Effects of Late Gestation Heat Stress on Physiology of Dam and Daughter

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Session 38
Applying physiology – improvements in animal productivity, water efficiency, welfare and behaviour

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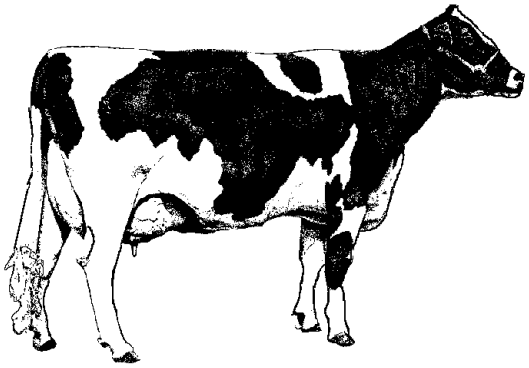
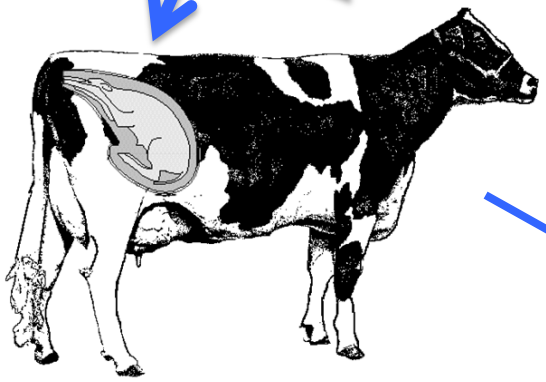
Milk yield?
Metabolism?
Immune function?



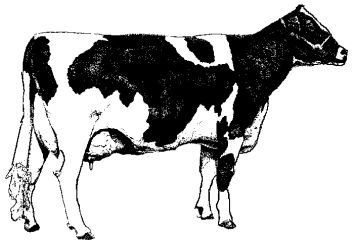
Late gestation



Calf health?
Calf growth?

Heifer growth?
Reproduction?

Cow performance?
Thermoregulation?



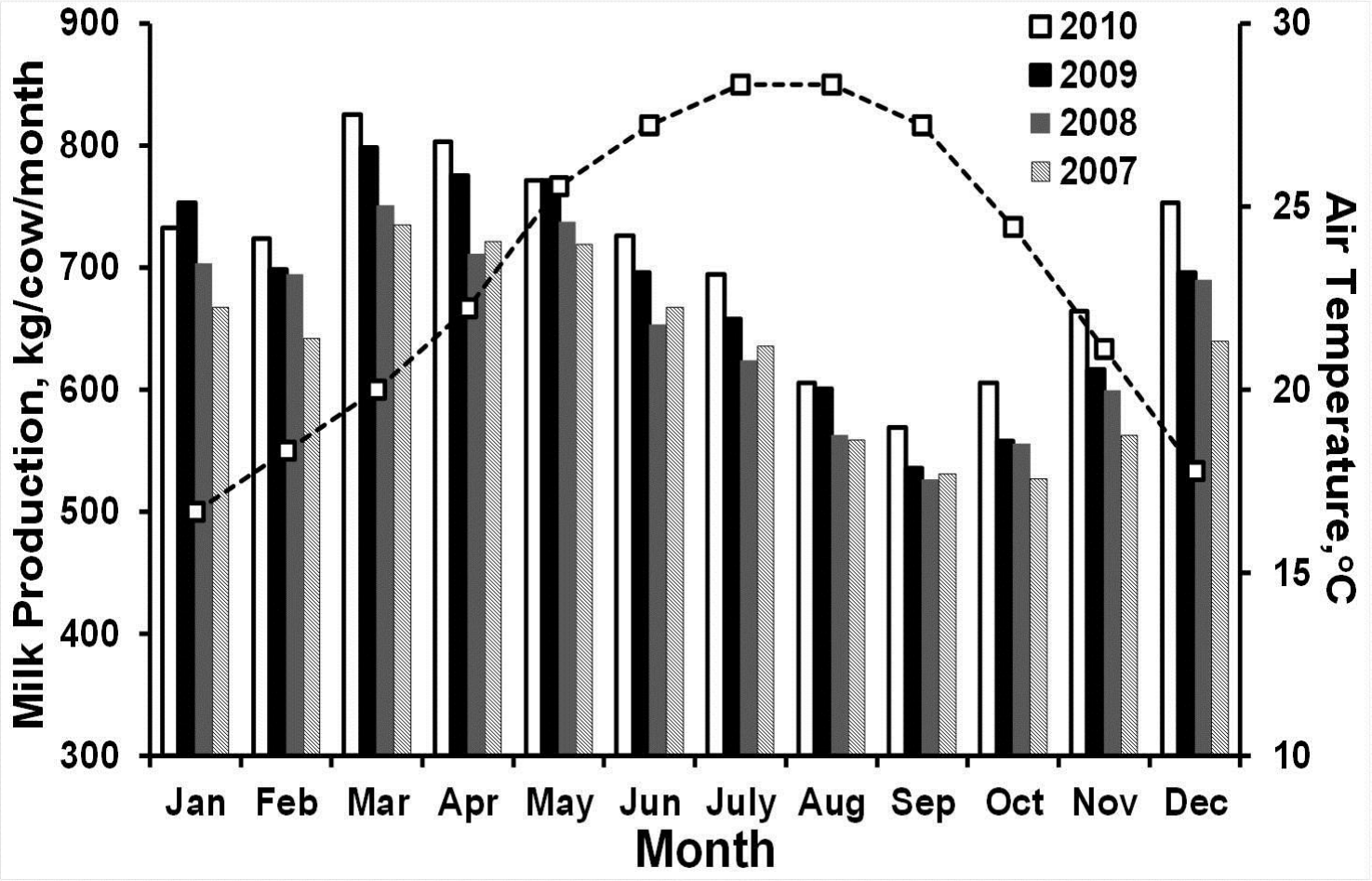
Heat Stress During Lactation

Heat Stress During Lactation

- Depresses DMI
- Reduces milk yield
- Recent studies suggest additional metabolic effects beyond DMI
- Recovery dependent on duration

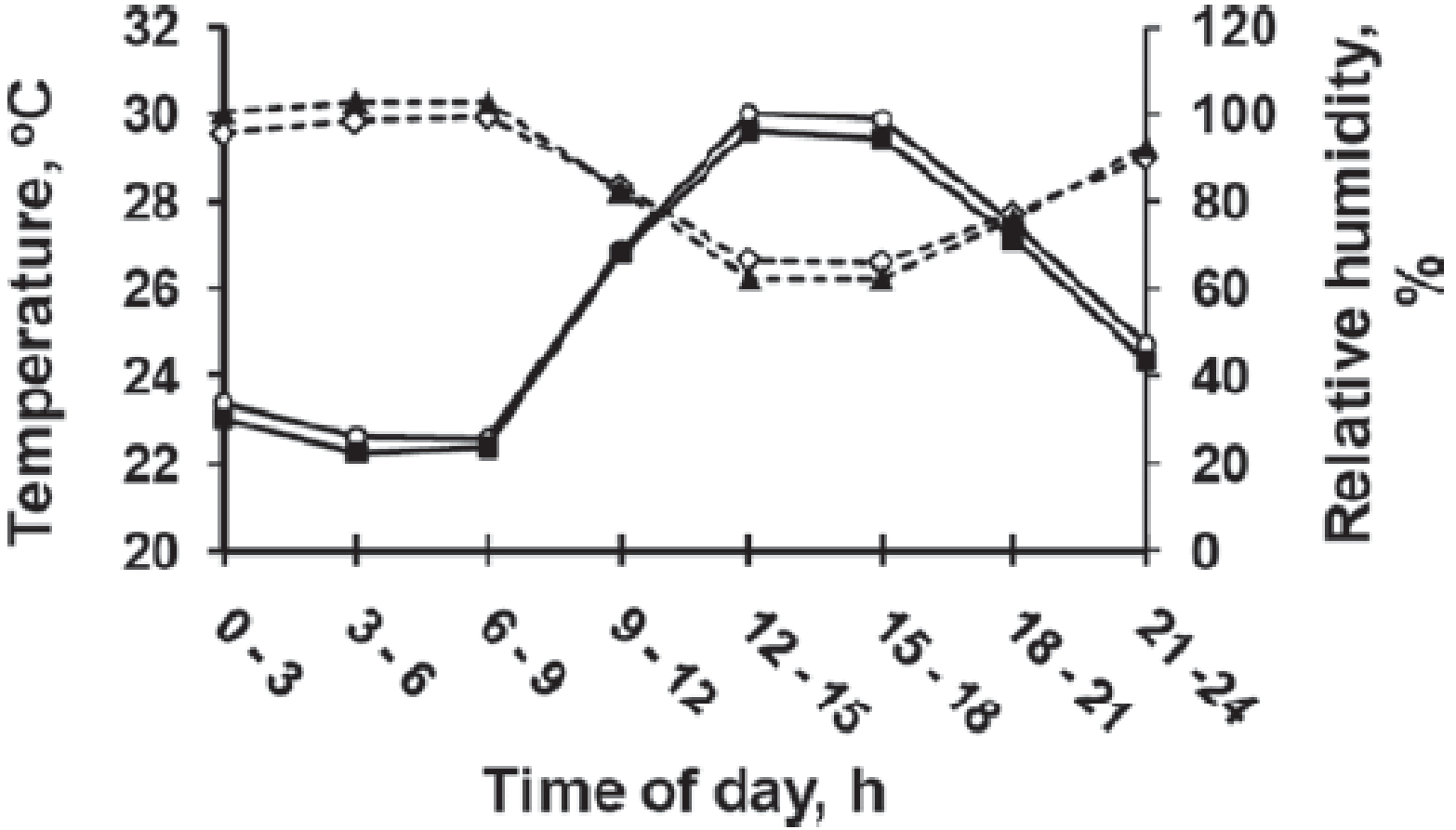
What about dry cows?

Heat Stress Effects on Yield Linger



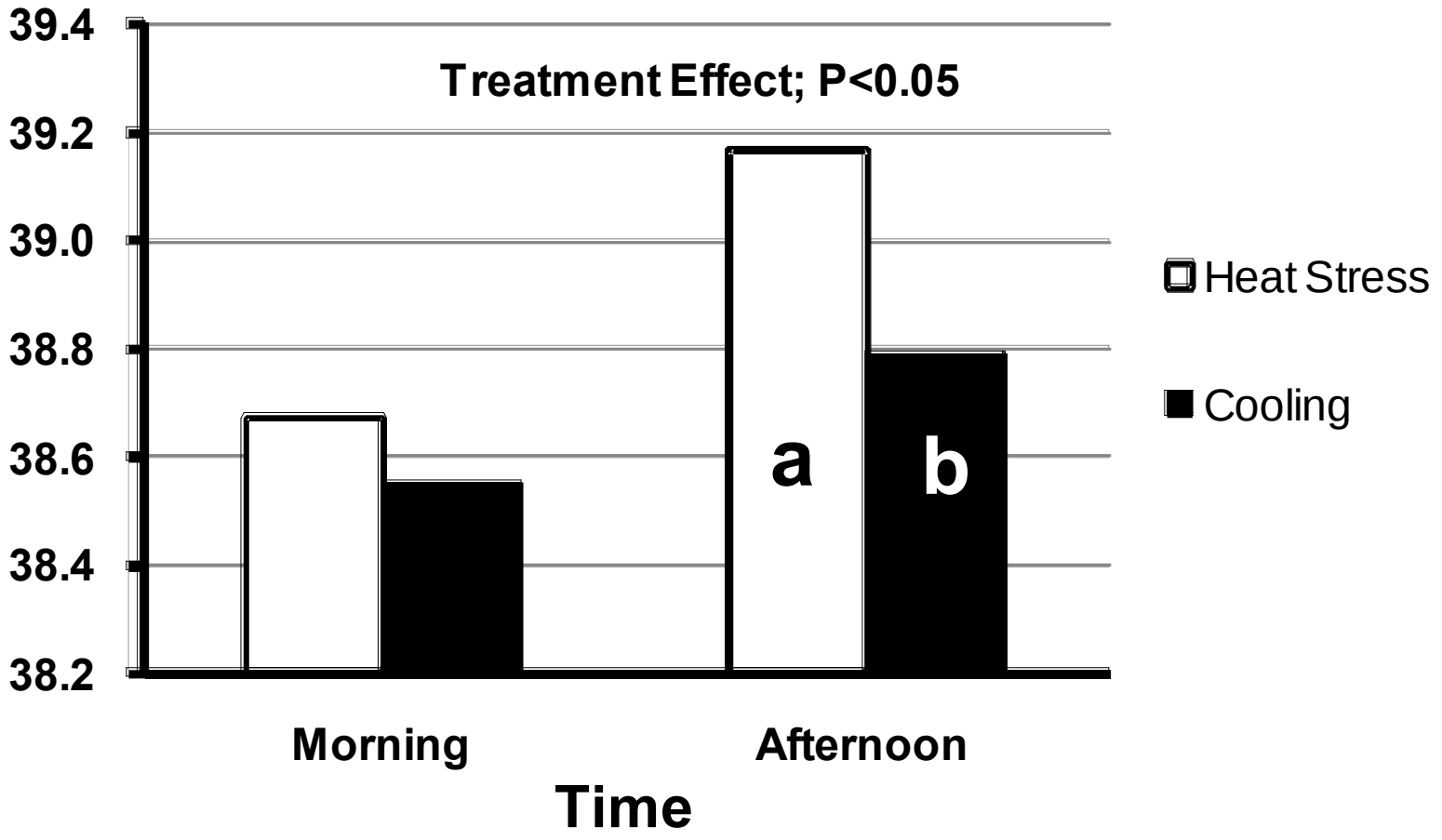
Tao & Dahl, *J. Dairy Sci.* 96:4079-4093

Study Design:
Heat Load of Dry Cows



Do Amaral et al., *J. Dairy Sci.* 94:86–96

Heat Stress Increases Mean Rectal Temperature



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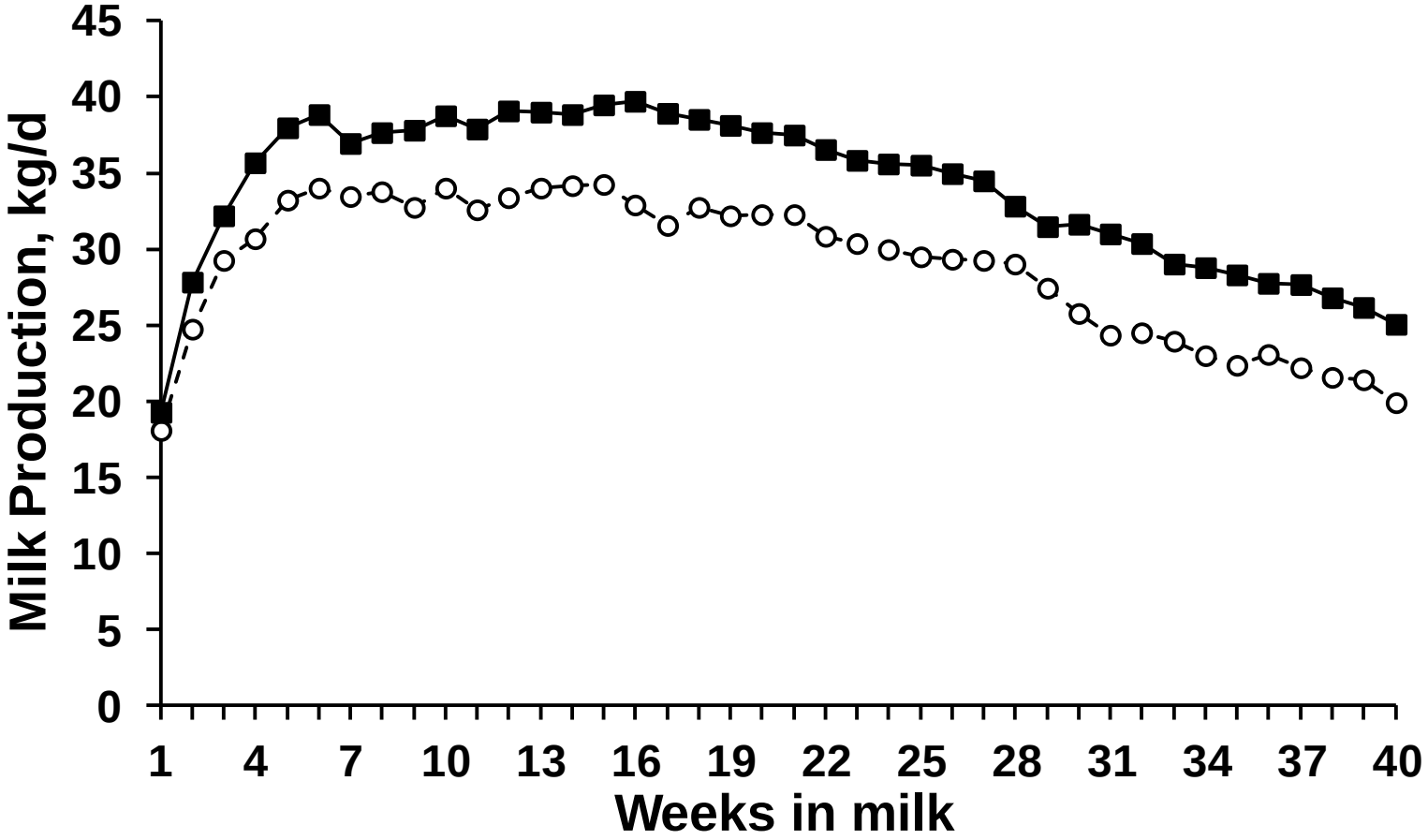
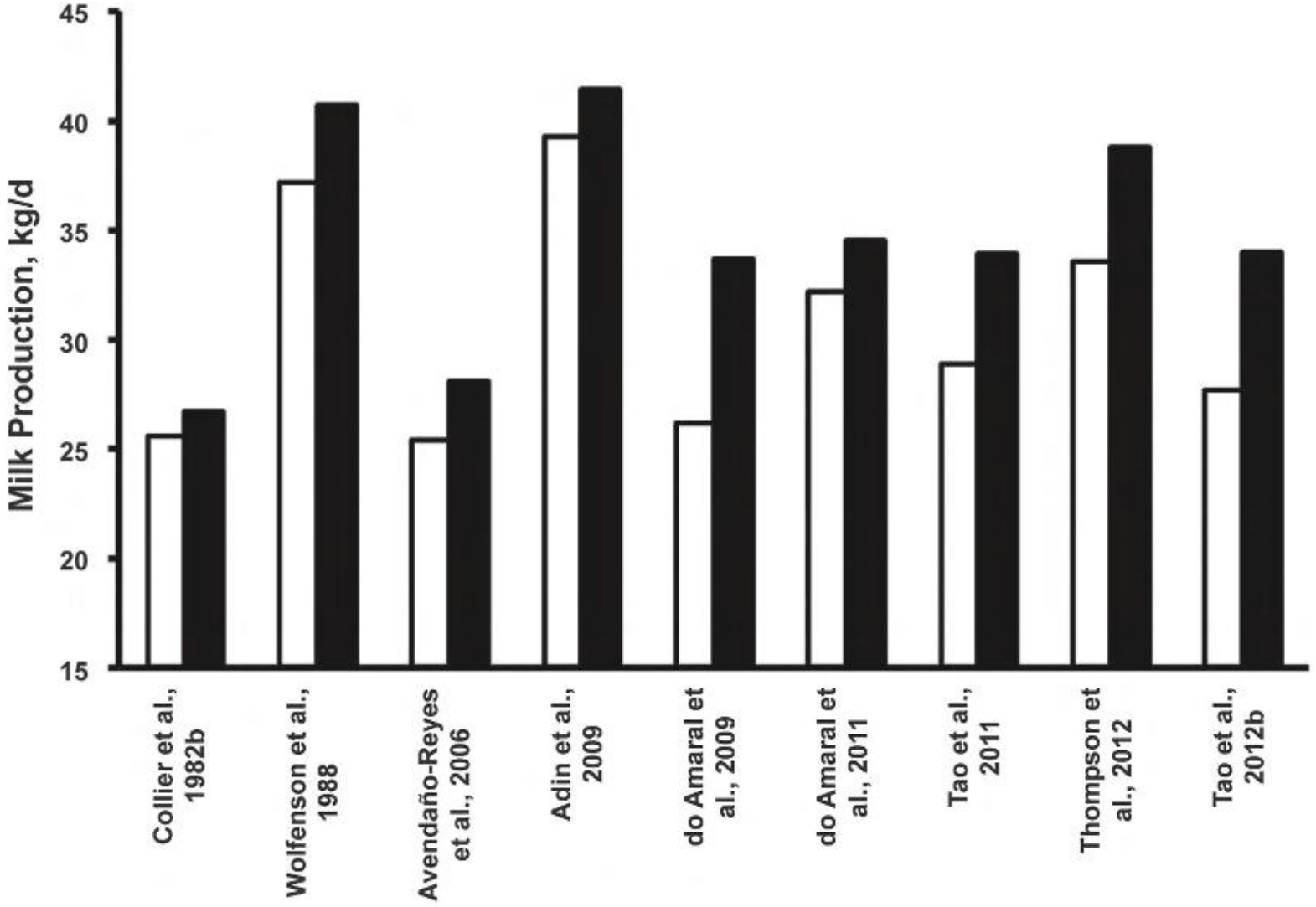
Cooling Dry Cows Increases Milk



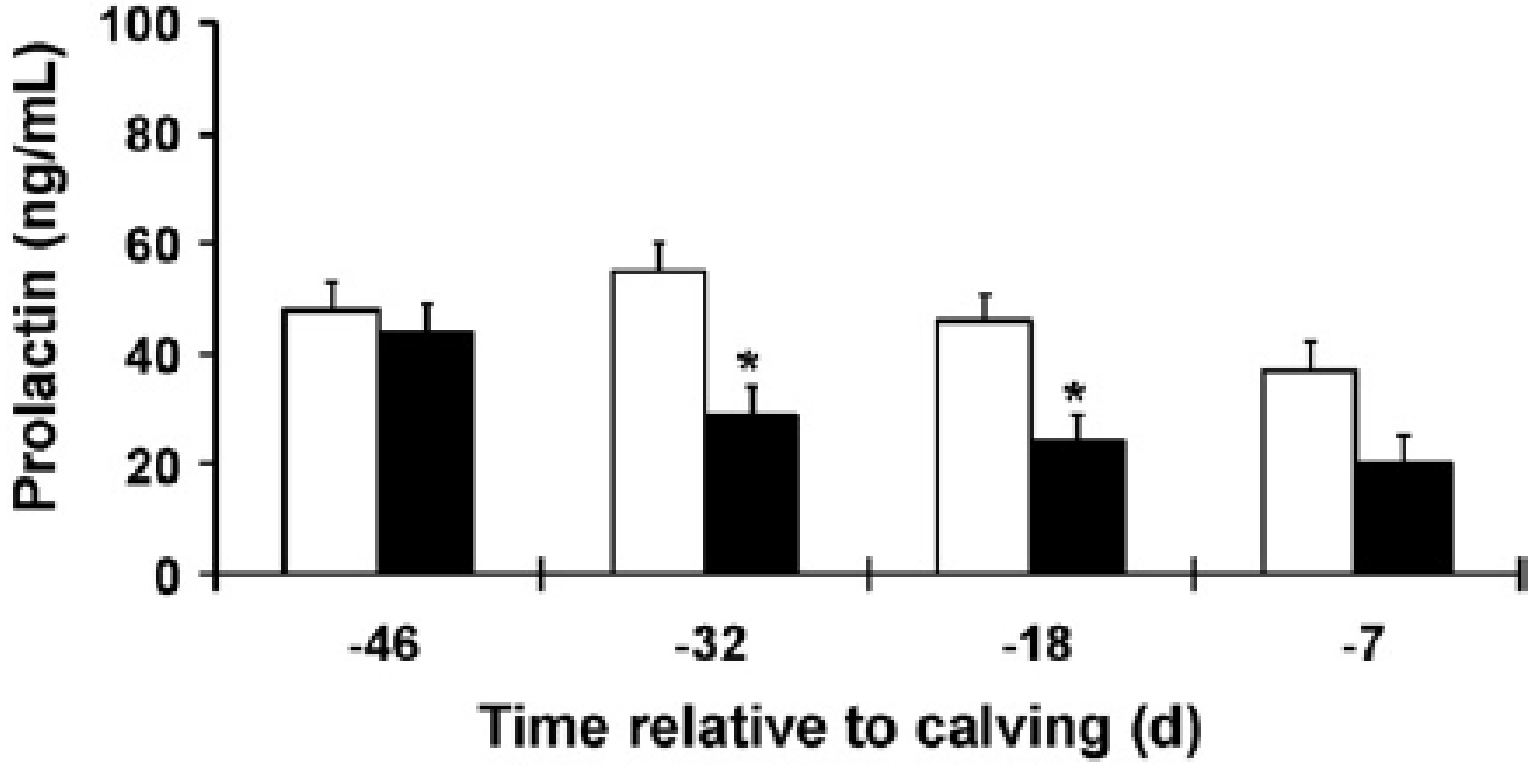
Tao et al., *J. Dairy Sci.* 94:5976–5986

Cooling Dry Cows Increases Milk



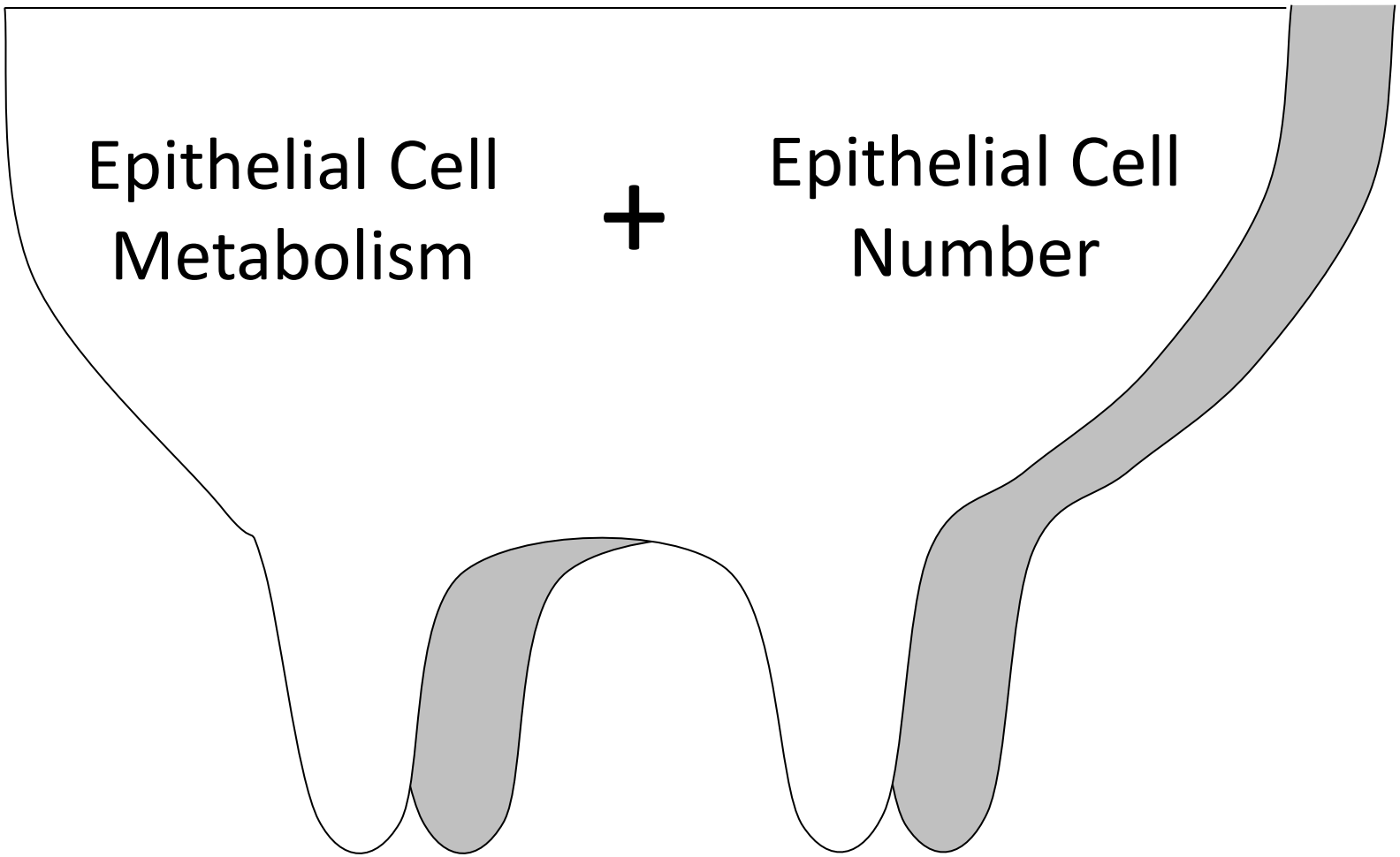
Tao & Dahl, *J. Dairy Sci.* 96:4079-4093

Cooling Dry Cows Decreases PRL – During Dry Period

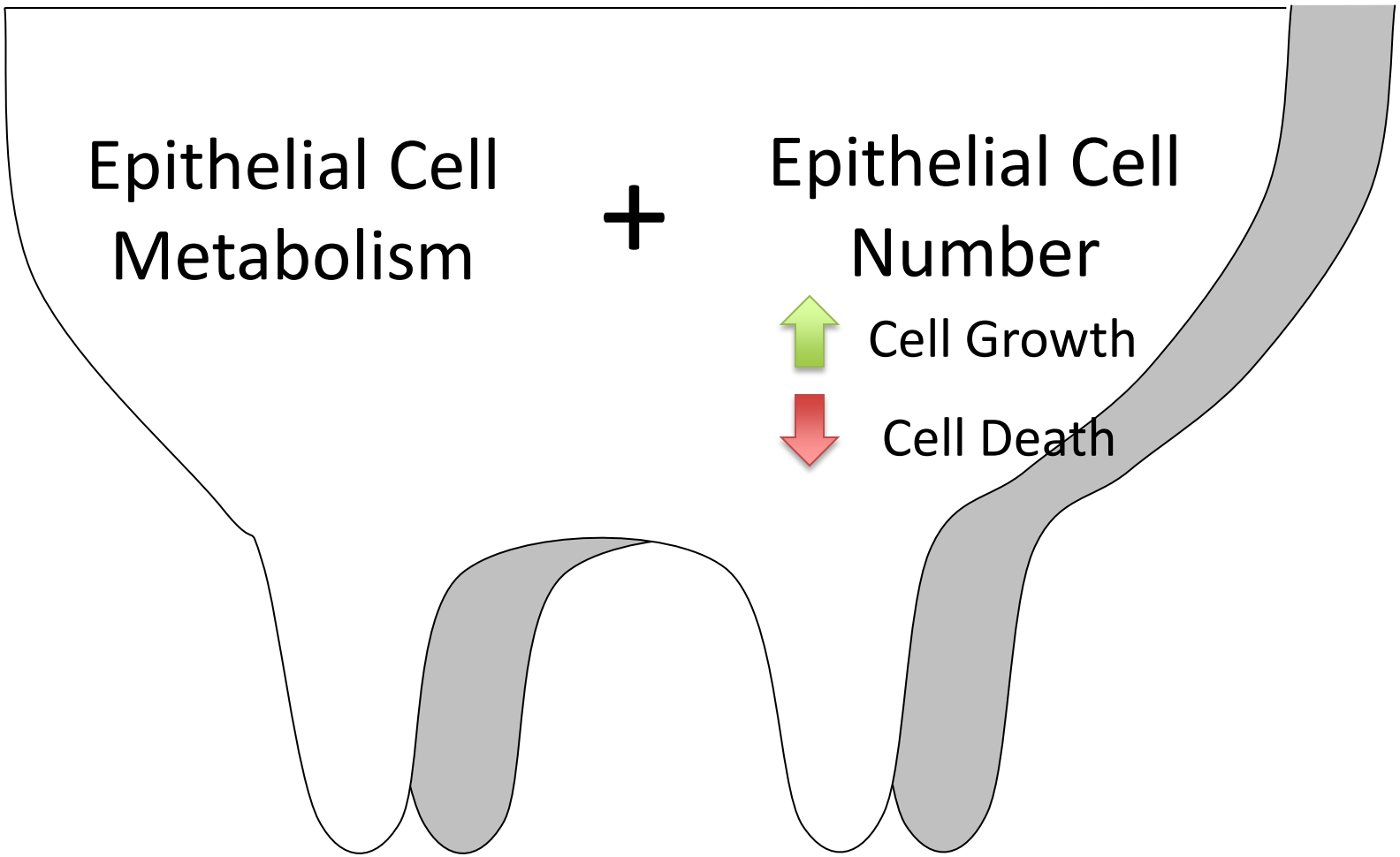


Do Amaral et al., *Domest. Anim. Endo.* 38:38-45

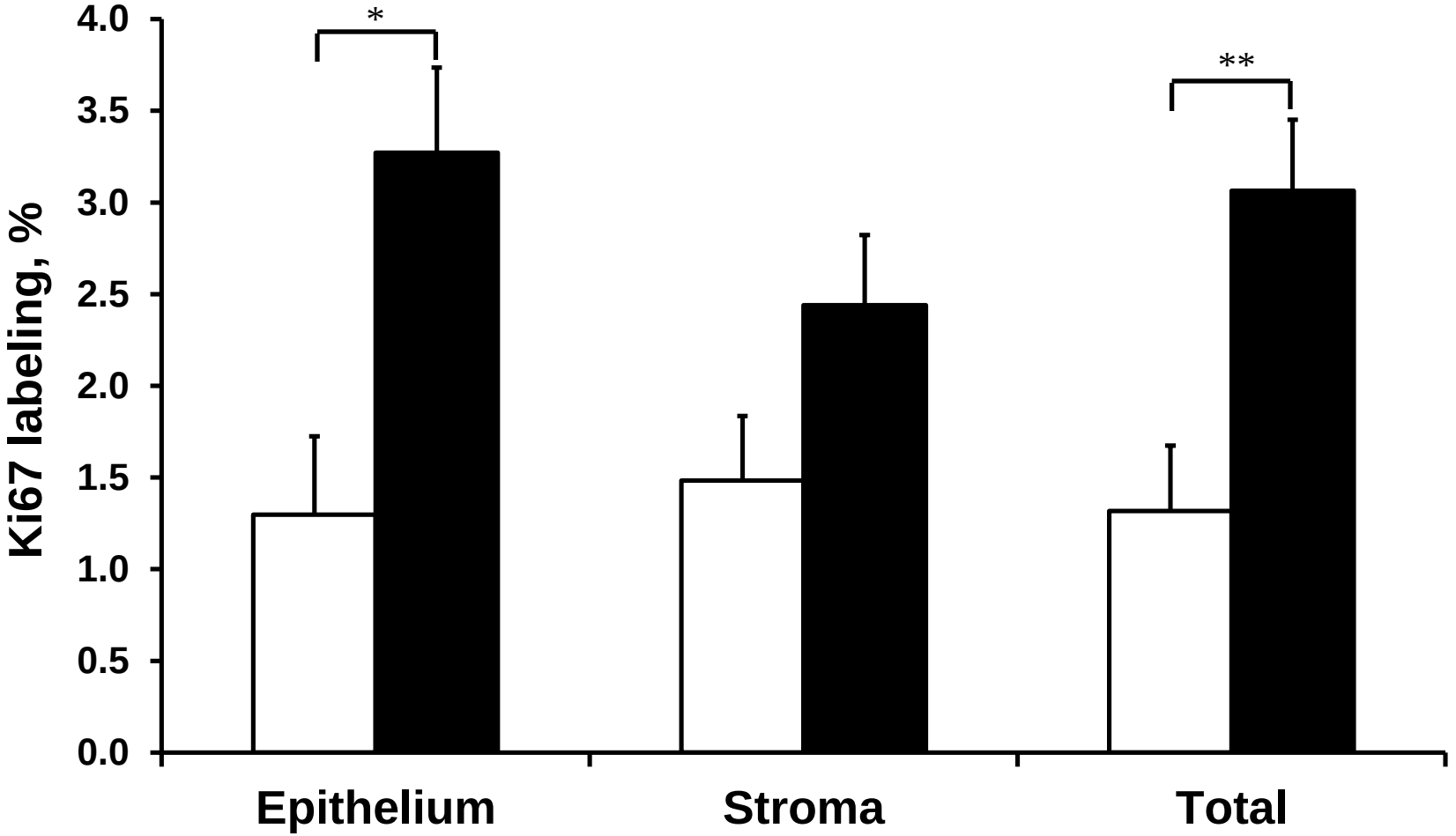
Milk Production



Milk Production

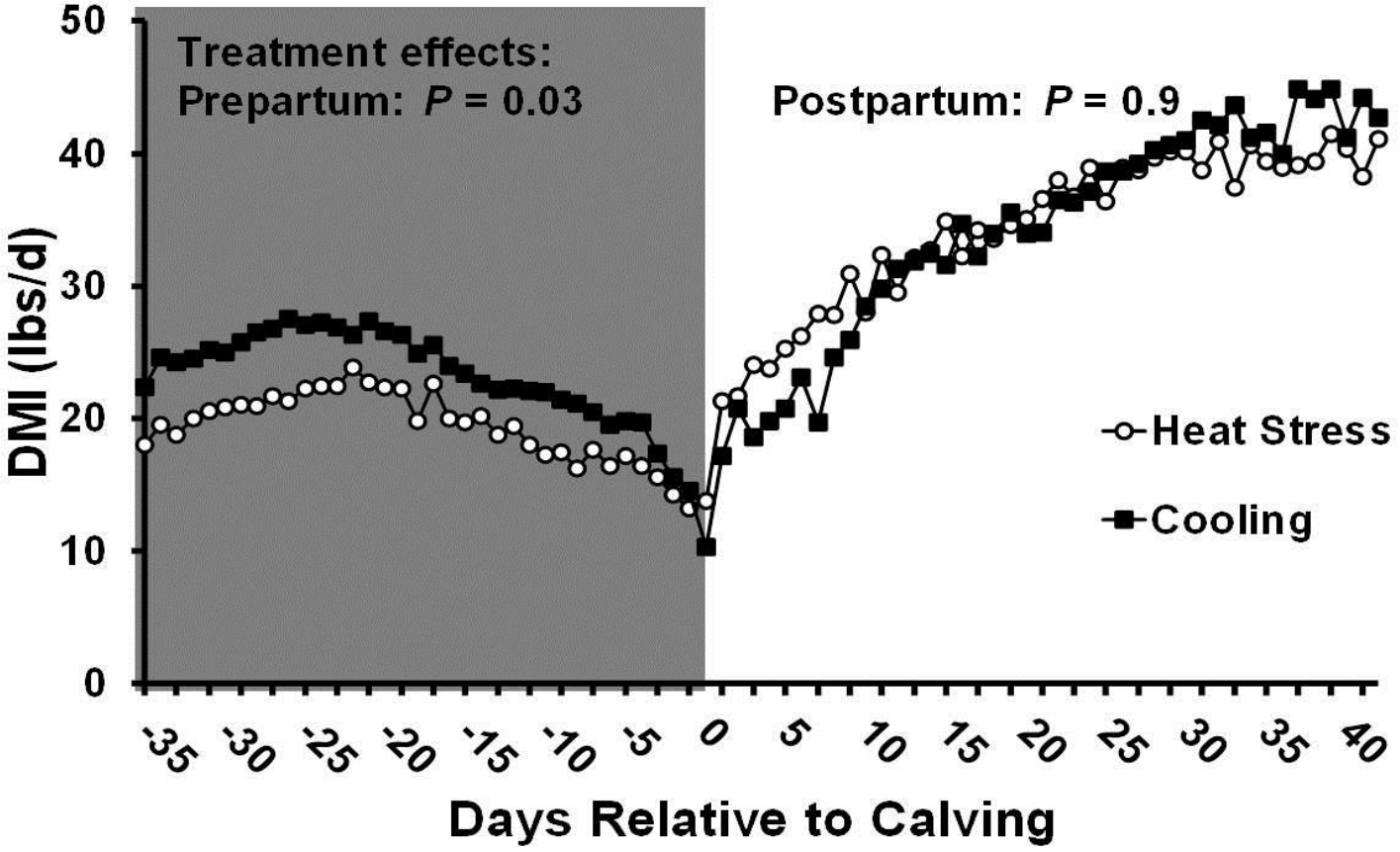


Cooling Increased Proliferation of Mammary Cells Prepartum (d-20)



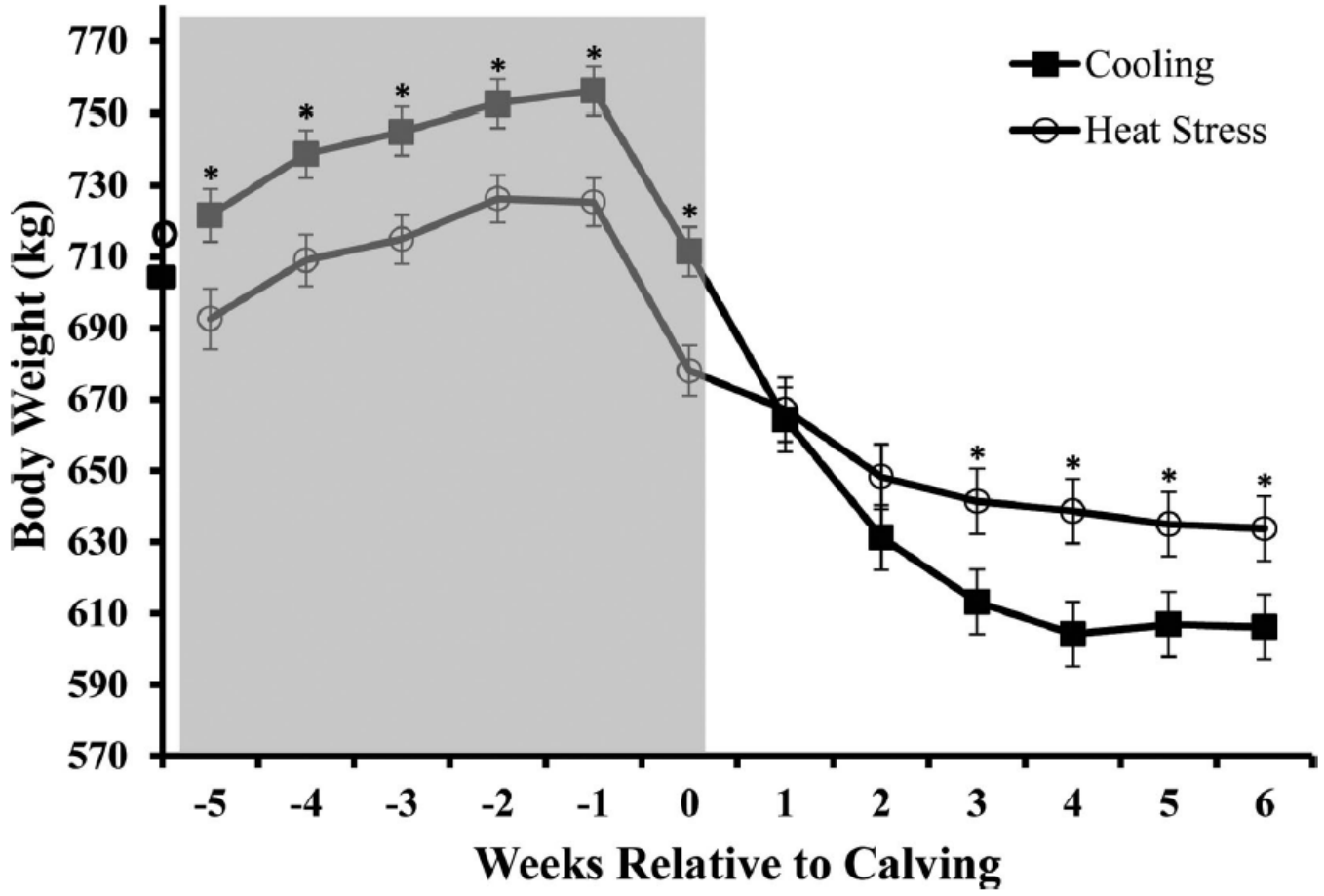
Tao et al., *J. Dairy Sci.* 94:5976–5986

Heat Stress Reduces DMI Prepartum But Not Postpartum

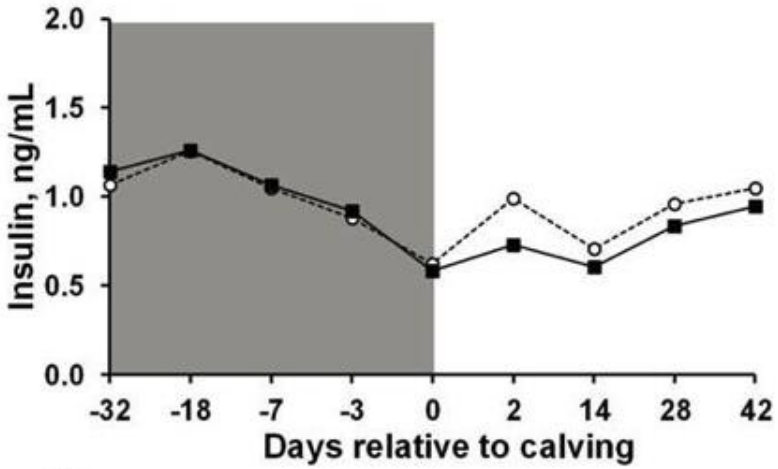


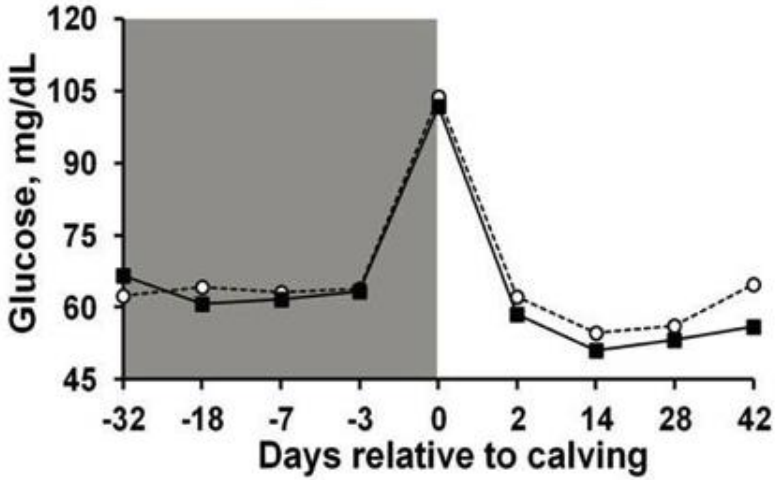
Tao et al., *J. Dairy Sci.* 94:5976–5986

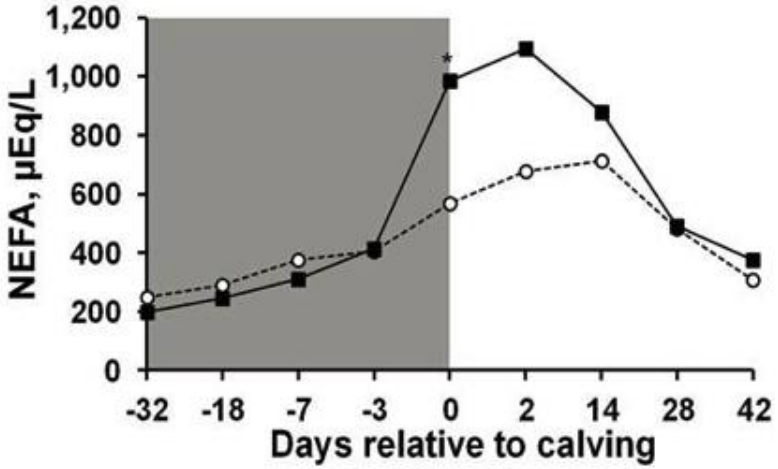
Cooling Dry Cows Increases BW Prepartum, Decreases Postpartum



Thompson et al., *J. Dairy Sci.* 97:7426-7436

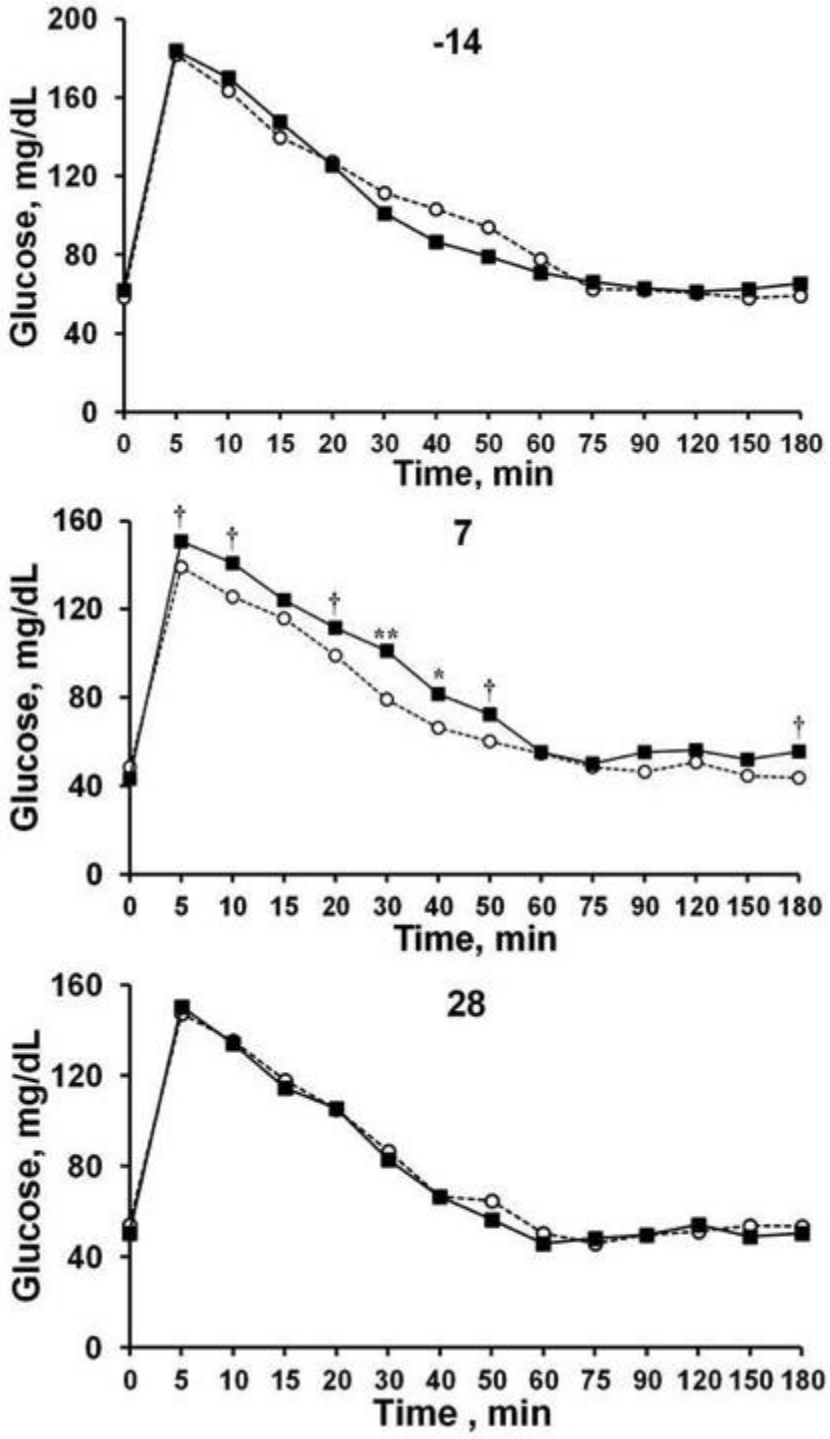






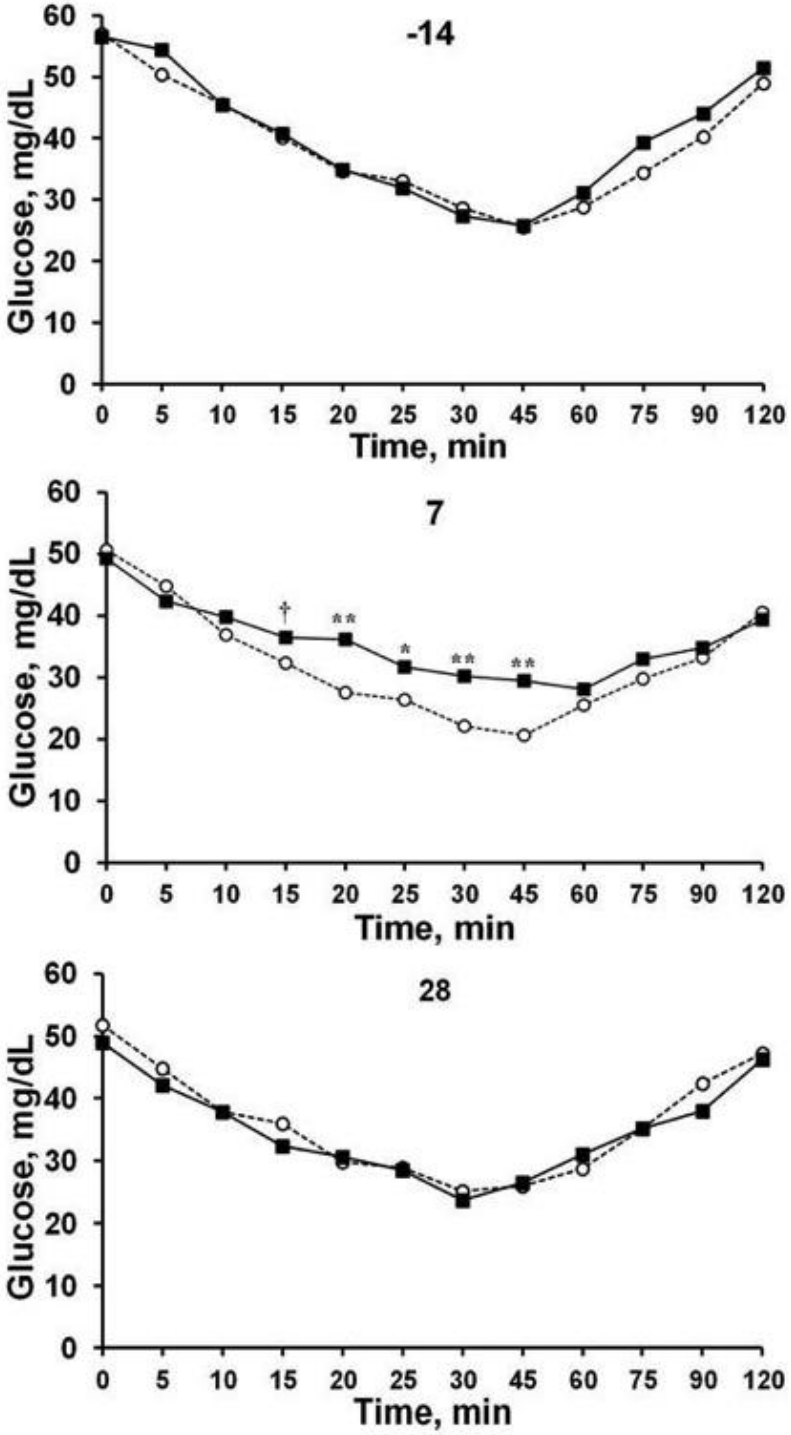
Effect of Cooling Dry Cows on Metabolic Profile

Tao et al., *J. Dairy Sci.* 95:5035-5046



Effect of Cooling Dry Cows on Glucose Profile with GTT

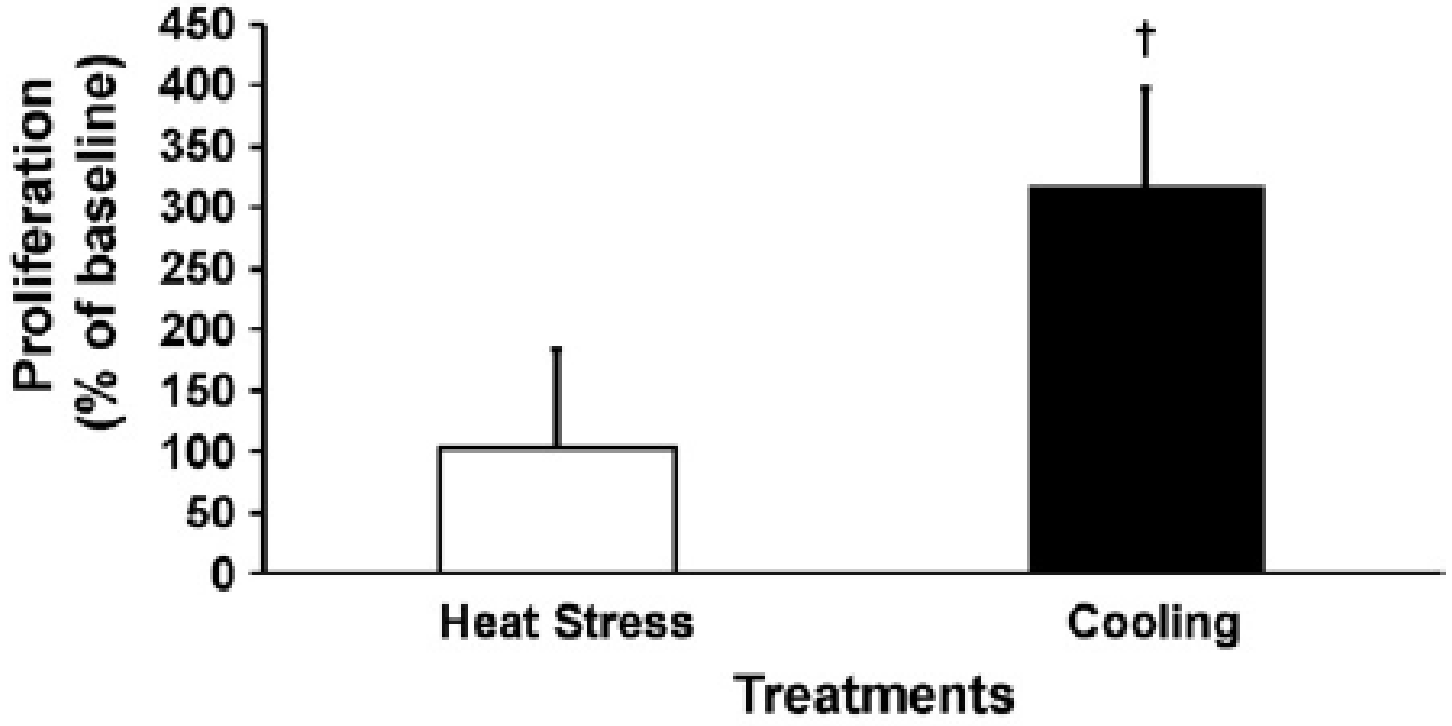
Tao et al., *J. Dairy Sci.* 95:5035-5046



Effect of Cooling Dry Cows on Glucose Profile with Insulin Challenge

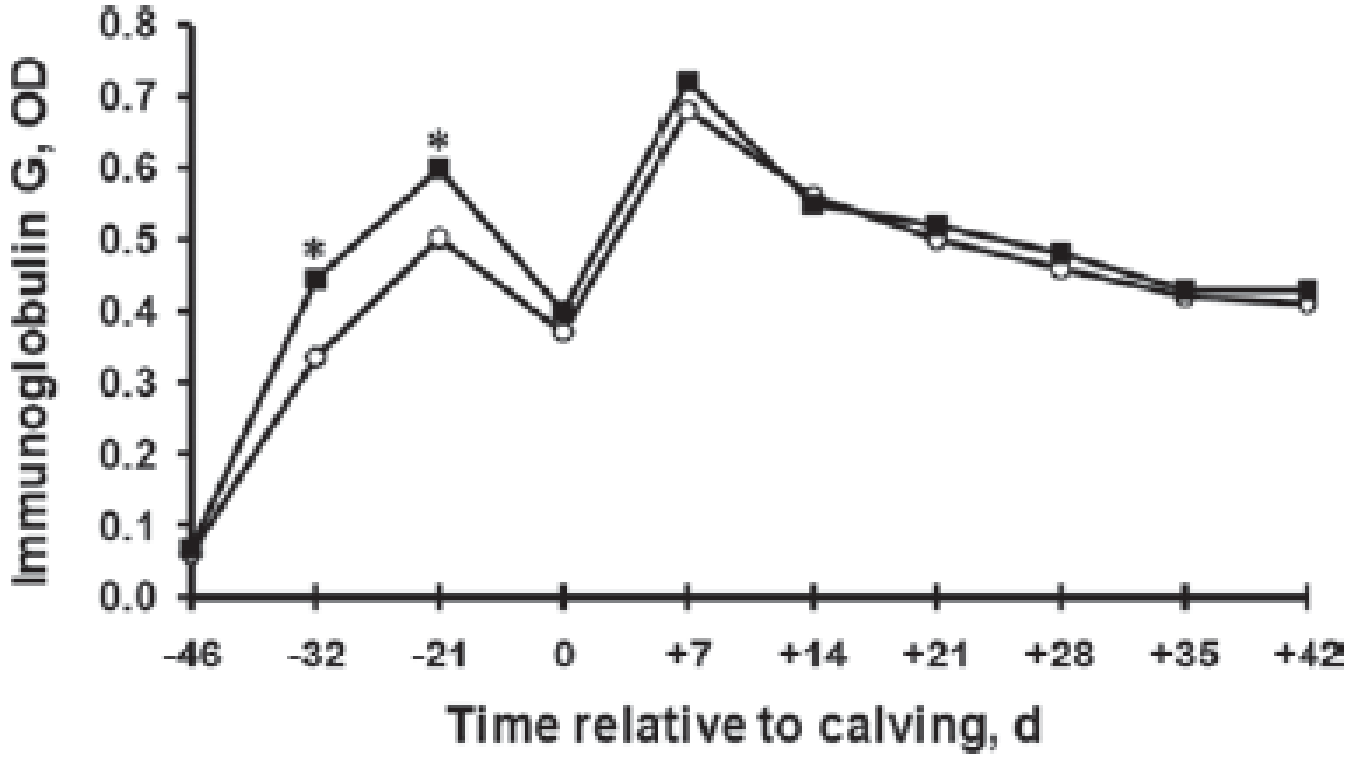
Tao et al., *J. Dairy Sci.* 95:5035-5046

Cooling Cows When Dry Increases Lymphocyte Proliferation



Do Amaral et al., *Domest. Anim. Endo.* 38:38-45

Cooling Dry Cows
Effects on Acquired Immunity

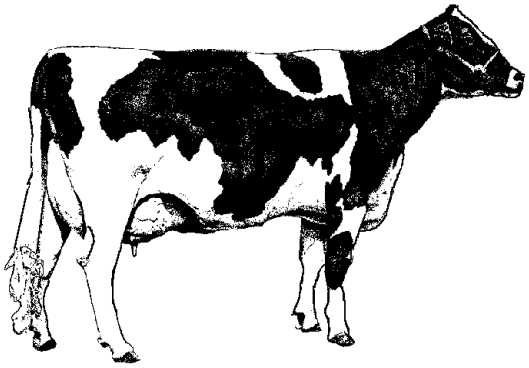


Do Amaral et al., *J. Dairy Sci.* 94:86–96

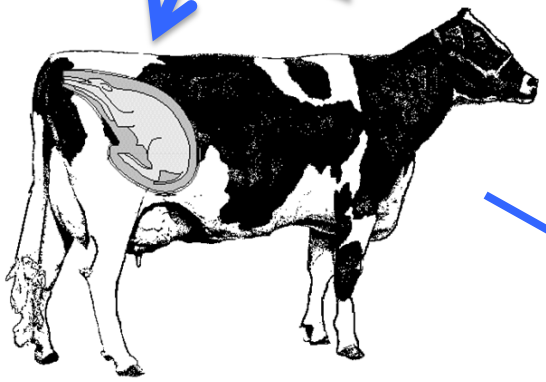
Heat Stress Summary – Dry Cows

- Cooling increases milk in subsequent lactation; related to increase in mammary growth
- Cooling dry cows improves DMI, BW and BCS during dry period, but other metabolic effects limited
- Cooling improves immune status during transition

- Decreases milk yield
- No prepartum metabolic effect
- Reduces immune function



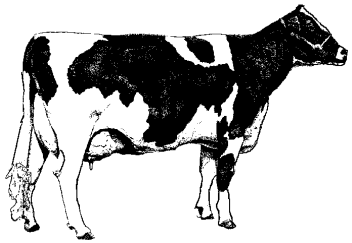
Late gestation



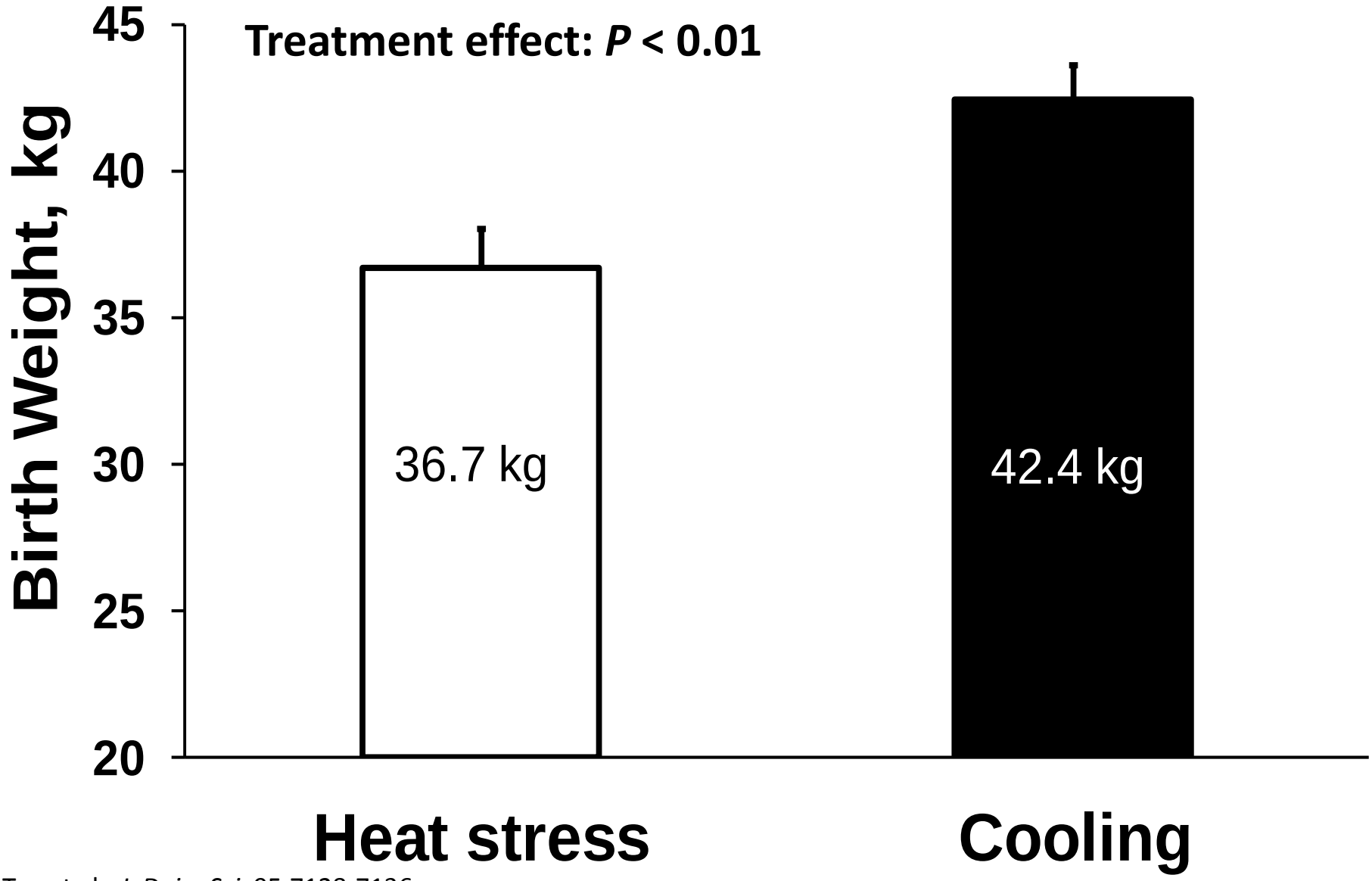
Calf health?
Calf growth?

Heifer growth?
Reproduction?

Cow performance?
Thermoregulation?

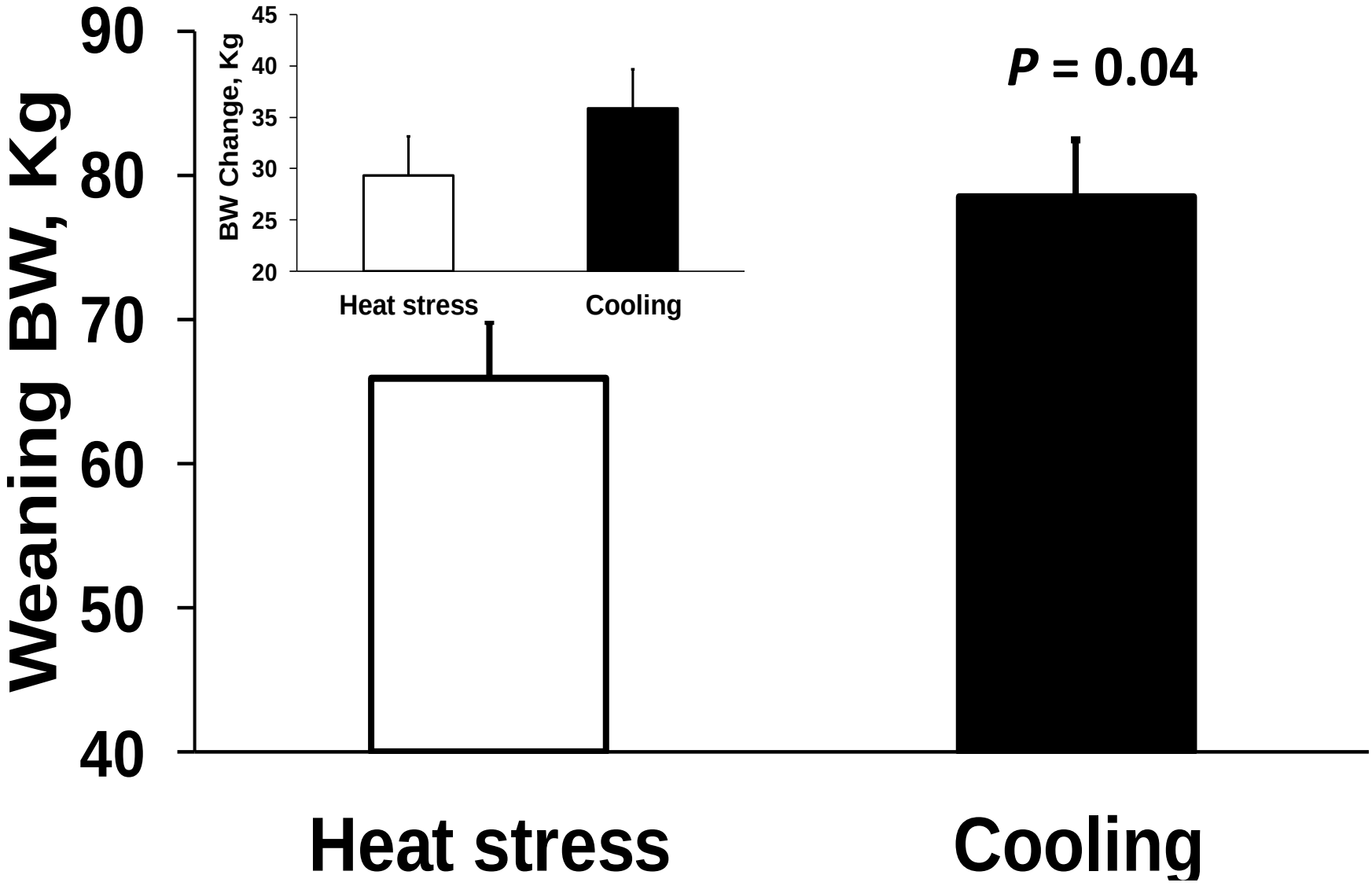


Cooling Increases Calf Birth Weight



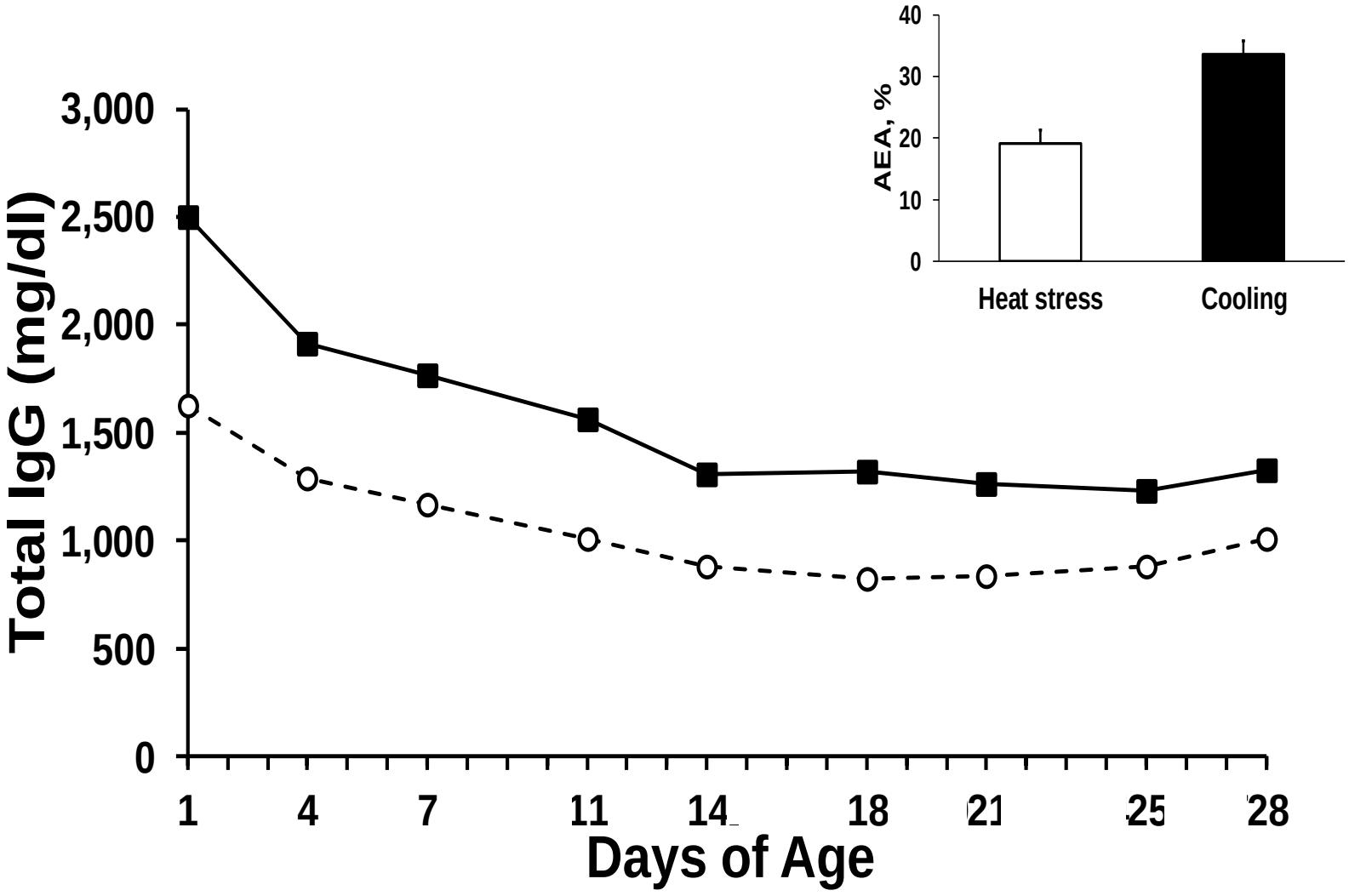
Tao et al., *J. Dairy Sci.* 95:7128-7136

Weaning Weight



Tao et al., *J. Dairy Sci.* 95:7128-7136

Cooling Improves Total IgG and AEA



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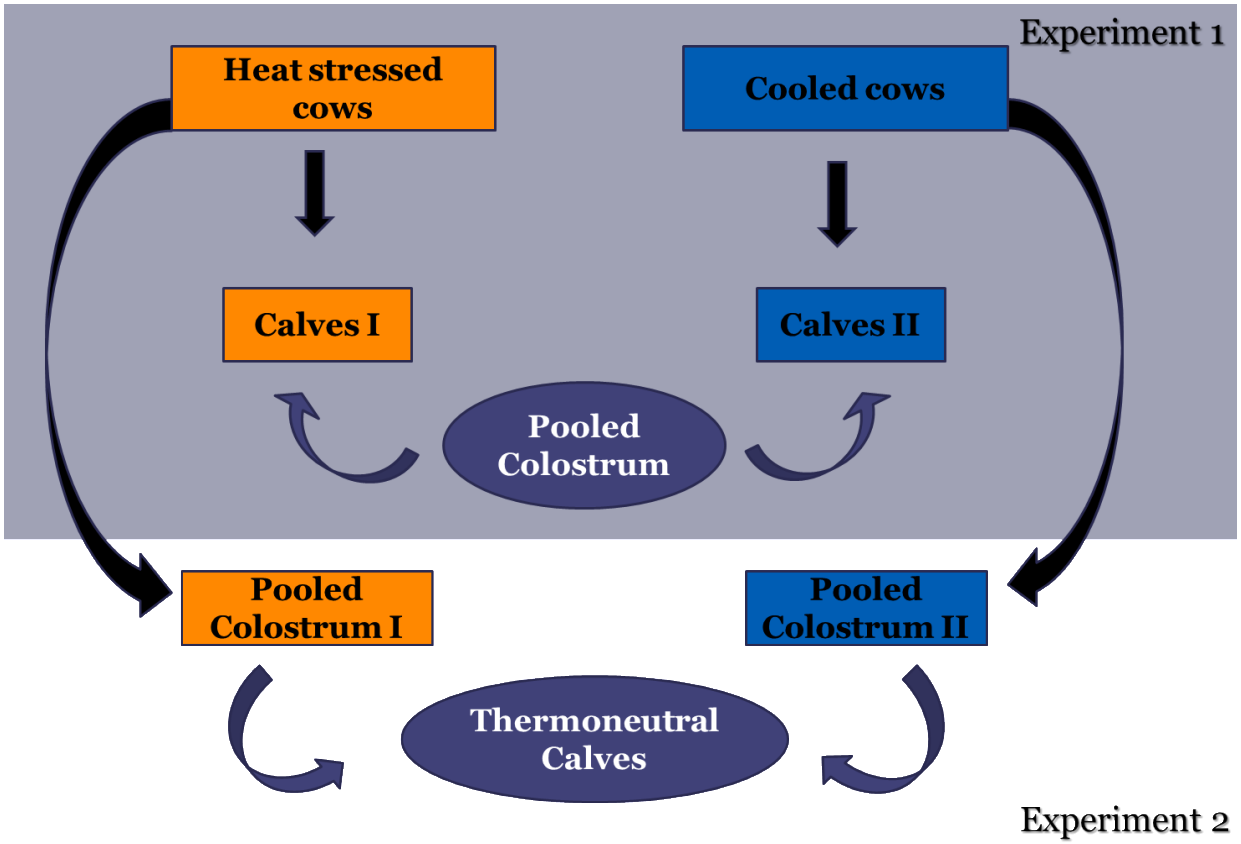
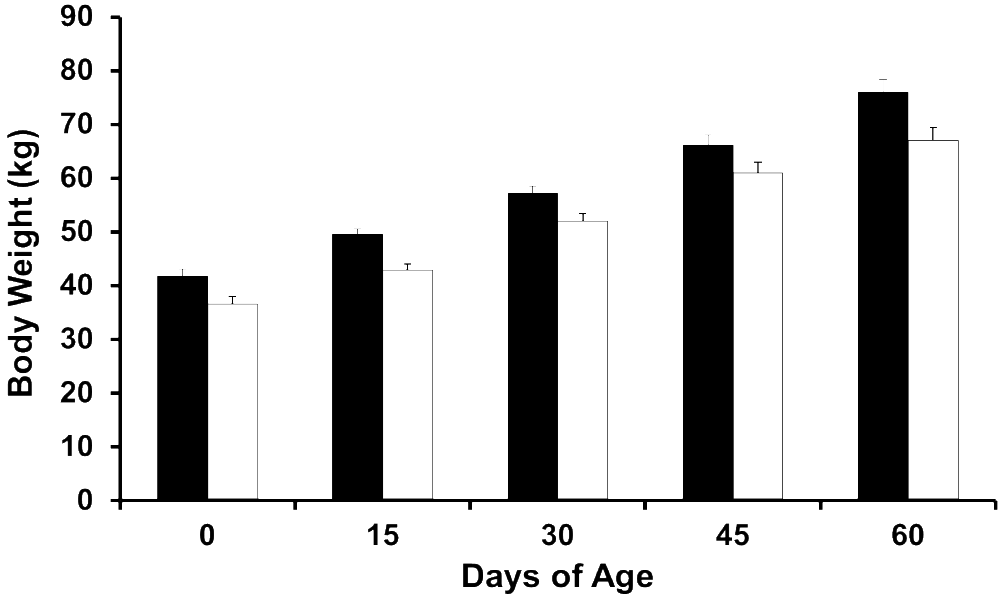
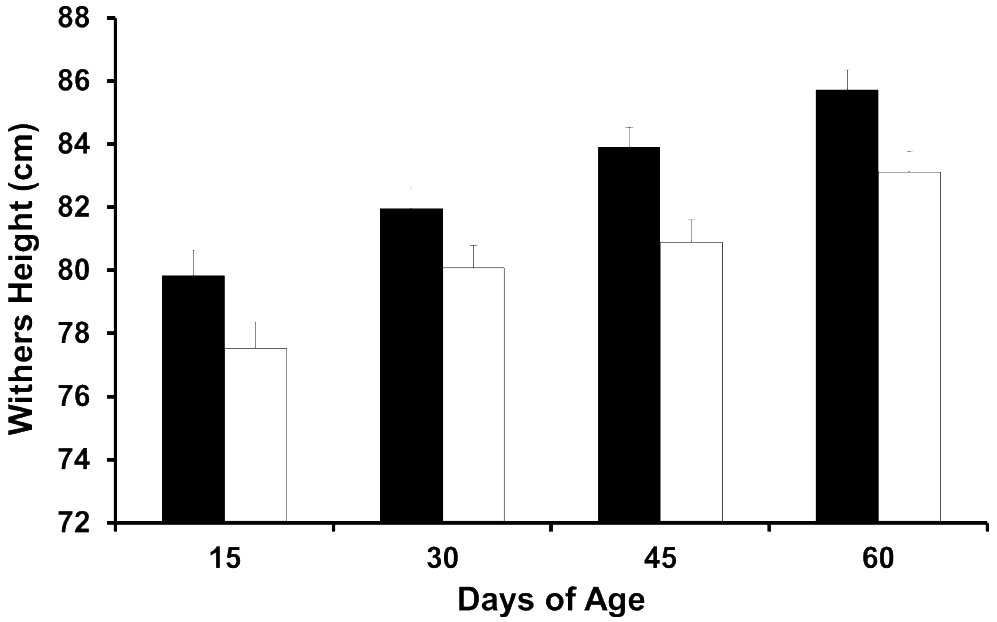
Why Does Cooling Affect AEA? Calf or Colostrum Effect?



Monteiro et al., *J. Dairy Sci.* 97:6426-6439

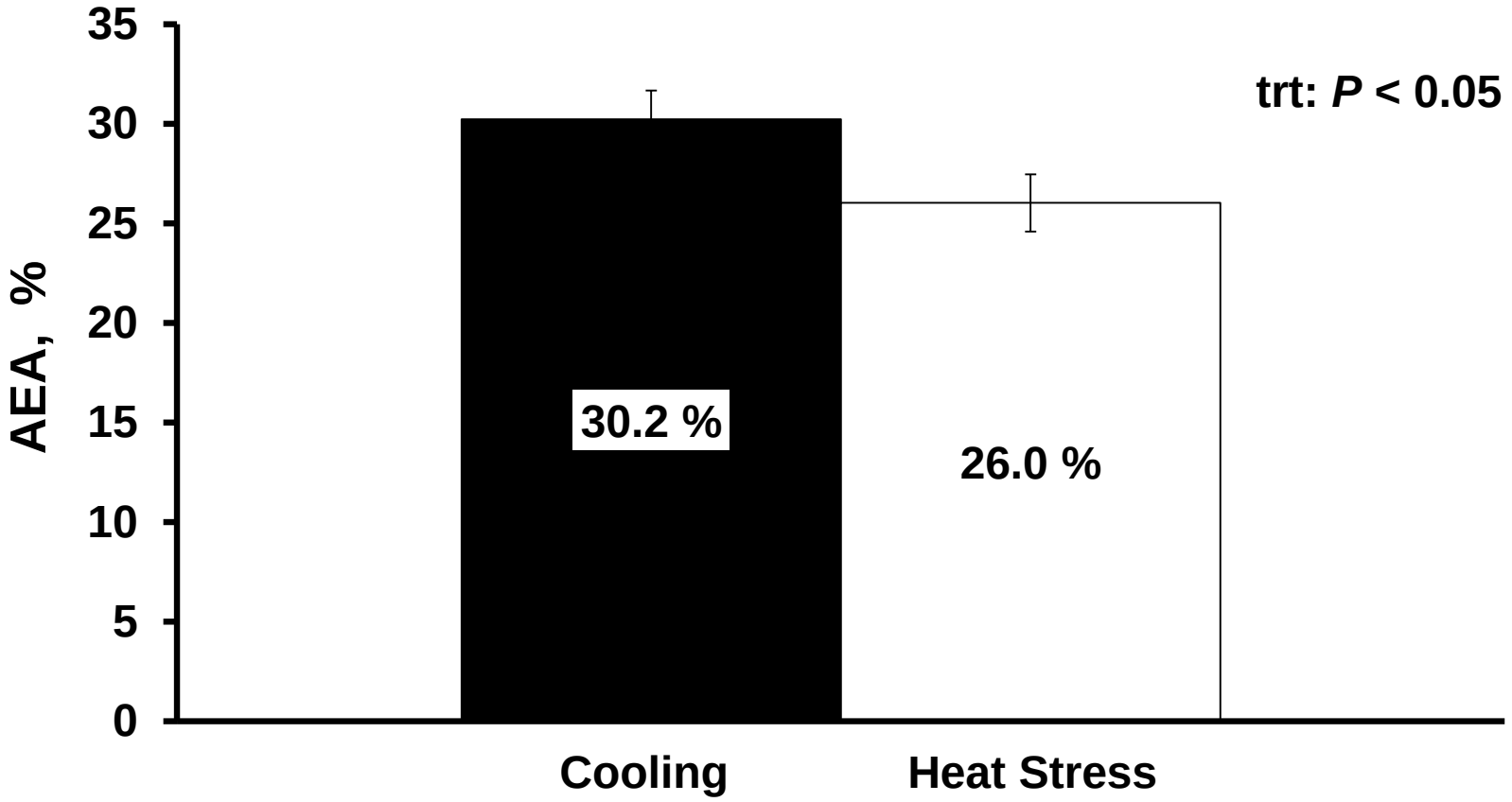
Experiment 1 - In utero heat stress for ~6 weeks reduces body weight and height to weaning





Monteiro et al., *J. Dairy Sci.* 97:6426-6439

Cooling Increased Apparent efficiency of IgG absorption (AEA*)



* AEA = [Serum [IgG] (g/L) * birth weight (kg) * 0.091 / IgG fed (g)] x 100

Heat Stress Summary – Short Term Effects on Calves

- Cooling increases weight at birth and weaning
- In utero heat stress reduces apparent efficiency of IgG absorption, but not an effect on colostrum quality
- In utero heat stress alters carbohydrate metabolism, consistent with greater fat deposition

J. Dairy Sci. 92:5988–5999
doi:10.3168/jds.2009-2343

Heat-stress abatement during the dry period: Does cooling improve transition into lactation?

B. C. do Amaral,* E. E. Connor,† S. Tao,* J. Hayen,* J. Bubolz,* and G. E. Dahl*[1]
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†Bovine Functional Genomics Laboratory, USDA-ARS, Beltsville Agricultural Research Center, Beltsville, MD 20705

J. Dairy Sci. 94:86–96
doi:10.3168/jds.2009-3004

Heat stress abatement during the dry period influences metabolic gene expression and improves immune status in the transition period of dairy cows

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†Bovine Functional Genomics Laboratory, USDA-ARS, Beltsville Agricultural Research Center, Beltsville, MD 20705

J. Dairy Sci. 94:5976–5986
doi:10.3168/jds.2011-4329

Effect of heat stress during the dry period on mammary gland development

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Department of Animal Sciences, University of Florida, Gainesville 32611

J. Dairy Sci. 95:5035–5046
http://dx.doi.org/10.3168/jds.2012-5405

Effect of cooling heat-stressed dairy cows during the dry period on insulin response

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†Department of Statistics, Institute of Food & Agricultural Sciences, University of Florida, Gainesville 32611

J. Dairy Sci. 97:7426–7436
http://dx.doi.org/10.3168/jds.2013-7621

Effect of cooling during the dry period on immune response after *Streptococcus uberis* intramammary infection challenge of dairy cows

I. M. T. Thompson, S. Tao, A. P. A. Monteiro, K. C. Jeong, and G. E. Dahl[1]
Department of Animal Sciences, University of Florida, Gainesville 32611

Retrospective analysis of records of calves from 5 studies between 2007 and 2011

Monteiro et al. , *J. Anim. Sci*. 91(Suppl. 1):184. Abstract #163.

J. Dairy Sci. 92:5988–5999
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J. Dairy Sci. 94:86-
doi:10.3168/jds.200

**Heat stress abatemen
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†Bovine Functional Genomics Laborator

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Effect of heat stres

S. Tao, J. W. Bubolz, B. C.
Department of Animal Sciences, Ur

J. Dairy Sci. 95:5
http://dx.doi.org/

**Effect of cooling hea
the dry period on in**

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Heat Stress Experiments 2007 - 2011

	Bulls	Heifers	**Total**
Cooling	31	41	72
Heat Stress	30	44	74
Total	61	85	147

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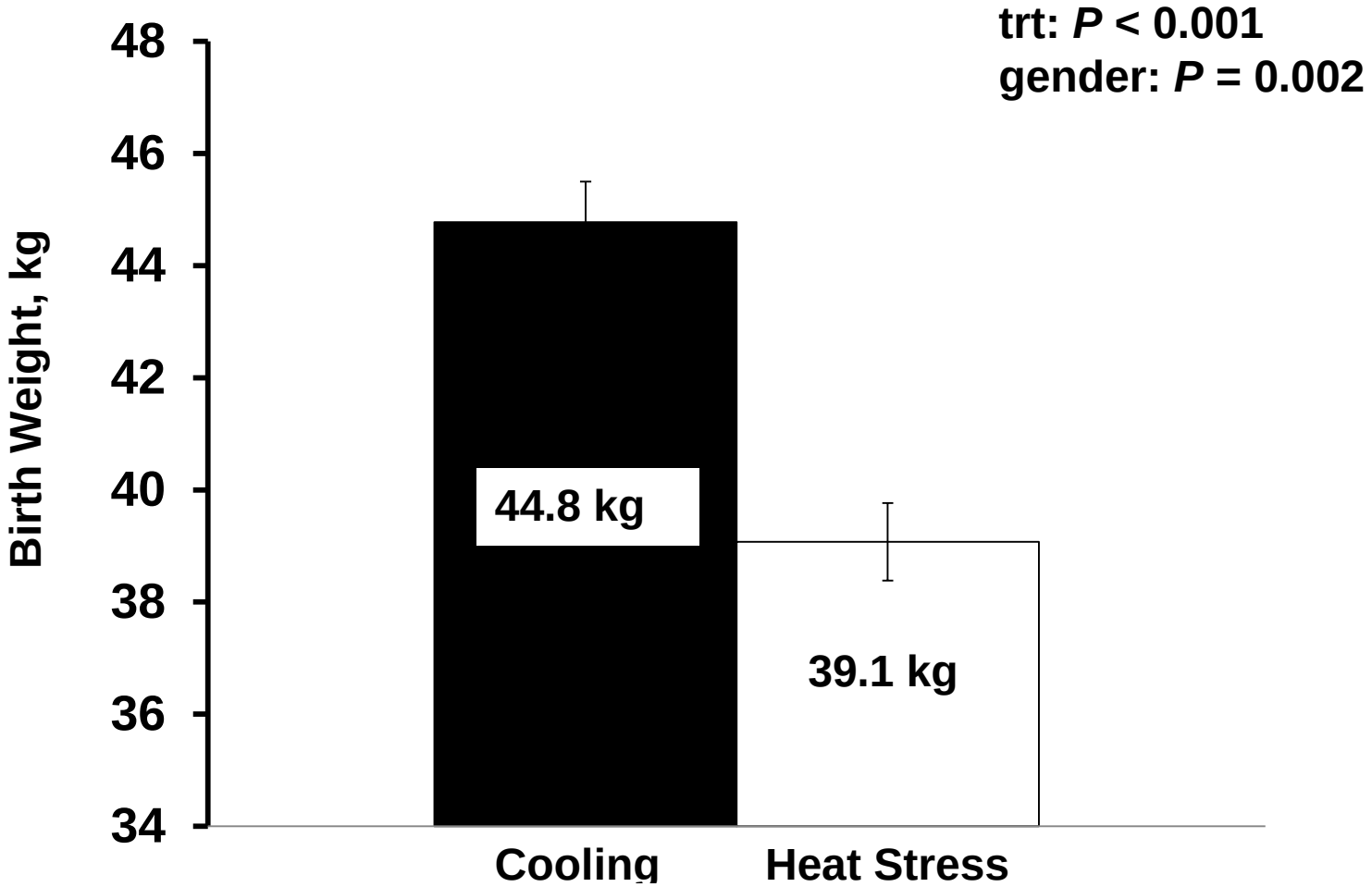
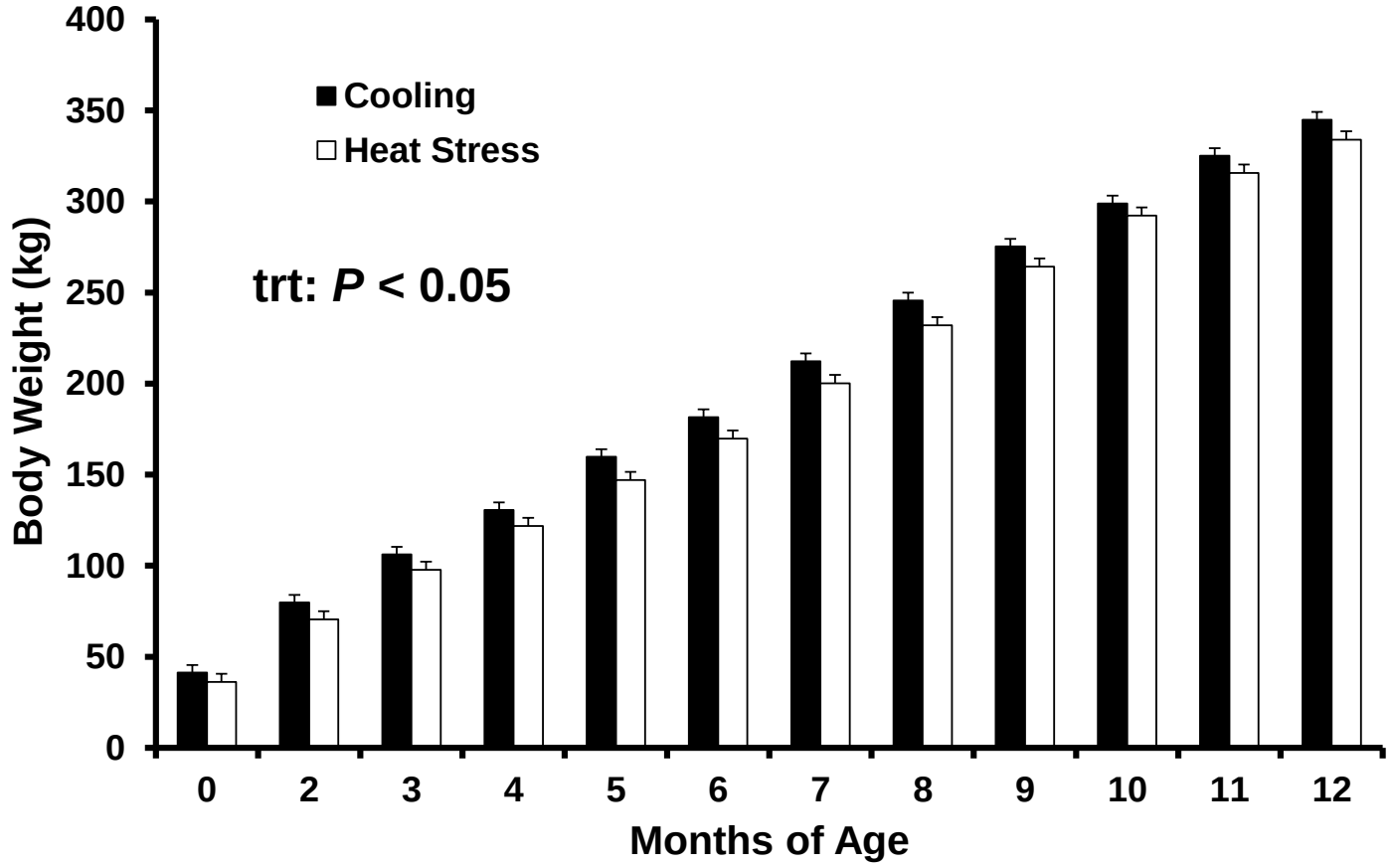
Birth Weight



Monteiro et al. , *J. Anim. Sci*. 91(Suppl. 1):184. Abstract #163

In Utero Heat Stress Decreases Calf Bodyweight to Puberty



Monteiro et al. , *J. Anim. Sci*. 91(Suppl. 1):184. Abstract #163

In Utero HS Decreases Calf Survival

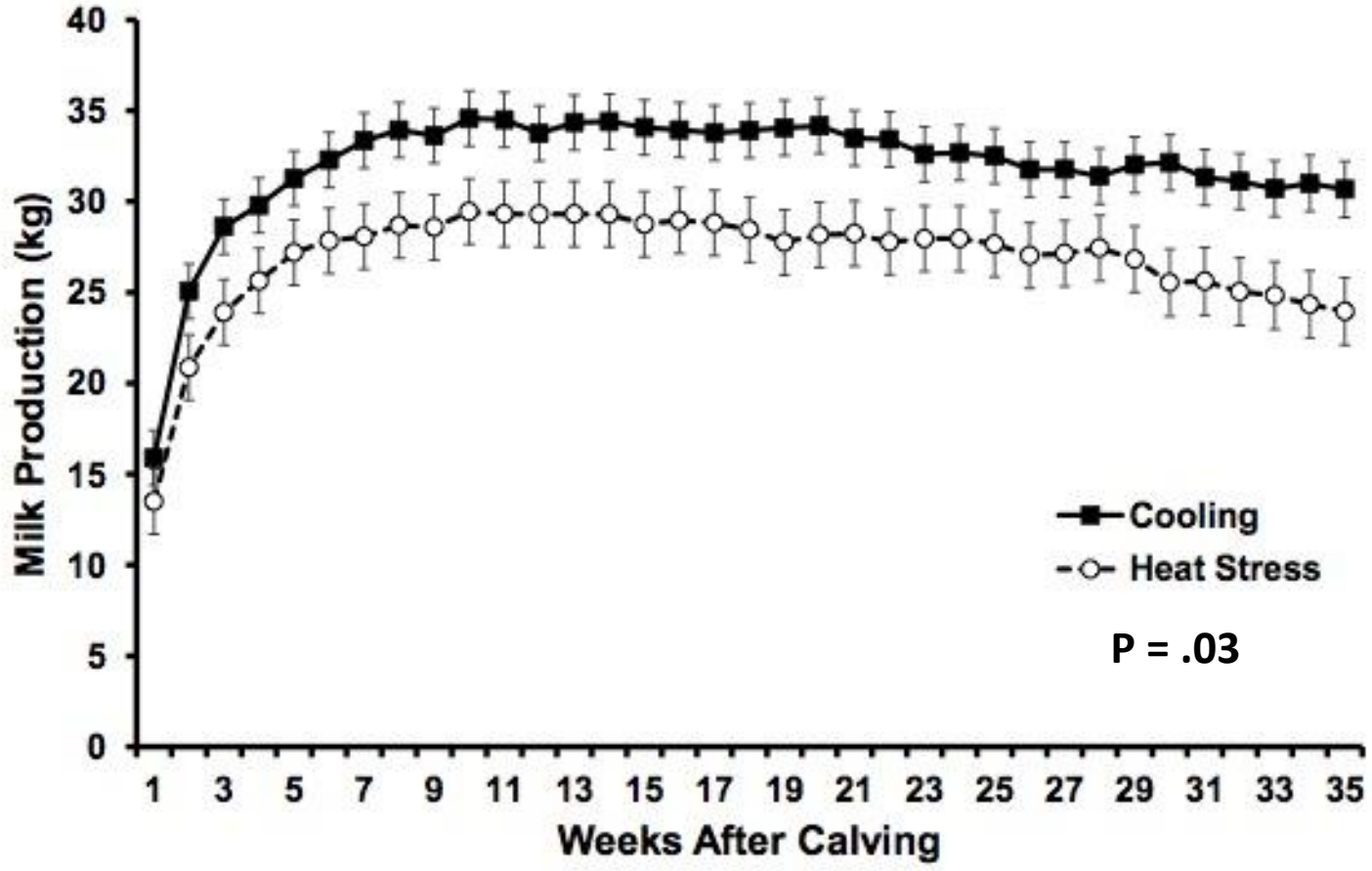
Table 1. Effect of maternal heat stress (HT) or cooling (CL) during late gestation on calf survival

	CL				HT				*P*
Parameter	AI	IVF[1]	Total	%[2]	AI	IVF	Total	%	Trt[3]
Bull calves, n	30	1	31	---	28	2	30	---	---
Heifer calves, n	29	12	41	---	29	15	44	---	---
DOA[4]	0	0	0	0.0	2	1	3	4.1	0.25
Males mortality by 4 mo of age	1	0	1	3.2	3	0	3	10.0	0.35
Heifers leaving herd before puberty	1	4	5	12.2	3	7	10	22.7	0.26
Due to sickness, malformation or growth retardation	1	0	1	2.4	3	5	8	18.2	0.03
Heifers leaving herd after puberty, before first lactation	1	0	1	2.4	3	0	3	6.8	0.62
Heifers completing first lactation	27	8	35	85.4	22	7	29	65.9	0.05

[1] IVF = in vitro fertilization.
[2] Percentage of animals (AI + IVF) affected out of total animals (males or females) in the respective treatment.
[3] Treatment.
[4] Dead on arrival. Includes male and female calves.

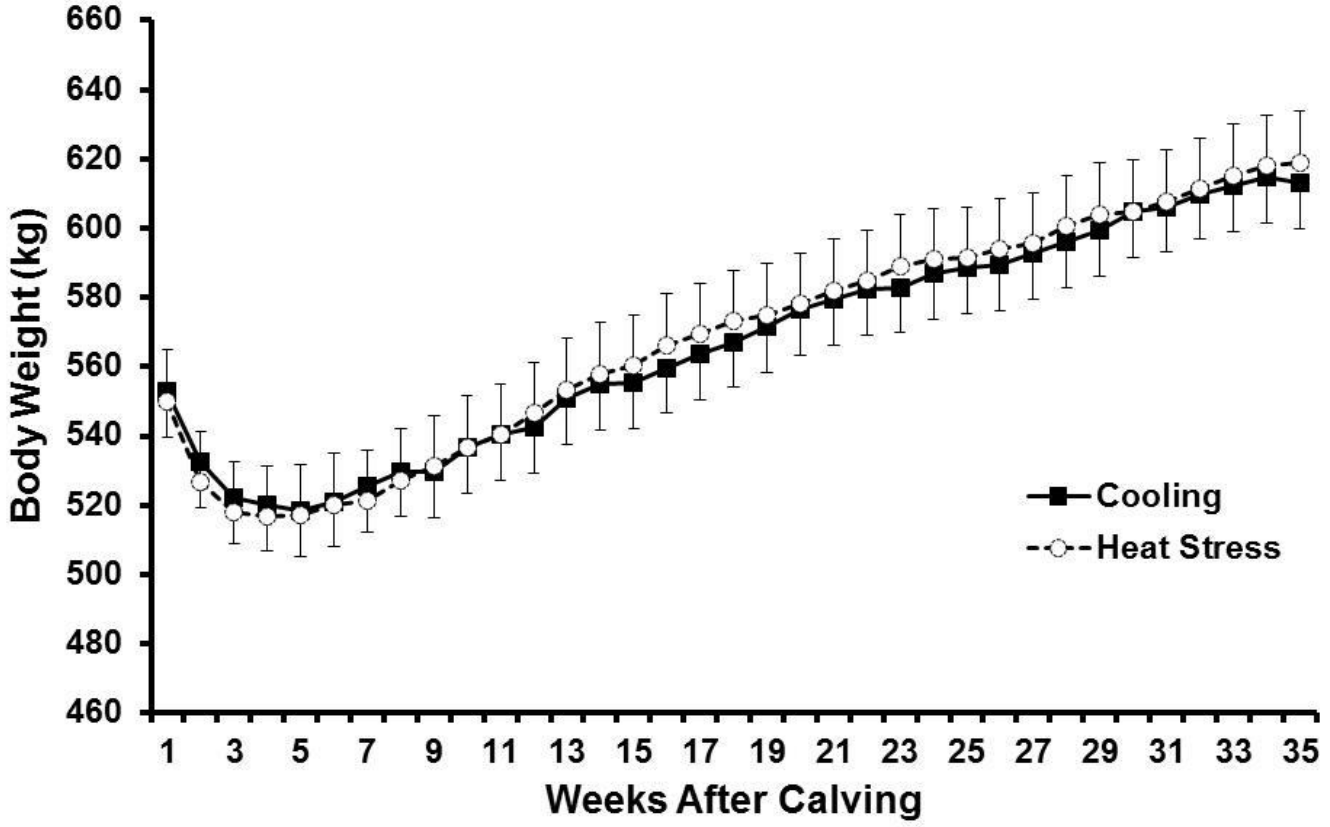
Monteiro et al. , *J. Anim. Sci*. 91(Suppl. 1):184. Abstract #163.

In Utero Heat Stress Reduces Milk Production



Monteiro et al. , *J. Anim. Sci*. 91(Suppl. 1):184. Abstract #163.

In Utero Heat Stress Does Not Affect Mature Bodyweight



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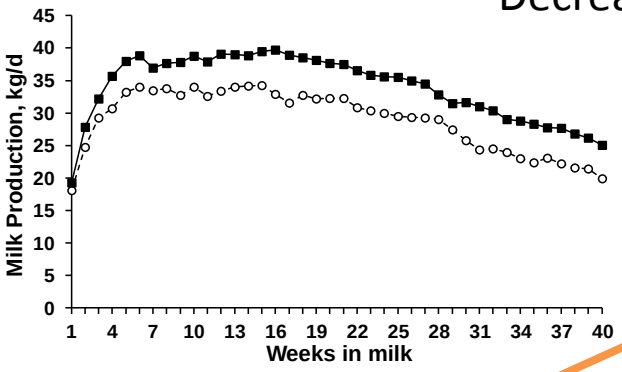
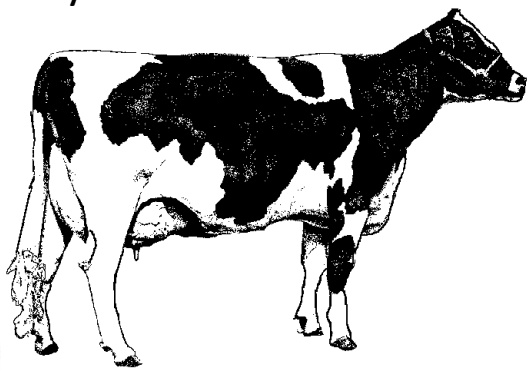
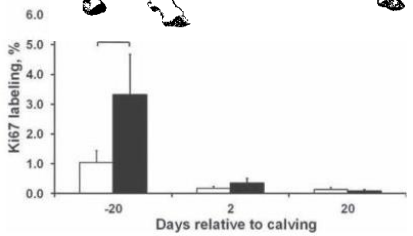
Decreased milk yield

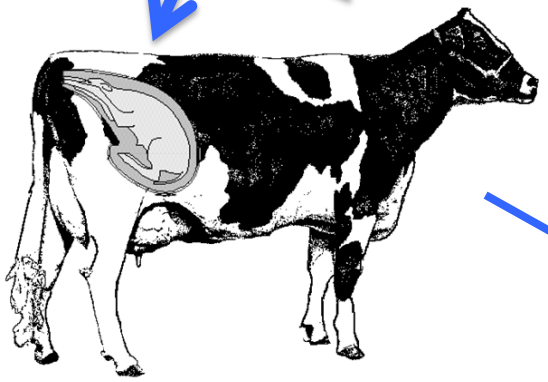




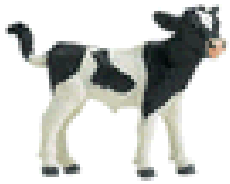


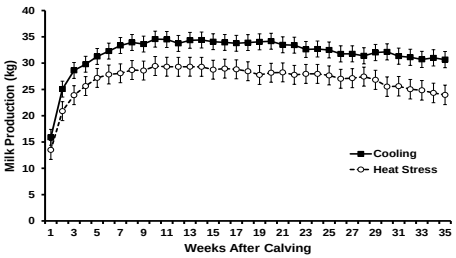
Decreased mammary growth

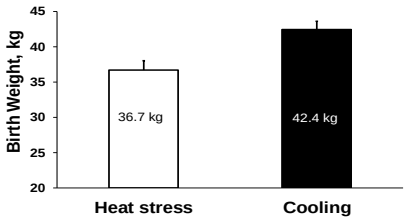
Late gestation

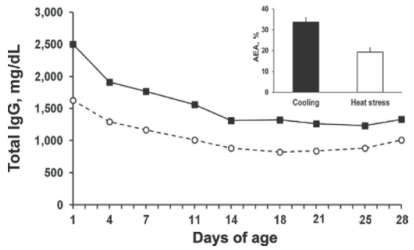


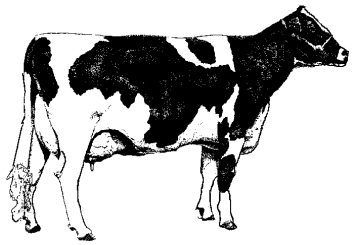
Altered autophagy











Lower body weight
Decreased IgG absorption

Reduced reproductive efficiency

Decreased milk yield

Thanks!

- Dr. Sha Tao
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- Ana Monteiro

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USDA

United States Department of Agriculture

National Institute of Food and Agriculture

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