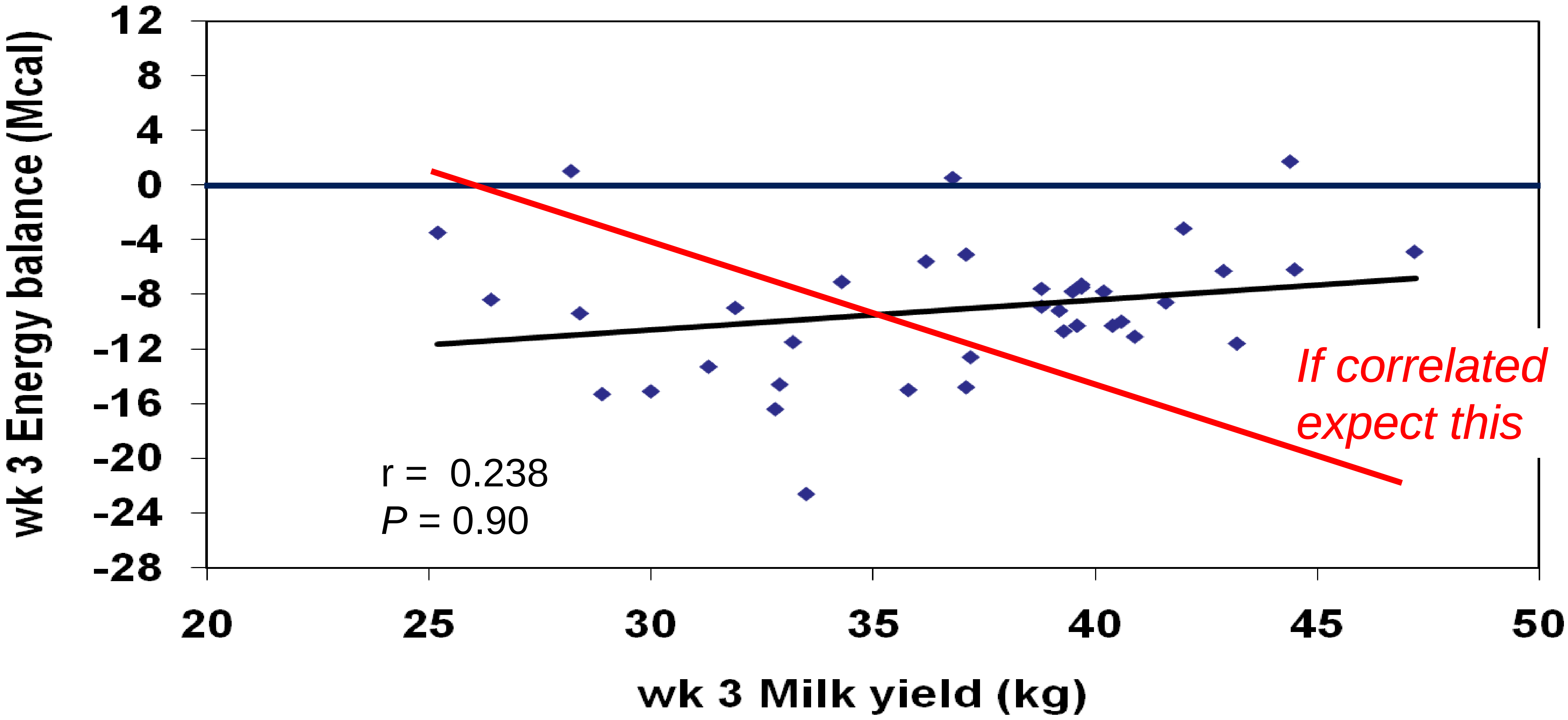
Adapted from J.K. Drackley

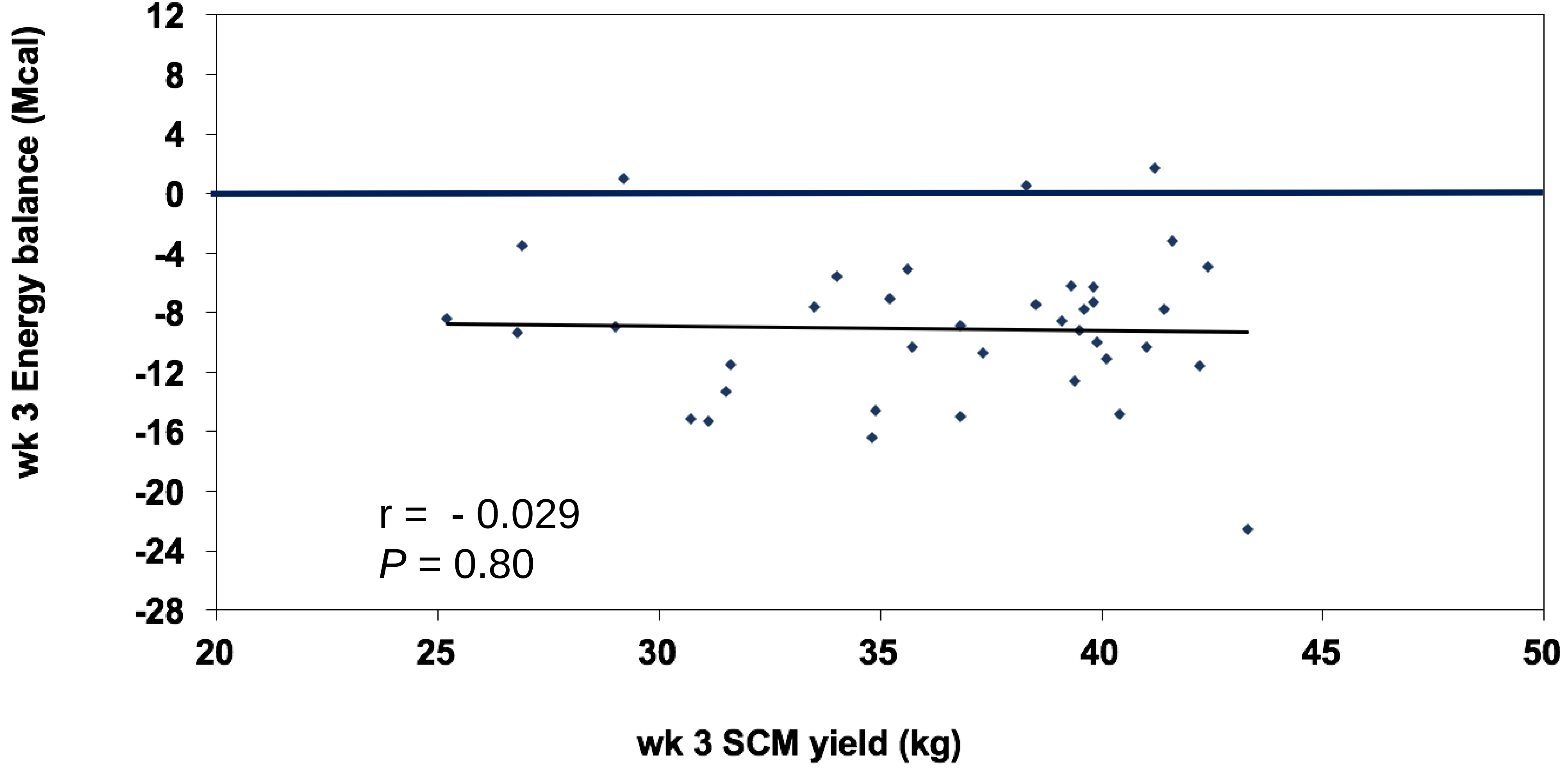
What drives negative energy balance?

Post-calving energy balance is not correlated with milk yield



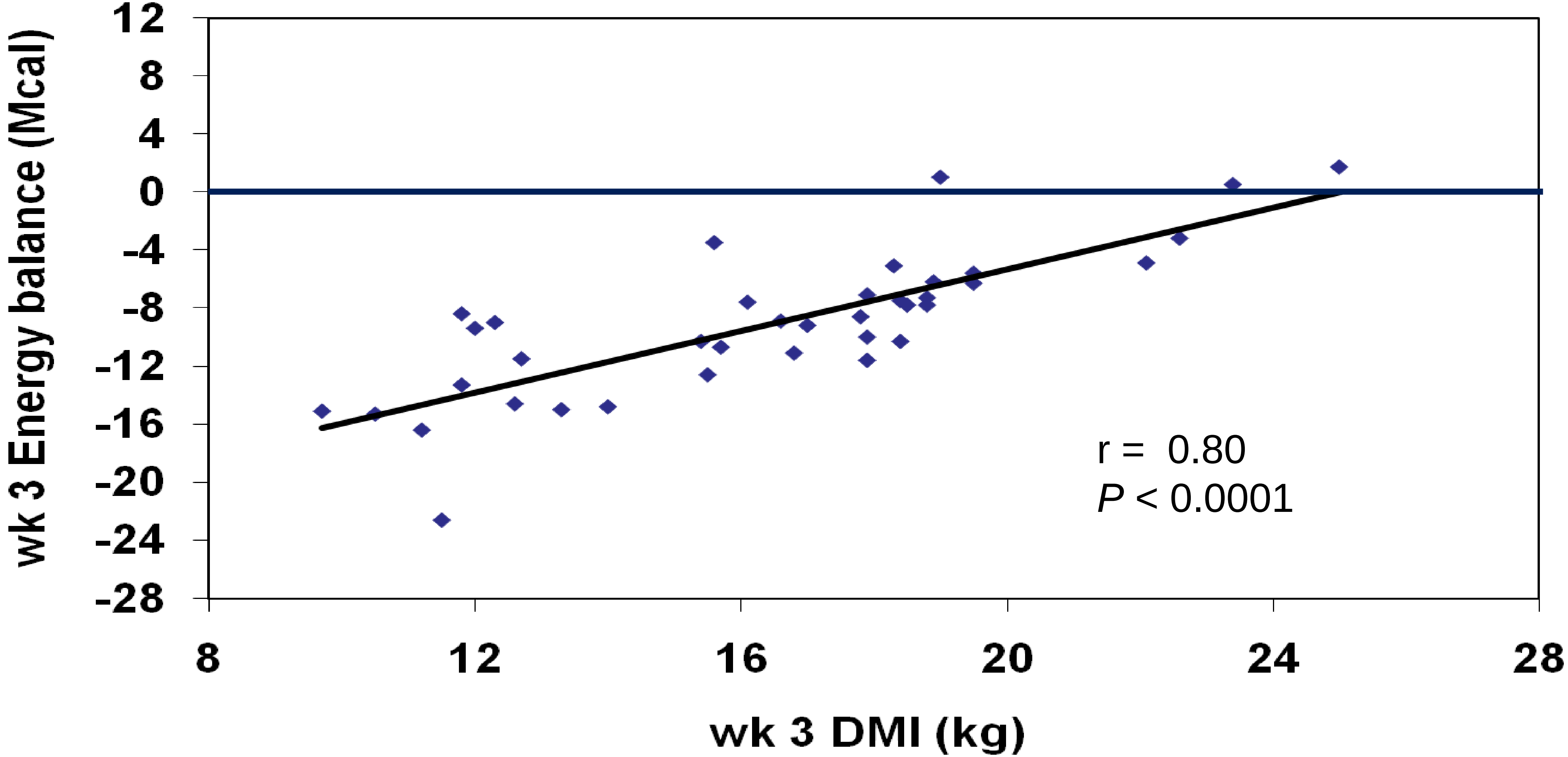
Drackley, 2006

Post-calving energy balance is not correlated with solids-corrected milk (SCM)



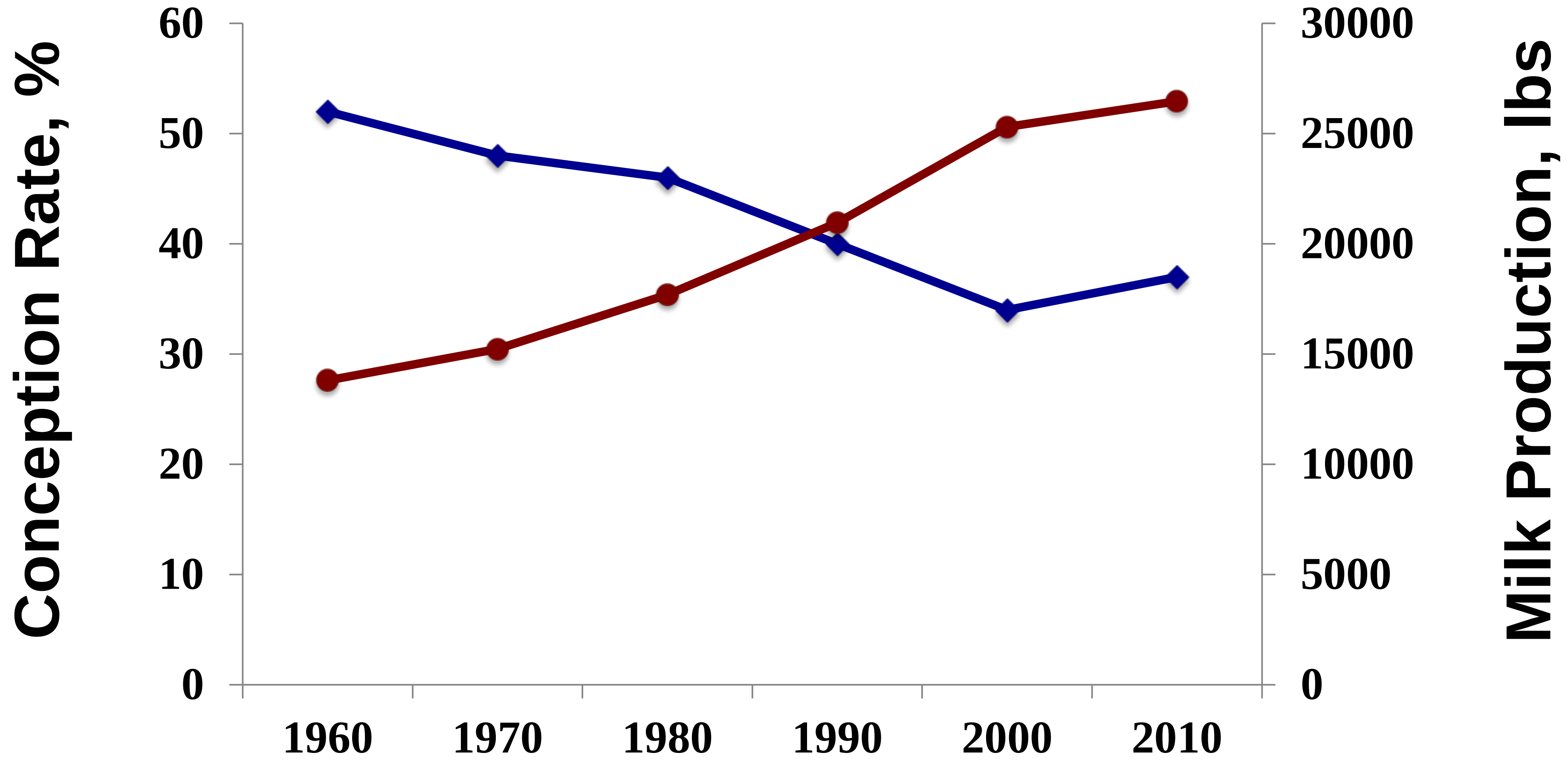
Drackley, 2006

Post-calving energy balance is highly correlated with DMI



Drackley, 2006

Evolution of Milk Production and Reproduction in the Last 50 years



Walsh,S.W. et al., 2011

Fertility and high milk production: Are they biologically compatible?

Quartile	Milk yield (kg/d)	Estrual cyclic. by d 65, %	Pregnant at d 30 post-AI, %	Pregnant at d 58 post-AI, %	Pregnancy loss d 30 to 58, %
1	32.1	72.7	37.2	30.3	12.7
2	39.1	77.6	38.9	29.8	11.6
3	43.6	77.6	39.3	33.7	12.8
4	50.0	75.3	37.6	35.3	15.6
P		**0.002**	0.74	**0.008**	0.57

6,396 cows on 4 TMR-fed farms in California

Santos et al., 2009

Reproduction: Early Embryonic Loss

Reference	Cows	Days 1st Check	Days last Check	Days	Loss %	Loss/ Day %
Chebel et al., 2002a	195	28	42	14	17.9	1.28
Moreira et al., 2000a	139	27	45	18	20.7	1.15
Chebel et al., 2002b	1,503	31	45	14	13.2	0.94
Stevenson et al., 2000	203	28	45	17	15.8	0.93
Santos et al., 2002b	360	31	45	14	11.1	0.79
Santos et al., 2002a	220	27	41	14	10	0.71
Cerri et al., 2002	176	31	45	14	9.7	0.70
Juchem et al., 2002	167	28	39	11	11.4	1.03

Daily embryonic loss in the first 50 days of pregnancy = 0.9%

Reproduction is affected by events occurring earlier in lactation

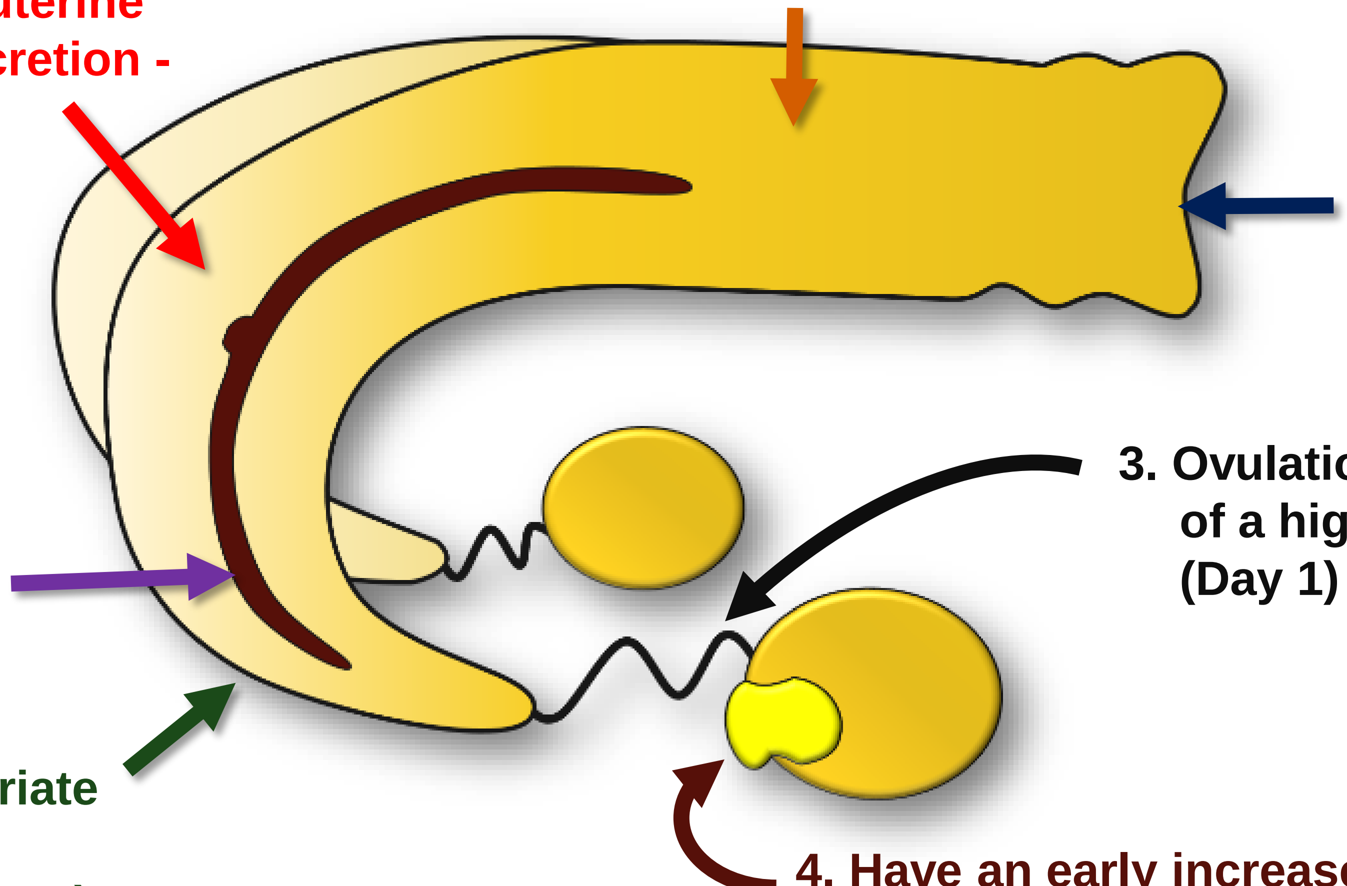
Health problem	Pregnant at day 30, %	*P*-value
No clinical disease	**66.9**	--
Single clinical disease	**56.5**	<0.01
Multiple clinical disease	**40.8**	<0.01
No subclinical disease	**68.0**	--
Single subclinical disease	63.6	0.36
Multiple subclinical disease	**52.2**	<0.01

Multiple factors affecting development of pre-antral follicles

957 multiparous cows in 2 farms

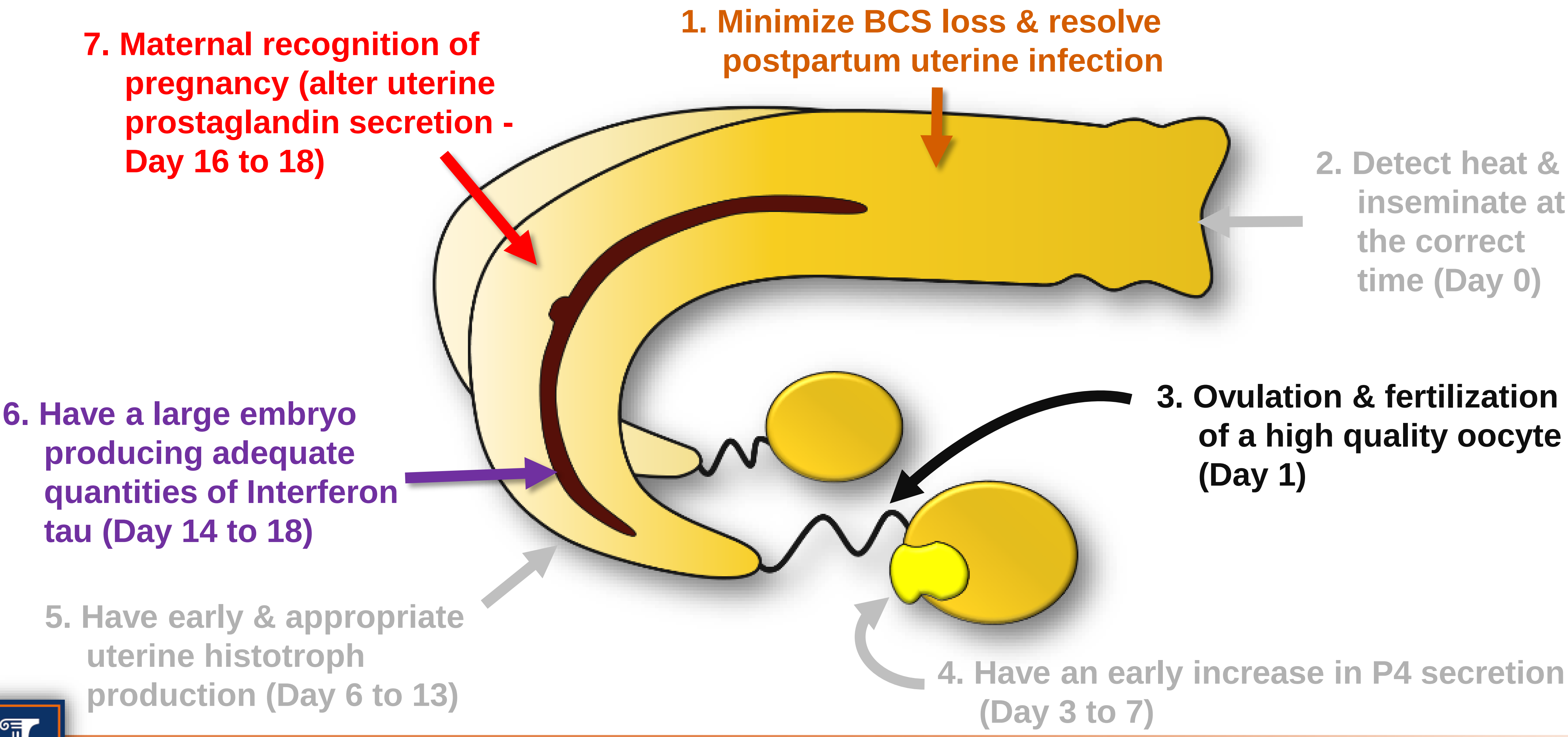
Adapted from Ribeiro et al., *J Dairy Sci* 2013

Factors Affecting Pregnancy in Dairy Cows



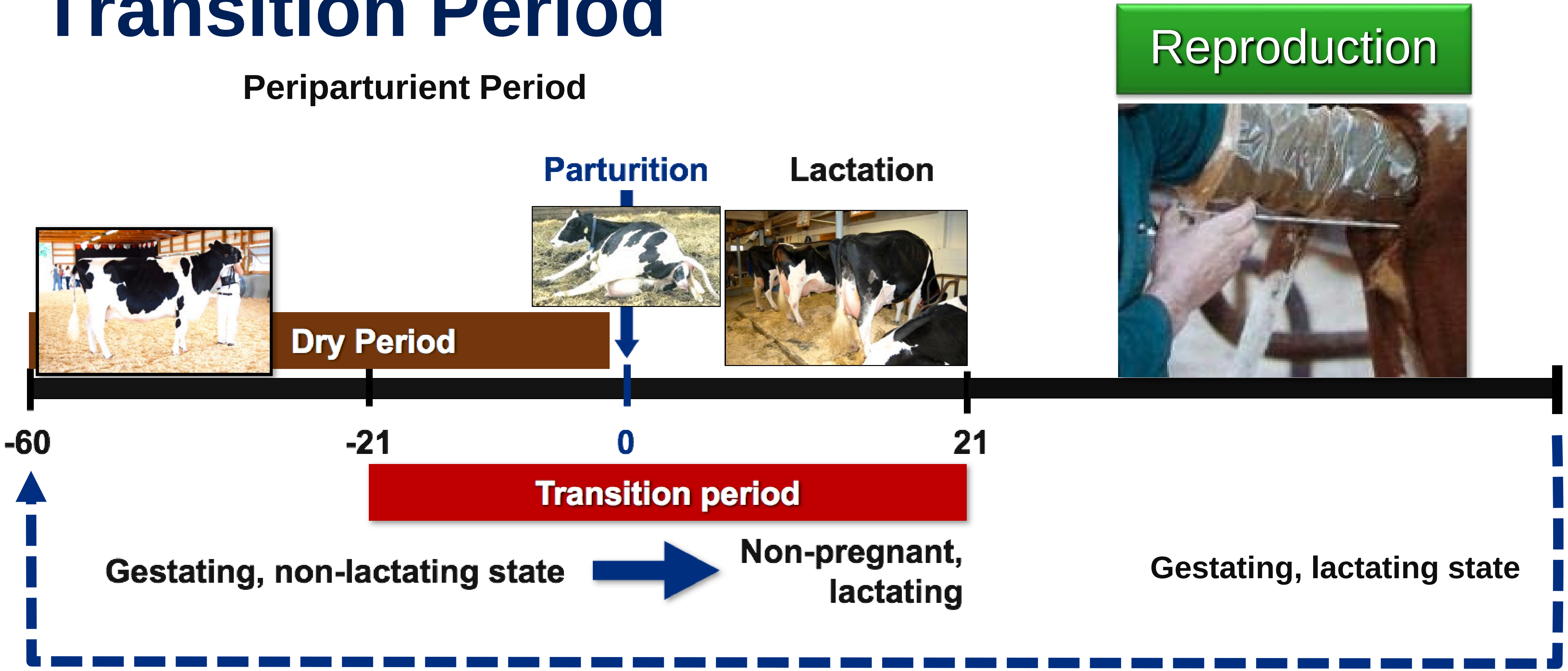
Walsh et al., 2011

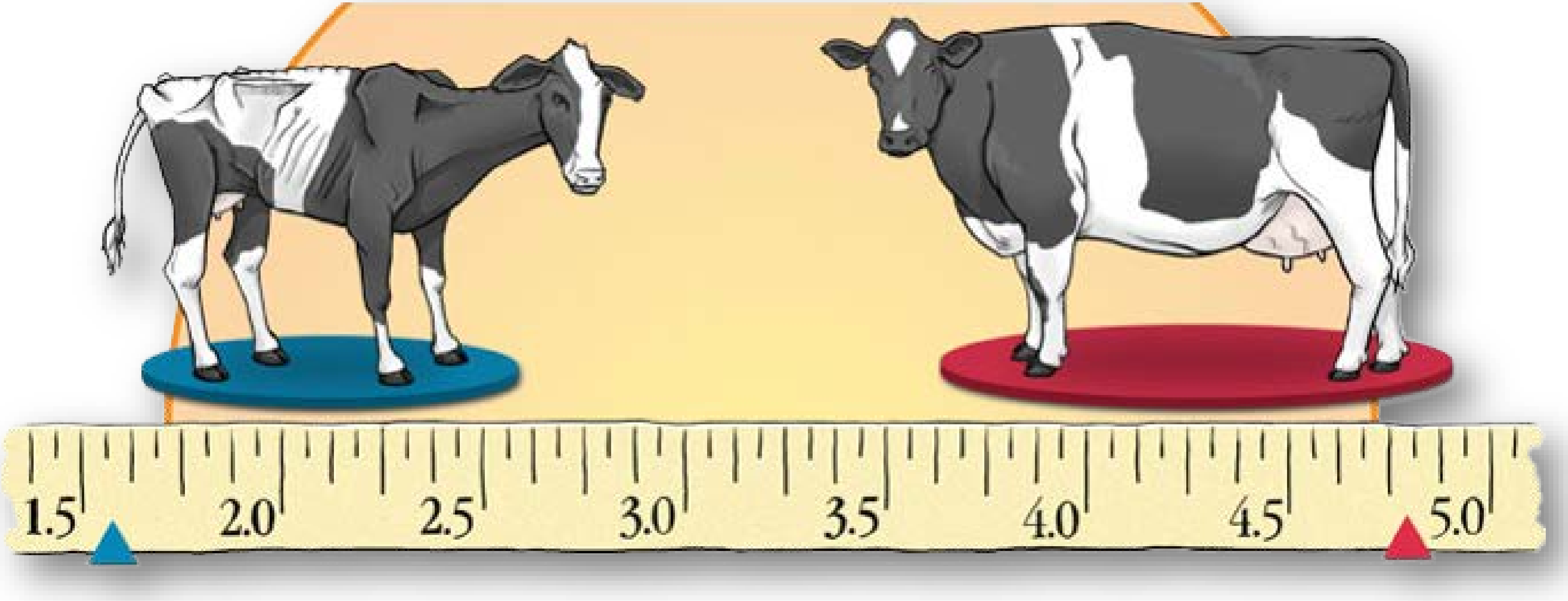
Factors Affecting Pregnancy in Dairy Cows



Walsh et al., 2011

Transition Period



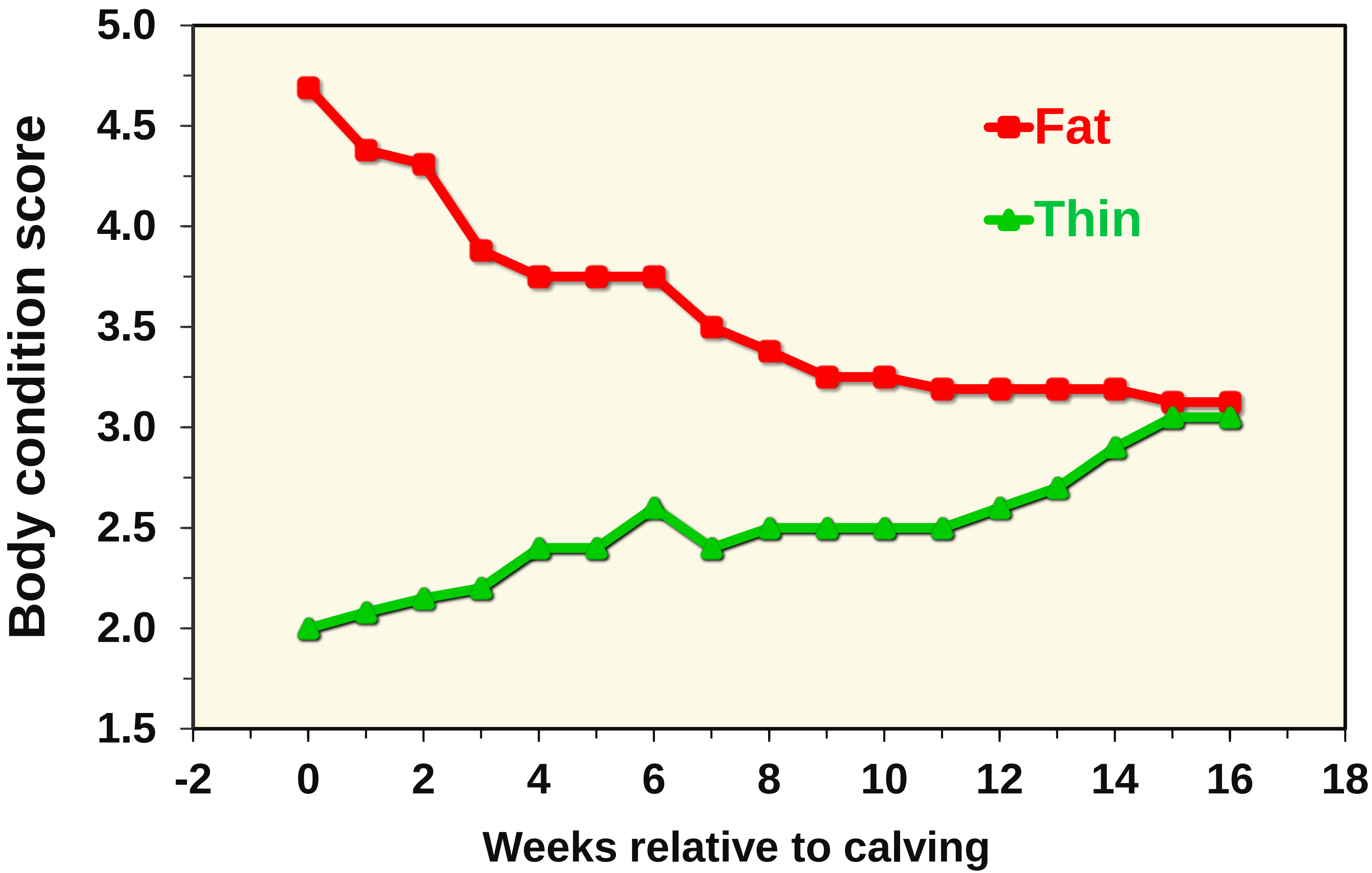


BCS at drying off: _______________

BCS at calving: _______________

BCS at breeding: _______________

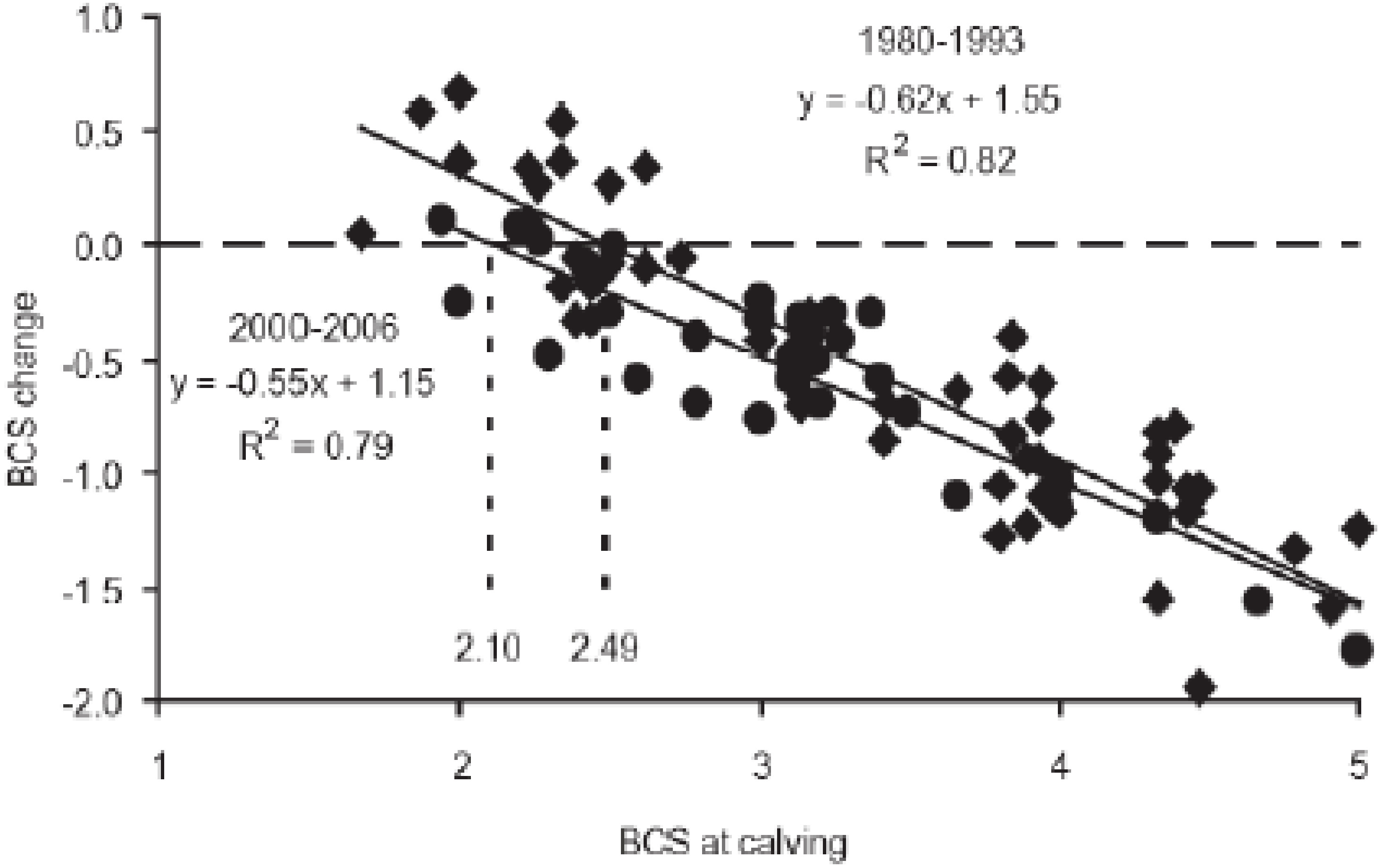
Changes in BCS in cows fed to be fat or thin at calving



*Thin cows had greater DMI and milk production

Redrawn from Garnsworthy, 1990

BCS at calving for neutral BCS change over the first 10 – 12 weeks of lactation was greater in older studies

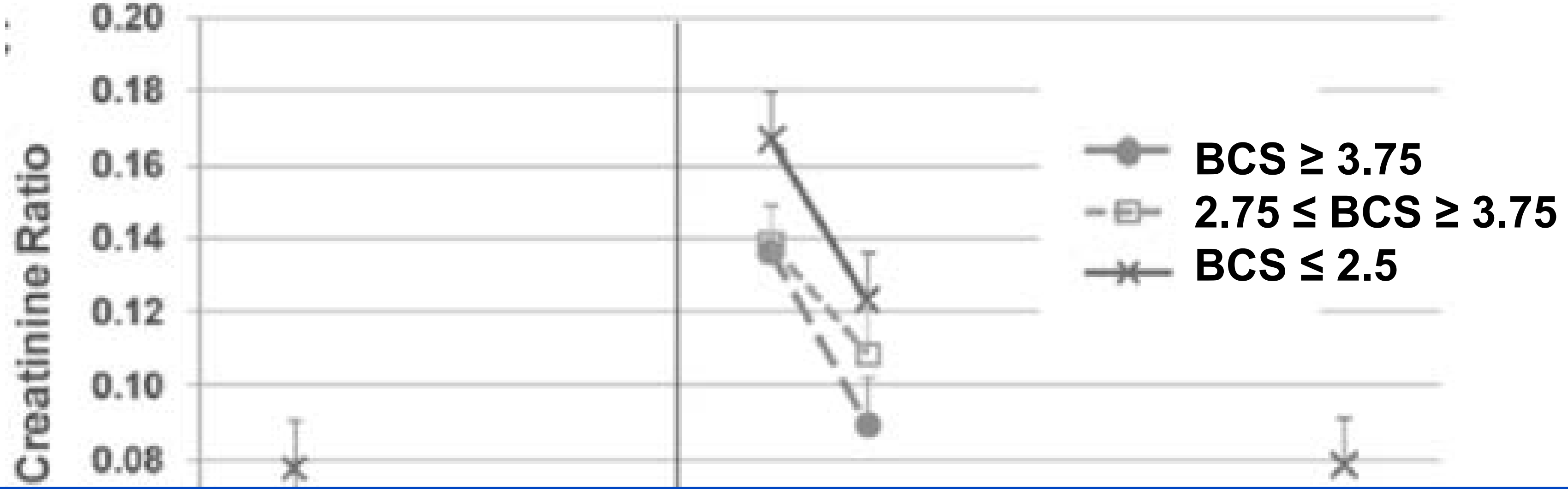


♦ studies 1980 – 1993

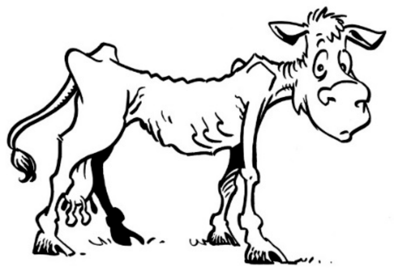
● studies 2000 – 2006

Redrawn from Garnsworthy, 1990

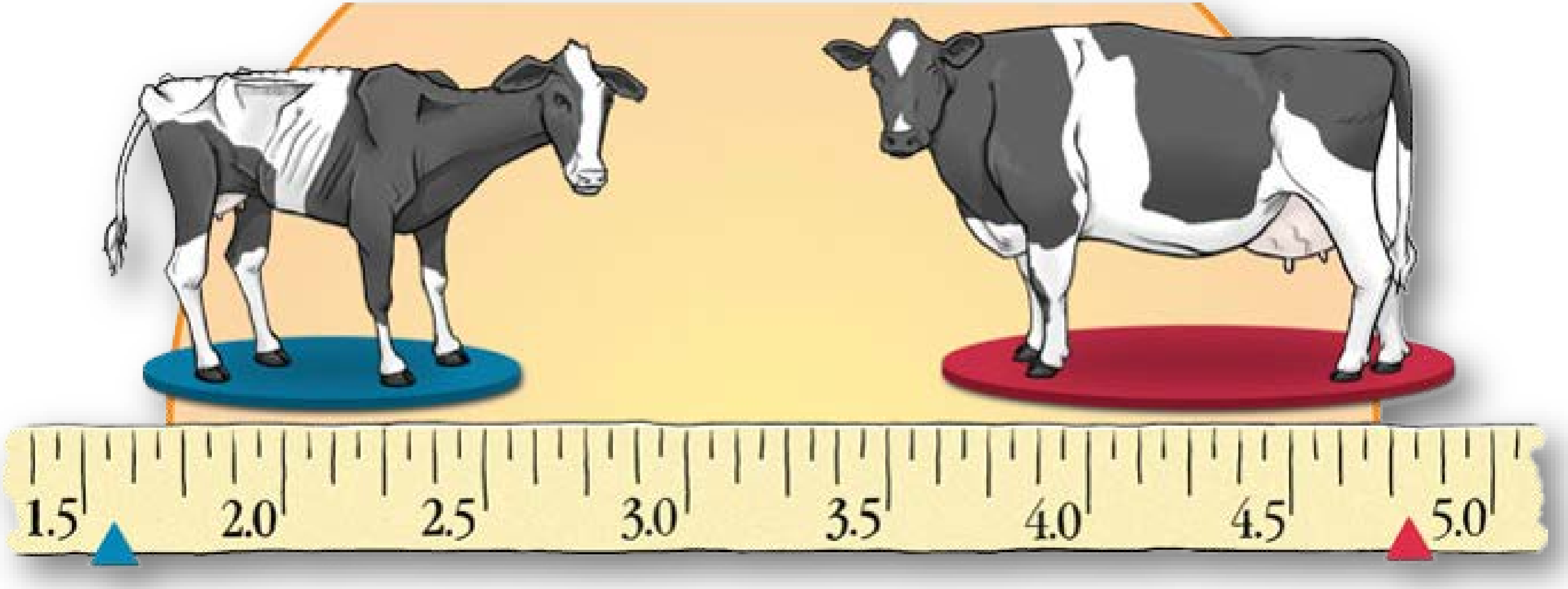
Thin cows before calving mobilize more protein after calving



Thin cows mobilized less body fat but had more intense muscle protein catabolism.
- Need more protein for thin cows?



Pires et al., 2013



BCS at drying off: ______________

BCS at calving: ______________

BCS at breeding: ______________

Hoards Dairyman
May 10, 2015

“It’s the change that matters”

It’s the change that matters

A cow’s body condition score at calving may not be as important as the change in body weight she experiences in early lactation.

by Phil Cardoso

NUTRIENT demand for milk synthesis climbs quickly in early lactation. If no compensatory intake of nutrients is provided to cope with such a requirement, physiological functions like synthesis and secretion of hormones, immune response and embryo development may be compromised. Since milk production rises faster than dry matter intake (DMI) in the first four to six weeks after calving, cows are likely to experience negative energy balance (NEB).

CARDOSO

The author is an assistant professor in the department of animal sciences at the University of Illinois.

Energy balance during late gestation is largely a factor of DMI, as the variation in energy requirements is relatively small; an exception may be cows carrying twins. Even after calving, research indicates that the extent of early lactation energy balance is still more highly correlated with DMI than with milk yield.

The role of excessive body condition in transition difficulties has been studied for many years but remains a problem in many dairy herds. It is more prevalent in modern TMR-fed dairy herds, particularly with the growing reliance on corn silage as a primary forage. High serum beta-hydroxybutyrate (BHBA) and nonesterified fatty acid (NEFA) concentrations before and after calving can lower DMI, lead to hepatic lipid accumulation and ketosis, negatively affect the immune system, and can cause oxidative stress and inflammation.

How about thin cows? Researchers from the French National Institute for Agricultural Research (INRA) showed that cows that were thin (body condition score (BCS) less than 2.5) before calving mobilized more protein after calving than cows that were classified as fat (BCS greater than 3.75). Those cows mobilized less body fat but had more intense muscle protein catabolism. Therefore, if thin cows don’t have high serum concentrations of BHBA or NEFA, it does not mean they are not at risk. Instead, perhaps the method we are using to try to assess their “sickness” is not adequate.

Cows have their own target

Recommendations for optimal BCS at calving have trended downward over the last two decades. A score of about 3.0 (on a 5-point scale) represents a good goal at present.

Researchers from the University of Nottingham (UK) showed that, over the first 12 weeks of lactation, cows that were fat at calving lost 0.9 to 1.0 BCS units; cows that were thin at calving gained 0.4 to 0.5 BCS units (see figure). For both groups of cows, BCS tended to converge at 2.5 in Weeks 12 to 15 of lactation, suggesting that cows have a target BCS that they try to achieve and maintain. Fat cows reached maximum DMI at Week 15, whereas thin cows reached maximum DMI at Week 9. It seems body fat had a direct effect on DMI.

If a cow’s BCS is above this genetically-programmed target, DMI is reduced, and she loses condition; if a cow’s BCS is below this target, DMI goes up, and she gains weight. Therefore, it seems that the theory of getting a cow to a “good condition” (BCS 3.50 to 3.75) at calving is counterproductive, as it will only reduce DMI and exacerbate NEB. We believe that more important than looking only at BCS at calving is to observe the BCS change from calving to about 12 weeks after calving.

Manage with nutrition

The ability of the cow to maintain a reasonable BCS change is affected by diet composition. Our group showed that cows fed high-energy (0.72 Mcal NEL/lb. DM) diets during the last four weeks before calving lost more BCS in the first six weeks postpartum than those fed controlled energy (0.60 Mcal NEL/lb. DM) diets (-0.43 and -0.30, respectively).

Cows fed even moderate-energy diets (0.67 to 0.72 Mcal NEL/lb. DM) will easily consume 40 to 80 percent more energy than required during both the far-off and close-up periods. Allowing dry cows to consume more energy than required, even if they do not become noticeably overconditioned, results in responses that would be typical of overly fat cows. Because energy consumed in excess by cows must either be dissipated as heat or stored as fat, we speculate that, at least in some cows, the excess is accumulated preferentially in internal adipose tissue depots.

Our group recently demonstrated that moderate overconsumption of energy by nonlactating cows for 57 days leads to greater deposition of fat in abdominal adipose tissues than in cows fed a high-bulk diet to control energy intake to meet requirements. The NEFA and signaling molecules released by the visceral adipose tissues travel directly to the liver, which may cause fatty liver, subclinical ketosis and secondary problems with liver function.

The effect of BCS change on cows’ fertility is also clear. Recently, researchers from the University of Wisconsin found that cows that either gained or maintained BCS from calving to 21 days after calving had higher pregnancy rates (83.5 and 38.2 percent, respectively) per A.I. at 40 days than cows that lost BCS (25.1 percent) during that same period.

And previously, researchers from the University of Florida found that cows that had greater than 1.0 BCS unit change from calving to A.I. at approximately 70 days postpartum had lower pregnancy per A.I. (28 percent) than cows that lost less than 1.0 BCS unit (37.3 percent) or did not have a BCS change (41.6 percent).

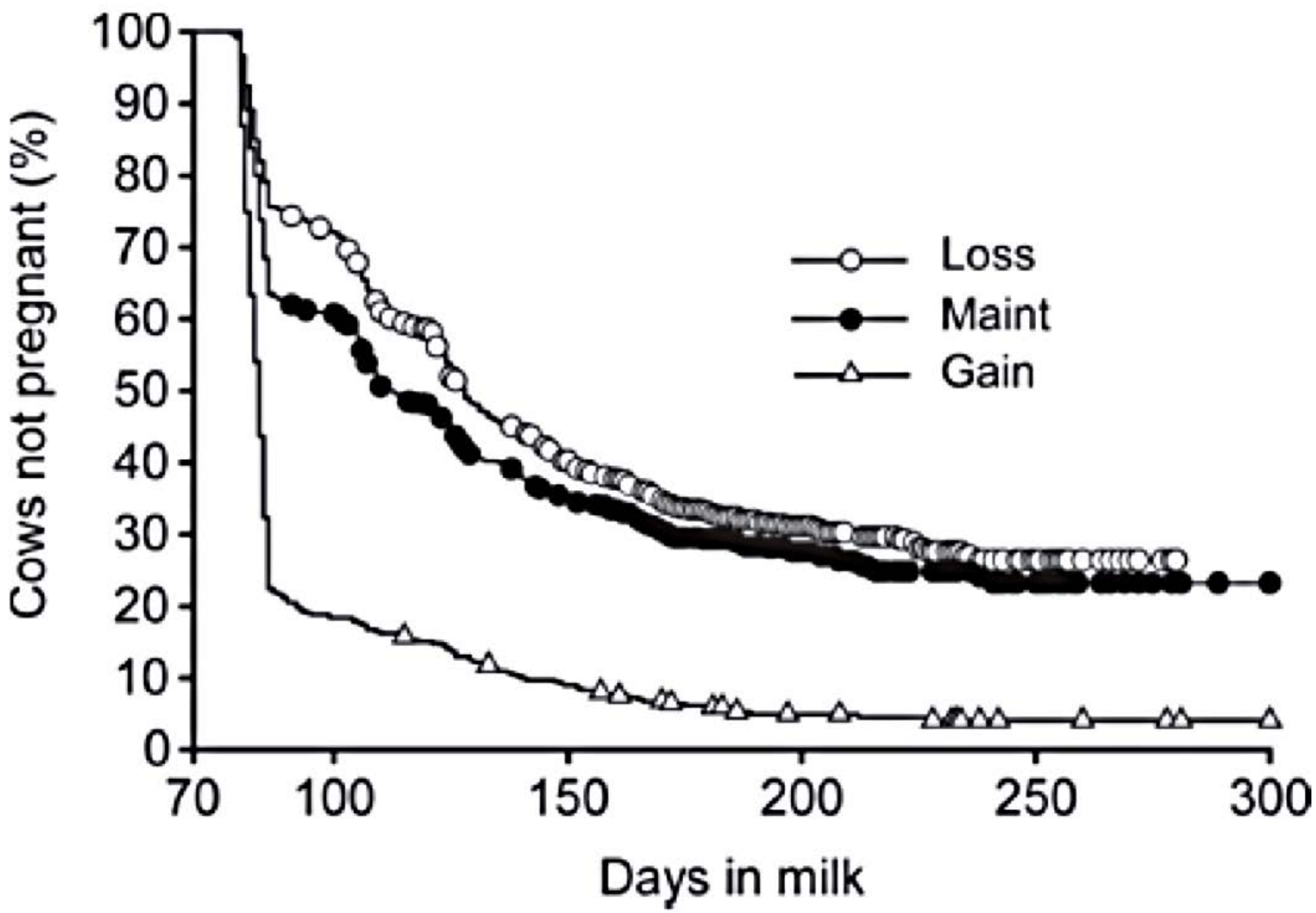
Two simple letters

Ideally, BCS would be measured in every cow in the herd every month. If that is an unachievable commitment, we recommend that farmers measure individual cow’s BCS at least three times per lactation: at dry-off, calving and breeding. With these numbers in hand, you will be able to calculate BCS change and maintain the goal for a loss of no more than 0.5 to 0.75 BCS units.

The variation between individuals assigning BCS to cows can be another challenge. To make it simple, train yourself and your team the two letters of BCS: “V” and “U.” This is the shape of the dip between a cow’s hips and pins. It is easy to visualize and can be used to determine when to move cows from the fresh/high pen to the next group.

If a cow has a BCS of “V,” consider letting her stay a little bit longer in the fresh/high group. Whenever a cow achieves a BCS of “U,” she is ready to be moved to the next nutritional group. This strategy will most likely help your cows to achieve the right BCS at dry-off, allowing for a minimal and more ideal BCS change when she calves in again.

Calving-to-pregnancy interval for cows that gained, maintained, or lost BCS between calving and 21 d postpartum



Carvalho et al., 2014

Dietary Recommendations for Dry Cows

- **NEL:** Control energy intake at 14 to 16 Mcal daily [diet ~ 1.30 Mcal/kg (0.60 Mcal/lb) DM] for mature cows
- **Crude protein:** 12 – 14% of DM
- **Metabolizable protein (MP):** > 1,200 g/d
- **Starch content:** 12 to 16% of DM
- **NDF from forage:** 40 to 50% of total DM or 4.5 to 5 kg per head daily (~0.7 – 0.8% of BW). Target the high end of the range if more higher-energy fiber sources (like grass hay or low-quality alfalfa) are used, and the low end of the range if straw is used (2-5kg).
- **Total ration DM content:** <55% (add water if necessary)
- **Minerals and vitamins:** follow guidelines (For close-ups, target values are 0.40% magnesium (minimum), 0.35 – 0.40% sulfur, potassium as low as possible, a DCAD of near zero or negative, 0.27% phosphorus, and at least 1,500 IU of vitamin E)

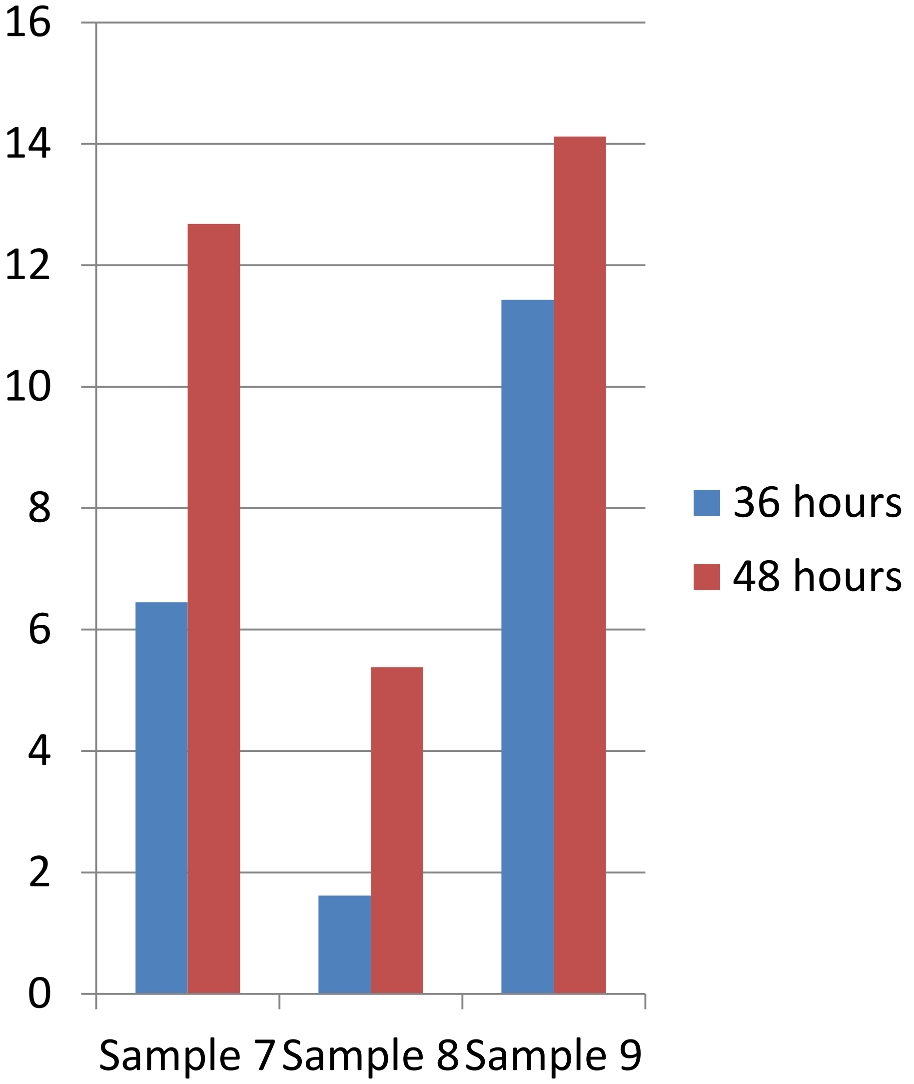
Crude Fiber… remember?

#	Almond hull variety	DM	CF	NDF	ADF	Ash
7	Cal 66%, HS 34%	91.3	22.3	36.5	25.1	5.9
8	B/P 50%, HS 50%	87.7	22.2	33.7	24.6	5.2
9	B/P 66%, HS 34%	88.3	21.8	32.4	23.8	5.5

- Conclusion

  Breaking fiber into ADF and NDF gives better understanding of what happens to fiber.

NDF Disappearance



Pate et al., *unpublished*

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Methionine
Lysine

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A summary of some early lactation cow rumen-protected Lys and Met supplementation experiments

7 experiments that measured production responses to increasing Met, Lys, or both in MP *after* calving

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+ 0.70 kg/d milk

+ 0.16% units milk protein

+ 79 g/d milk protein

+ 0.02% units milk fat

+ 48 g/d milk fat

5 experiments that measured production responses to increasing Met, or Met + Lys in MP starting *before* calving

---

+ 2.30 kg/d milk

+ 0.09% units milk protein

+ 112 g/d milk protein

+ 0.10% units milk fat

+ g/d milk fat

Garthwaite et al., 1999

Can AA Prevent Embryonic Losses?

Whole Rat Embryos Require Methionine for Neural Tube Closure when Cultured on Cow Serum[1−4]

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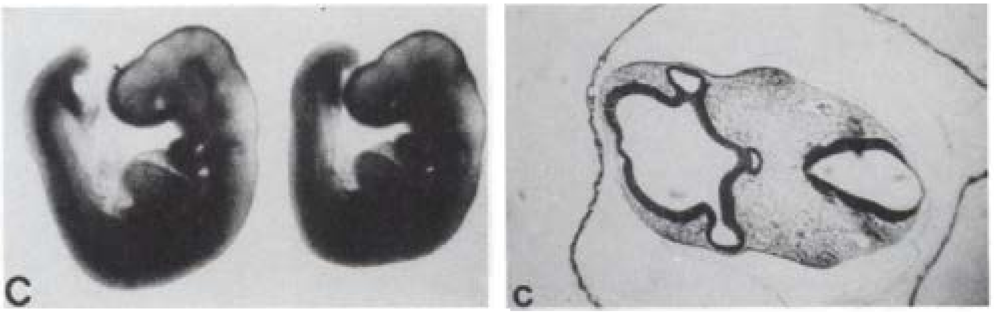
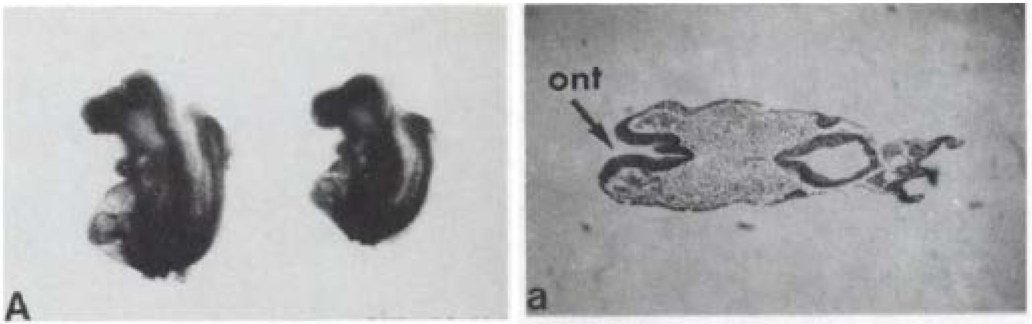


Culture in Rat Serum



Culture in Bovine Serum

Cow serum with:	Embryo Protein	% Abnormal
None	73.7 $\pm$ 8.6[a]	100%
Amino acids + vitamins	**130.0 $\pm$ 7.7[b]**	**0%**
Amino acids	**117.1 $\pm$ 8.5[b]**	**0%**
Vitamins	56.6 $\pm$ 5.76[a]	100%
Amino acids w/o methionine	82.9 $\pm$ 8.7[a]	100%
Methionine	**133.7 $\pm$ 5.5[b]**	**0%**

Coelho et al., 1989

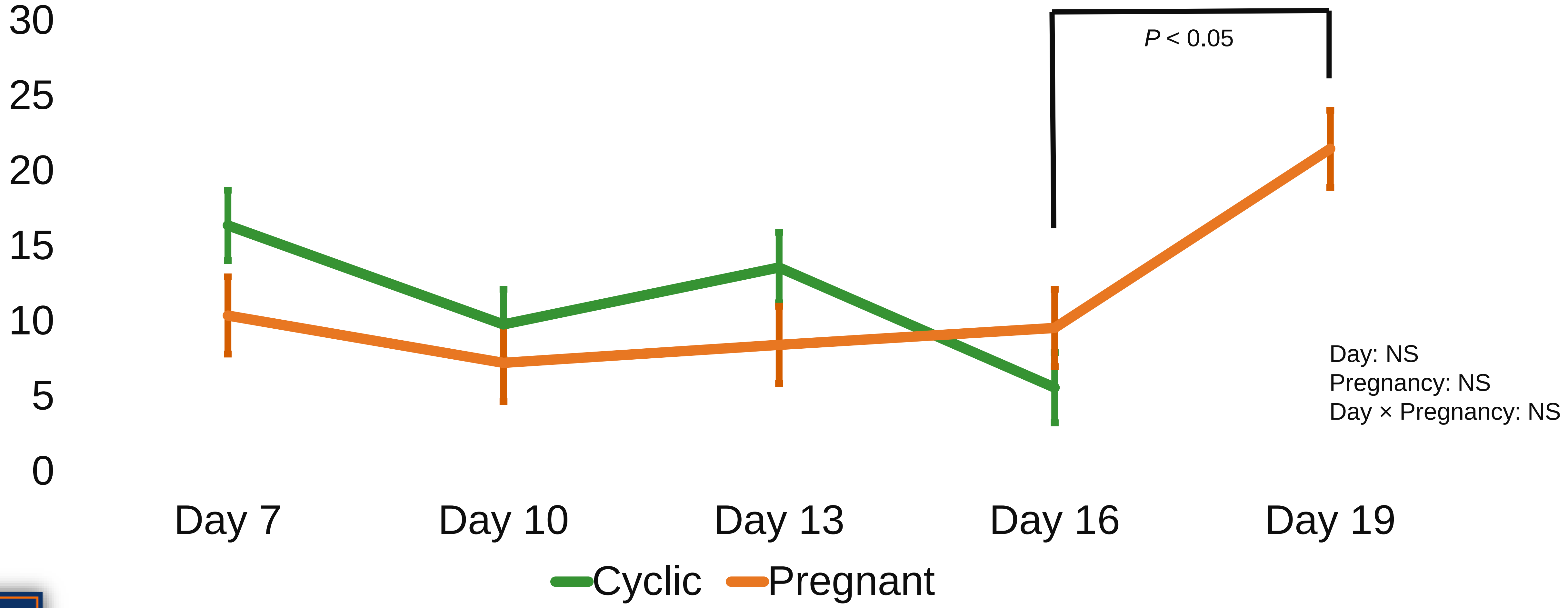
Nutritional Effects from Pre-fresh to Early Pregnancy on Embryo Development and Fertility

It is now evident that nutritional effects on oocyte quality can originate when ovarian follicles emerge from the primordial pool and become committed to growth (approx. three to four months in cows). Undernutrition at this time reduces the number of follicles that emerge and therefore the number available to ovulate.
Ashworth et al. 2009

Methionine enriched diets impact on embryo quality? → Improved Fertility?

Adapted from Wiltbank et al., 2014

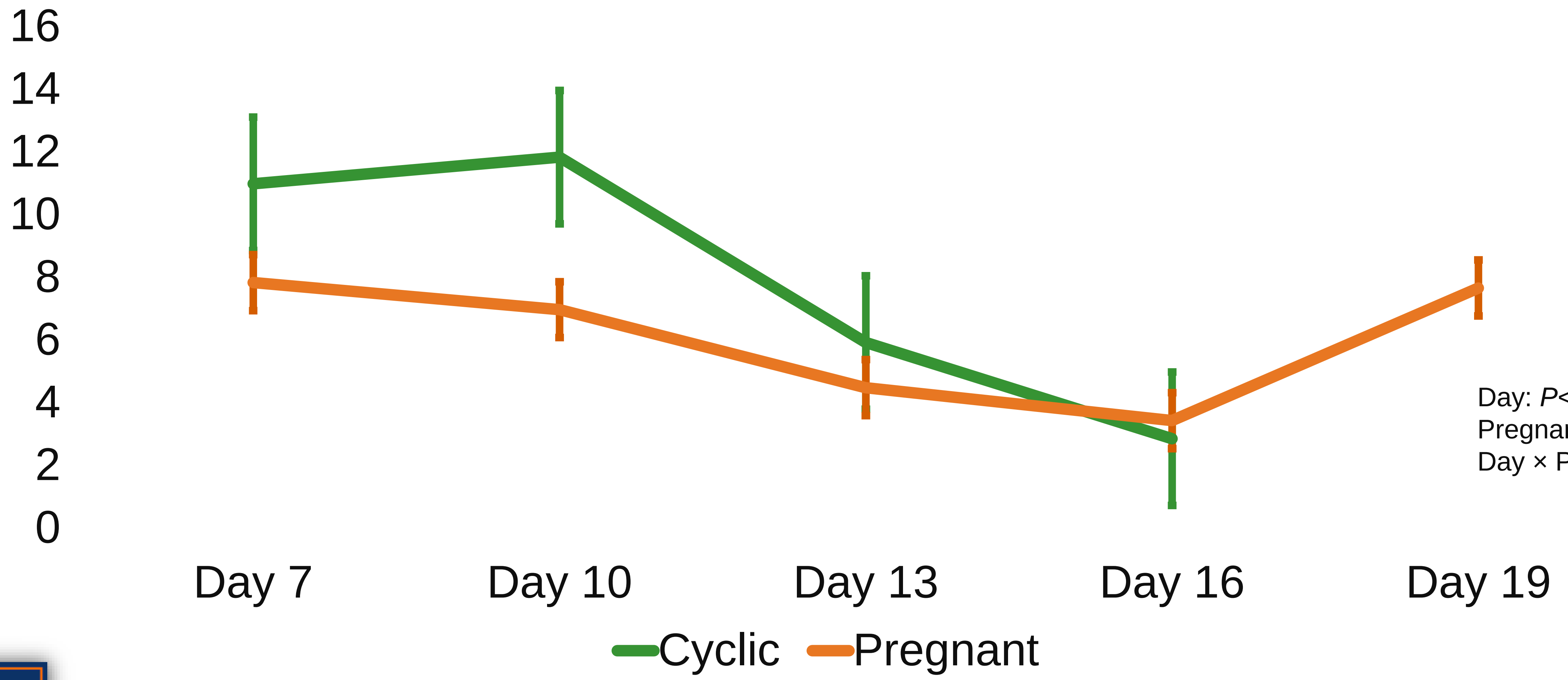
Lysine concentration (µ*M*) in uterine luminal fluid of cross-bred beef heifers



n = 5 per treatment per time-point

Forde et al., 2014

Methionine concentration (μ*M*) in uterine luminal fluid of cross-bred beef heifers

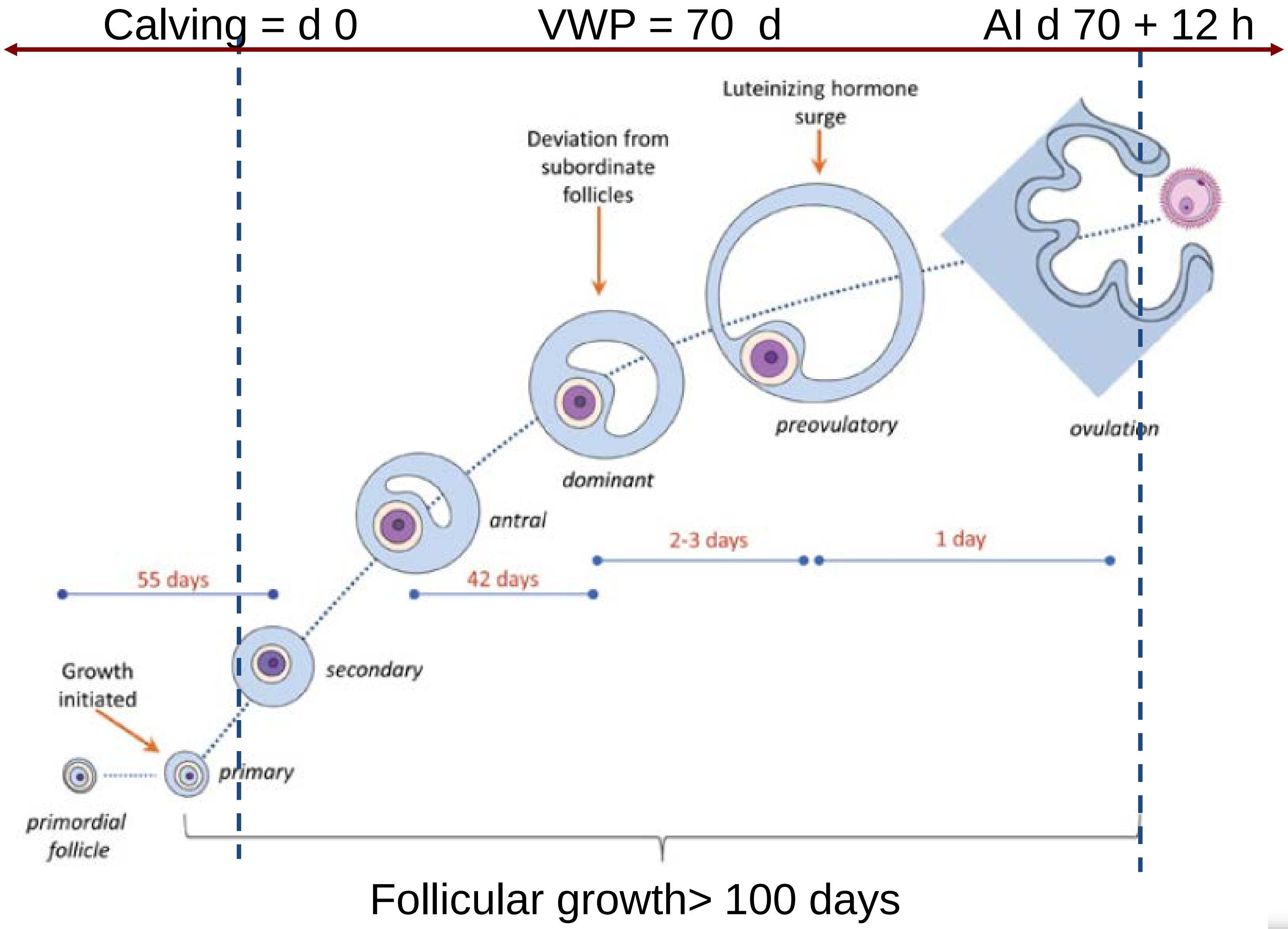


Day: *P*<0.001
Pregnancy: *P*<0.05
Day × Pregnancy: NS

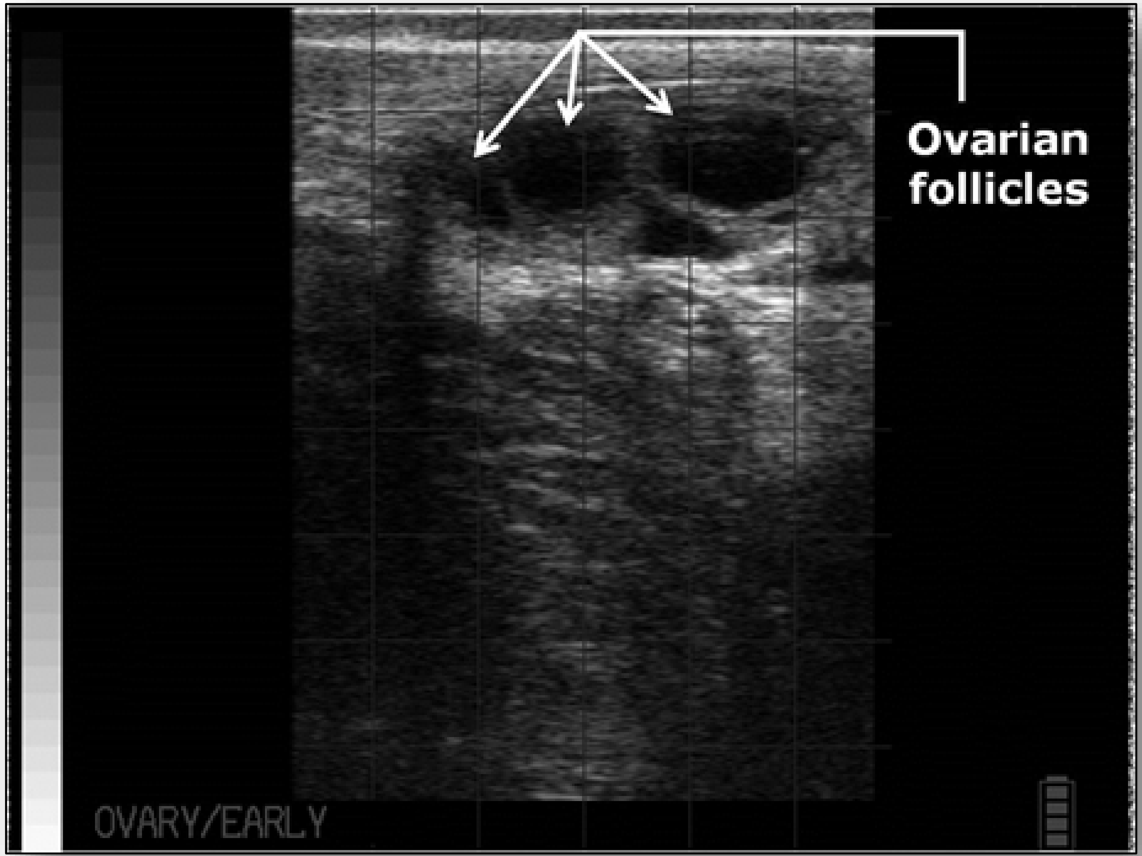
n = 5 per treatment per time-point

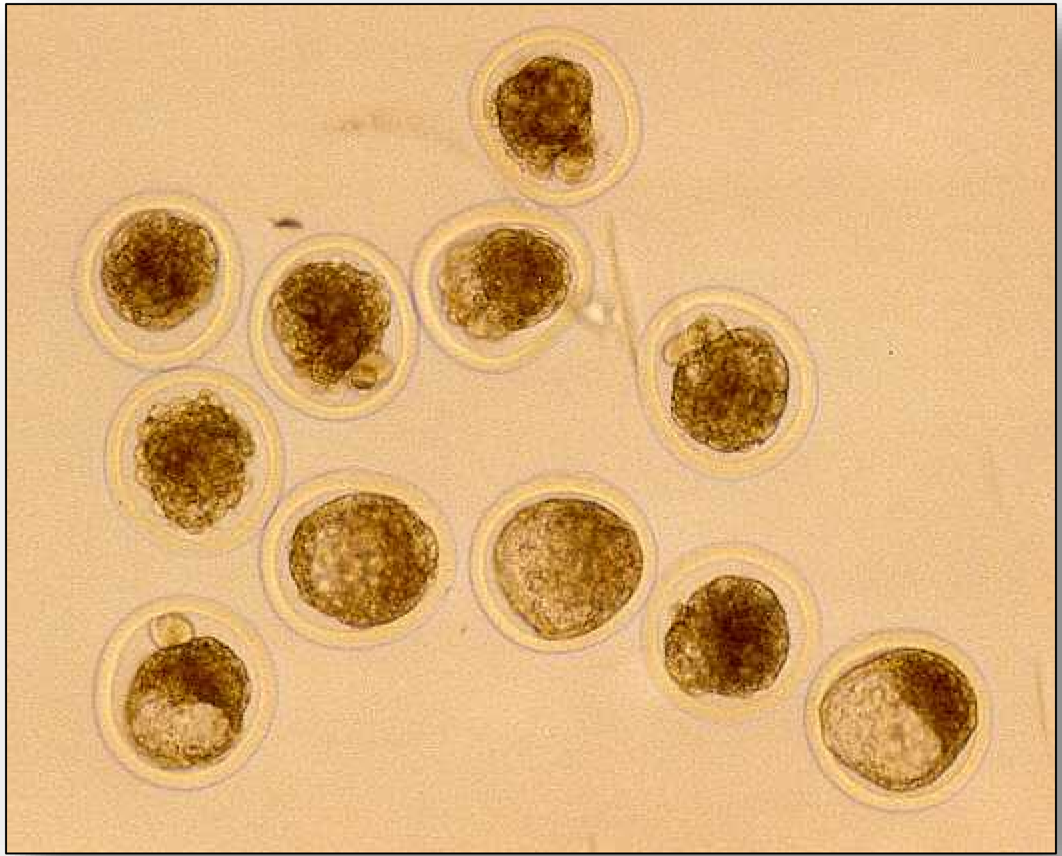
Forde et al., 2014

The Growth of the Follicle Starts Prior to Calving



Hansen, 2013


Ovarian
follicles
OVARY/EARLY



Effects of Rumen-Protected Methionine or Choline Supplementation on the First Dominant Follicle

- 72 Holstein cows entering 2nd or greater lactation
- Experimental design was a randomized block design
- Housed in tie stalls with sand bedding
- Milked 3x per day
- Fed same basal TMR to meet but not exceed 100% of the energy requirements as outlined by NRC, 2001
  - From -34 d to calving: prepartum diet
  - From 0 to 30 DIM: fresh cow diet
  - From 31 to 72 DIM: high cow diet
- Treatments were given as top-dress

Acosta et al., 2016

Effects of Rumen-Protected Methionine or Choline Supplementation on the First Dominant Follicle

1. Rumen-protected methionine
   (**MET**; n = 20, received 0.08% of the DM of the diet/d as methionine, Smartamine M®, Adisseo, Alpharetta, GA, USA, to a Lys:Met = 2.9:1)

2. Rumen-protected choline (**CHO**; n = 17, received 60 g/d choline, Reassure, Balchem Corporation, New Hampton, NY)

3. Both rumen protected methionine and choline
   (**MIX**; n = 19, received 0.08% of the DM of the diet/d as methionine to a Lys:Met = 2.9:1 and 60 g/d choline)

4. No supplementation to serve as control
   (**CON**; n = 16, fed TMR with a Lys:Met = 3.5:1)

Acosta et al., 2016

Diets

Ingredients	Pre-Fresh -21 d to calving	Fresh Calving to 30 DIM	High 31 to 73 DIM
	% DM		
Alfalfa silage	8.35	5.07	6.12
Alfalfa hay	4.29	2.98	6.94
Corn silage	36.40	33.41	35.09
Wheat straw	15.63	2.98	---
Cottonseed	---	3.58	3.26
Wet brewers grain	4.29	9.09	8.16
Soy hulls	4.29	4.18	4.74
Blood meal	0.86	1.50	1.43
Concentrate mix	25.89	37.21	34.26

Acosta et al., 2016

Diets; chemical composition

Item	Pre-Fresh -21 d to calving	Fresh Calving to 30 DIM	High 31 to 73 DIM
	% DM		
DM, %	47.1	47.9	47.1
CP, % of DM	18.0	17.6	18.3
ADF, % of DM	22.7	24.4	23.2
NDF, % of DM	35.6	37.3	36.3
Lignin, % of DM	4.53	4.00	3.80
Starch, % of DM	22.3	21.4	23.6
Crude fat, % of DM	5.23	4.70	4.57

Acosta et al., 2016

Milk Yield and Components

Parameter	MET		SEM	P-value			
	With	Without		MET	Parity	Time	M × T
Milk composition (%)							
Fat	3.72	3.74	0.11	0.92	-	<0.01	0.58
Protein	3.32[a]	3.14[b]	0.05	<0.01	-	<0.01	0.67
SCC	1.86	1.81	0.07	0.55	-	<0.01	0.85
Lactose	4.70	4.69	0.03	0.79	<0.01	<0.01	0.90
Total solids	12.65	12.39	0.12	0.13	-	<0.01	0.24
Other solids	5.62	5.60	0.03	0.58	<0.01	<0.01	0.82
MUN	12.80	12.94	0.30	0.75	-	0.50	0.92
Milk production (kg/day)							
Milk yield	44.32[a]	40.32[b]	1.29	0.03	-	<0.01	0.60
Milk fat yield	1.67[a]	1.53[b]	0.05	0.04	-	<0.01	0.47
Milk protein yield	1.51[a]	1.33[b]	0.05	<0.01	-	<0.01	0.73
ECM	44.81[a]	40.25[b]	1.05	<0.01	-	<0.01	0.16

Zhou et al., 2016

Milk Yield and Components

Parameter	MET		SEM	*P*-value			
	With	Without		MET	Parity	Time	M × T
Milk composition (%)							
Fat	3.72	3.74	0.11	0.92	-	<0.01	0.58
Protein	3.32[a]	3.14[b]	0.05	<0.01	-	<0.01	0.67
SCC	1.86	1.81	0.07	0.55	-	<0.01	0.85
Lactose	4.70	4.69	0.03	0.79	<0.01	<0.01	0.90
Total solids	12.65	12.39	0.12	0.13	-	<0.01	0.24
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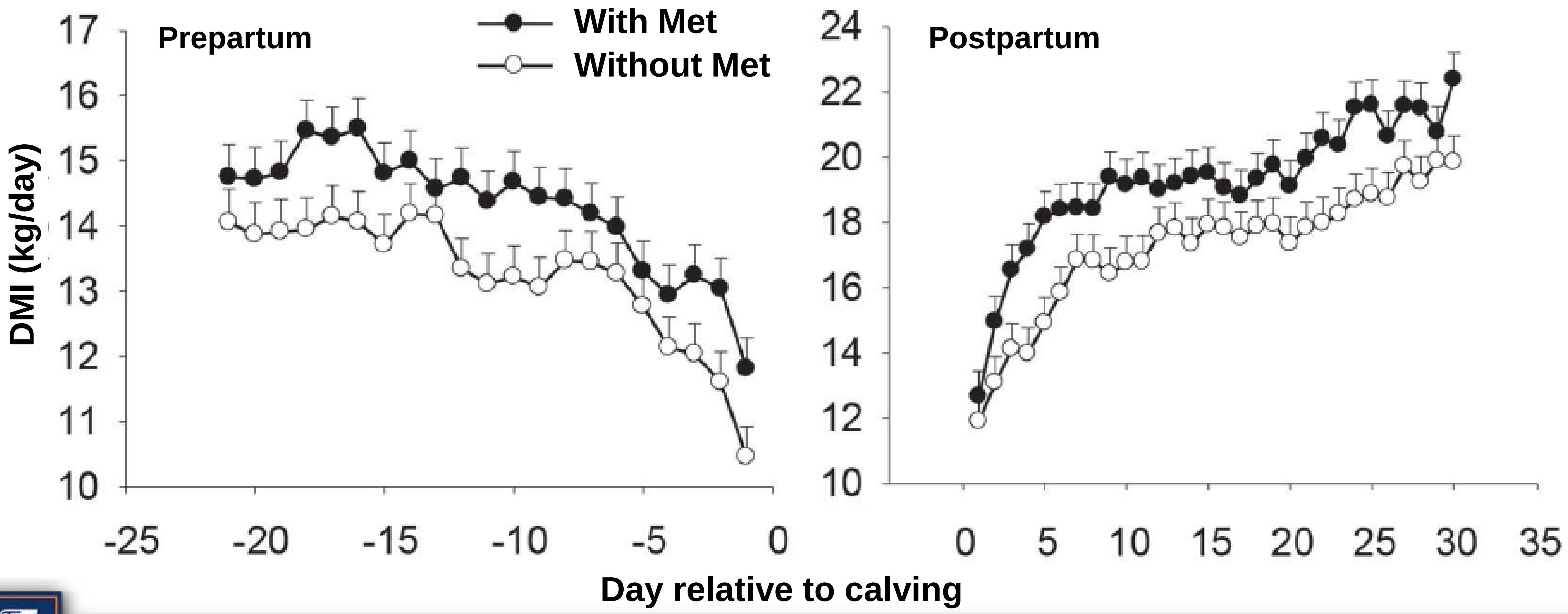
Zhou et al., 2016

Improved postpartal performance in dairy cows supplemented with rumen-protected methionine during the peripartal period



Zhou et al., 2016

Theriogenology 96 (2017) 1–9

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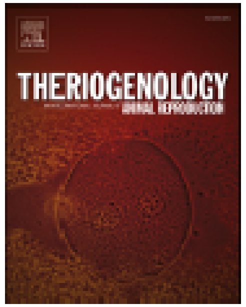


Effects of rumen-protected methionine and choline supplementation on steroidogenic potential of the first postpartum dominant follicle and expression of immune mediators in Holstein cows

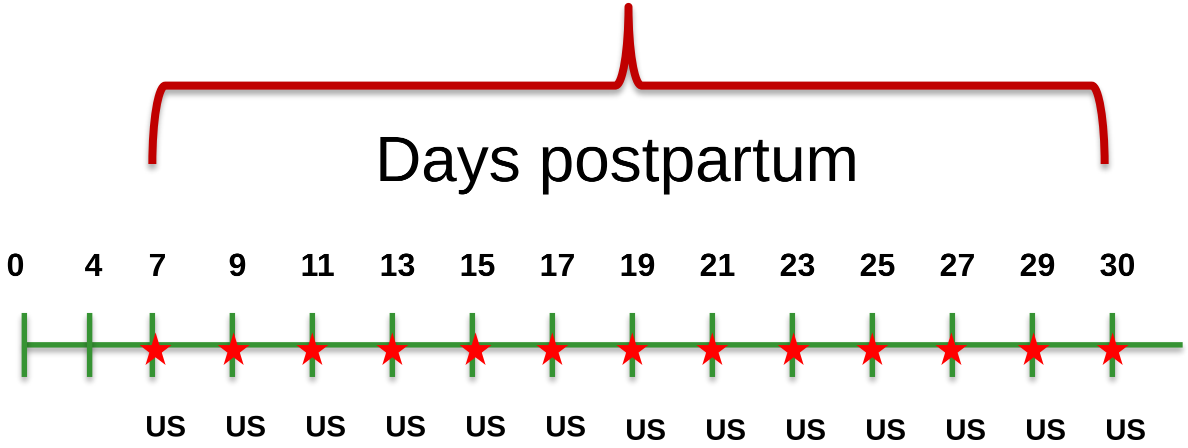
CrossMark

D.A.V. Acosta [a, b, e], M.I. Rivelli [a], C. Skenandore [a], Z. Zhou [a], D.H. Keisler [c], D. Luchini [d], M.N. Corrêa [e], F.C. Cardoso [a, *]

[a] *Department of Animal Sciences, University of Illinois, Urbana, IL, USA*
[b] *The Colombian Corporation for Agricultural Research (CORPOICA), Bogotá, Colombia*
[c] *Division of Animal Sciences, University of Missouri, Columbia, USA*
[d] *Adisseo, Alpharetta, GA, USA*
[e] *Department of Clinics, Faculty of Veterinary Medicine, Universidade Federal de Pelotas, Pelotas, RS, Brazil*

Ovulation, first dominant follicle (n = 40)

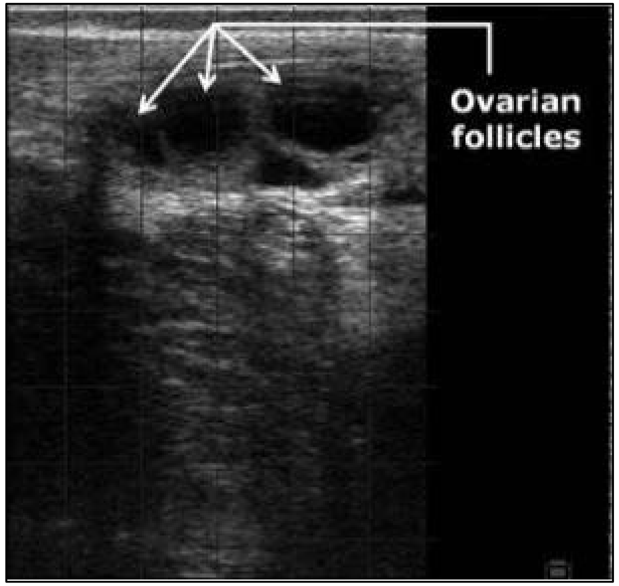
Follicular Aspiration, 16mm (n = 40)

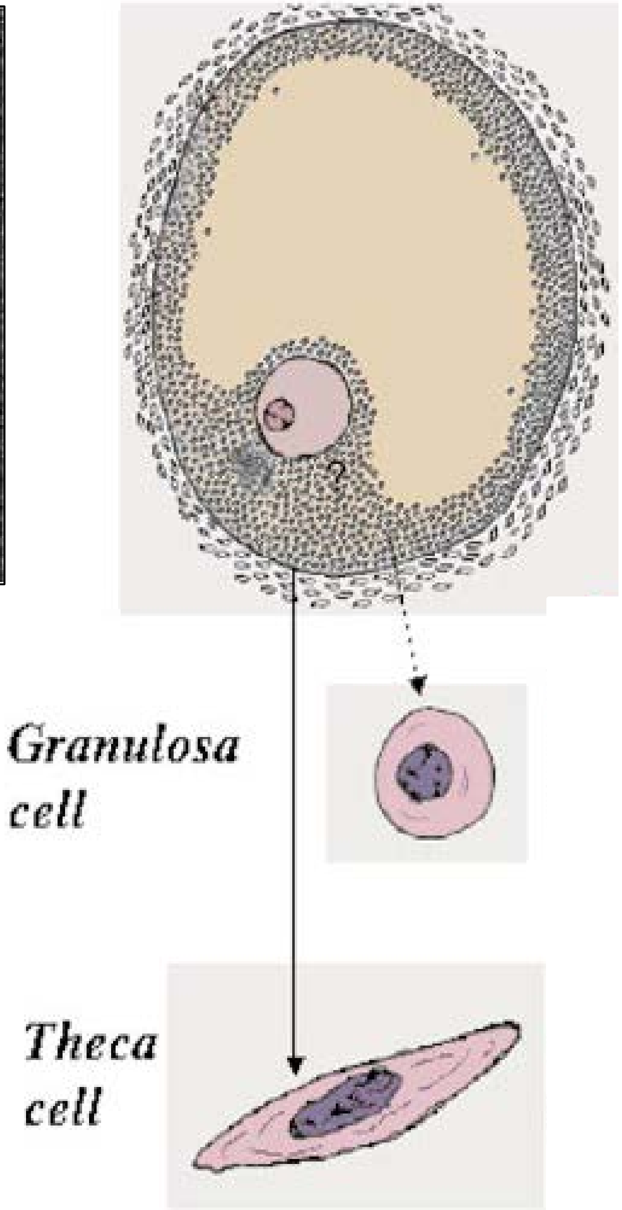


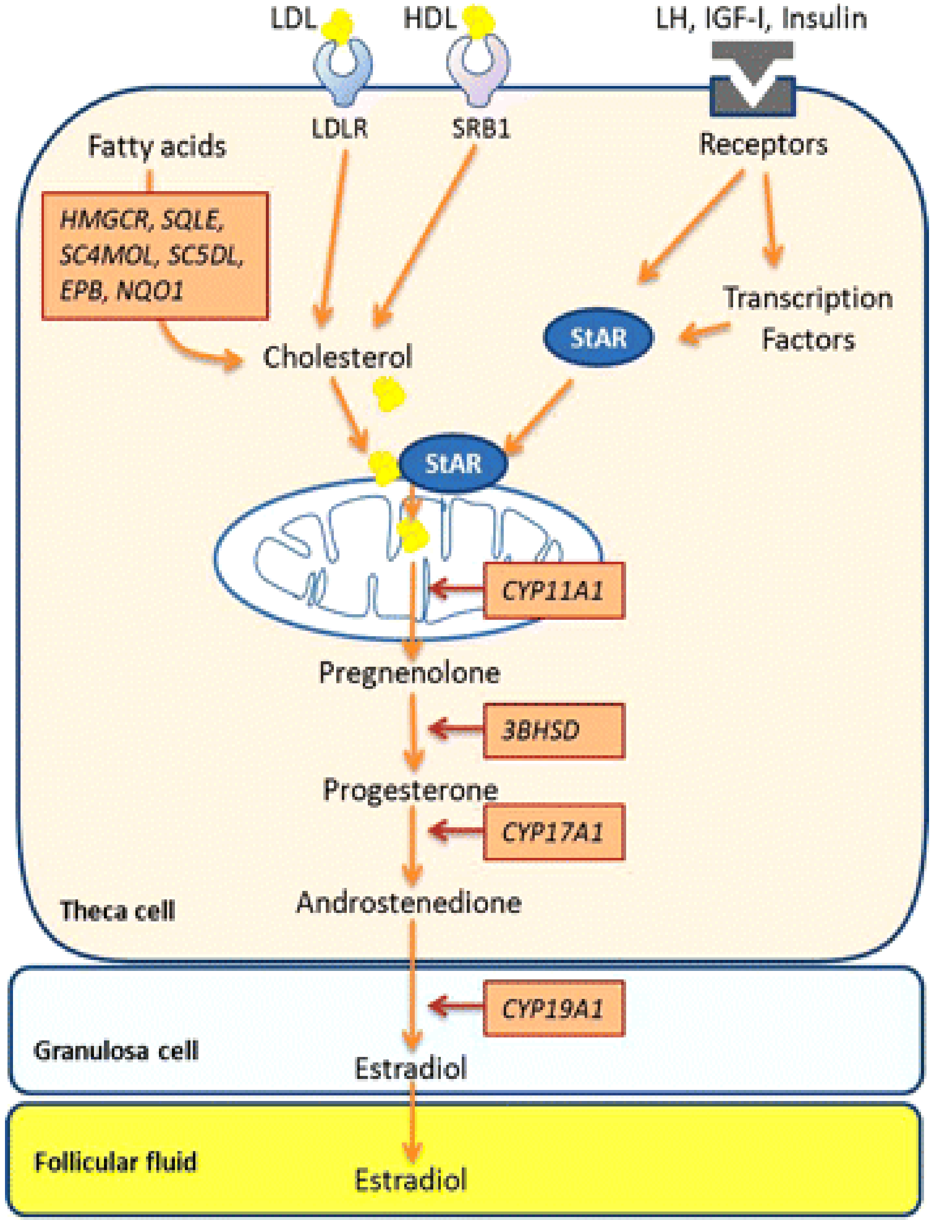
★ Blood Samples

US: Ultrasonography

Acosta et al., 2017

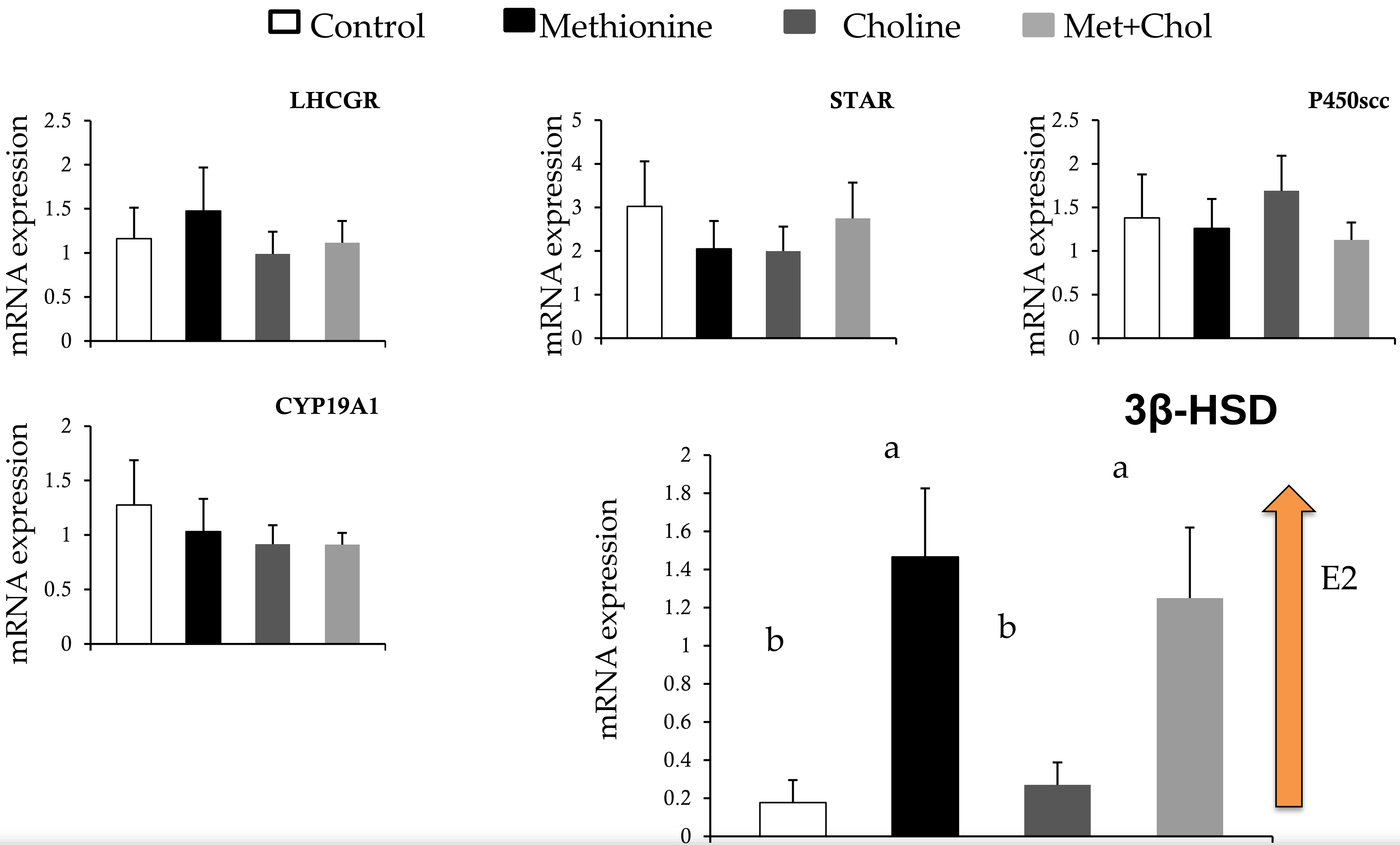






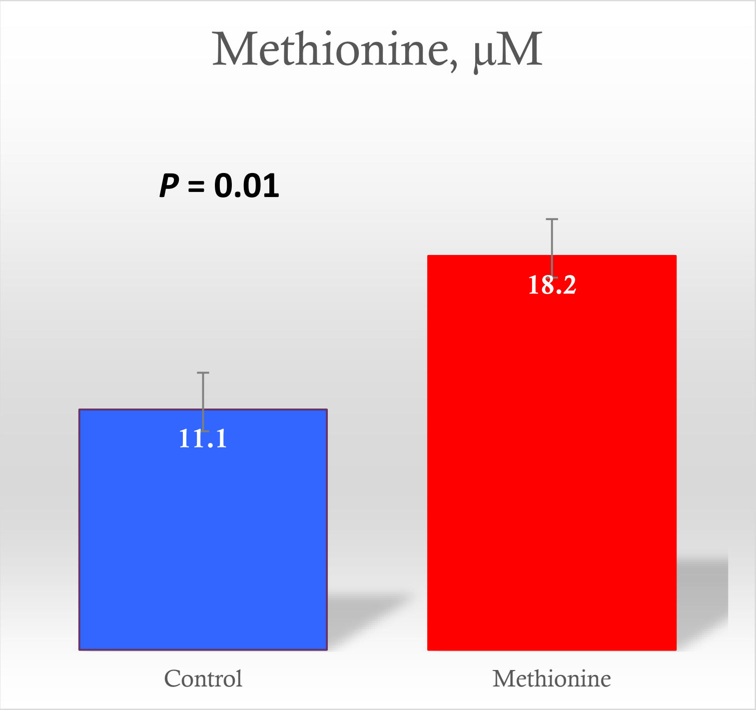
Walsh et al., 2012

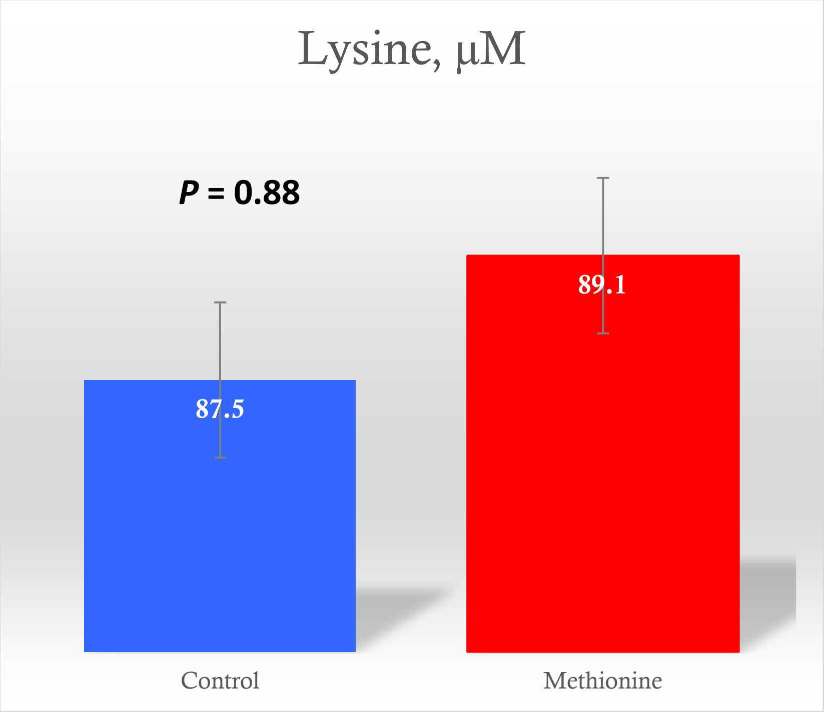
Steroidogenesis Pathway

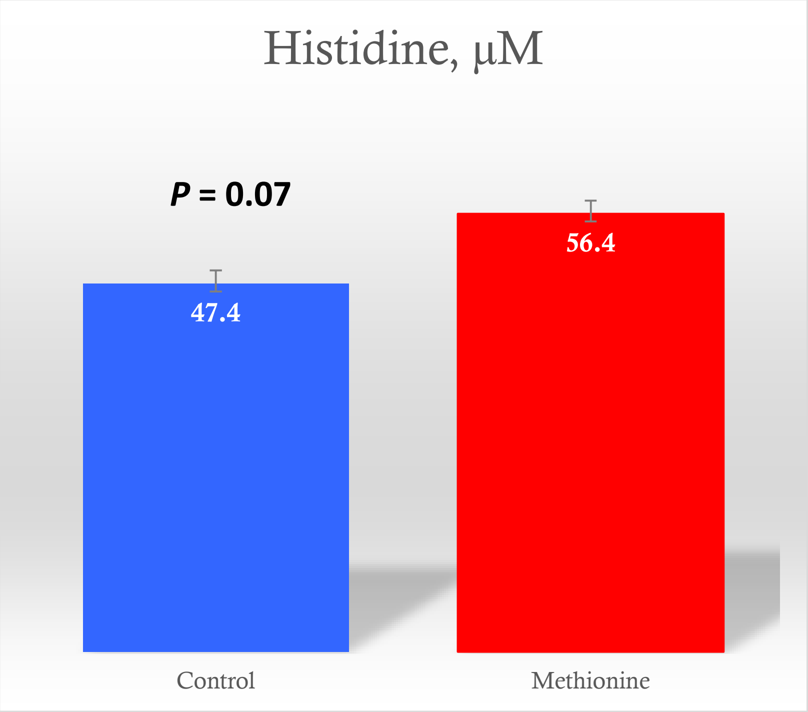


Acosta et al., 2017

Follicular Fluid AA Concentration from Cows at the Day of Follicular Aspiration of the Dominant Follicle of the 1st Follicular Wave Postpartum (~16 mm)



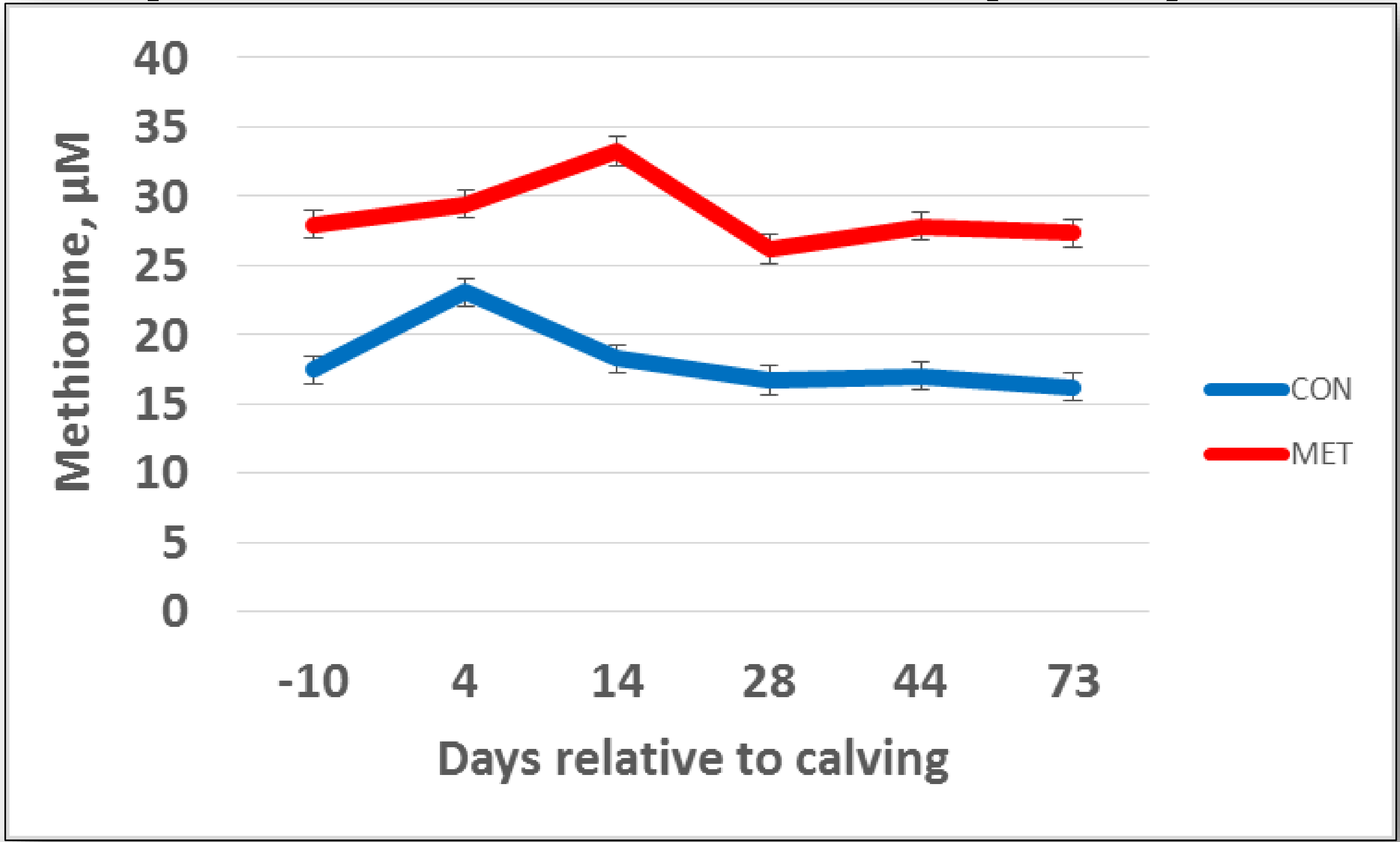




Control: n = 7; Methionine: n = 8

Acosta et al., 2017

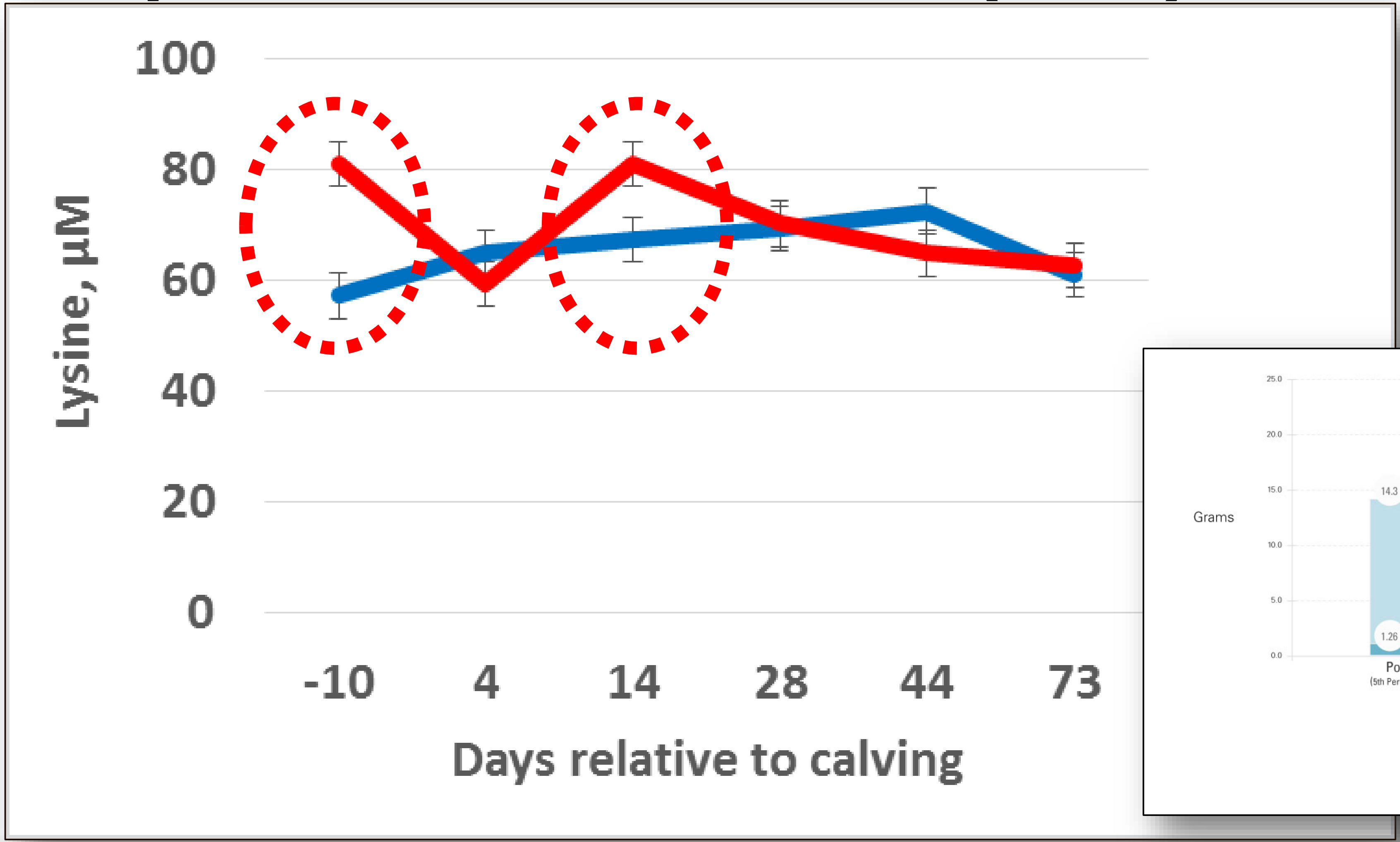
Serum Methionine Concentration from Cows Fed rumen-protected methionine (MET) or not (CON)

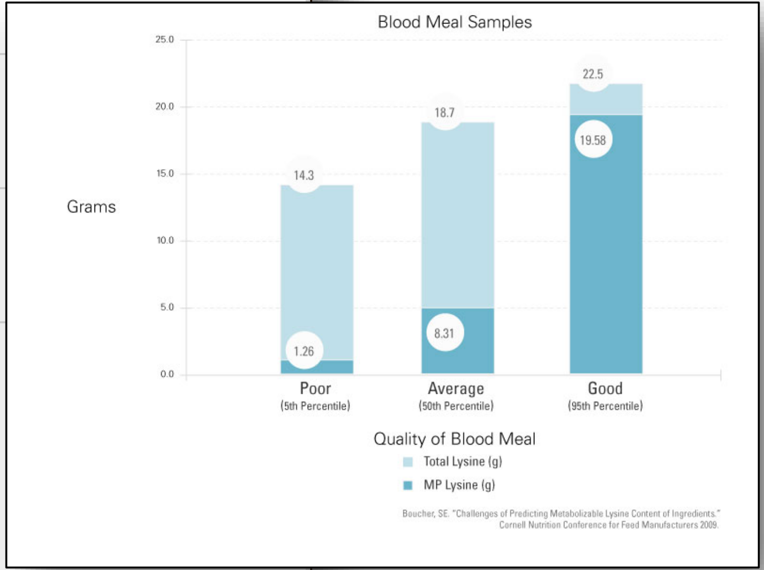


Control: n = 7; Methionine: n = 10

Stella et al., *unpublished*

Serum Lysine Concentration from Cows Fed rumen-protected methionine (MET) or not (CON)

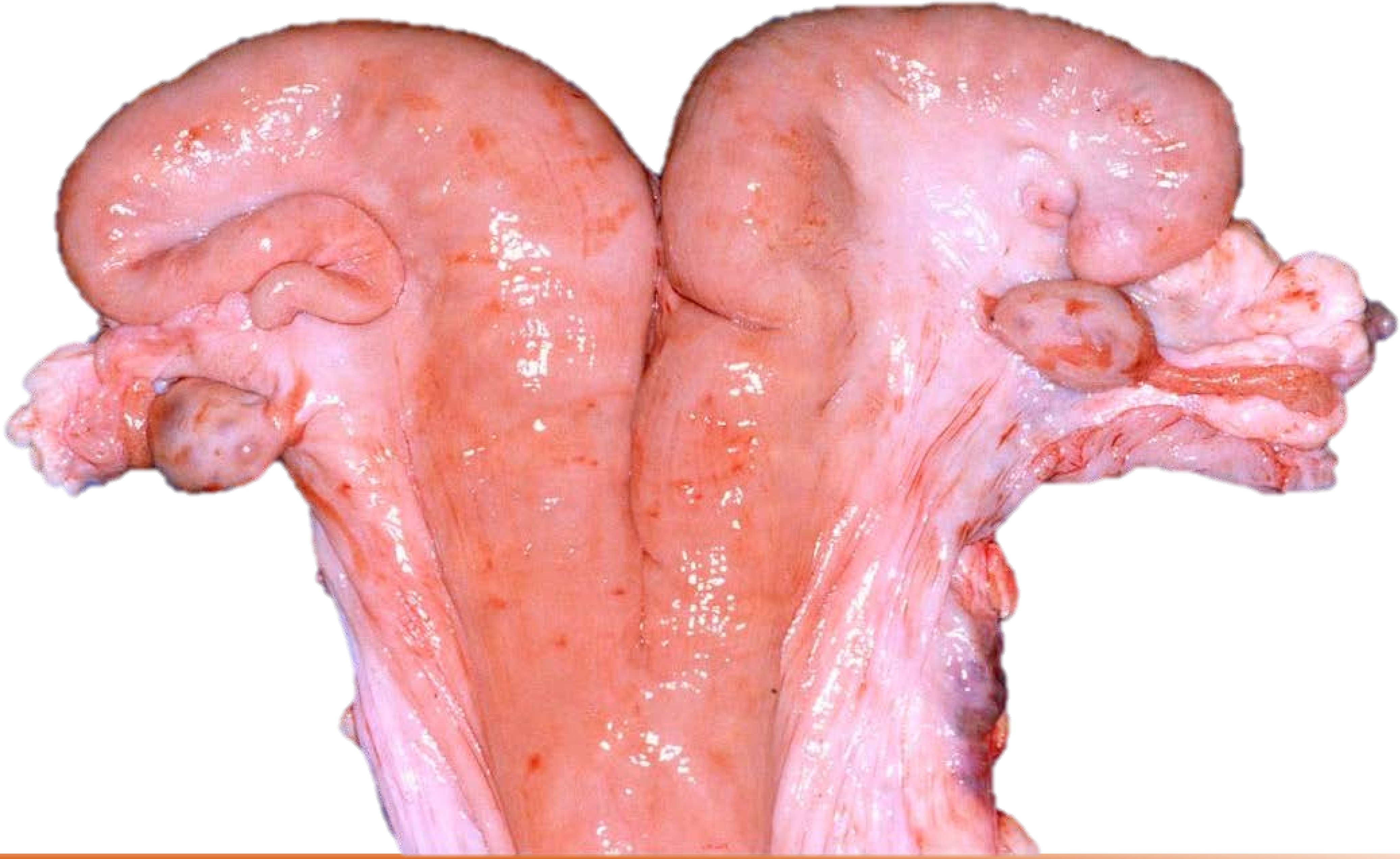




University of Illinois at Urbana-Champaign

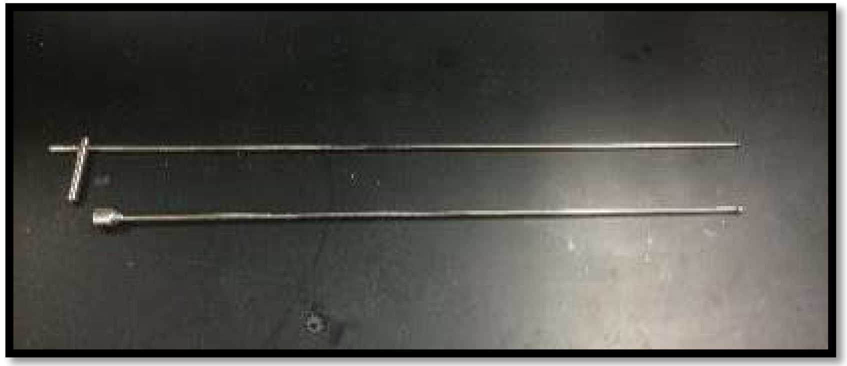
Control: n = 7; Methionine: n = 10

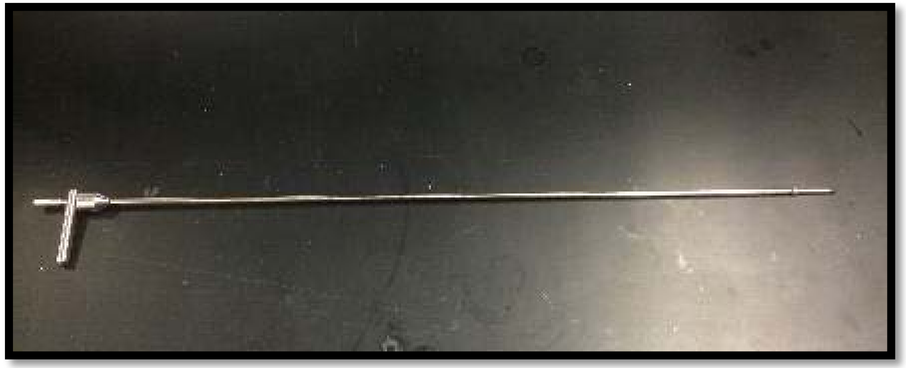
Stella et al., *unpublished*

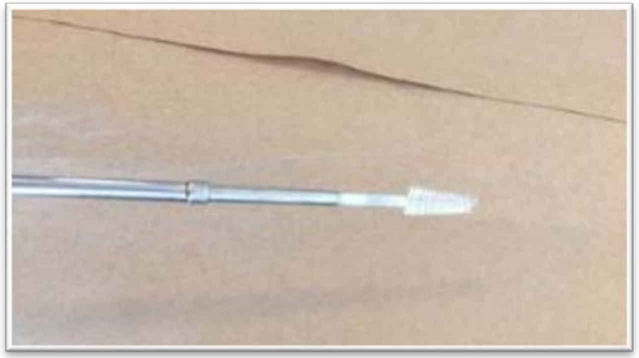


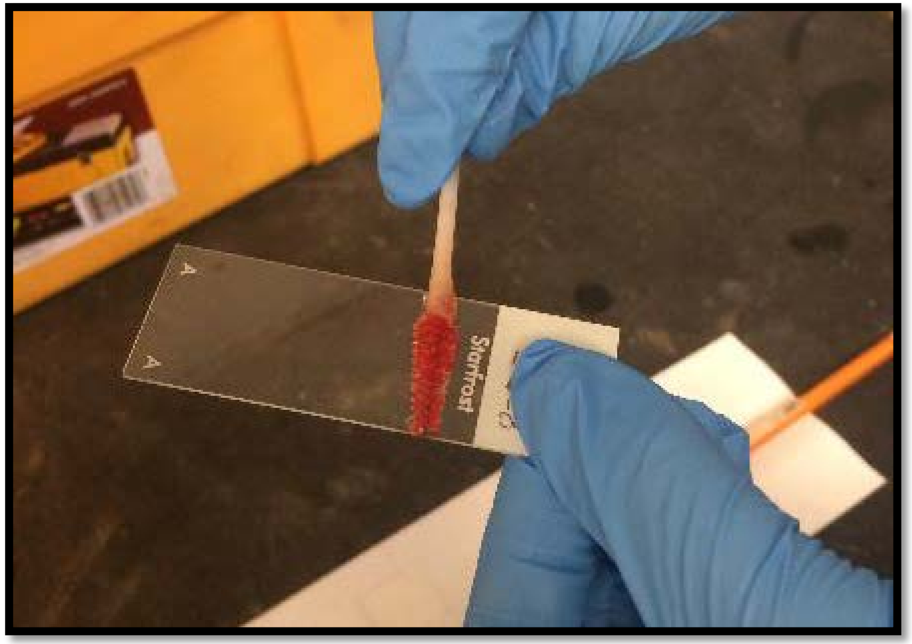
http://loribovinesection.blogspot.com/2013_07_01_archive.html

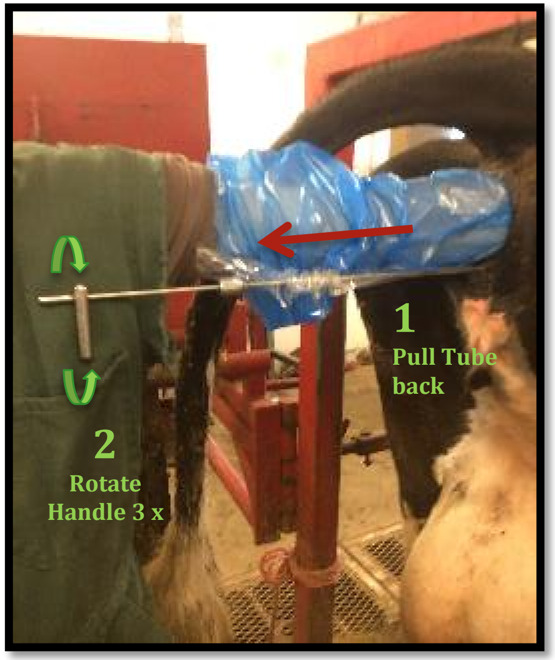
Uterine Cytology



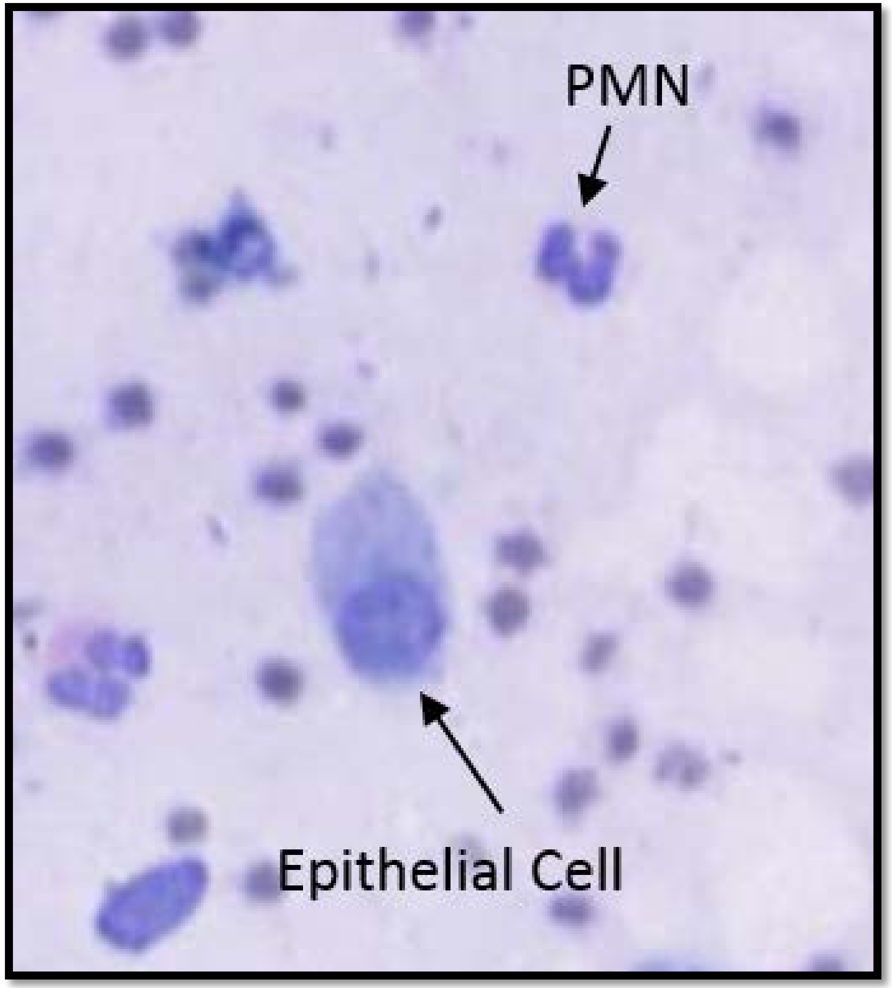




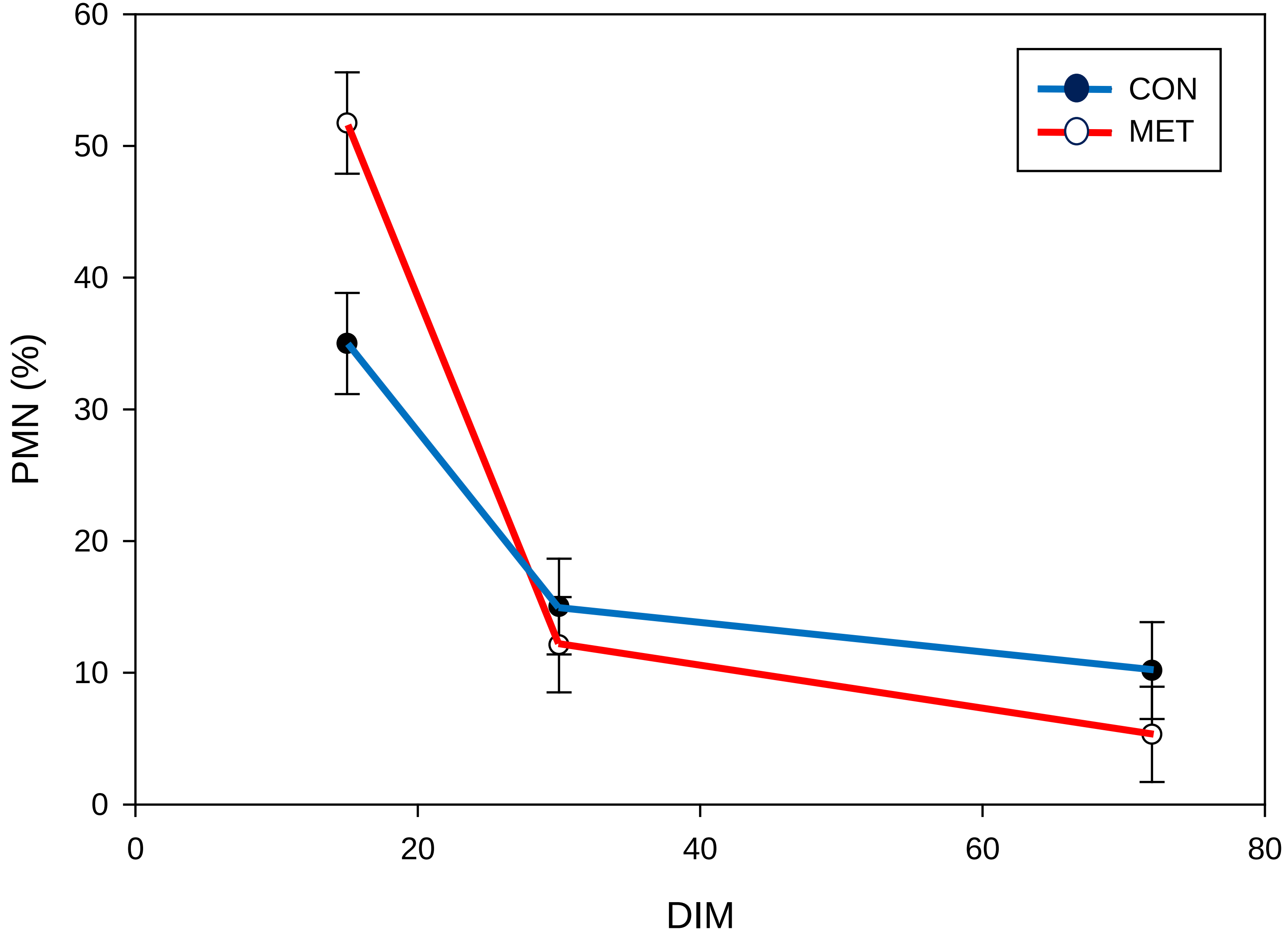




Uterine Cytology – Polymorphonuclear (PMN)



PMN in Uterus of Cows Fed rumen-protected methionine (MET) or not (CON)



Effect	*P*-Value
TRT	0.93
DIM	<0.001
TRT*DIM	0.01

Control: n = 36; Methionine: n = 36

Skenadore et al., 2017

Animal (2014), 8:s1, pp 54–63
doi:10.1017/S1751731114000524

animal

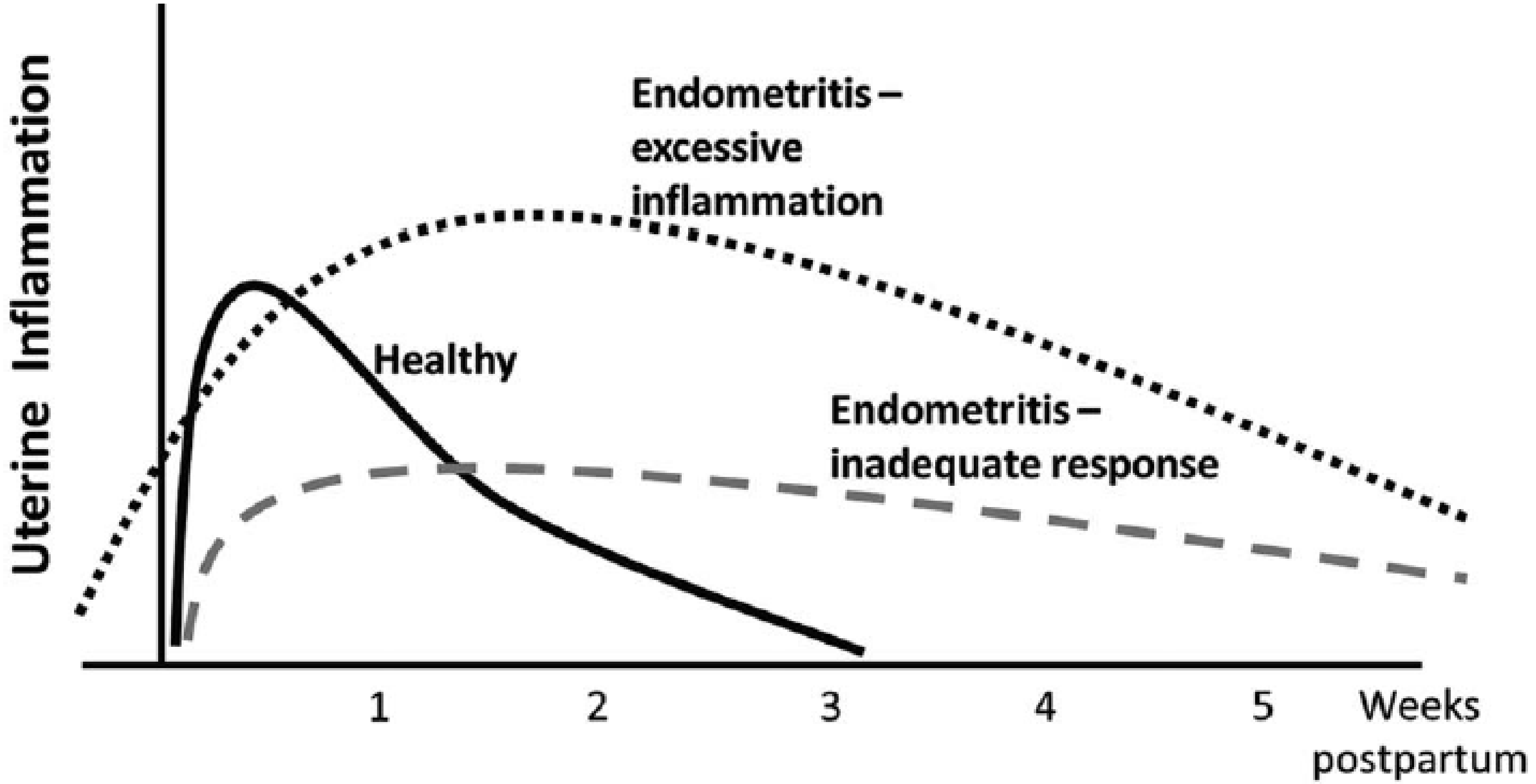
Reproductive tract inflammatory disease in *postpartum* dairy cows

S. J. LeBlanc[†]

Department of Population Medicine, University of Guelph, Guelph, ON, Canada N1G 2W1

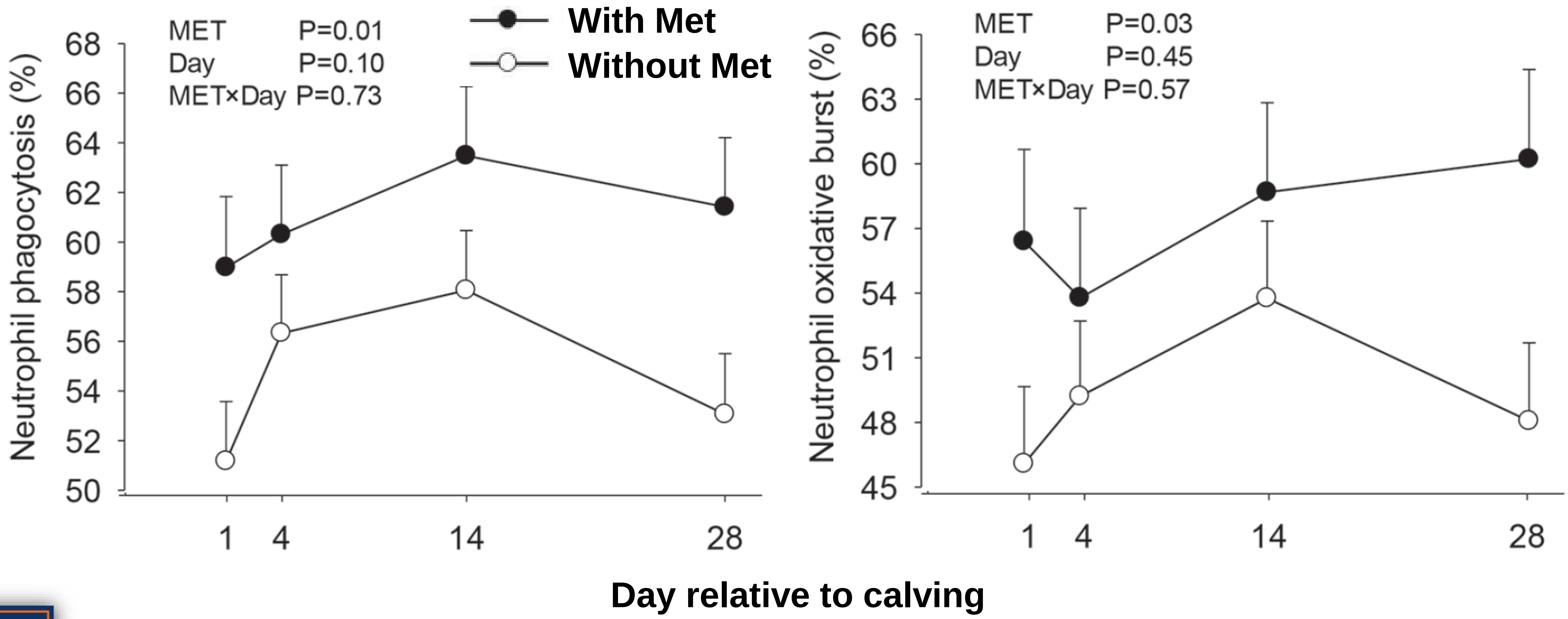
(Received 23 October 2013; Accepted 10 February 2014; First published online 28 March 2014)

Schematic Representation of Concepts of the Patterns of Immune and Inflammatory Response in Dairy Cows in the Postpartum Period

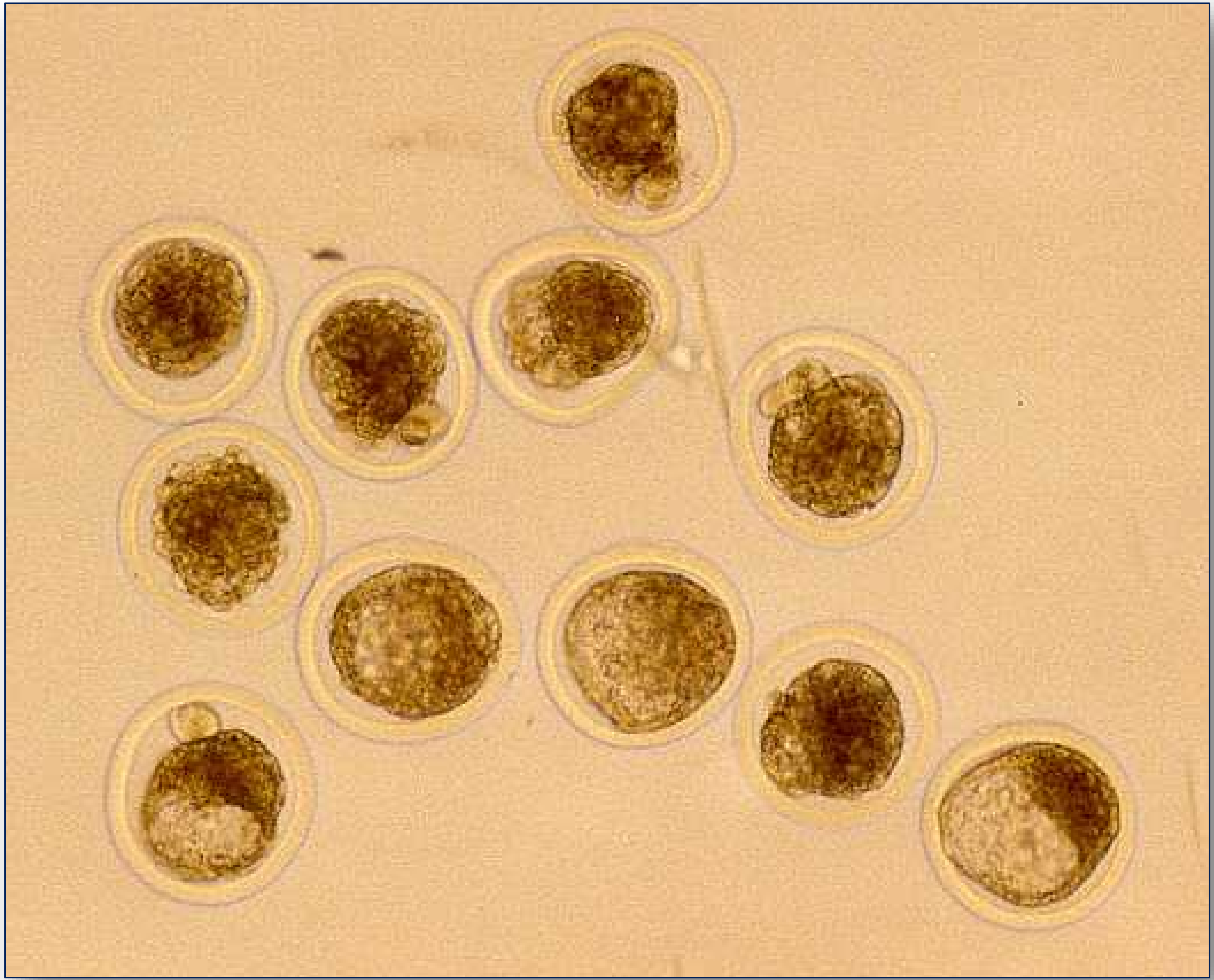


LeBlanc, 2014

Rumen-protected methionine improves immunometabolic status in dairy cows during the peripartal period



Zhou et al., 2016



Theriogenology 85 (2016) 1669–1679

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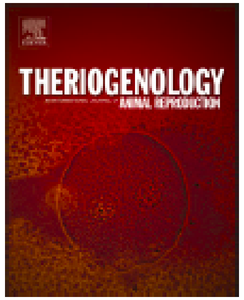


Effects of rumen-protected methionine and choline supplementation on the preimplantation embryo in Holstein cows

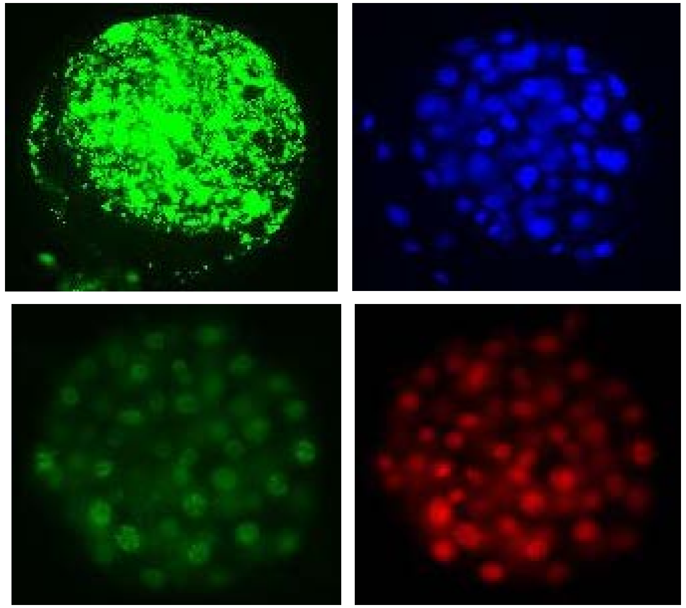
CrossMark

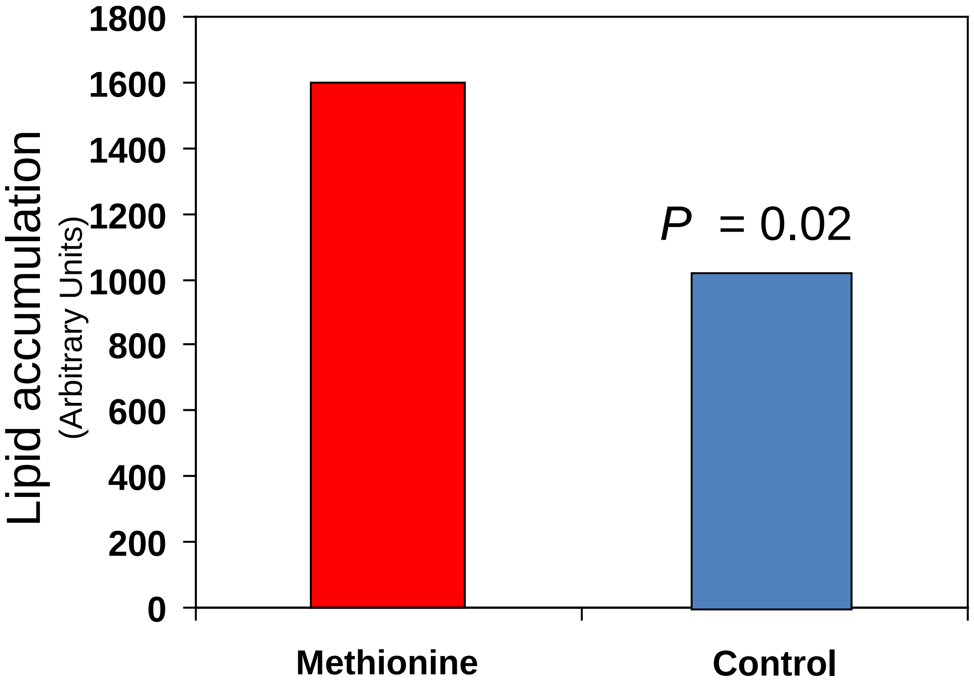
D.A.V. Acosta [a,b], A.C. Denicol [c,d], P. Tribulo [d], M.I. Rivelli [a], C. Skenandore [a], Z. Zhou [a], D. Luchini [e], M.N. Corrêa [b], P.J. Hansen [d], F.C. Cardoso [a,*]

[a] Department of Animal Sciences, University of Illinois, Urbana, Illinois, USA
[b] Faculty of Veterinary Medicine, Department of Clinics, Universidade Federal de Pelotas, Pelotas, Rio Grande do Sul, Brazil
[c] Department of Biology, Northeastern University, Boston, Massachussets, USA
[d] Department of Animal Science, University of Florida, Gainesville, Florida, USA
[e] Adisseo NACA, Alpharetta, Georgia, USA

Effect of Methionine Supplementation from -21 DIM to 72 DIM on Lipid Accumulation of Preimplantation Embryos

Embryos (n= 37) harvested 7 d after timed AI at 63 DIM from cows fed a control diet or the control diet enriched with rumen-protected methionine.





Fluorescence intensity of Nike Red staining

Acosta et al., 2016

OPEN ACCESS Freely available online

PLOS | ONE

Effect of Maternal Methionine Supplementation on the Transcriptome of Bovine Preimplantation Embryos

Francisco Peñagaricano[1], Alex H. Souza[2], Paulo D. Carvalho[2], Ashley M. Driver[1], Rocio Gambra[1], Jenna Kropp[1], Katherine S. Hackbart[2], Daniel Luchini[3], Randy D. Shaver[2], Milo C. Wiltbank[2]*, Hasan Khatib[1]*

1 Department of Animal Sciences, University of Wisconsin, Madison, Wisconsin, United States of America, 2 Department of Dairy Science, University of Wisconsin, Madison, Wisconsin, United States of America, 3 Adisseo USA Inc., Alpharetta, Georgia, United States of America

Penagaricano et al., 2013

OPEN ACCESS Fre

PLOS | ONE

Effect of ... ion on the Transcri... bryos

Francisco Peña ... Rocio Gambra[1],
Jenna Kropp[1], ... Wiltbank[2]*,
Hasan Khatib[1]*

1 Department of Animal ..., University of Wisconsin, Madison,
Wisconsin, United States

Table 3. Top 30 most significant genes that showed differential expression between control and methionine-rich treatment.

Gene	Name	log2 FC	FDR
LAPTM5	Lysosomal protein transmembrane 5	−14.9	4.7×10^{-9}
NKG7	Natural killer cell group 7 sequence	−13.6	4.4×10^{-8}
VIM	Vimentin	−13.8	1.8×10^{-7}
TYROBP	TYRO protein tyrosine kinase binding protein	−13.2	3.2×10^{-6}
IFI6	Interferon, alpha-inducible protein 6	−12.6	1.5×10^{-5}
CUFF.2147.1	*Novel transcript unit*	−8.2	1.5×10^{-5}
LOC505451	Olfactory receptor, family 1, subfamily J, member 2-like	−13.0	1.5×10^{-5}
SLAMF7	Signaling lymphocyte-activating molecule family 7 family member 7	−10.4	3.5×10^{-5}
LOC788199	Olfactory receptor 6C74-like	−10.4	7.6×10^{-5}
LCP1	Lymphocyte cytosolic protein 1 (L-plastin)	−9.9	1.1×10^{-4}
LOC100849660	*Uncharacterized*	11.9	2.2×10^{-4}
BLA-DQB	MHC class II antigen	−11.1	2.2×10^{-4}
SHC2	SHC (Src homology 2 domain containing) transforming protein 2	−11.5	3.4×10^{-4}
NT5C3	5′-nucleotidase, cytosolic III	−11.5	3.5×10^{-4}
LOC510193	Apolipoprotein L, 3-like	7.8	4.3×10^{-4}
LOC100848815	SLA class II histocompatibility antigen, DQ haplotype D alpha chain-like	−11.4	4.3×10^{-4}
CUFF.606.1	*Novel transcript unit*	−5.6	4.3×10^{-4}
LOC100850656	*Uncharacterized*	−11.2	4.8×10^{-4}
SLC11A1	Solute carrier family 11 (proton-coupled divalent metal ion transporters), member 1	−10.7	6.9×10^{-4}
LOC100852347	Beta-defensin 10-like	−11.2	7.3×10^{-4}
LOC100297676	C-type lectin domain family 2 member G-like	−6.8	9.2×10^{-4}
BCL2A1	BCL2-related protein A1	−7.1	1.2×10^{-3}
INSR	Insulin receptor	−5.1	1.3×10^{-3}
NOVA1	Neuro-oncological ventral antigen 1	−10.6	1.5×10^{-3}
TBX15	T-box 15	−11.2	2.2×10^{-3}
TMEM200C	Transmembrane protein 200C	−6.6	2.2×10^{-3}
GPNMB	Glycoprotein (transmembrane) nmb	−7.5	2.3×10^{-3}
ARHGAP9	Rho GTPase activating protein 9	−5.7	2.7×10^{-3}
EIF4E1B	Eukaryotic translation initiation factor 4E family member 1B	−11.3	3.1×10^{-3}
LOC100295170	Protein BEX2-like	−9.3	3.5×10^{-3}

A negative log2 Fold Change (FC) value means that the gene showed higher expression in control treatment while a positive value means that the gene showed higher expression in methionine-rich treatment.

doi:10.1371/journal.pone.0072302.t003

University of

Penagaricano et al., 2013

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Effect of ... ion on the Transcri... bryos

Francisco Peña... ocio Gambra[1], Jenna Kropp[1] ... Wiltbank[2]*

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SLAMF7	Signaling lymphocyte-activating molecule family 7 family member 7	−10.4	3.5×10^{-5}
LOC788199	Olfactory receptor 6C74-like	−10.4	7.6×10^{-5}
LCP1	Lymphocyte cytosolic protein 1 (L-plastin)	−9.9	1.1×10^{-4}
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LOC510193	Apolipoprotein L, 3-like	7.8	4.3×10^{-4}
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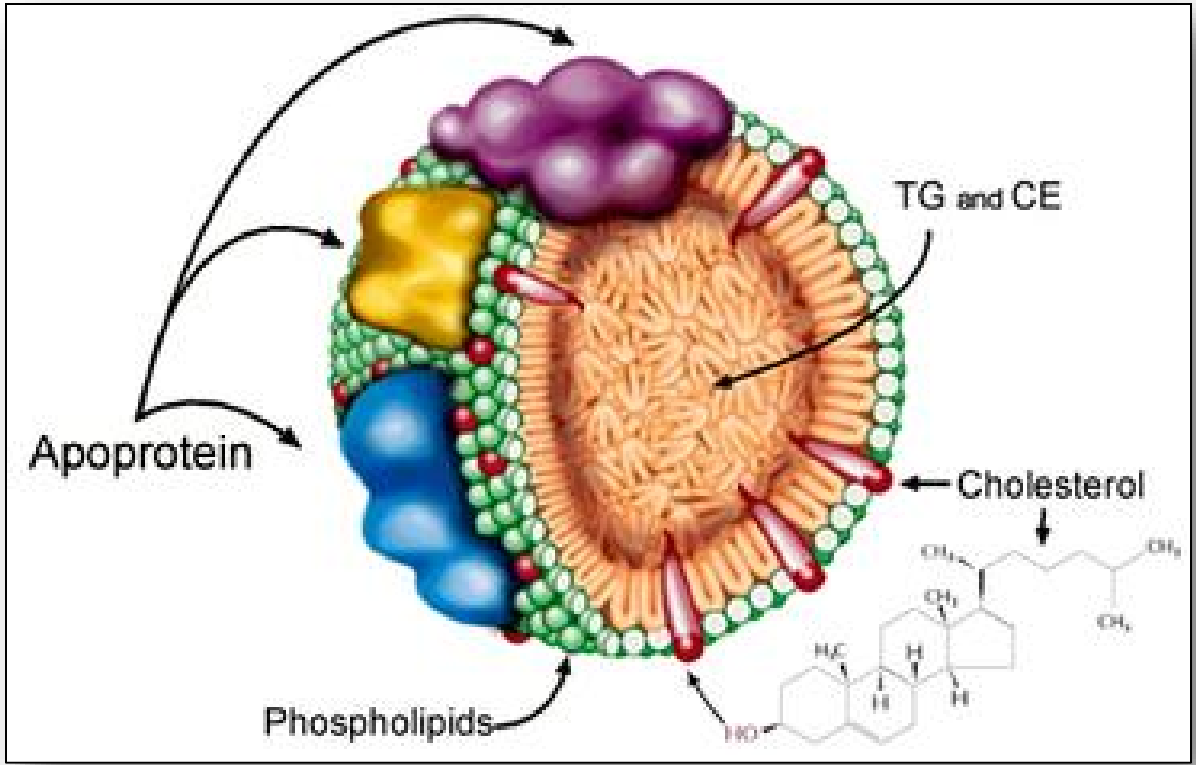
doi:10.1371/journal.pone.0072302.t003

University of

Penagaricano et al., 2013



Apolipoproteins are involved in the transport and metabolism of lipids, including cholesterol, and allow the binding of lipids to organelles

Methionine influences lipid metabolism in the preimplantation embryo

Penagaricano et al., 2013

Effect of Supplementation with Smartamine M on Reproduction of Lactating Dairy Cows

Cows were fed a basal TMR (6.9% Lys of MP and 1.87% Met of MP) from 30 ± 2 to 128 ± 2 DIM and assigned to two treatments:

RPM: Basal TMR top dressed daily with Smartamine M

CON: Basal diet top dressed daily with DDG

Toledo et al., *unpublished*

Effect of Supplementation with Smartamine M on Reproduction of Lactating Dairy Cows

RPM cows were top dressed with 50 g (29 g DDG and 21 g of Smartamine M)
CON cows were top dressed with 50 g of DDG

RPM

CON

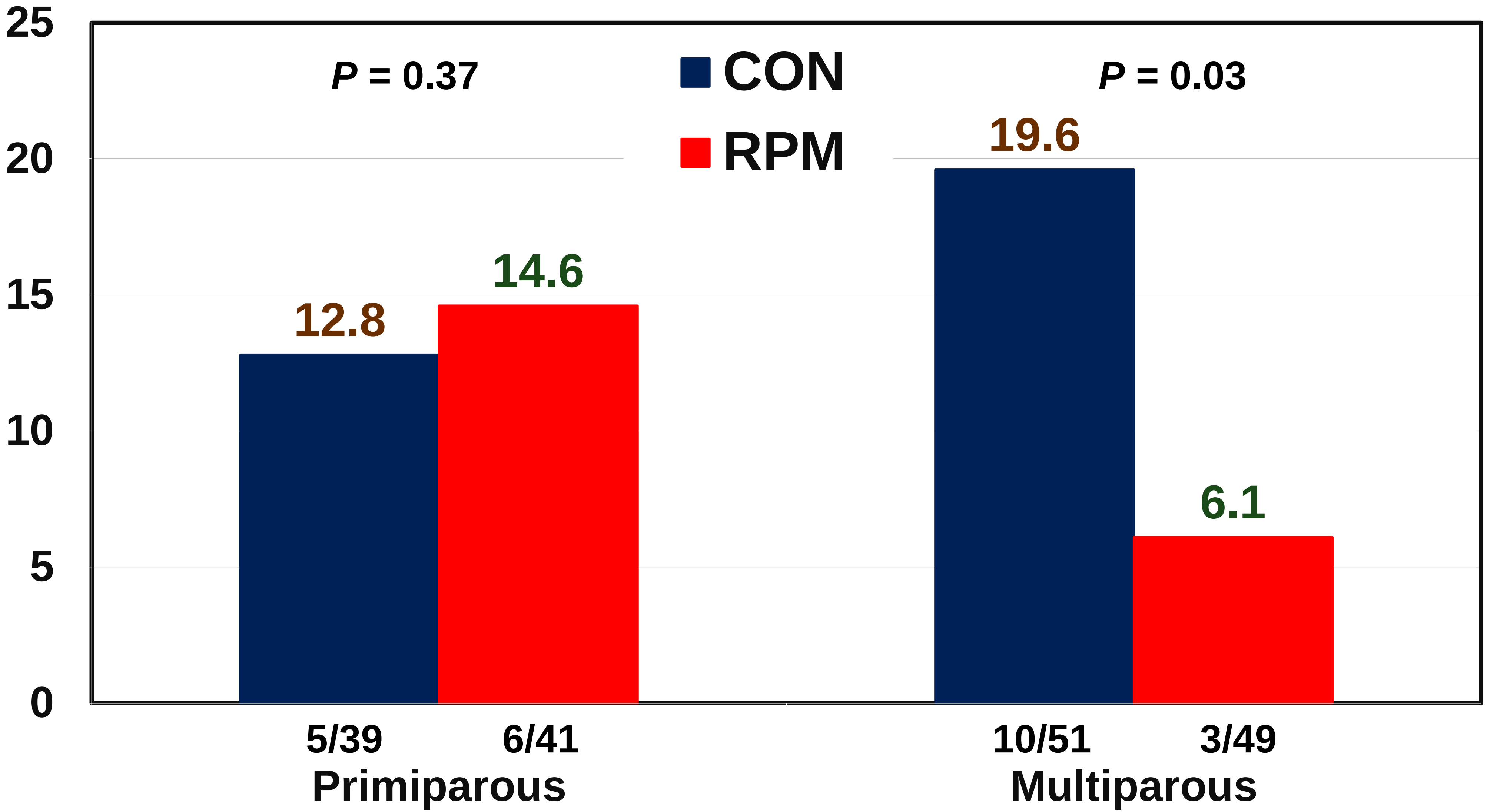
Toledo et al., *unpublished*

Animals

	CONTROL	RPM	TOTAL
Primiparous	68	70	138
Multiparous	85	86	171
TOTAL	153	156	309

Toledo et al., *unpublished*

Pregnancy Losses (%) from 28 to 61 days after AI



Toledo et al., *unpublished*

Amniotic vesicle size

Day 33	n	Volume (mm^3) ± SEM
Primiparous		
Control	31	**610.6** ± 38.6
RPM	36	**596.0** ± 36.9
P-value		**0.71**
Multiparous		
Control	35	**472.3** ± 28.6
RPM	45	**592.1** ± 46.0
P-value		**0.05**

Toledo et al., *unpublished*

Is *Increased* Embryo Lipid Composition Associated with Lower Embryonic Death in Dairy Cows?

Is *Increased* In-Utero Lysine Concentration (d 16 – 19) Associated with Lower Embryonic Death in Dairy Cows?

Summary

- Promote high DMI immediately after calving.
- Rumen-protected methionine increased methionine concentration in serum and follicular fluid of dairy cows.
- The cow's pregnancy success starts during the transition phase.
- Amino acid balancing (methionine and lysine) from pre-fresh to confirmed pregnancy may not only improve milk production and composition, it may also improve embryo quality and reduce early embryo losses.

- Manage dietary ingredients for
  - Manage for adequate CP (~13% Dry & 16% Lactation)
  - Metabolizabe methionine in TMR (30 g/d Dry & 46 g/d Lactation)
    - ~ 15 g/d Dry & 20 g/d Lactation of rumen-protected methionine
  - Metabolizabe lysine in TMR (84 g/d Dry & 129 g/d Lactation)
    - ~ 26 g/d Dry & 36 g/d Lactation rumen-protected lysine
    - Balanced for the ratios: Met 2.6% MP; Lys, 7.0% MP (LYS:MET ratio of 2.8:1)
    - Methionine supply relative to energy is ~ 0.97-1.0 g/Mcal ME
    - Lysine supply relative to energy is ~ 2.72-2.78 g/Mcal ME
- Pregnancy rate > 20% (go for > 25%; conception rate at first AI > 40%)
- Embryonic death < 15% (go for < 10%)

THANK YOU

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