



***IN UTERO* HEAT STRESS ALTERS CALF PHENOTYPE: THE ROLE OF PROGRAMMING**

G. E. Dahl, J. Laporta*

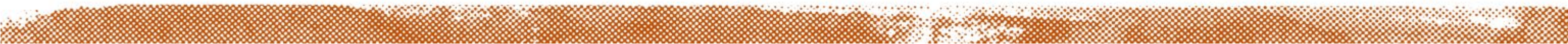
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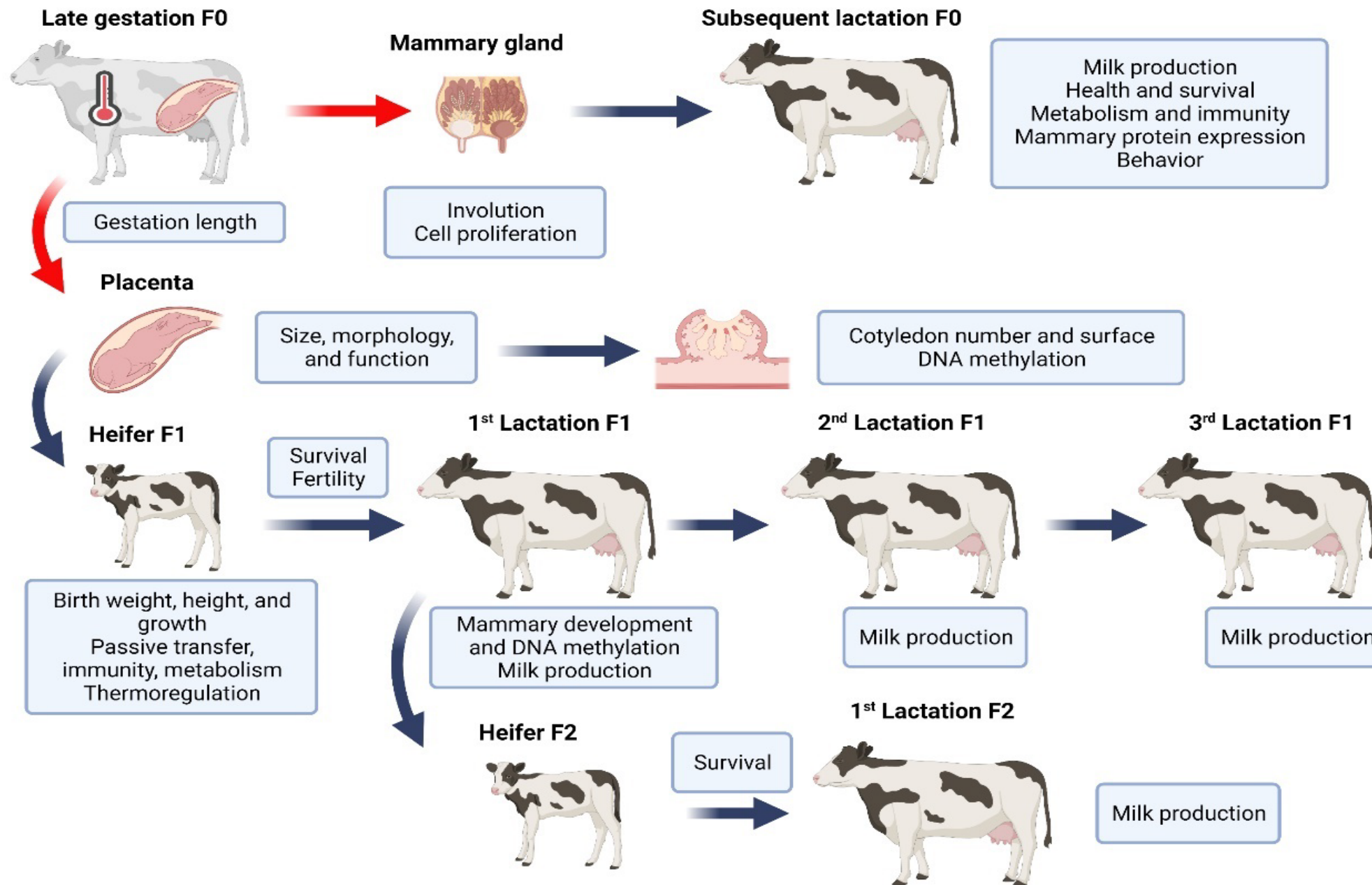
gdahl@ufl.edu

EAAP 2024

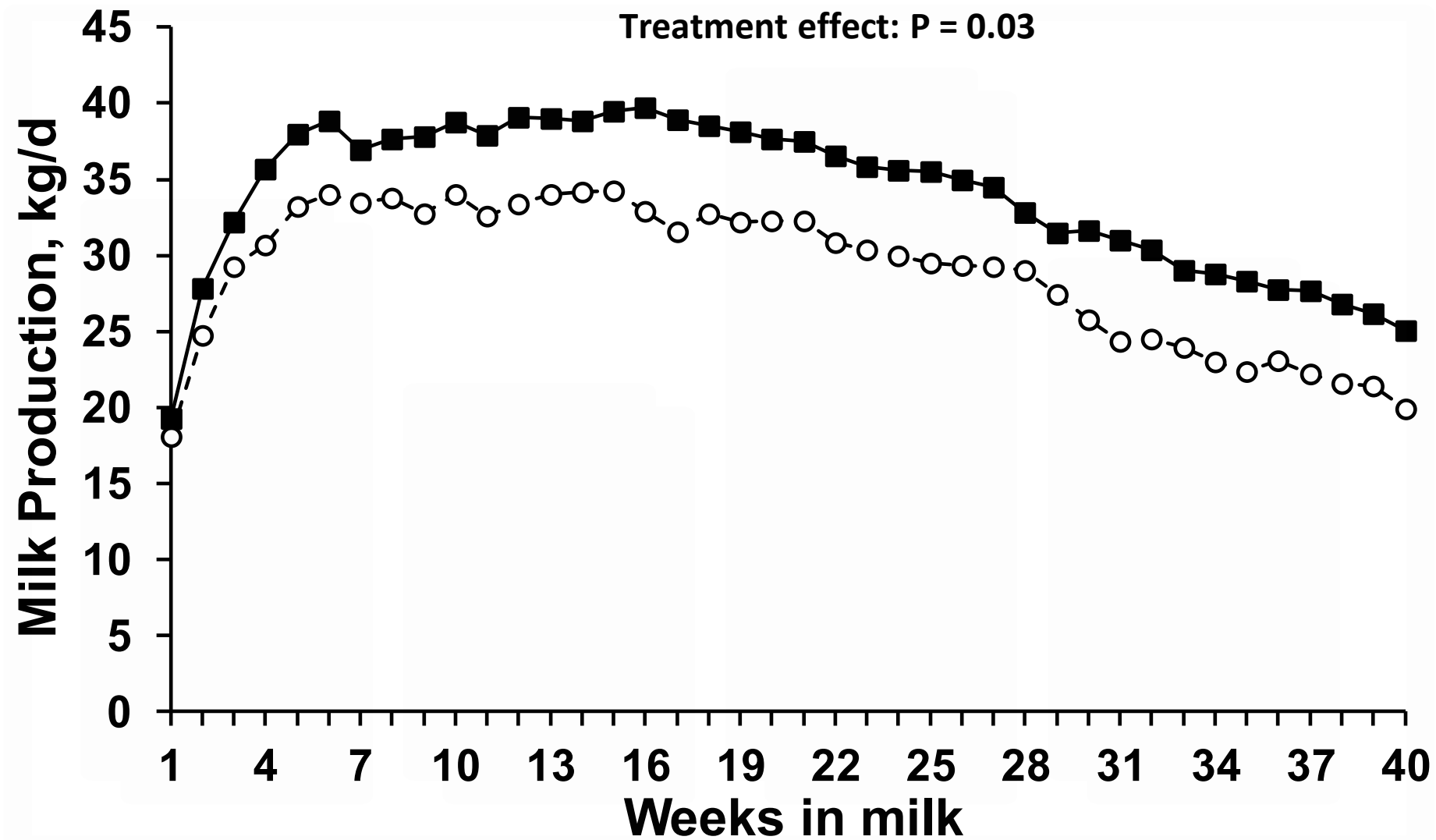
3 September 2024



LATE GESTATION HEAT STRESS

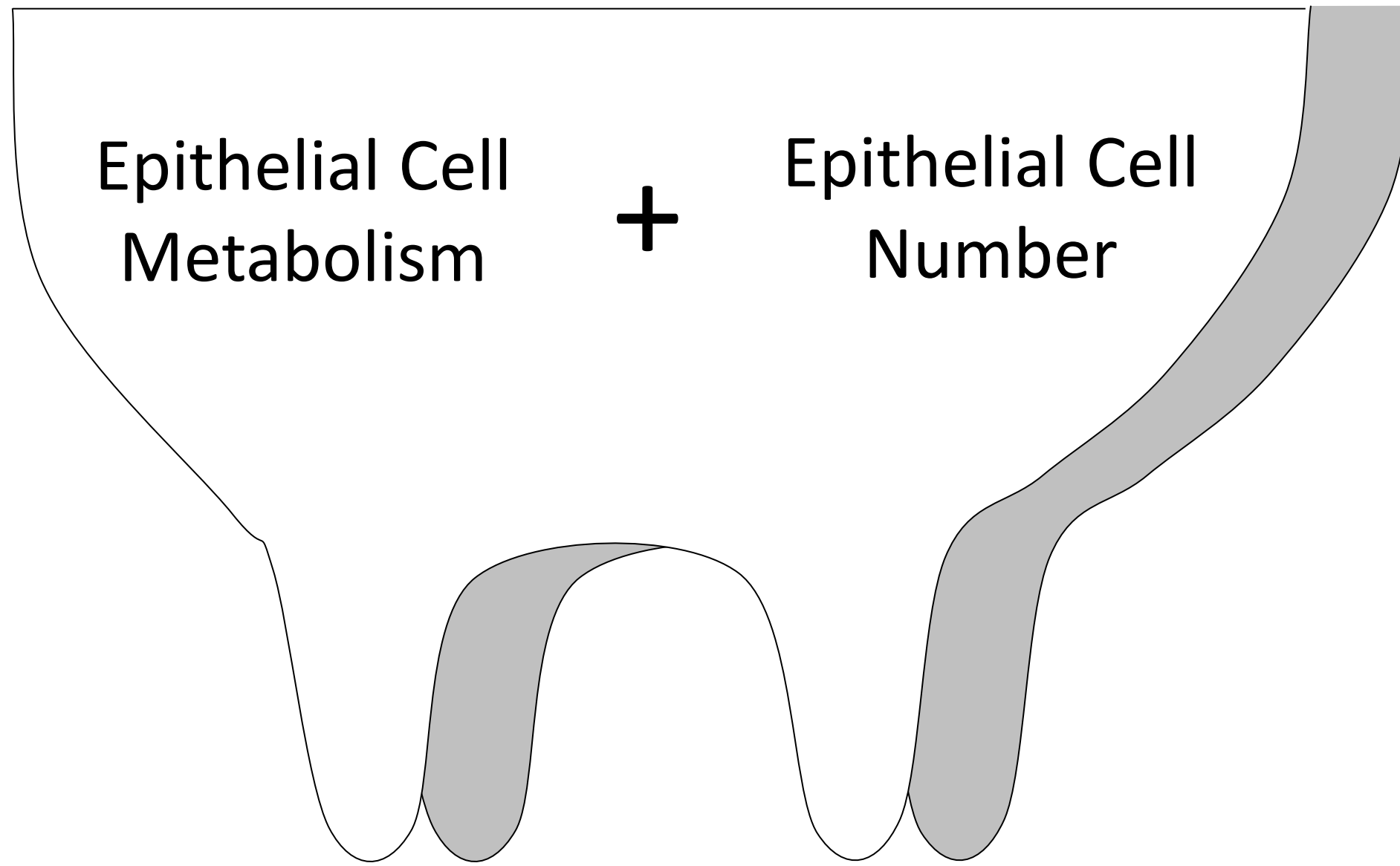


COOLING DRY COWS INCREASES MILK

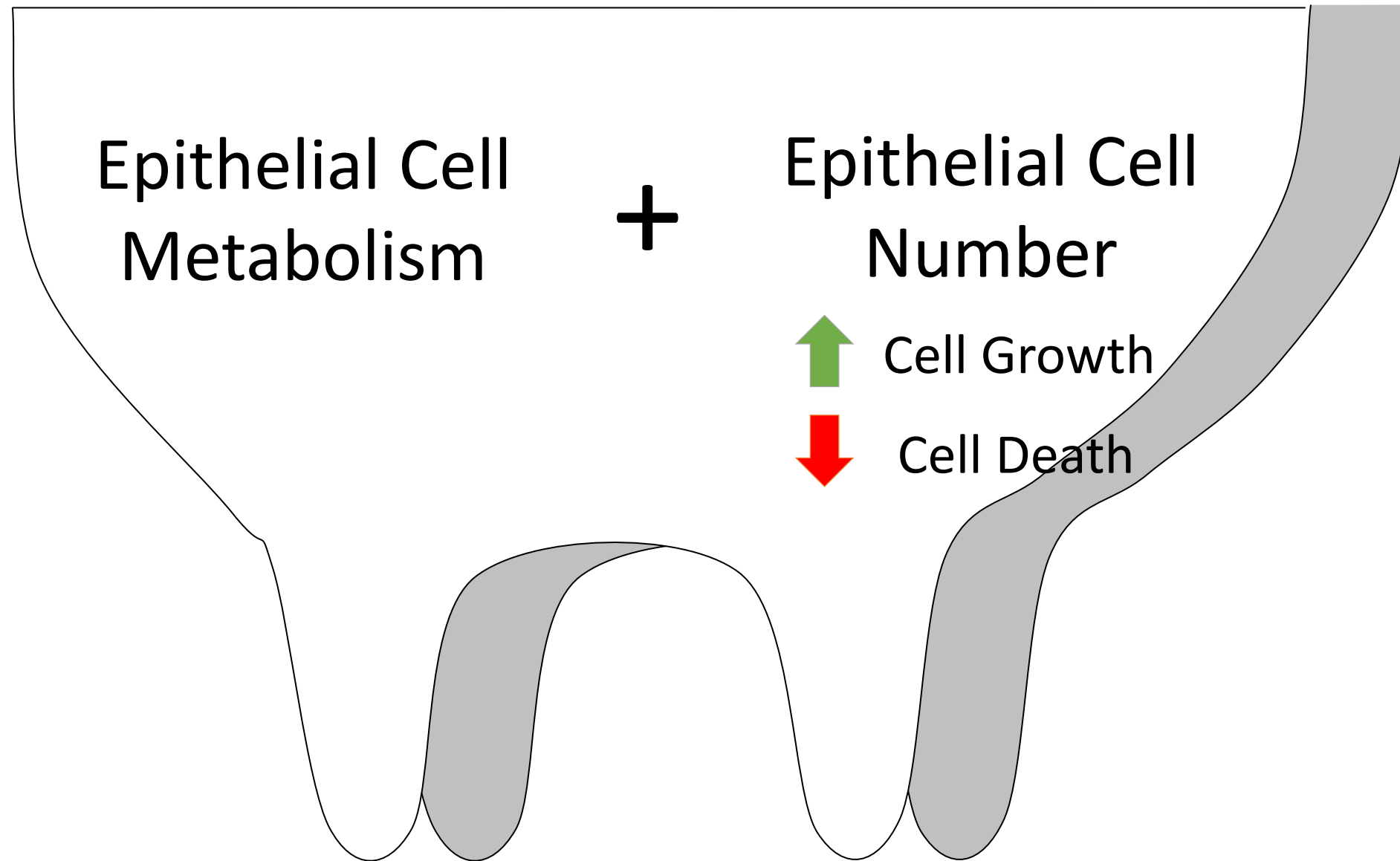


Tao et al., *J. Dairy Sci.* 94:5976–5986

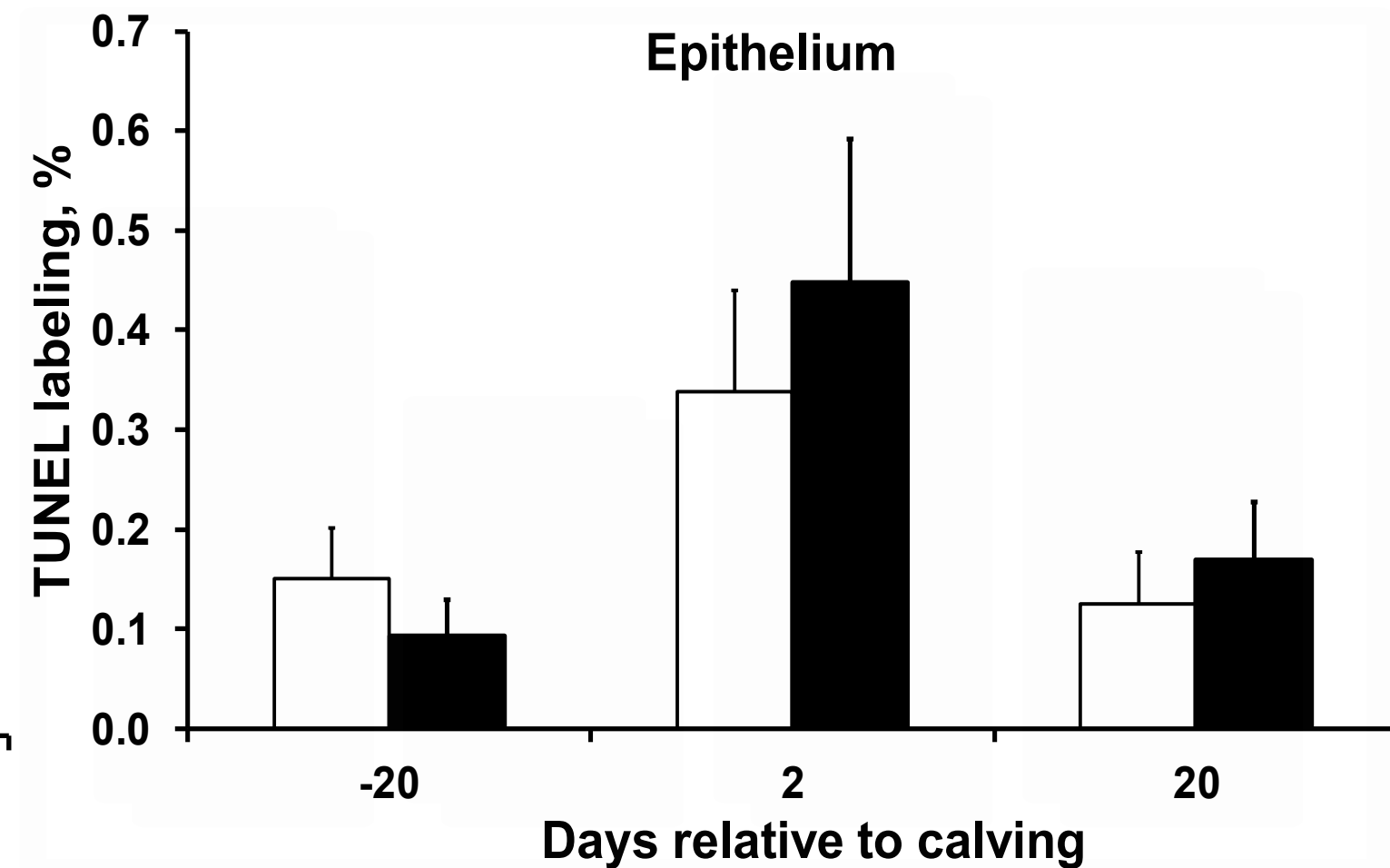
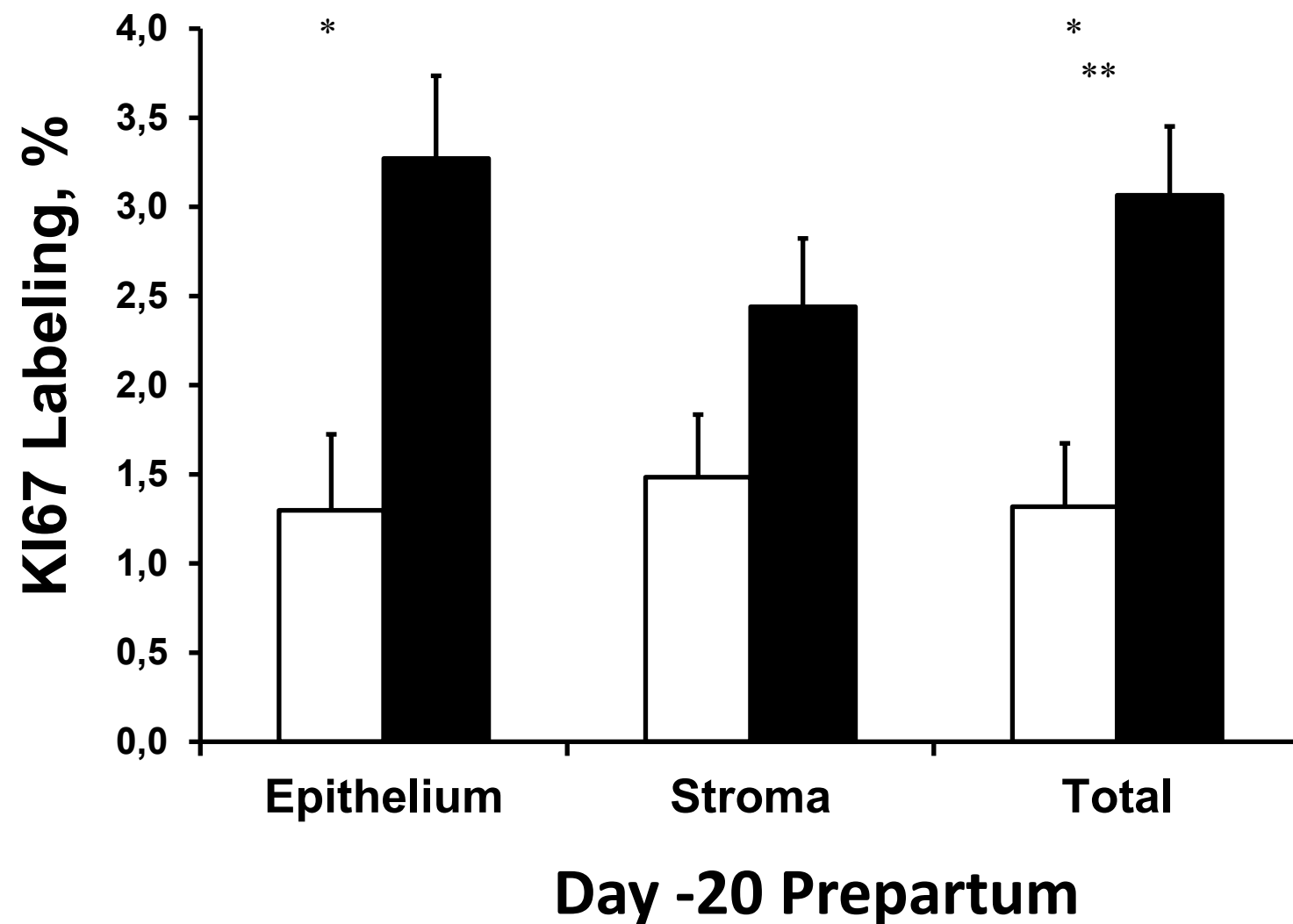
Milk Production



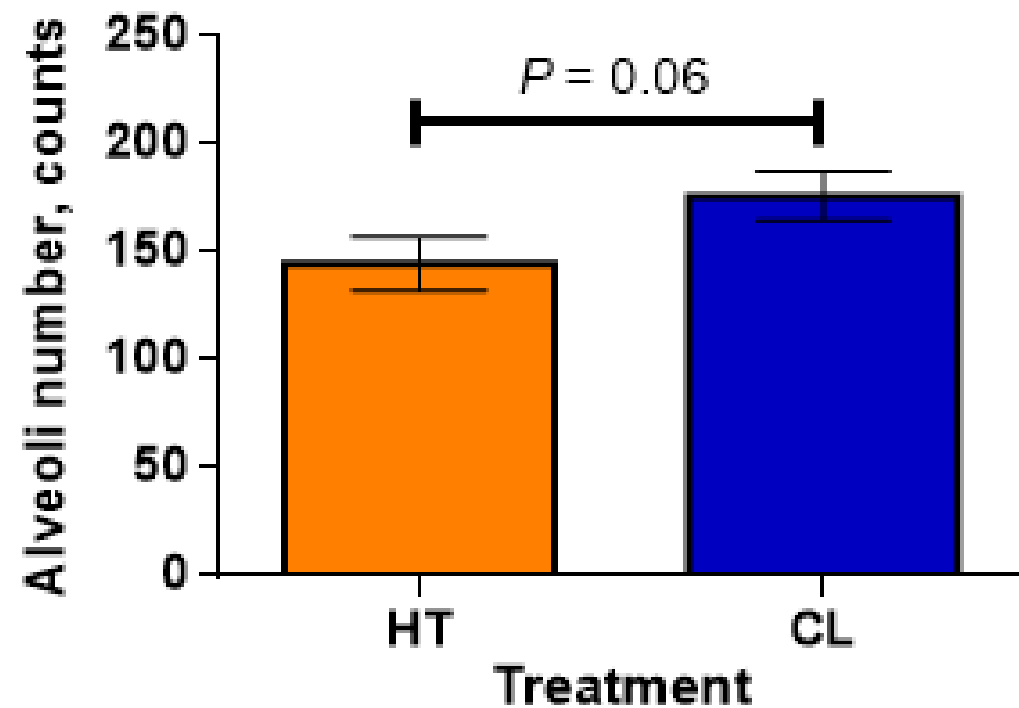
Milk Production



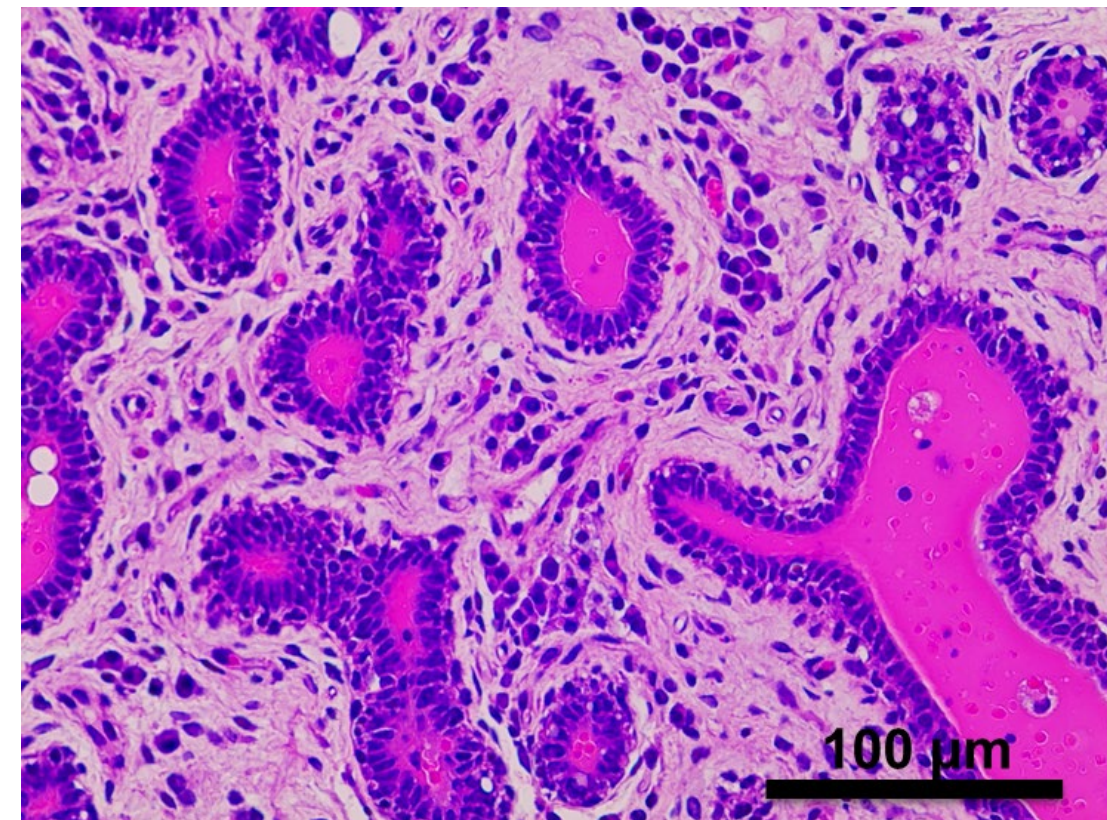
COOLING INCREASES PROLIFERATION OF MAMMARY CELLS PREPARTUM; APOPTOSIS UNAFFECTED

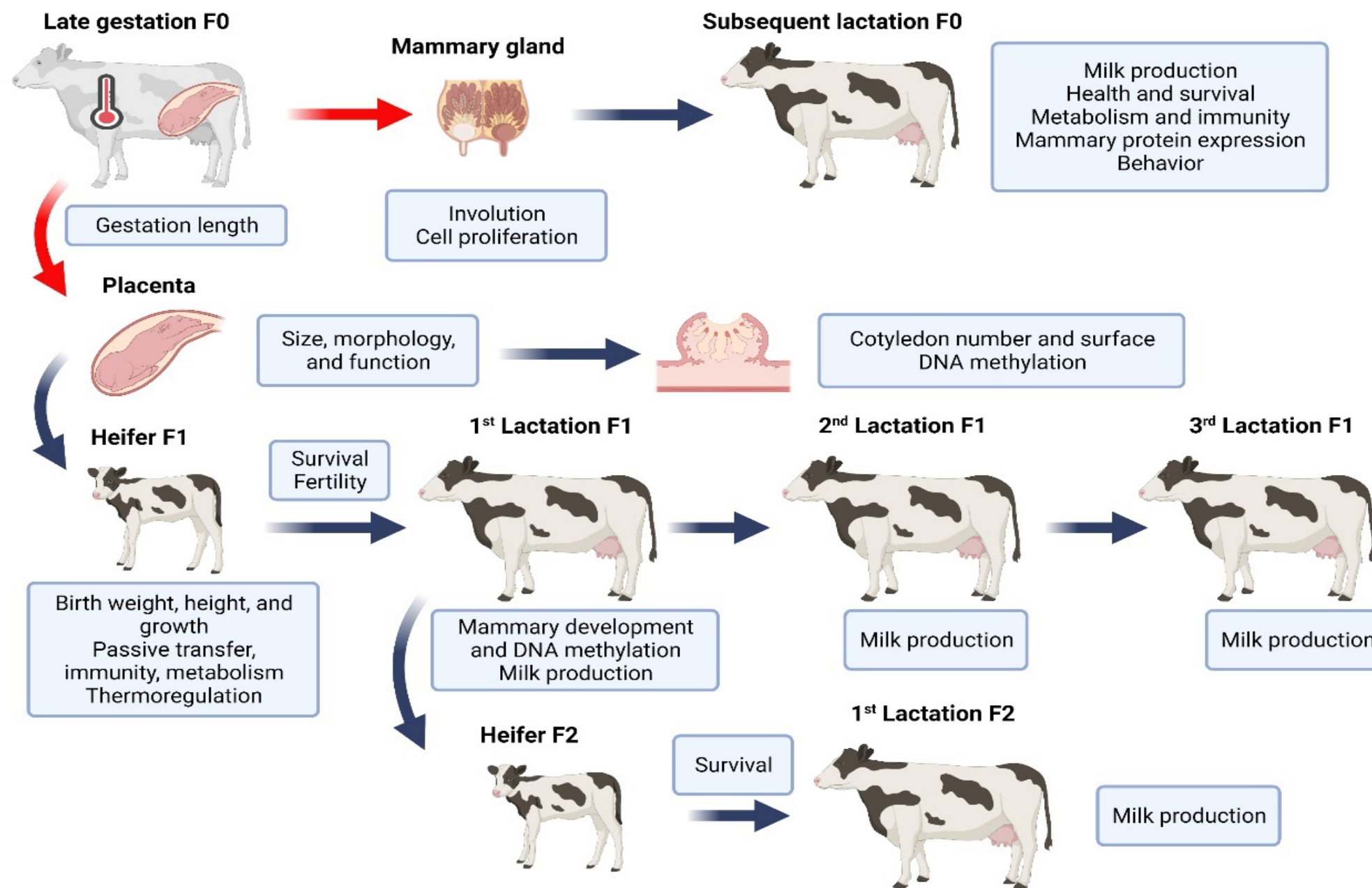


HEAT STRESS DECREASES ALVEOLI NUMBER

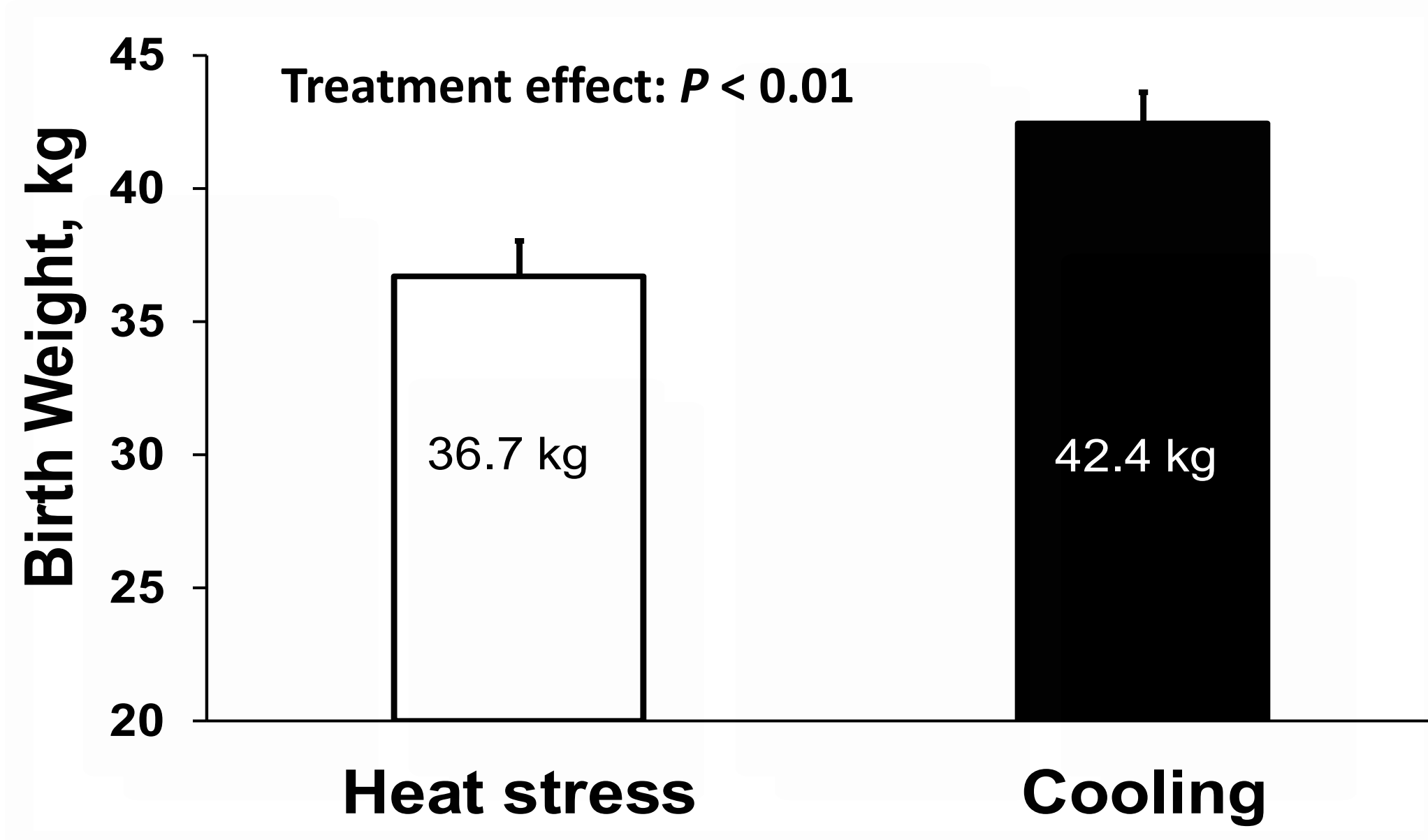


H&E Stain

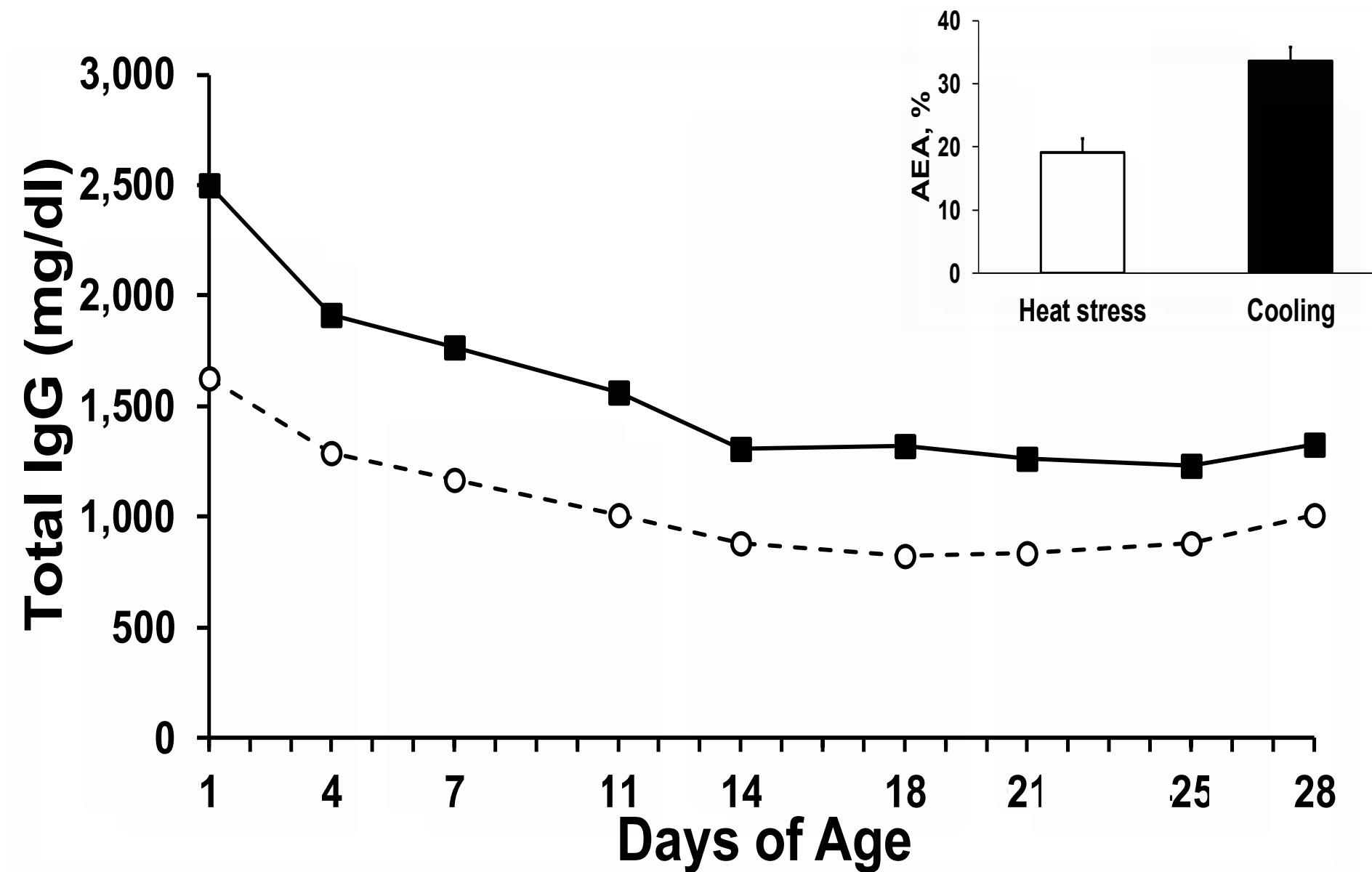




COOLING INCREASES CALF BIRTH WEIGHT

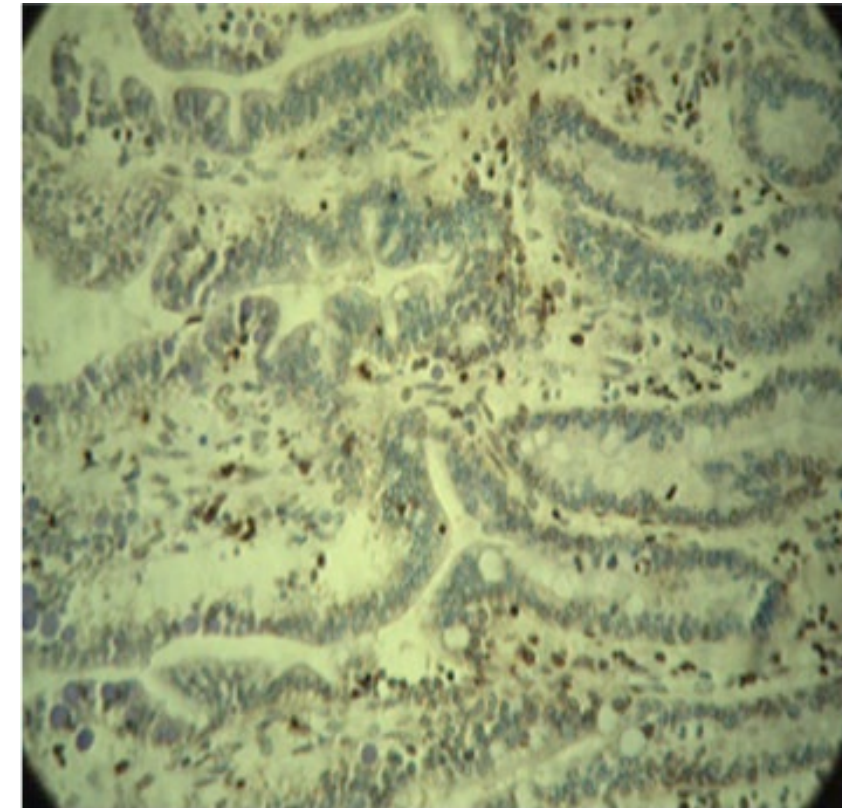
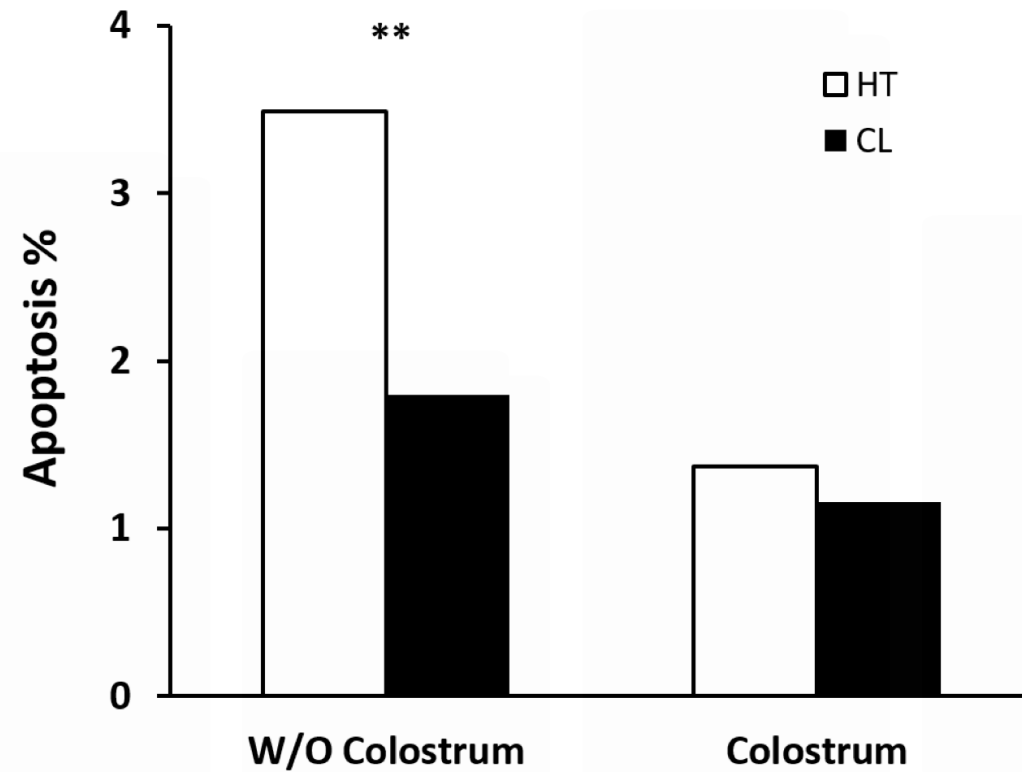


COOLING IMPROVES TOTAL IgG AND AEA



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

***IN UTERO* HT ACCELERATES GUT CLOSURE**



Ahmed et al. , *JDS Commun.* 2:<https://doi.org/10.3168/jdsc.2021-0098>.

J. Dairy Sci. 92:5988–5999
doi:10.3168/jds.2009-2343
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Heat-stress abatement during the dry period: Does cooling improve transition into lactation?

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 J. Dairy Sci. 94:86–96
doi:10.3168/jds.2009-3004
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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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 J. Dairy Sci. 94:5976–5986
doi:10.3168/jds.2011-4329
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Effect of heat stress during the dry period on mammary gland development

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 J. Dairy Sci. 95:5035–5046
<http://dx.doi.org/10.3168/jds.2012-5405>
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Effect of cooling heat-stressed dairy cows during the dry period on insulin response

S. Tao,* I. M. Thompson,* A. P. A. Monteiro,* M. J. Hayen,* L. J. Young,† and G. E. Dahl*¹
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 J. Dairy Sci. 97:7426–7436
<http://dx.doi.org/10.3168/jds.2013-7621>
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Effect of cooling during the dry period on immune response after *Streptococcus uberis* intramammary infection challenge of dairy cows

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

Monteiro et al. , *J. Dairy Sci.* 99:8443-8450.

J. Dairy Sci. 92:5988–5999
doi:10.3168/jds.2009-2343
© American Dairy Science Association, 2009.

Heat-stress abatement during the transition period
Does cooling improve transition?

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J. Dairy Sci. 94:86–96
doi:10.3168/jds.2009-3004
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Heat stress abatement during the dry period
metabolic gene expression and improved health
status in the transition period of dairy cows

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Effect of heat stress during the transition period

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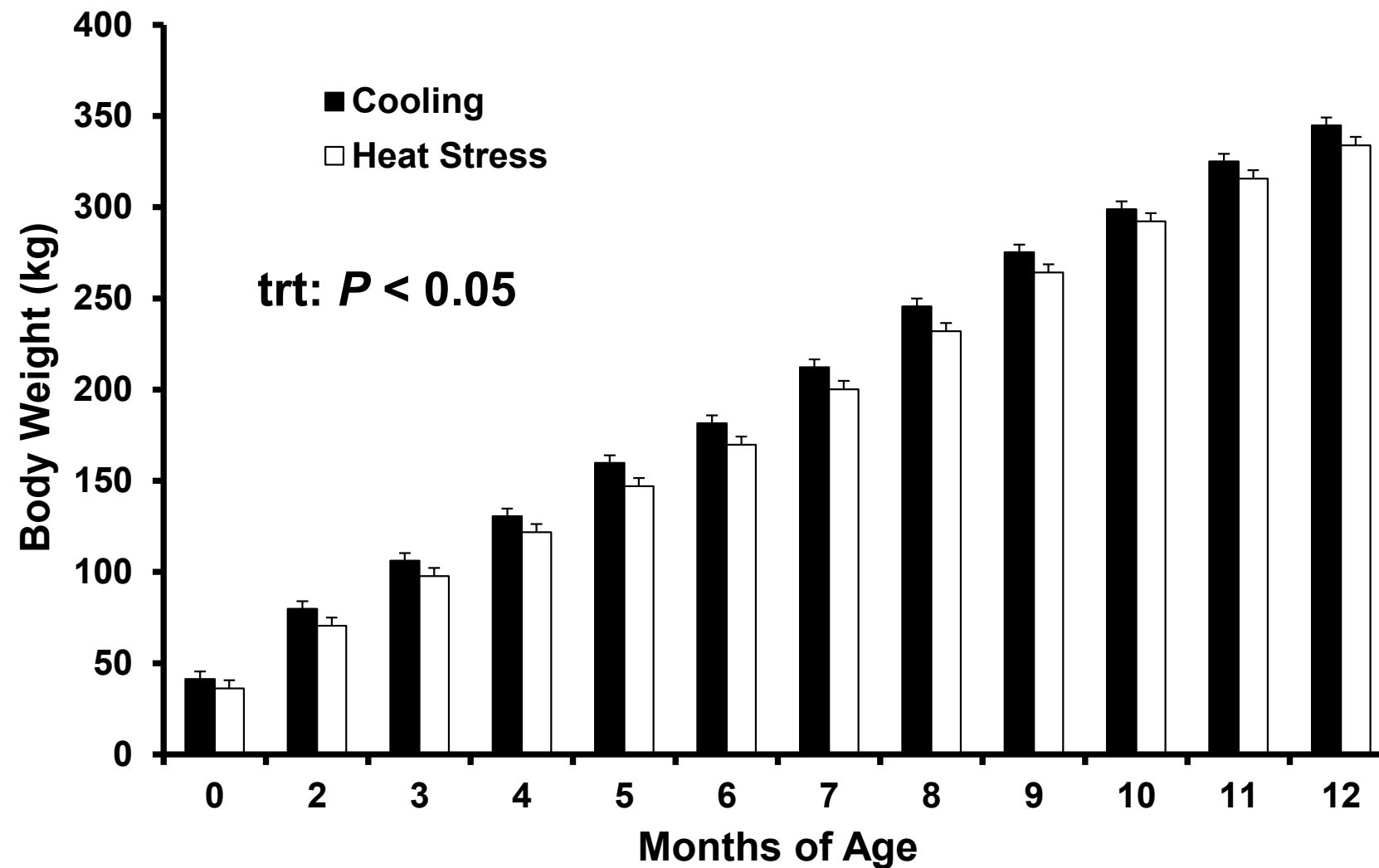


J. Dairy Sci. 95:5035–5046
http://dx.doi.org/10.3168/jds.2012-5405
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Heat Stress Experiments 2007 - 2011			
	Bulls	Heifers	Total
Cooling	31	41	72
Heat Stress	30	44	74
Total	61	85	147

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immune response after
ction challenge of dairy cows
nd G. E. Dahl¹

***IN UTERO* HEAT STRESS DECREASES CALF BODYWEIGHT TO PUBERTY**



Monteiro et al. , *J. Dairy Sci.* 99:8443-8450.

IN UTERO HS DECREASES CALF SURVIVAL

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

Parameter	CL				HT				<i>P</i>
	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

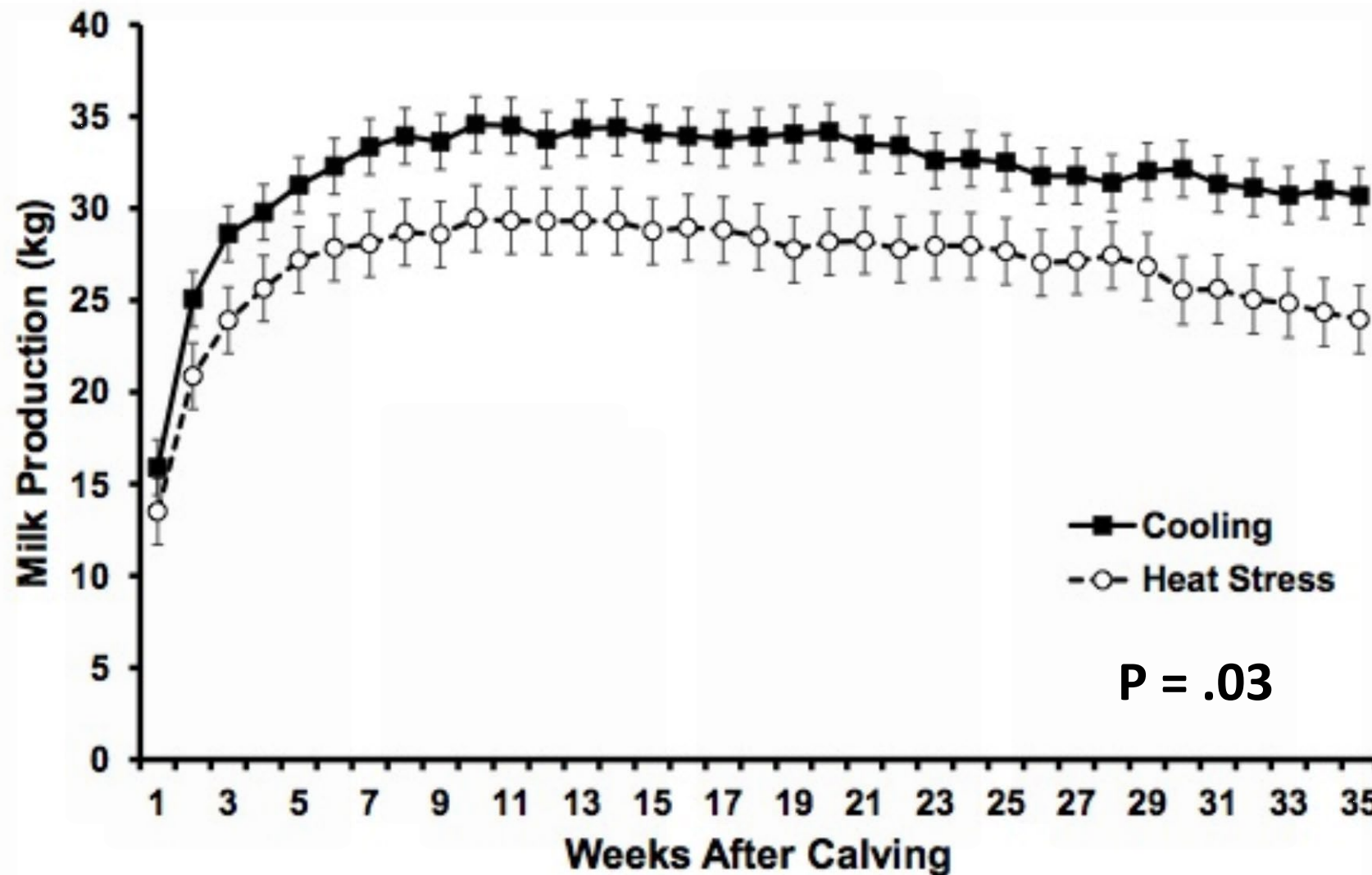
¹ IVF = in vitro fertilization.

² Percentage of animals (AI + IVF) affected out of total animals (males or females) in the respective treatment.

³ Treatment.

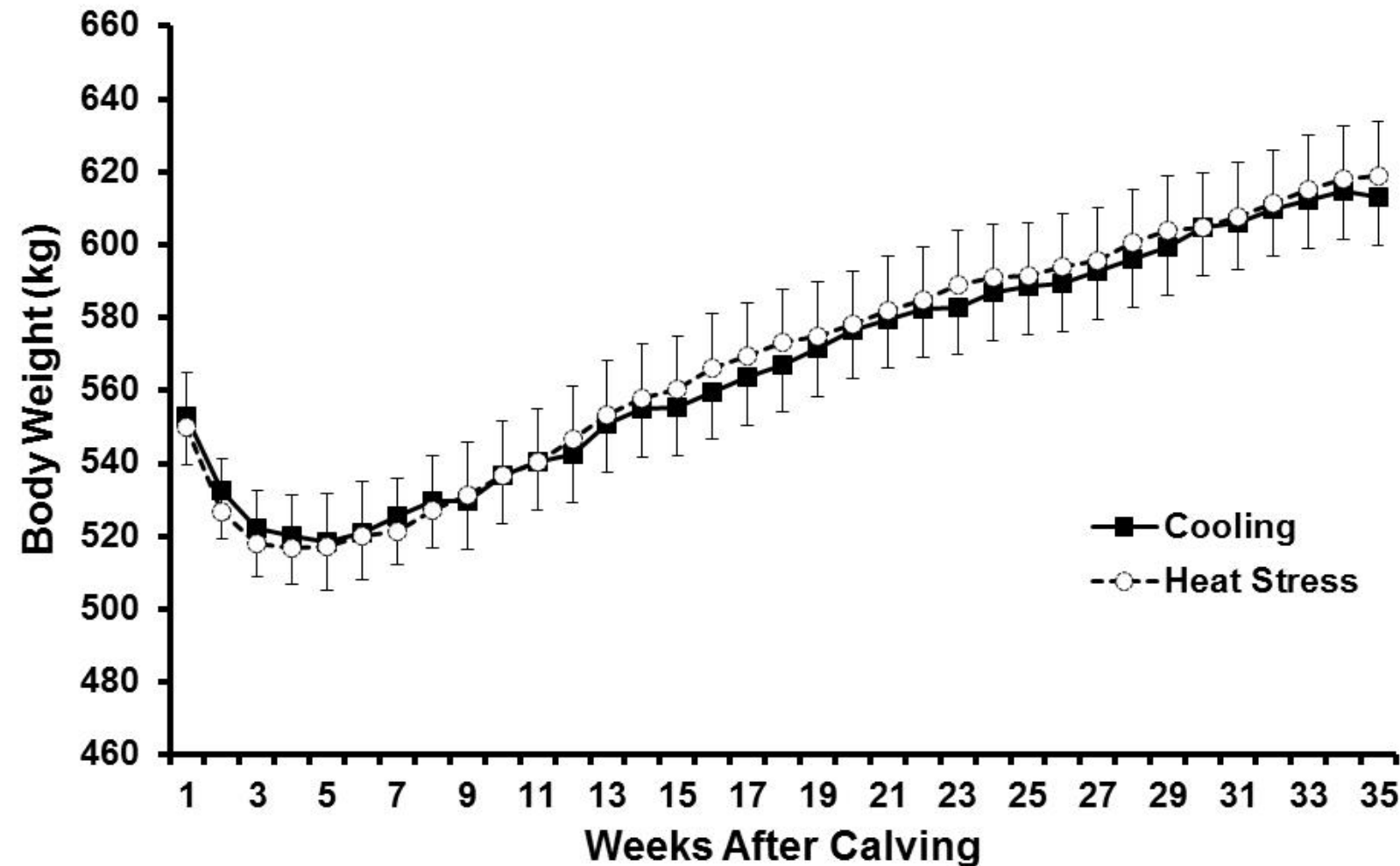
⁴ Dead on arrival. Includes male and female calves.

***IN UTERO* HEAT STRESS REDUCES MILK PRODUCTION**



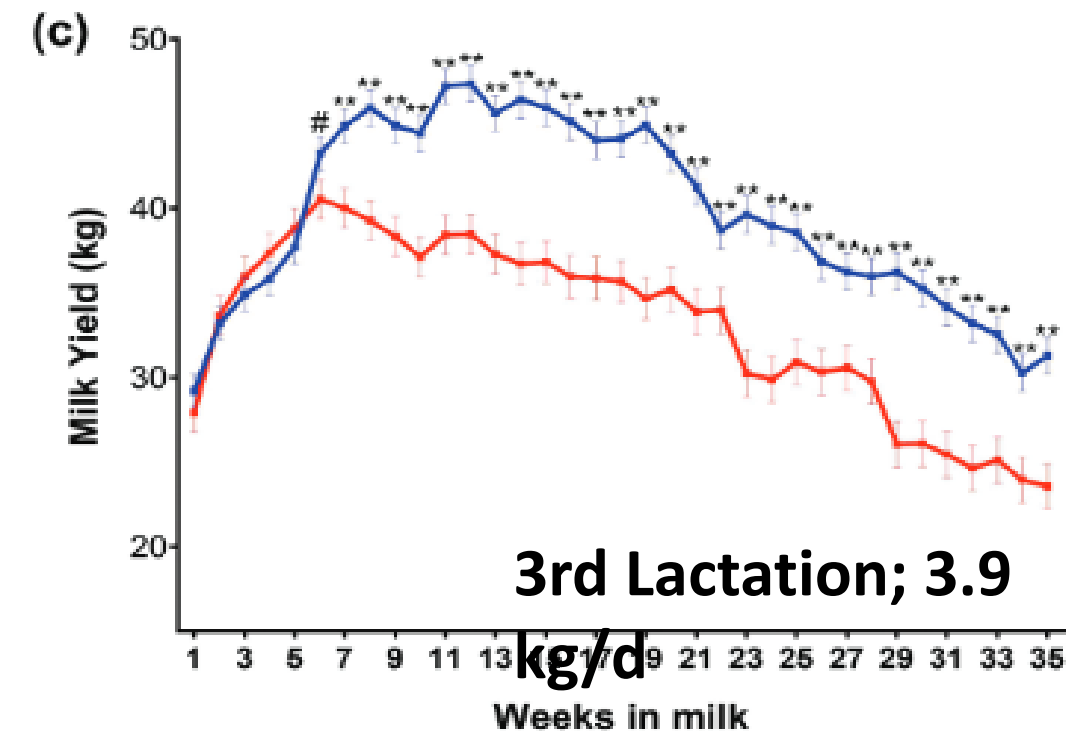
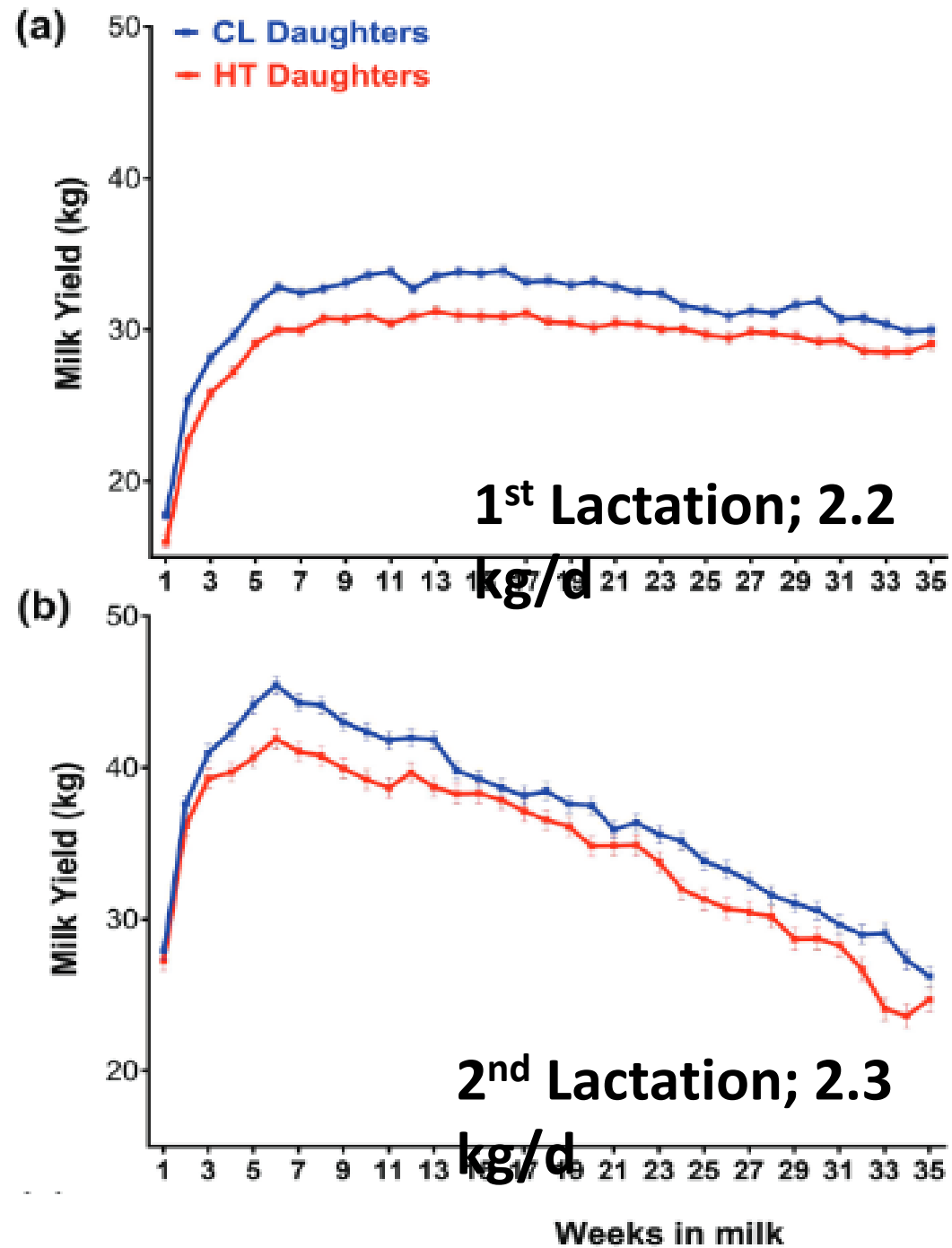
Monteiro et al. , *J. Dairy Sci.* 99:8443-8450.

***IN UTERO* HEAT STRESS DOES NOT AFFECT MATURE BODYWEIGHT**



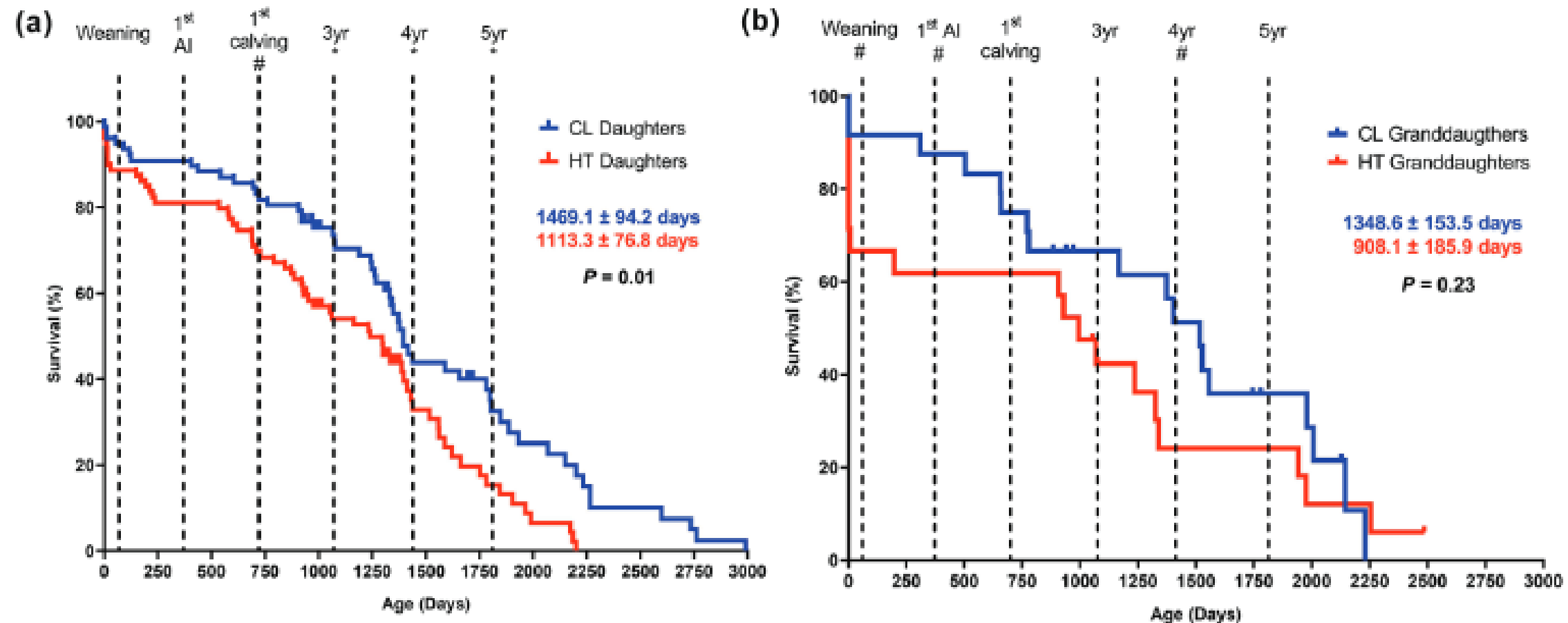
Monteiro et al. , *J. Dairy Sci.* 99:8443-8450.

In Utero Heat Stress Alters Lifetime Yield



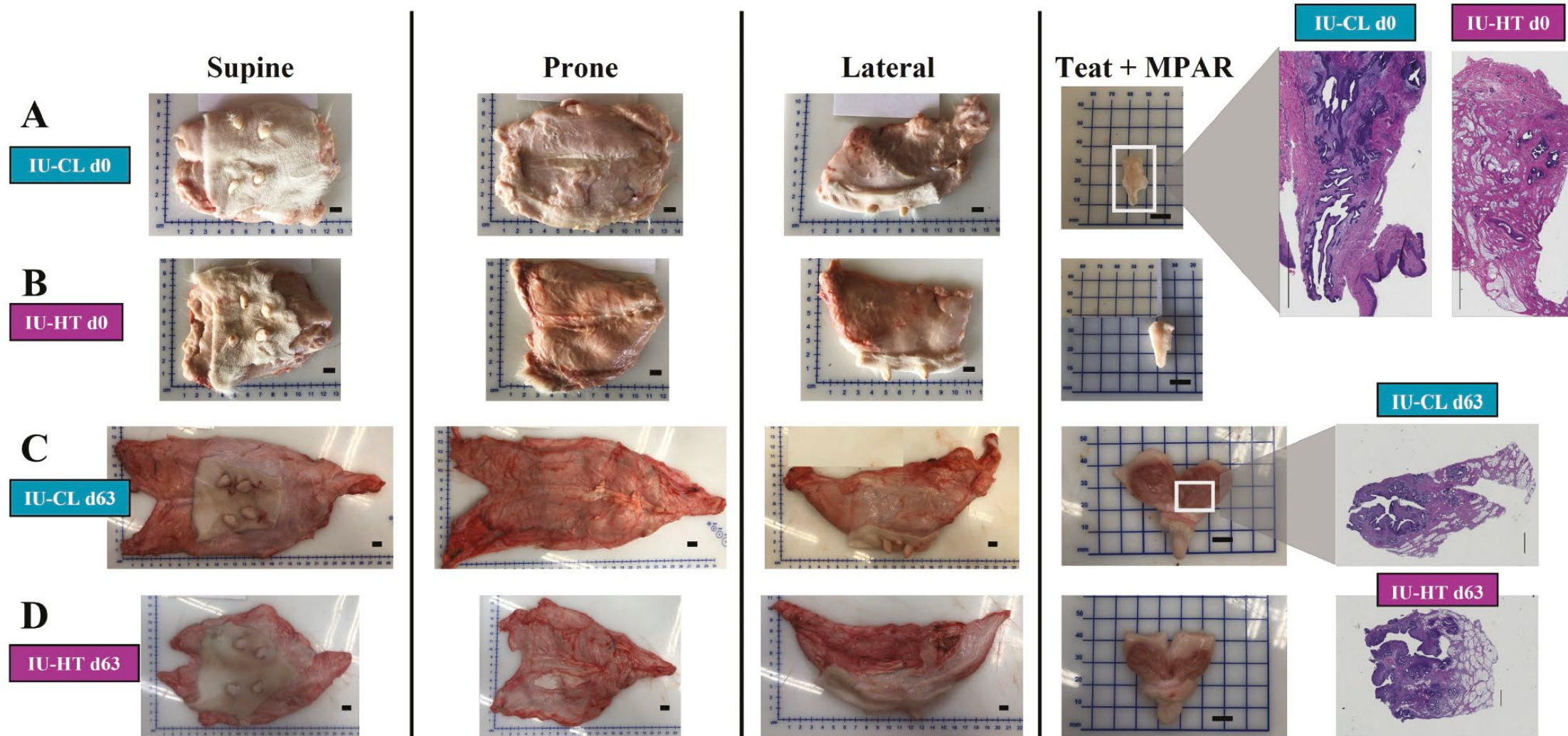
Laporta et al. , *J. Dairy Sci.* 103:7555-7568.

IN UTERO HEAT STRESS REDUCES SURVIVAL IN HERD



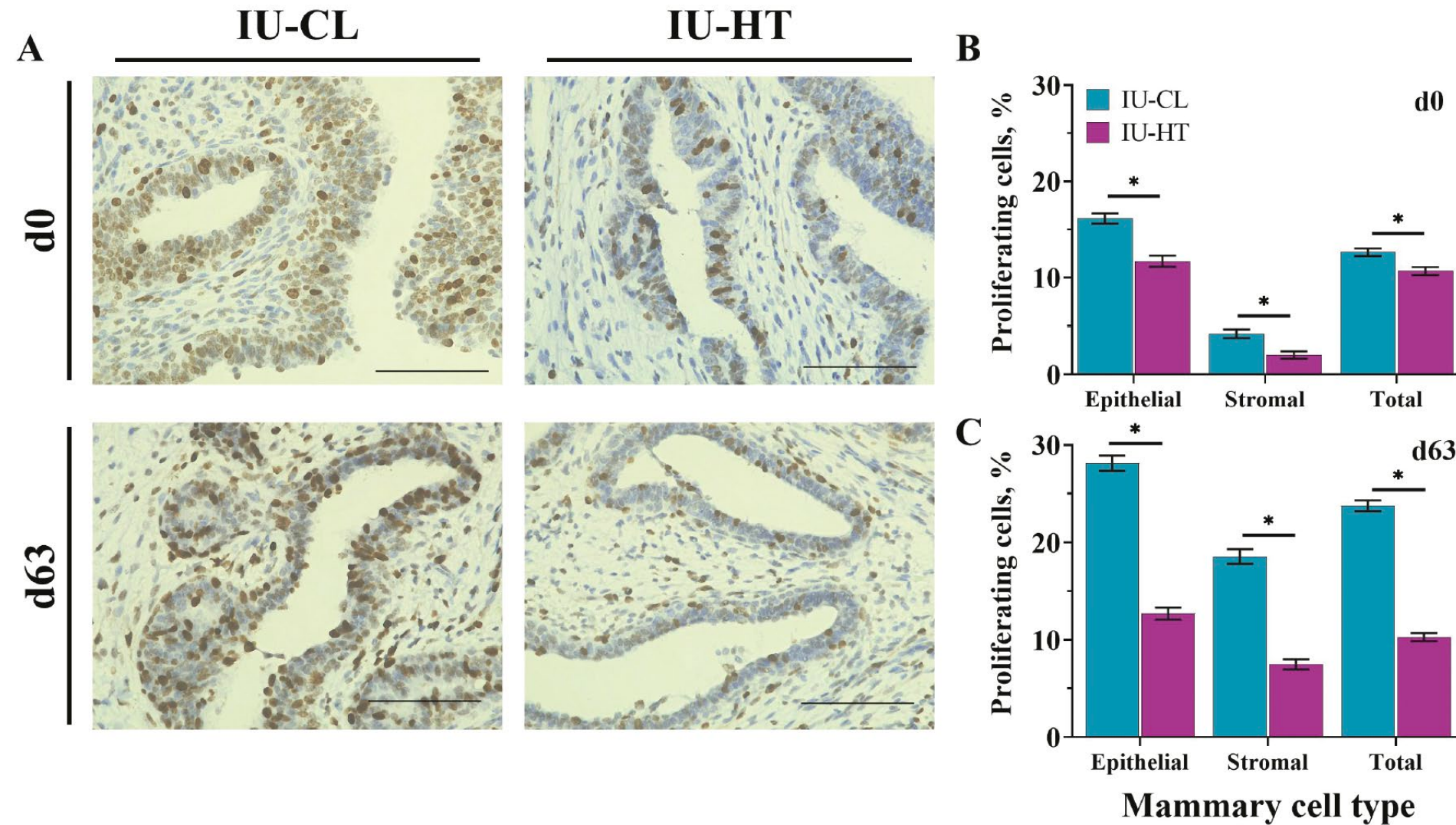
Laporta et al. , *J. Dairy Sci.* 103:7555-7568.

IN UTERO HEAT STRESS REDUCES MAMMARY DEVELOPMENT



Dado-Senn et al. , *J. Anim. Sci.* 100:1-11.

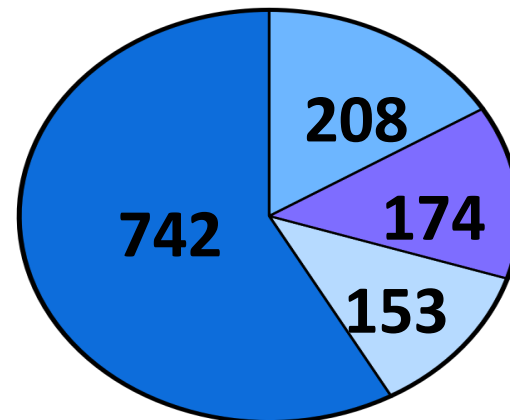
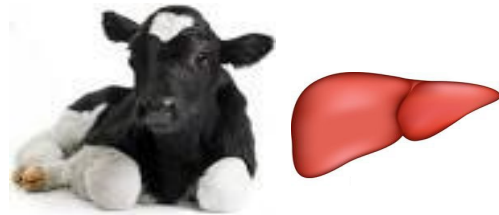
***IN UTERO* HEAT STRESS REDUCES MAMMARY DEVELOPMENT**



Dado-Senn et al. , *J. Anim. Sci.* 100:1-11.

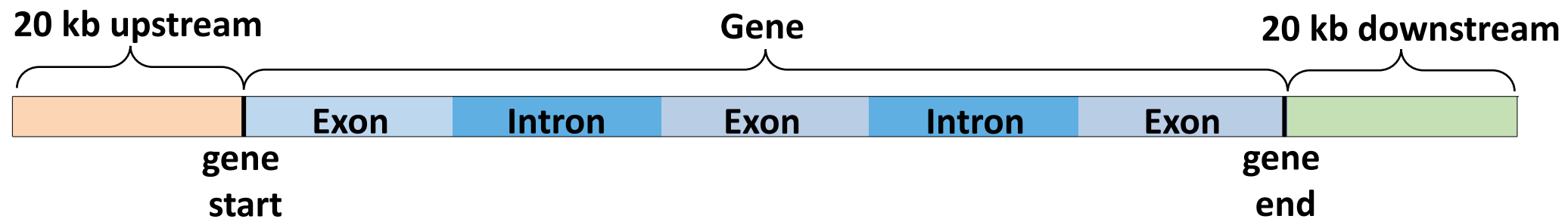
DIFFERENTIALLY METHYLATED CYTOSINES (DMC'S)

Bull calves

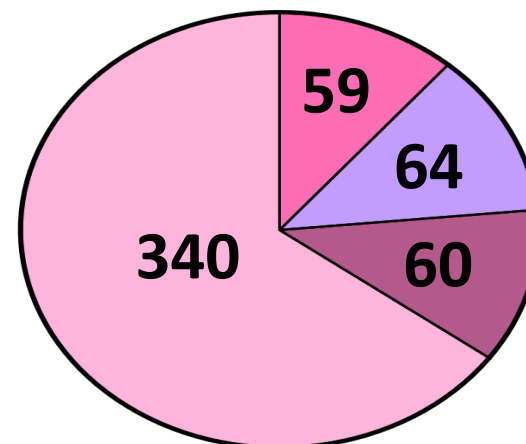
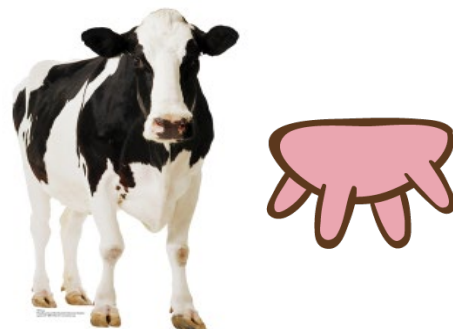


- Within 20 kb downstream
- Within gene
- Within 20 kb upstream
- Outside genic region

1277 DMC's



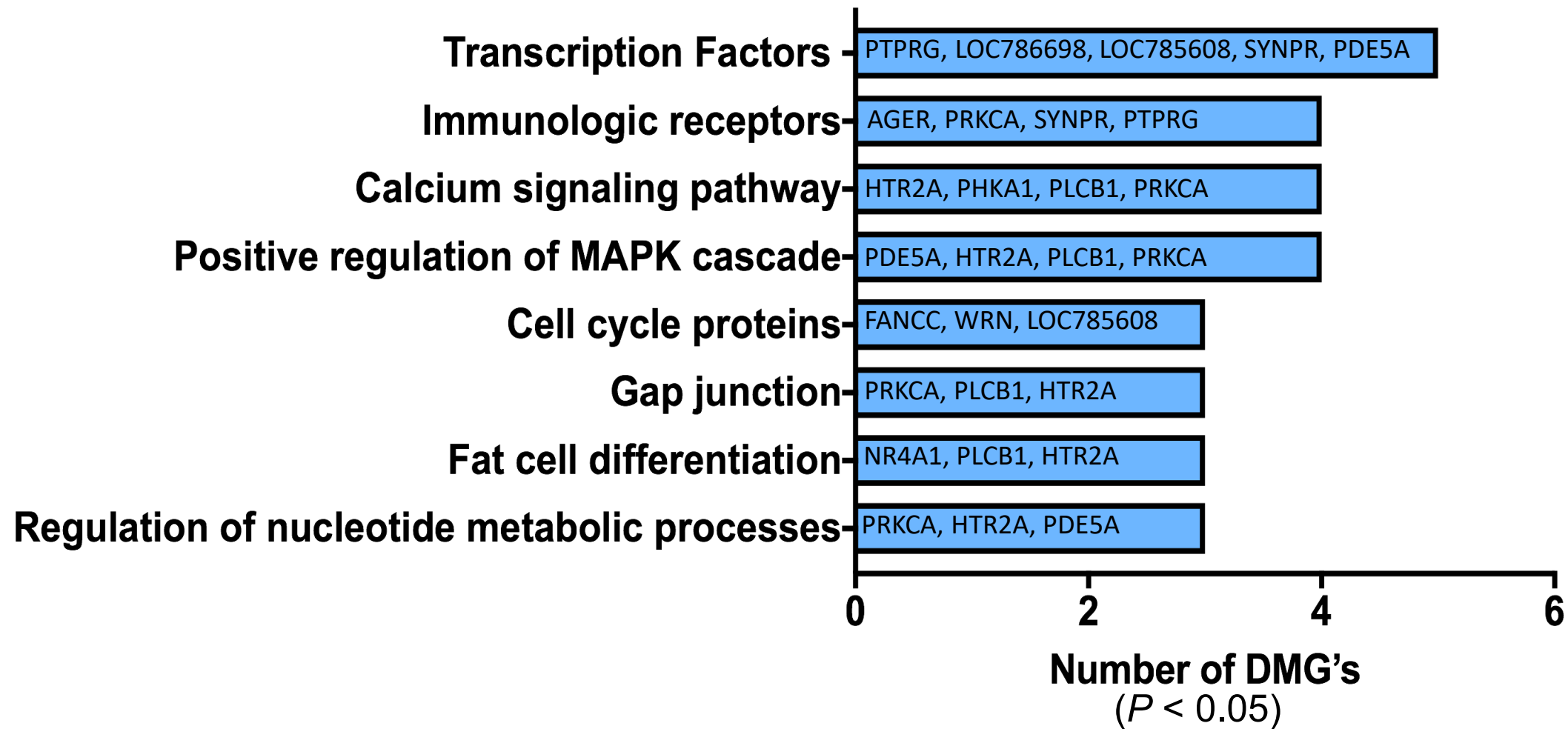
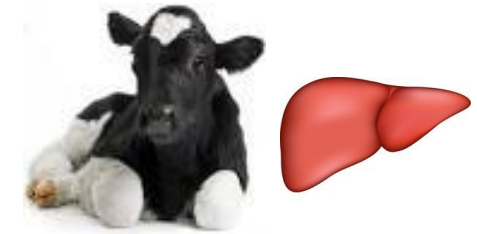
Cows



- Within 20 kb downstream
- Within gene
- Within 20 kb upstream
- Outside genic region

523 DMC's

BIOLOGICAL PATHWAYS AND FUNCTIONS



Skibiel et al., *Sci. Reports* 8(1):14609.

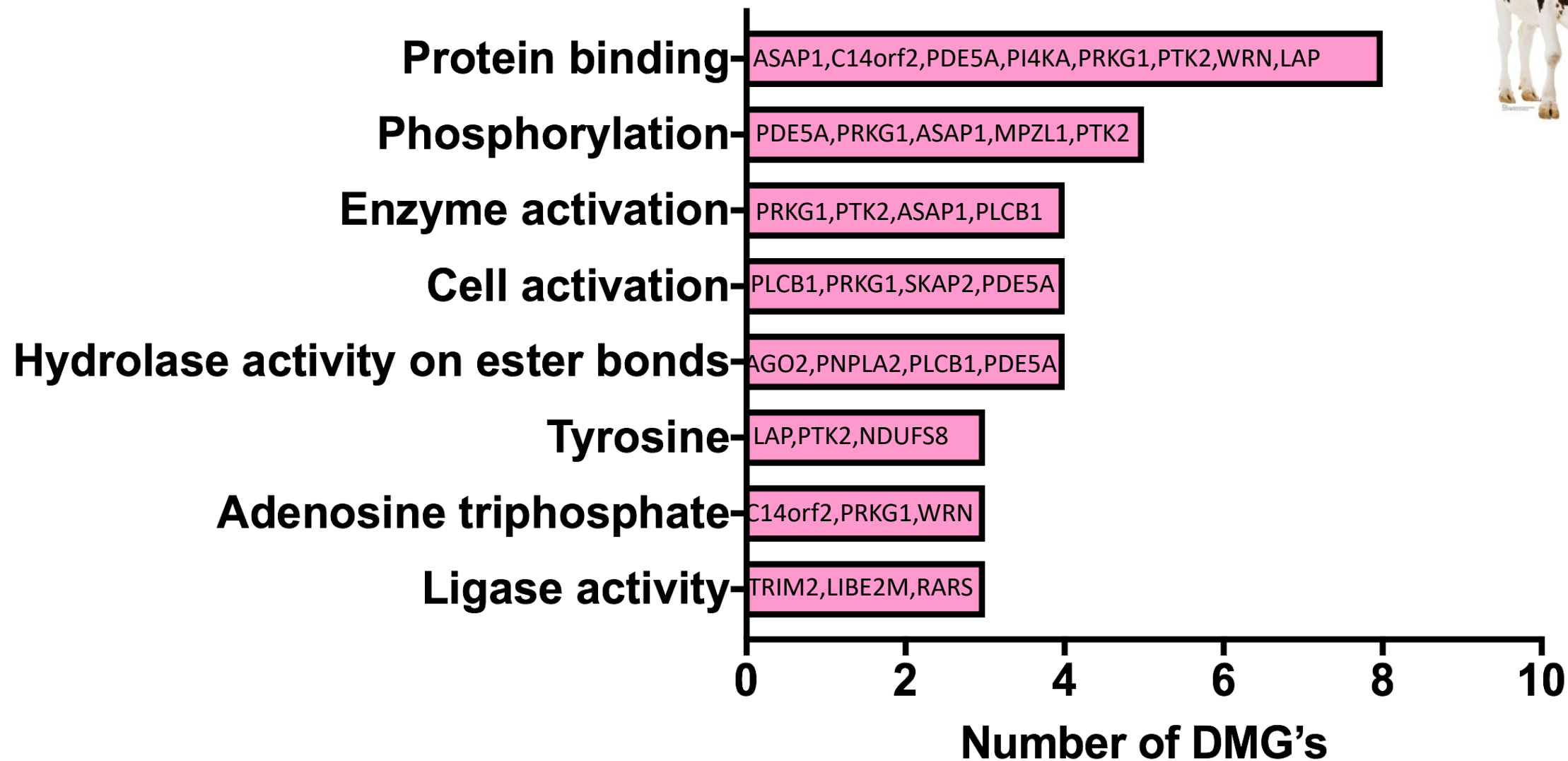
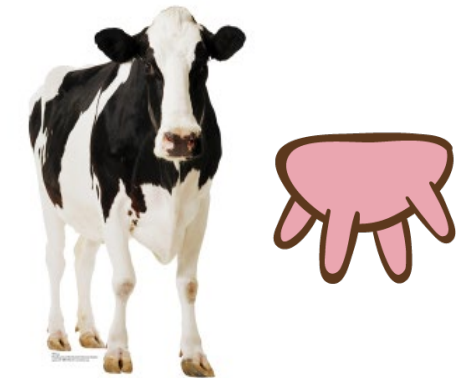
***AGER* GENE**



- ***In utero* HT - hypomethylation of C's upstream of gene**
- **Innate immune function and inflammation**
 - Production of pro-inflammatory cytokines
 - Leukocyte recruitment
- **Oxidative stress**
 - ROS production
 - Depress glutathione and ascorbic acid levels

Chavakis et al., 2004; Bierhaus et al., 2005; Lin et al., 2009

BIOLOGICAL PATHWAYS AND FUNCTIONS

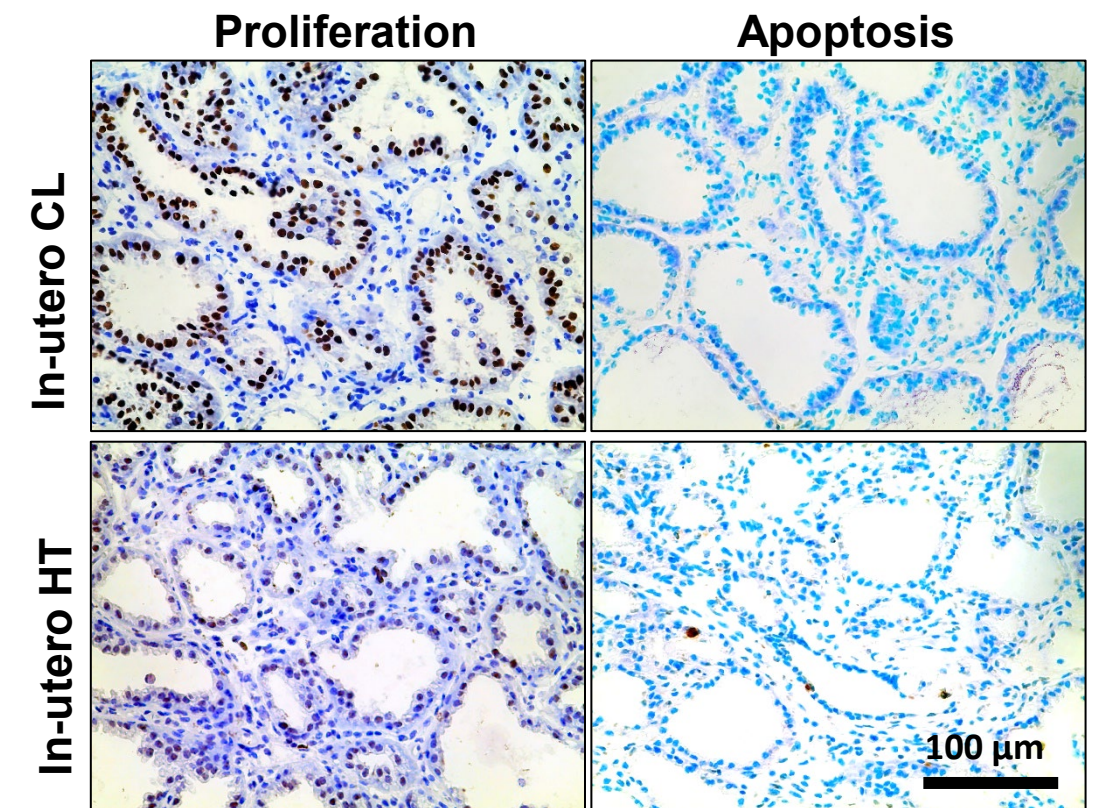
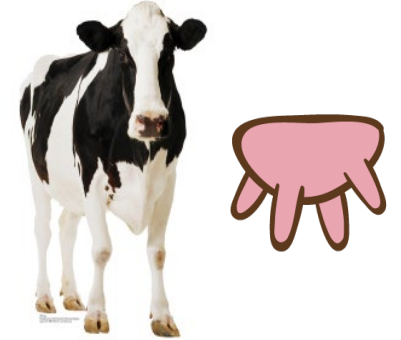


Skibiel et al., *Sci. Reports* 8(1):14609.

($P < 0.05$)

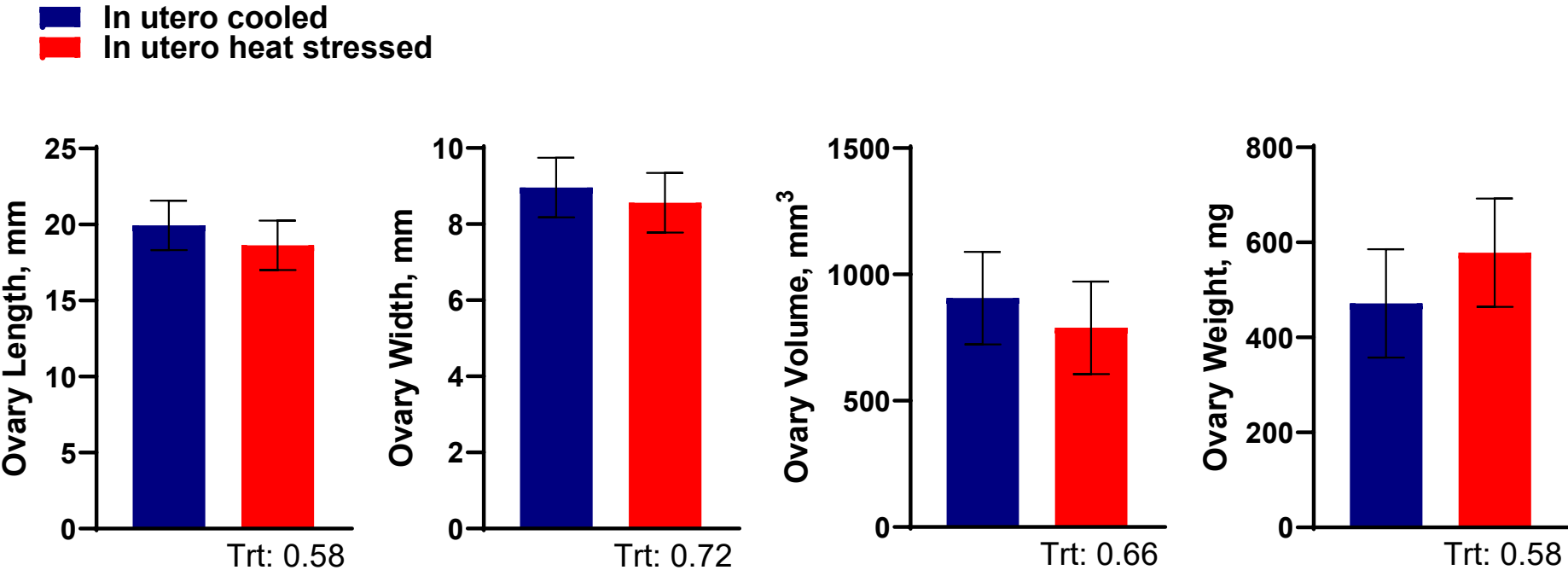
***PRKG1* GENE**

- **In-utero HT - hypomethylation of C's within gene**
- **Cell signal transduction**
 - Major intracellular receptor for cGMP
 - Catalyzes substrate phosphorylation
- **Decrease intracellular Ca**
- **Apoptotic effect**

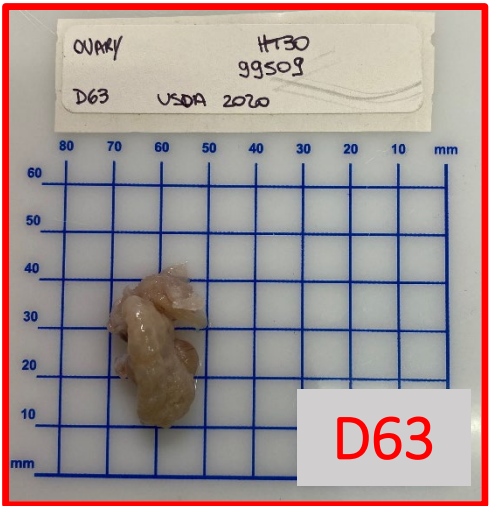
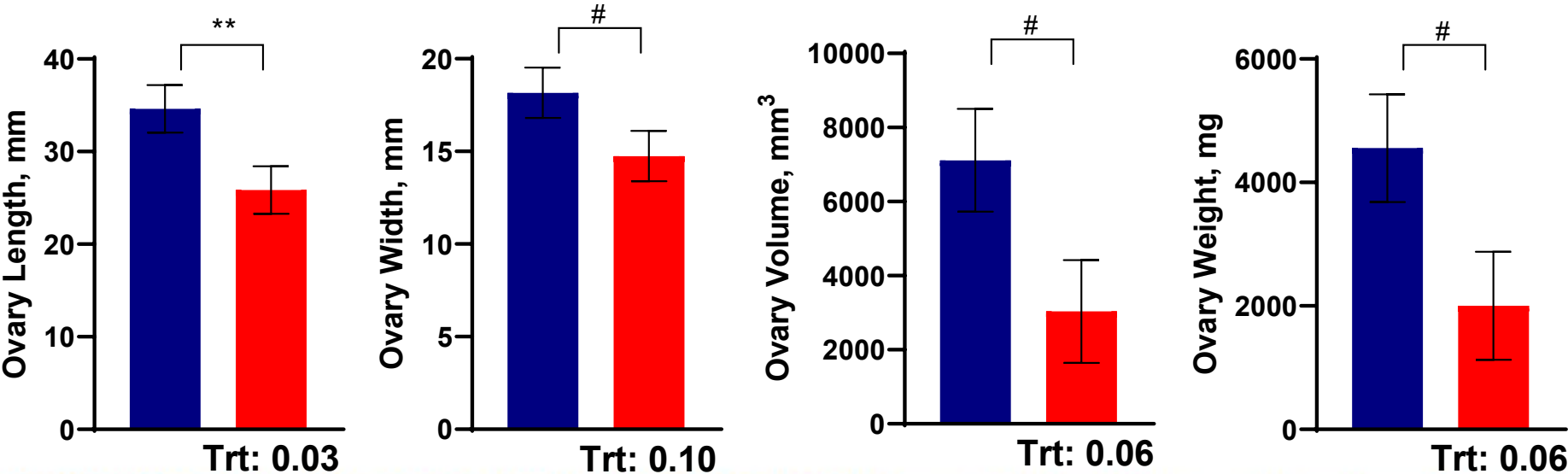


~~In Utero~~ Cooling Increases Ovarian Size at D63

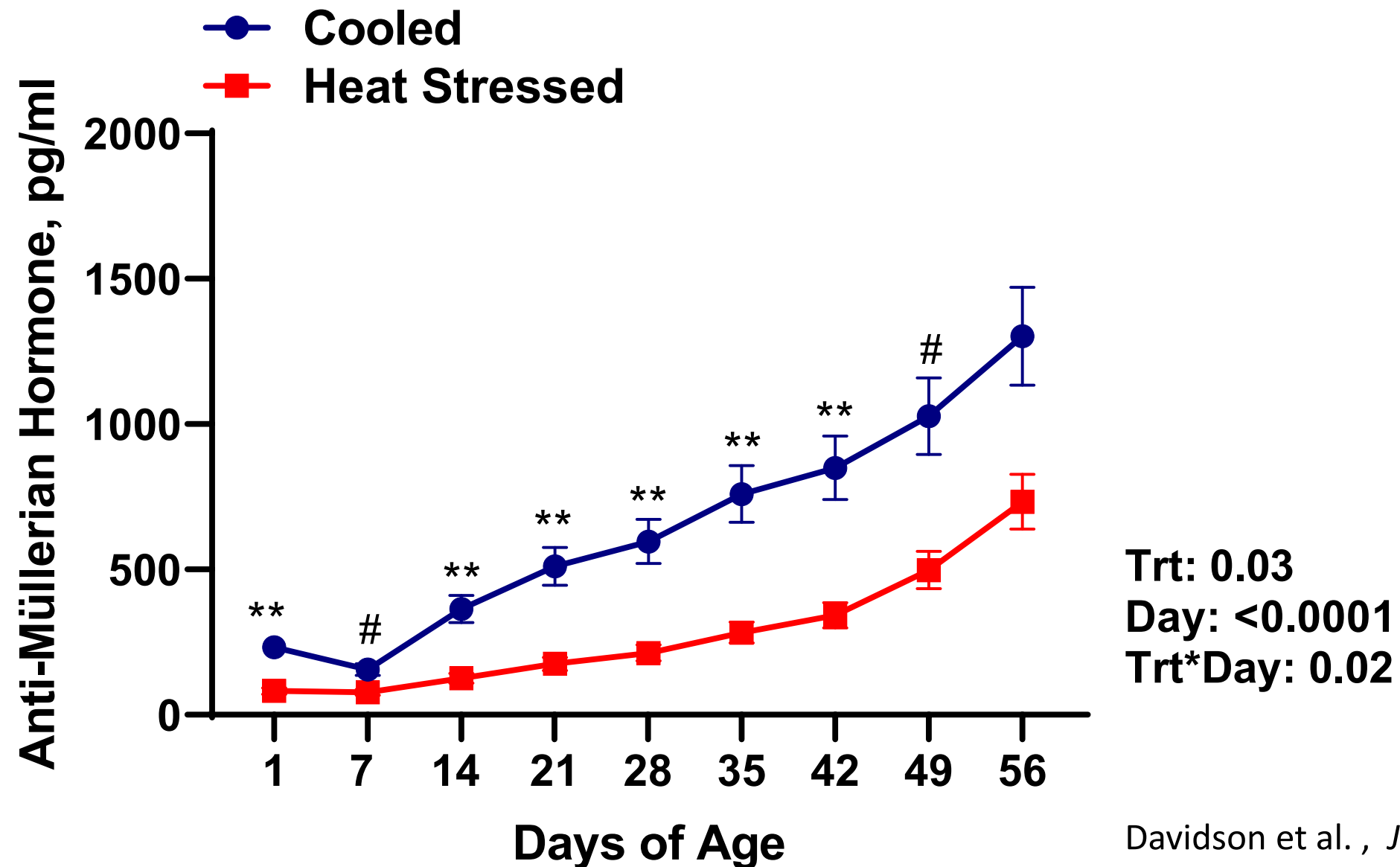
Birth



D63

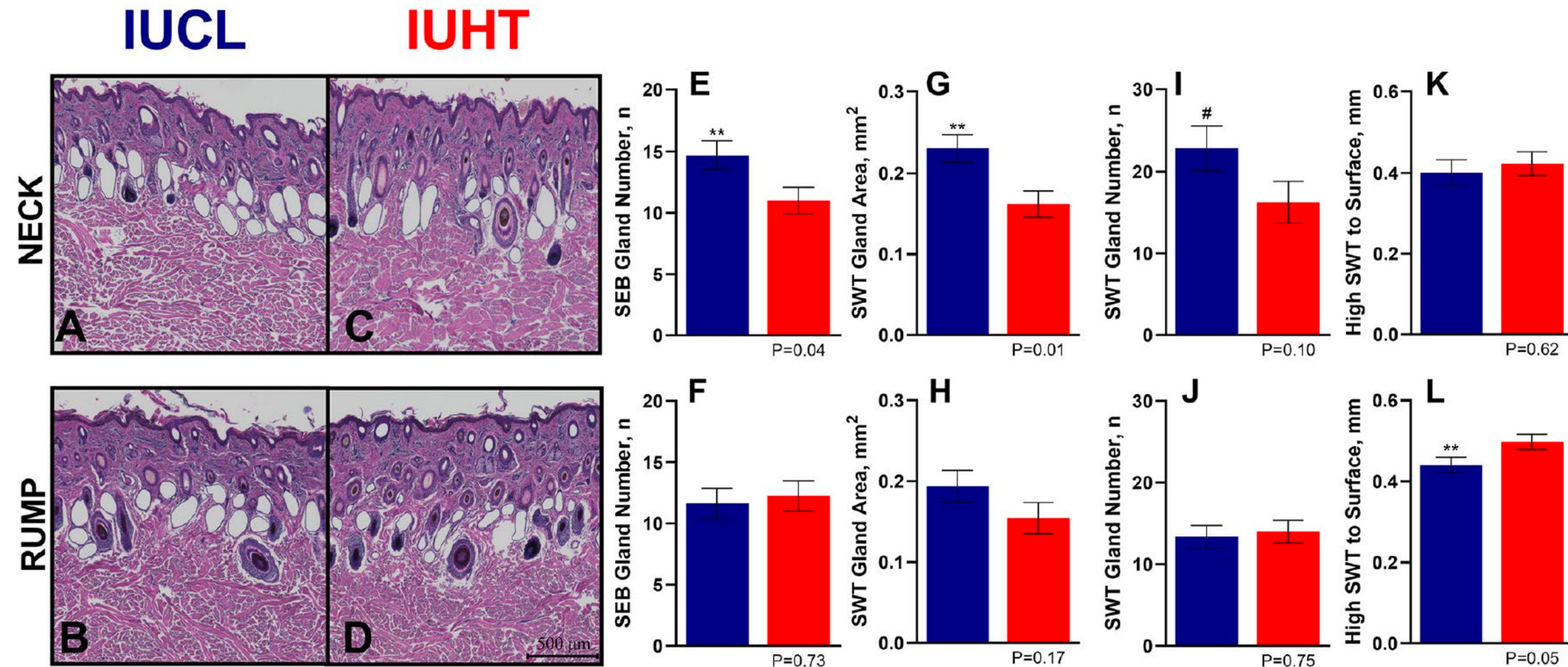


AMH CONCENTRATIONS WERE HIGHER IN IUCL CALVES FROM D1 TO D56



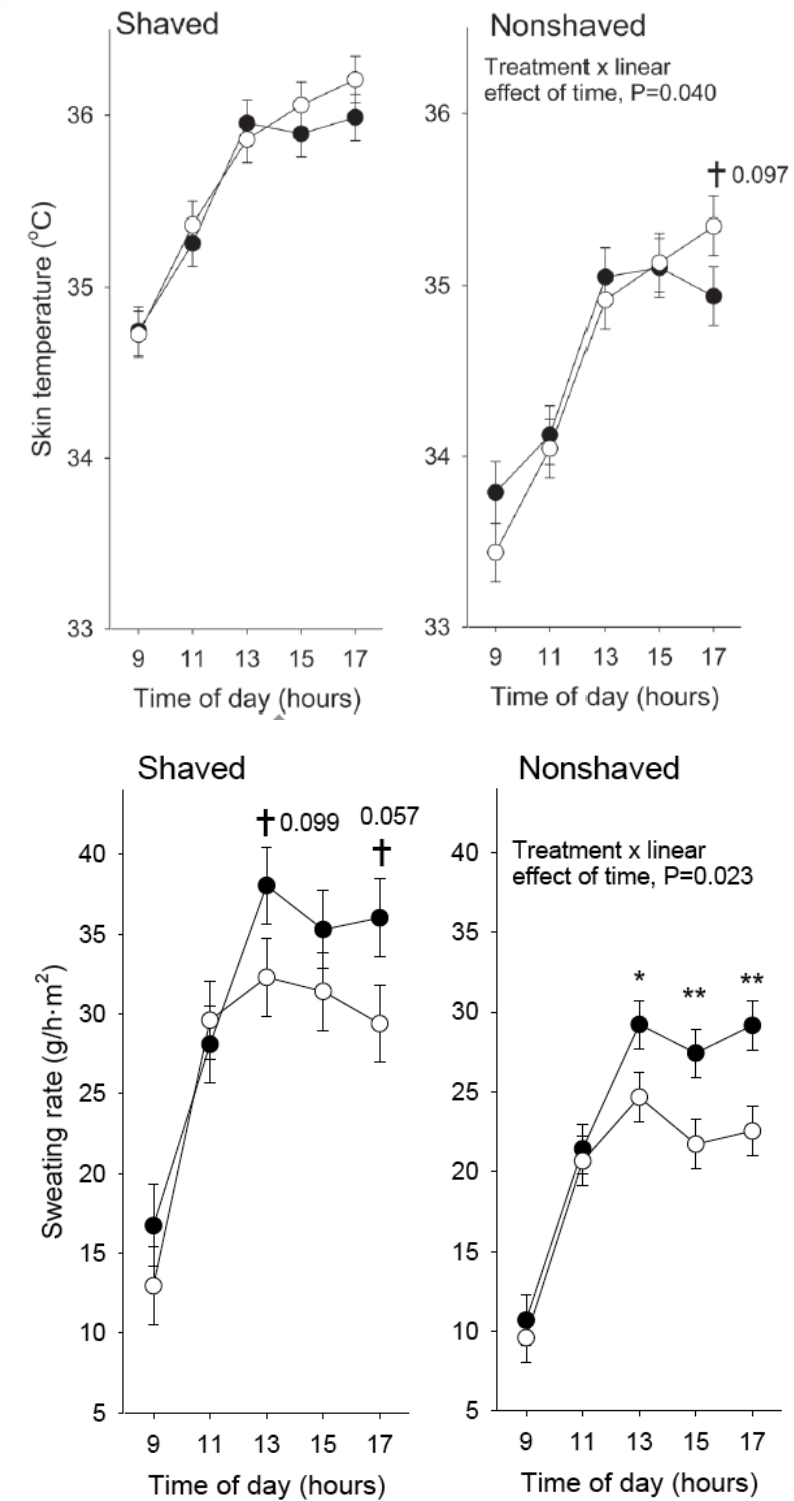
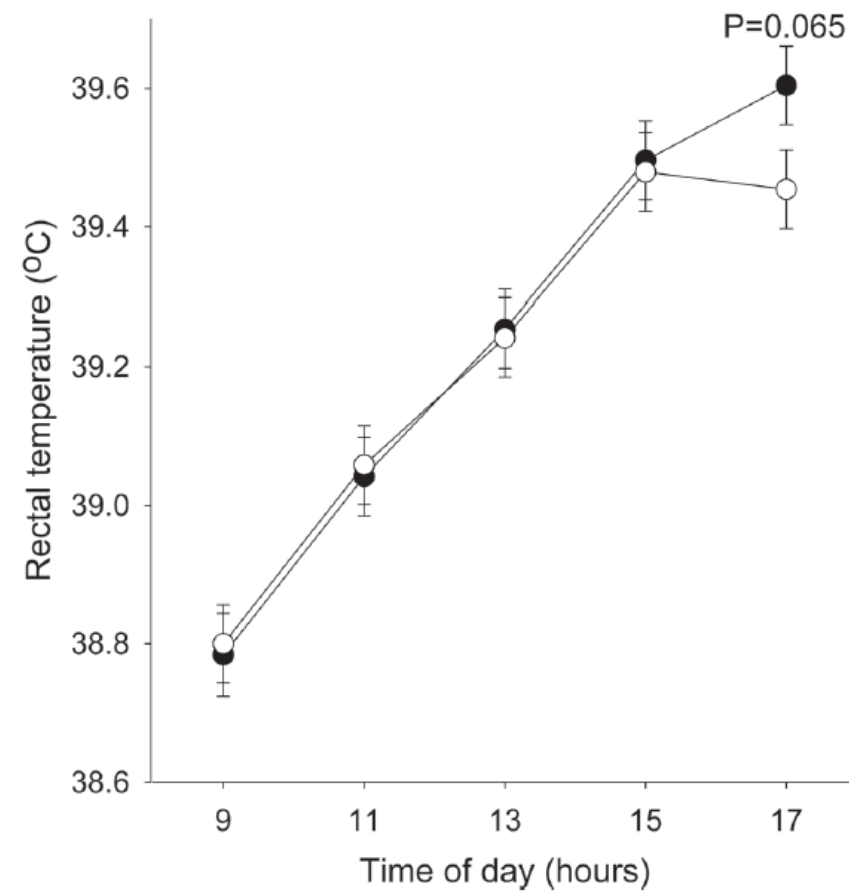
Davidson et al. , *JDS* 2023; Abstract

IN UTERO HEAT STRESS ALTERS SKIN MORPHOLOGY



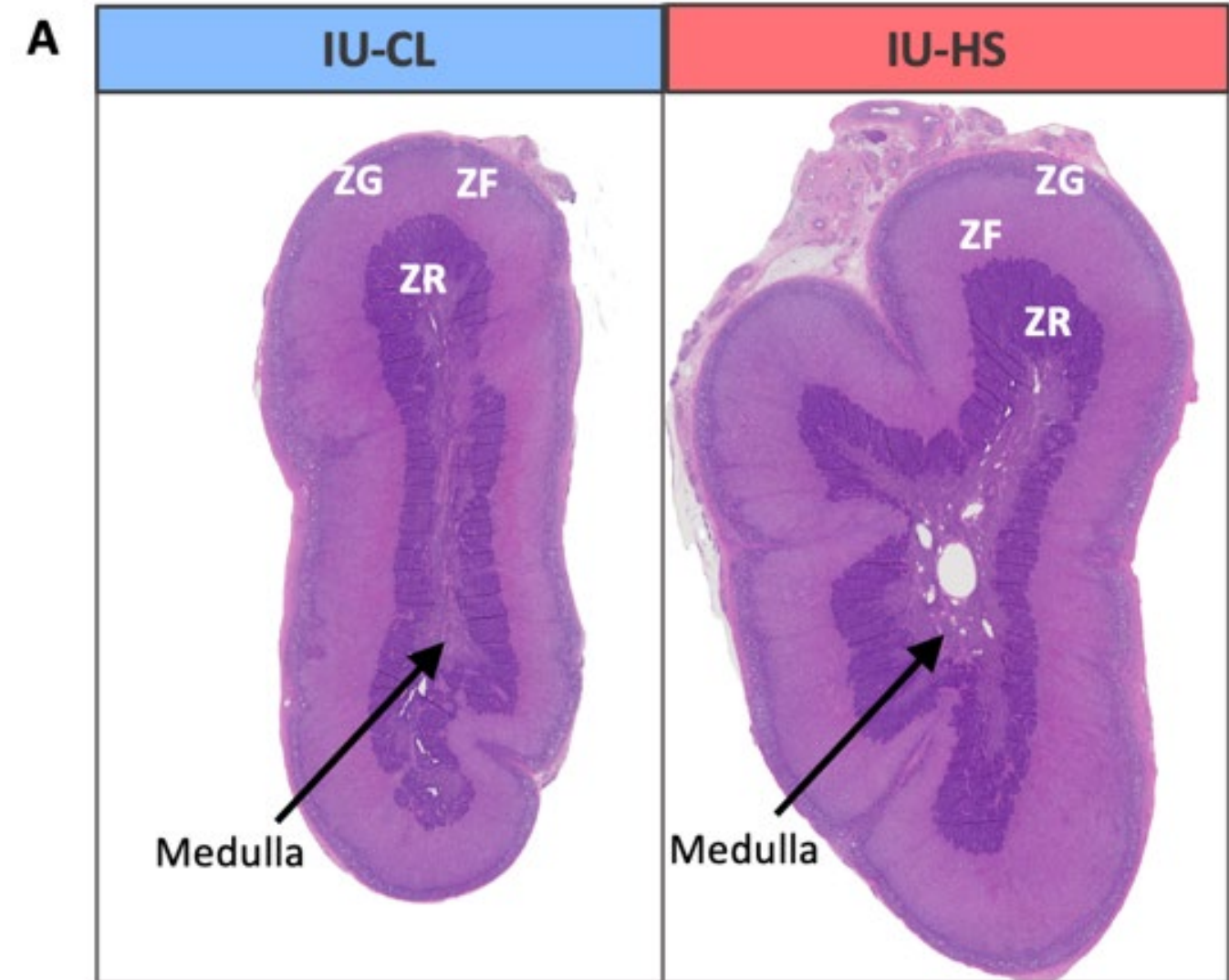
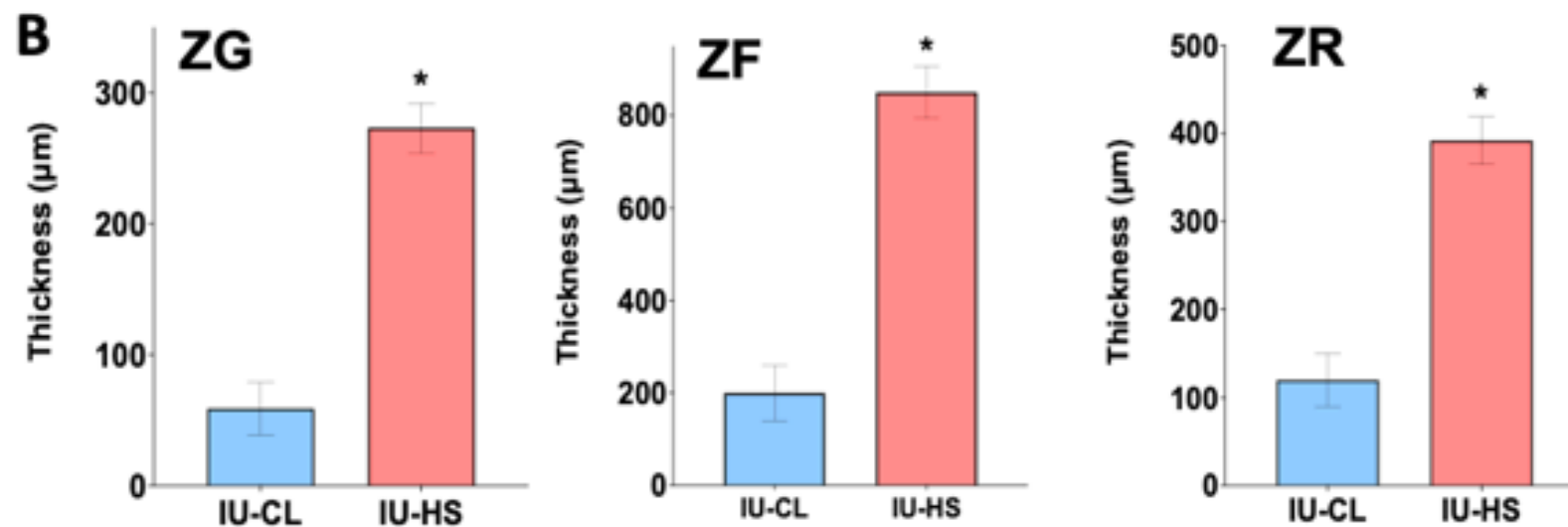
Davidson et al. , *J. Dairy Sci.* 105:8898-8910.

IN UTERO HS ALTERS BODY TEMPERATURE REGULATION AT MATURITY

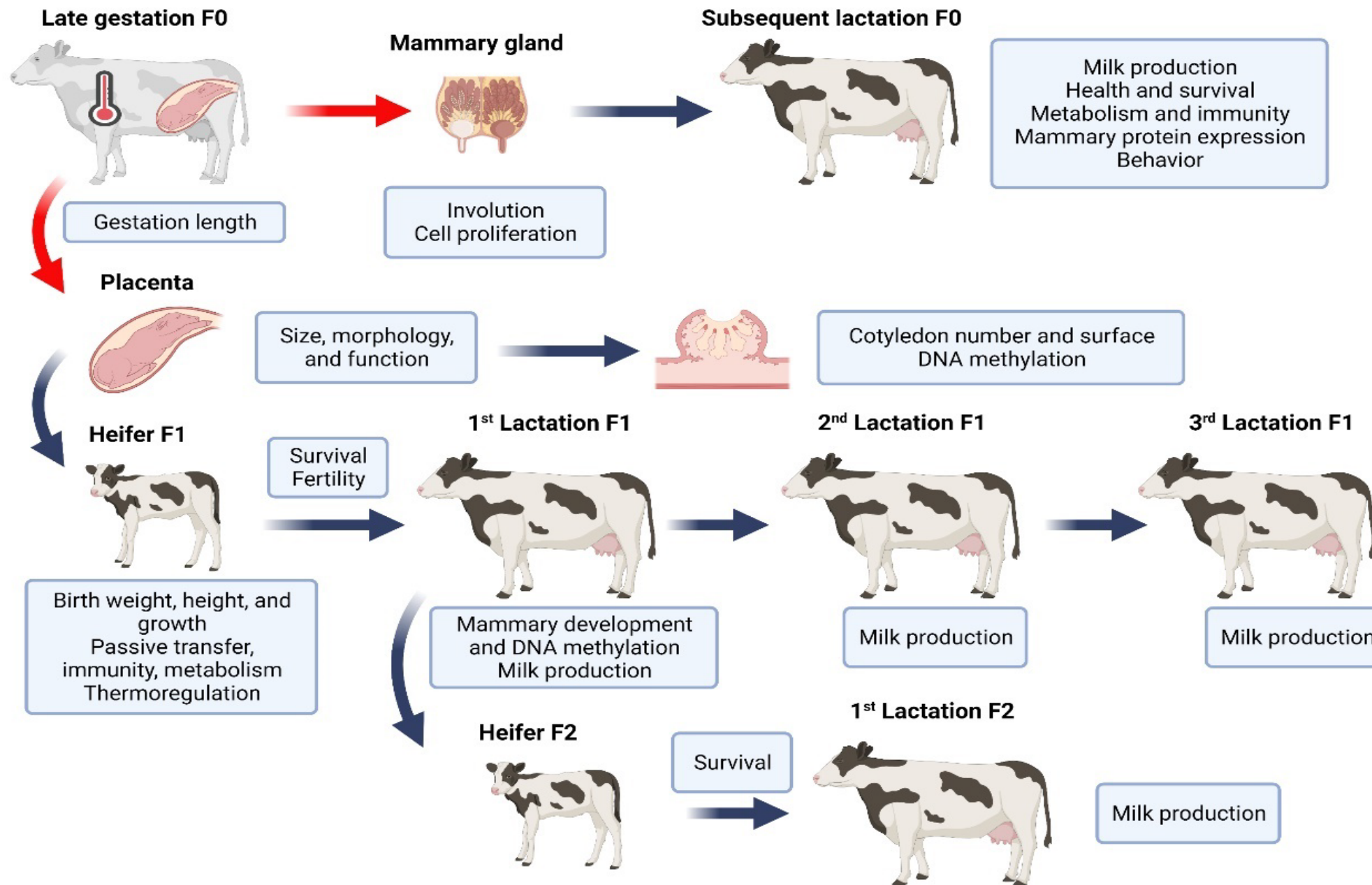


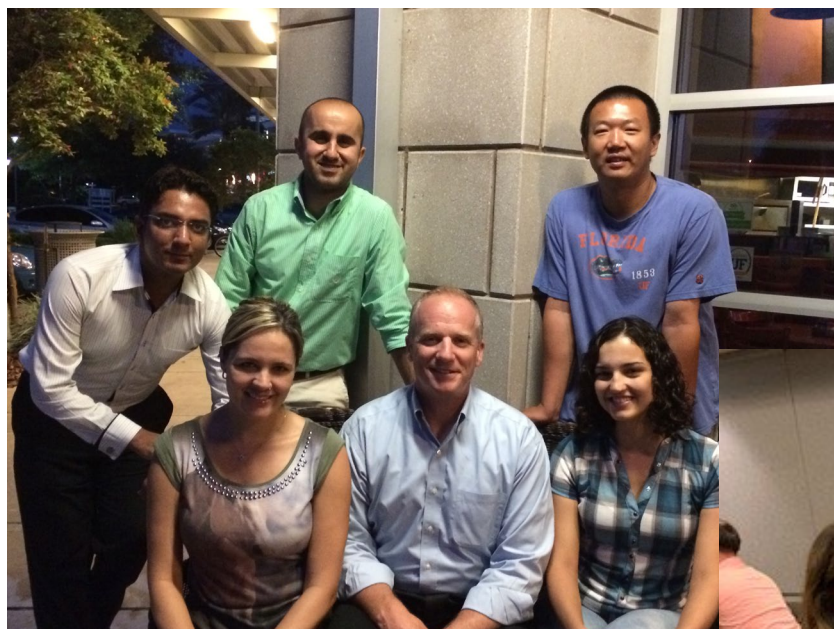
Ahmed et al. , *J. Anim. Sci.* 95:3497-3503.

IN UTERO HS ALTERS ADRENAL DEVELOPMENT AT WEANING



LATE GESTATION HEAT STRESS





THANKS!



United States
Department of
Agriculture

National Institute
of Food and
Agriculture



Jean-Baptiste Le Rond
D'Alembert