

Epigenetics: different environments, different reactions

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National Genetics Conference

June 26-27, 2019, Appleton, WI

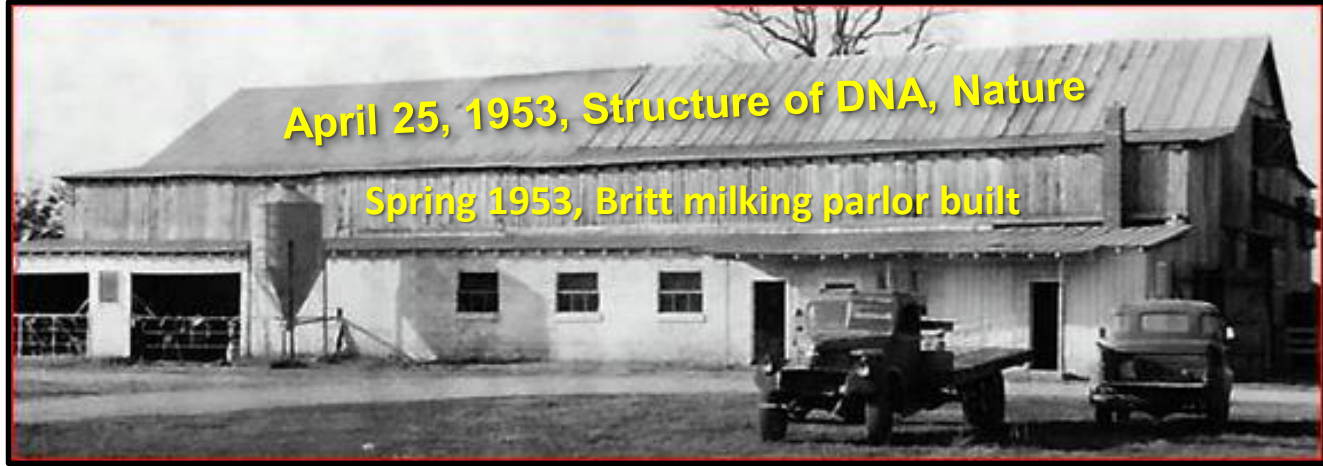
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What is epigenetics?
Is it an underlying part of genomics?
How do we discover its impacts?
Can we capture data to manage it?

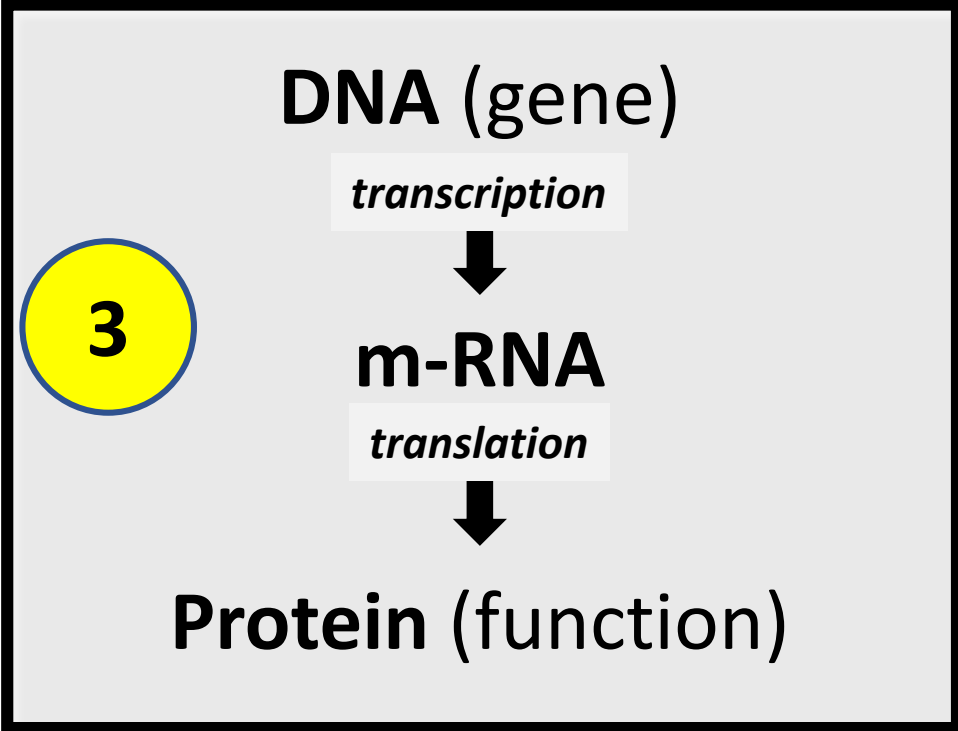
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Mike Hutjens, IL; Gordie Jones, WI; Jeff Stevenson, KS; Pam Ruegg, MI; Chad Dechow, PA; George Seidel, CO; Bob Cushman, NB; Tony McNeel, MI; Louise Holt, VT; Hilary Dobson, UK; Martin Sheldon, UK; Patrice Humblot; SE

Functional genomics -- the original simple model (66 years ago)



1



Many genes "turned off"

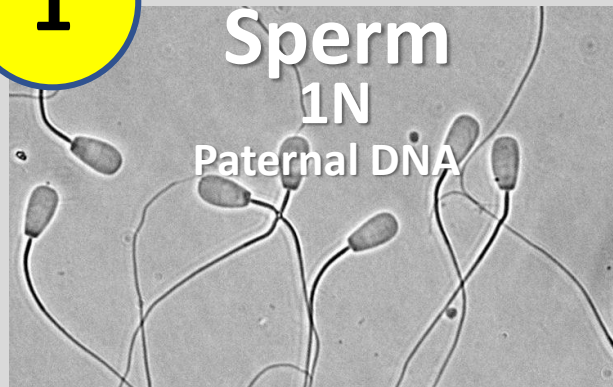
Epigenetics affects cell function

Specialized stem cells

https://www.researchgate.net/profile/Yutaka_Fukui

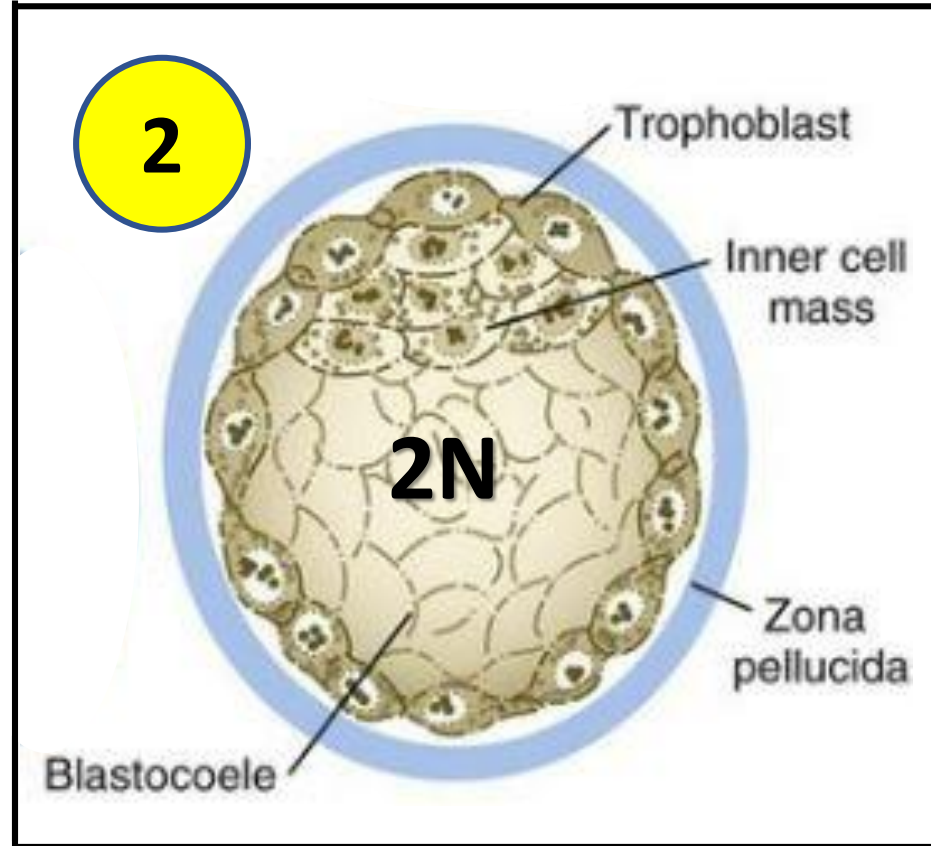


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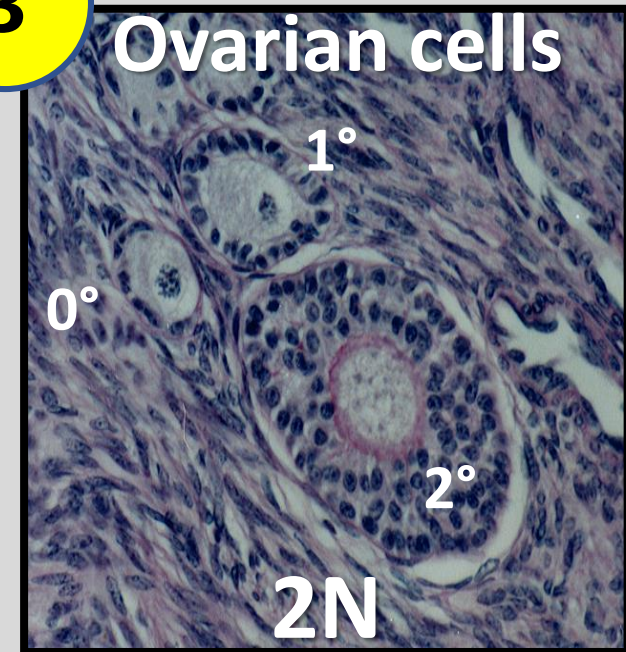
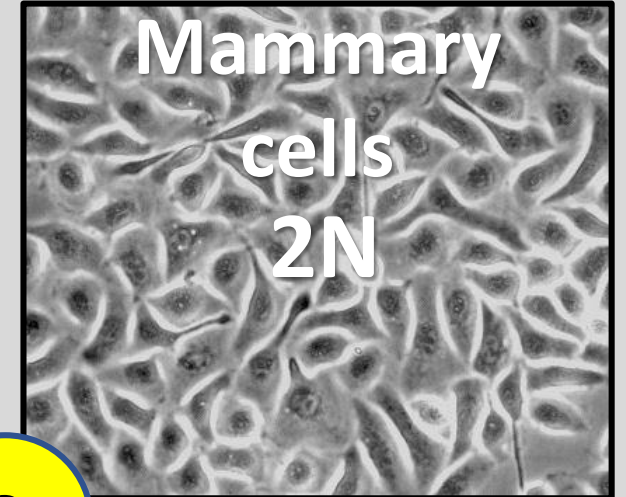


http://www.ansci.wisc.edu/jjp1/ansci_repro/lab/procedures/sperm/bull_morp/bull_morphology.html

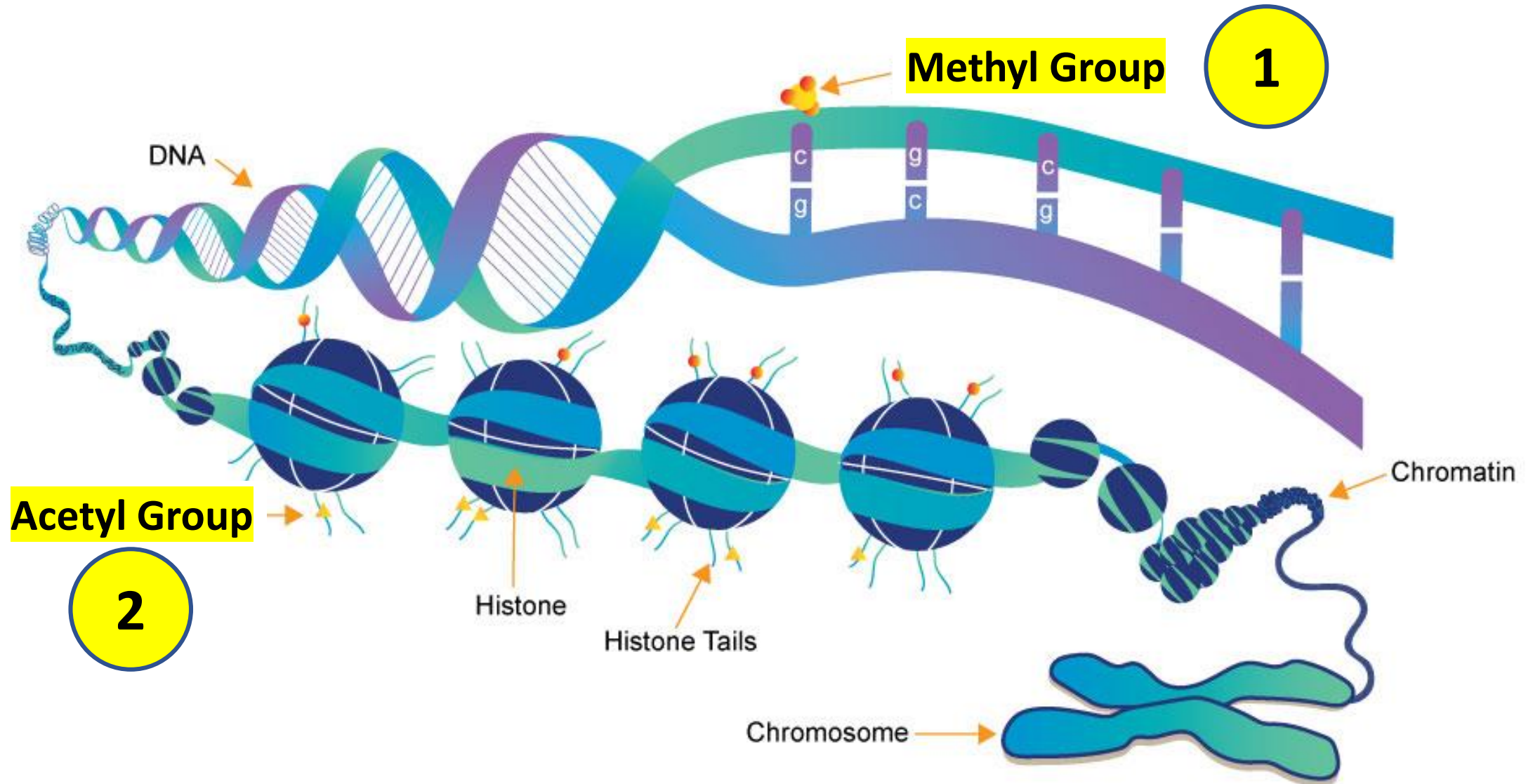
Many genes "turned on"
as cells become specialized



3

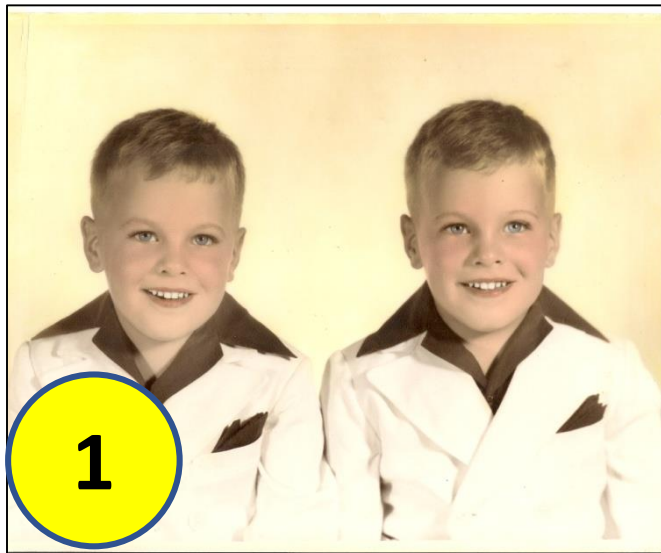
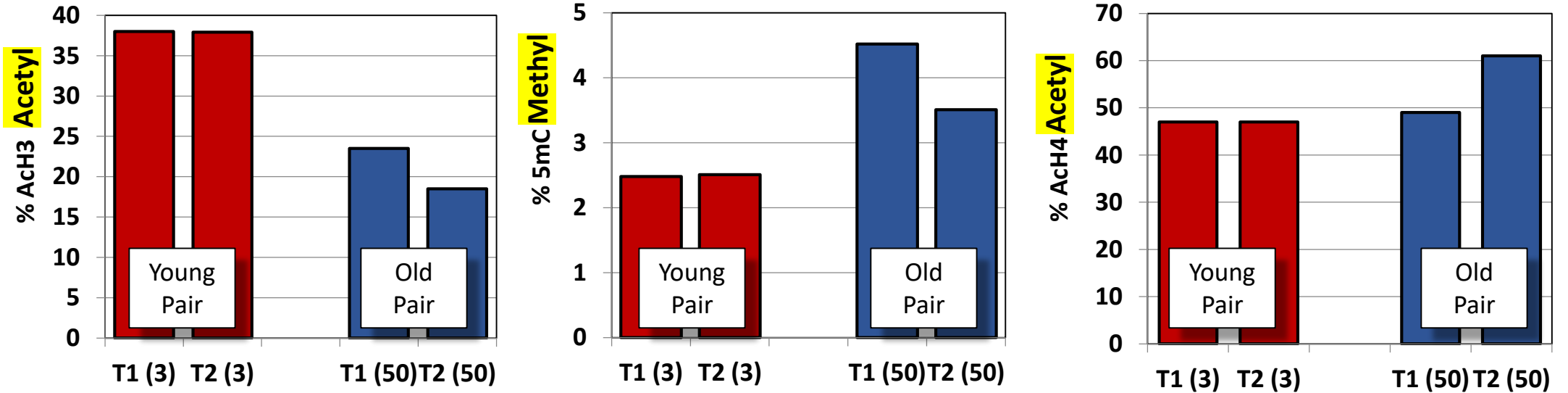


Classical epigenetic markers on DNA bases and histone proteins



Epigenetic markers among 40 identical-twin pairs at 3 or 50 years of age

3



Genomics + Epigenomics – today’s model is much more complex



1

2

DNA (gene)

transcription



m-RNA

translation



Protein (function)

DNA, methyl-DNA, acetyl-Histones

m-RNA, m-RNA, RNAi, microRNA, lncRNA

“Expression” of DNA affected many ways

Epigenetics alters gene expression by restricting enzyme access to DNA strands

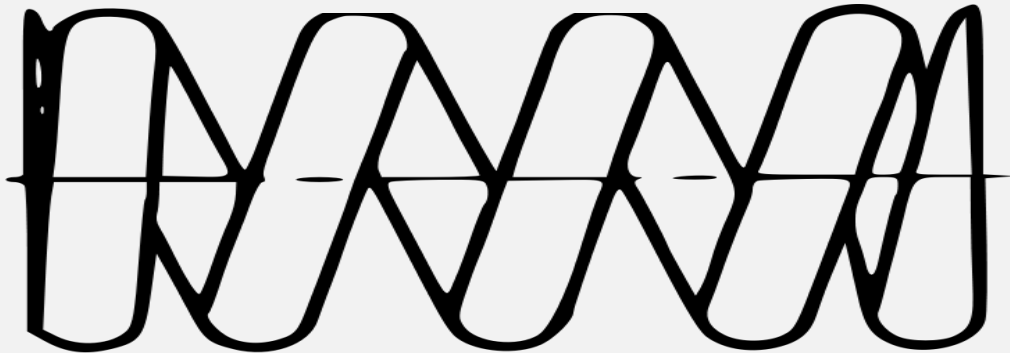
Epigenomics = changes in gene expression in somatic and germ cells without changing the genetic code

Normal

1

t a a a g c
a t g c c g

Relaxed DNA Helix

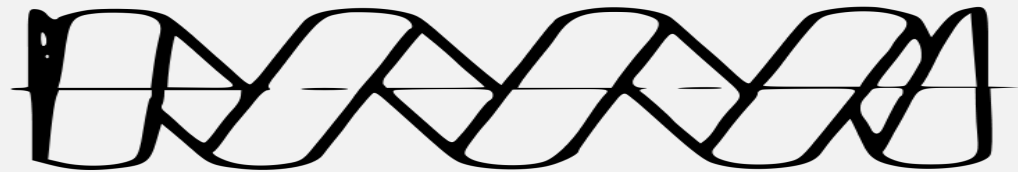


Epigenetic (methyl, acetyl or other)

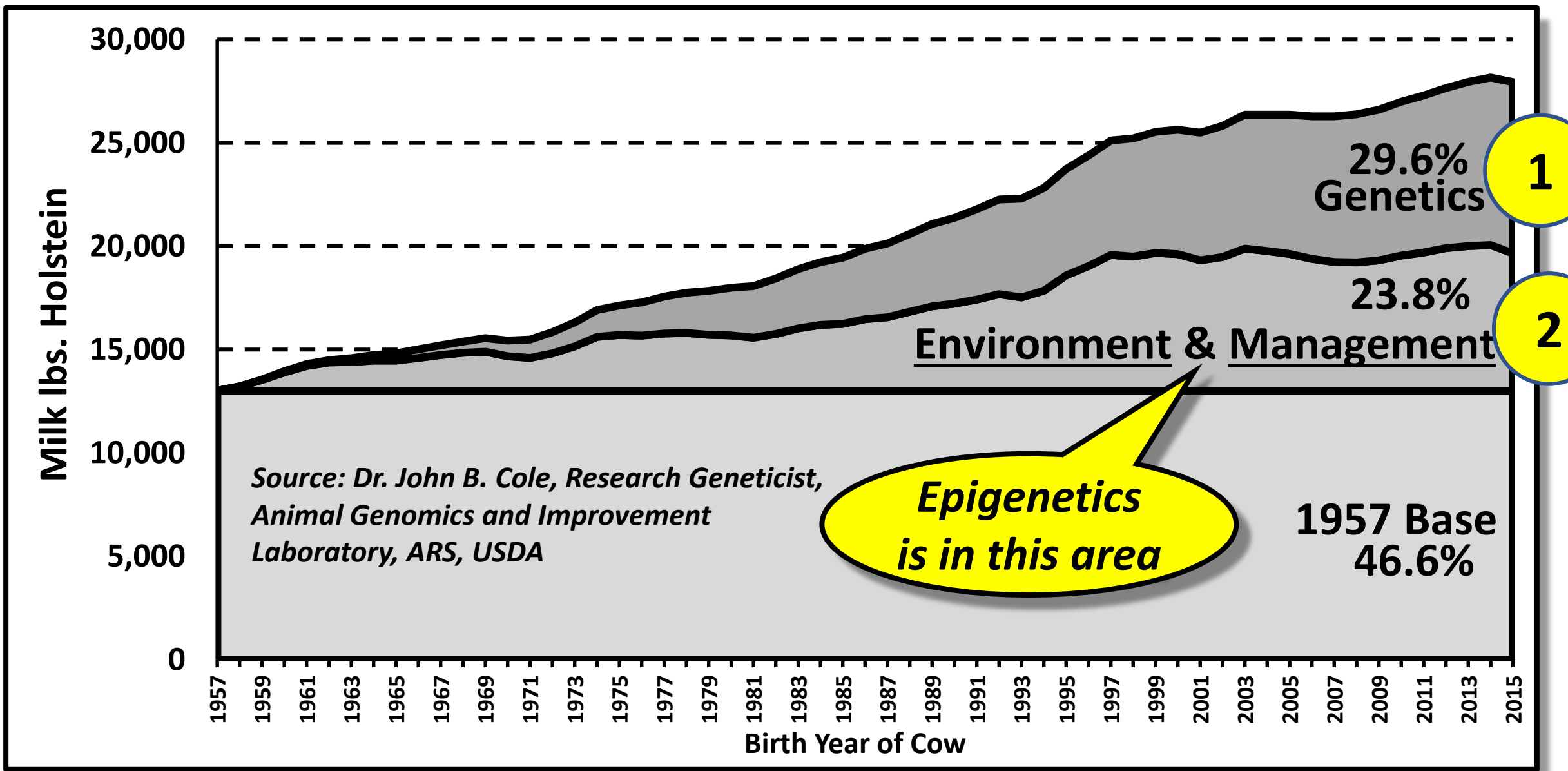
2

a^tt^ag^ac^ac^gg^c

Restrained DNA Helix



Milk yield increases attributed to genetics and environment & management



Examples of potential epigenetic-like effects

1

Milk fresh cows 4X for
3-4 wks. postpartum



Greater yield from 2X milking
remainder of lactation

2

Greater BCS loss
3 wks. postpartum



Lower fertility at TAI
at 80 days postpartum

3

IVF and MOET for
producing embryos



Poorer health &
underperforming yields

4

Heat stress during
6 wks. before birth



Lower yields for at least
next 3 generations of daughters

5

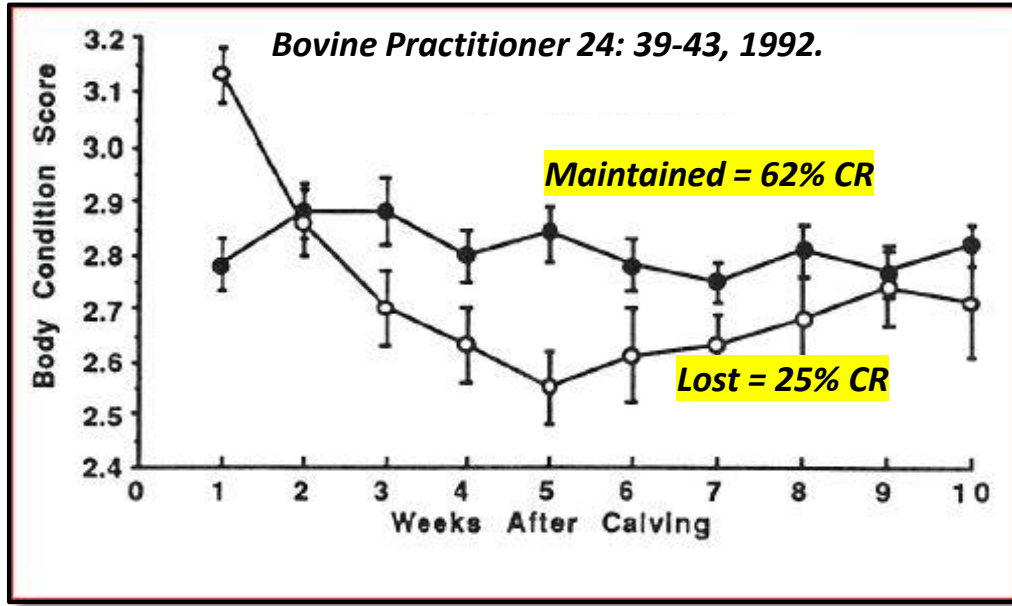
Fetal development
during lactation



Lower yield and longevity
than expected

Example: How does weight loss affect fertility of a cow's eggs?

"Britt Hypothesis" Here's what observed.

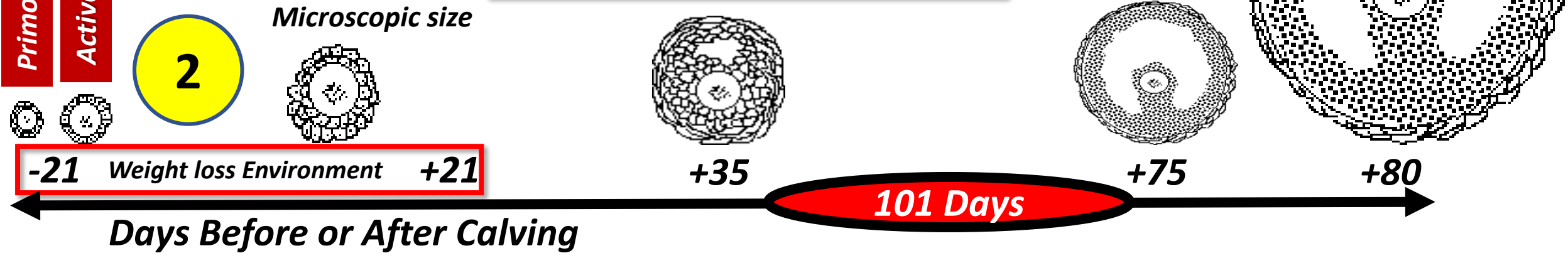


Primordial pool
Activated oocyte from ovarian reserve

1

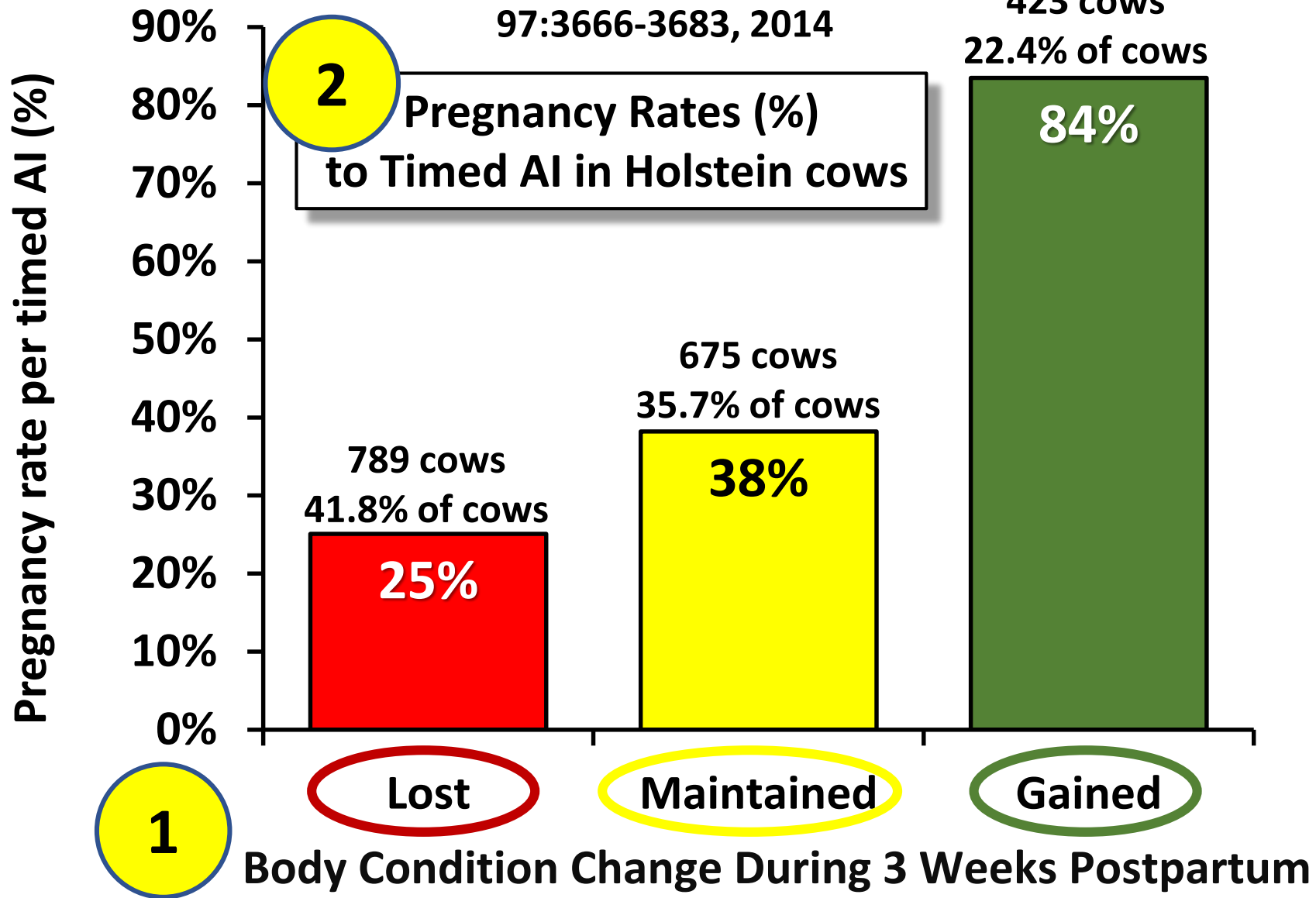
Ovulation of egg

Here's a diagram of our hypothesis.



The Britt Hypothesis: 22 years later...

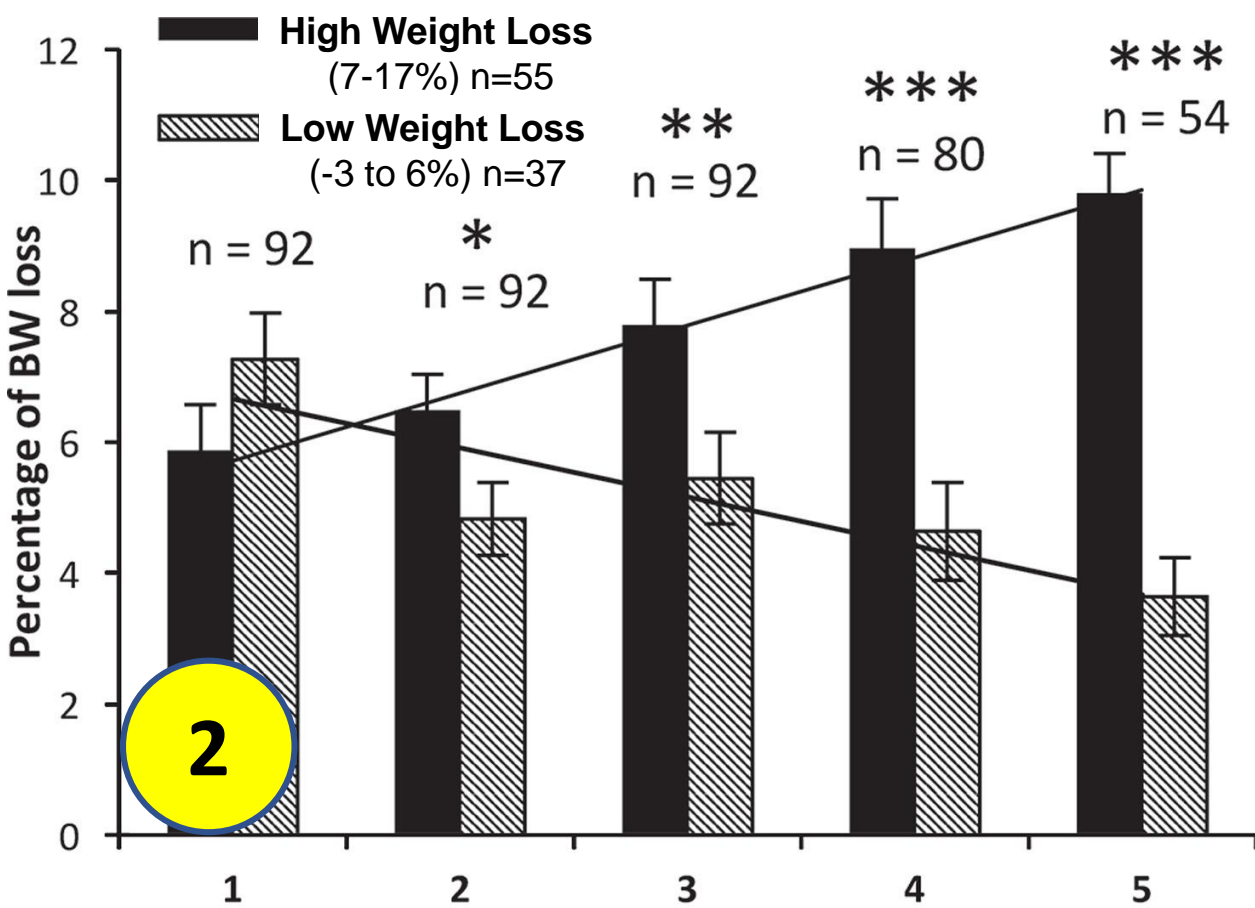
Carvalho et al, J Dairy Science
97:3666-3683, 2014



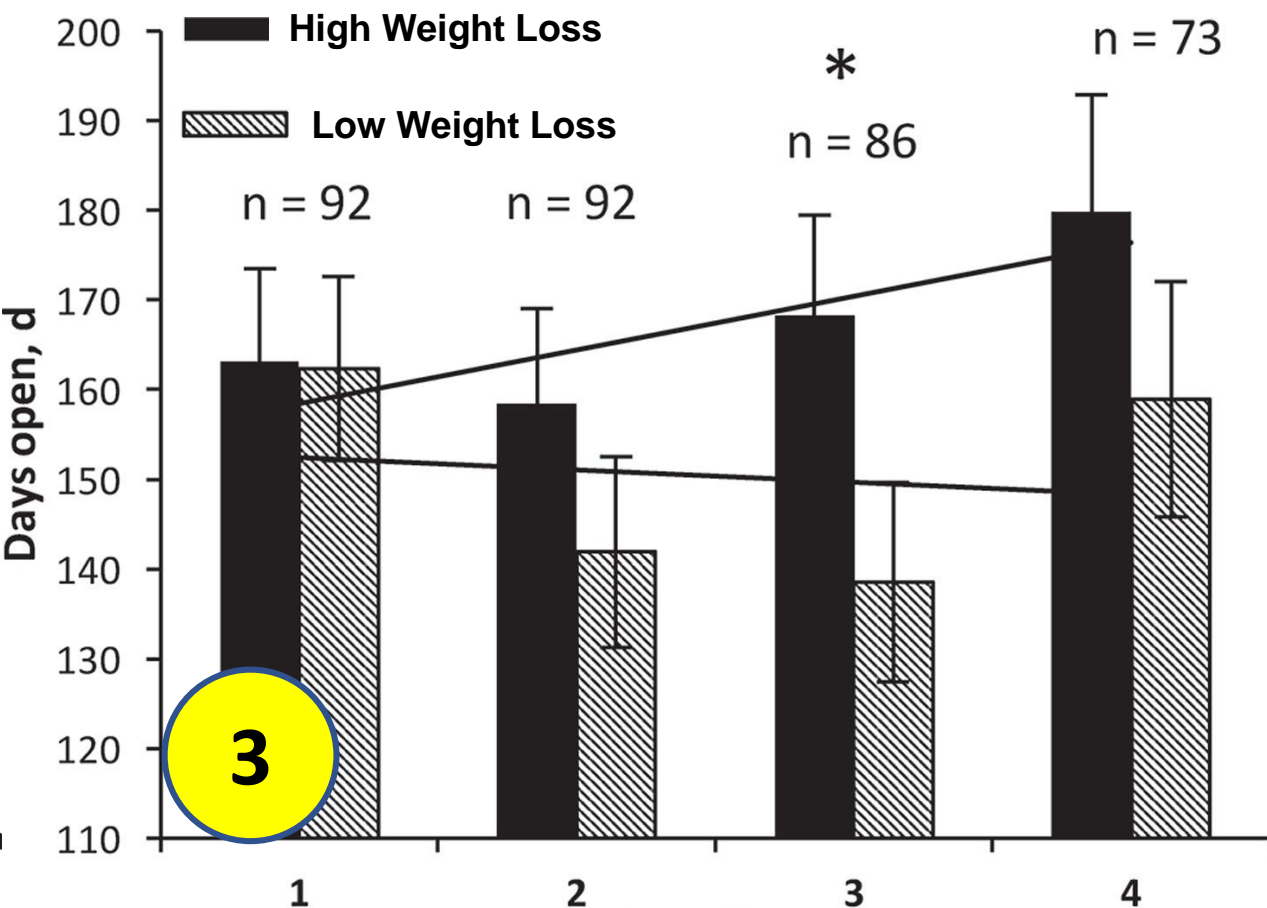
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Do cows have to lose more weight naturally to have high yields?

M. Zachut and U. Moallem. 2017. J. Dairy Sci. 100 (4) 3143–3154



	High	Low
Avg 305 d yield, lbs.	86.7	85.8
Milk fat, %	3.40	3.46
Milk protein, %	3.09	3.15

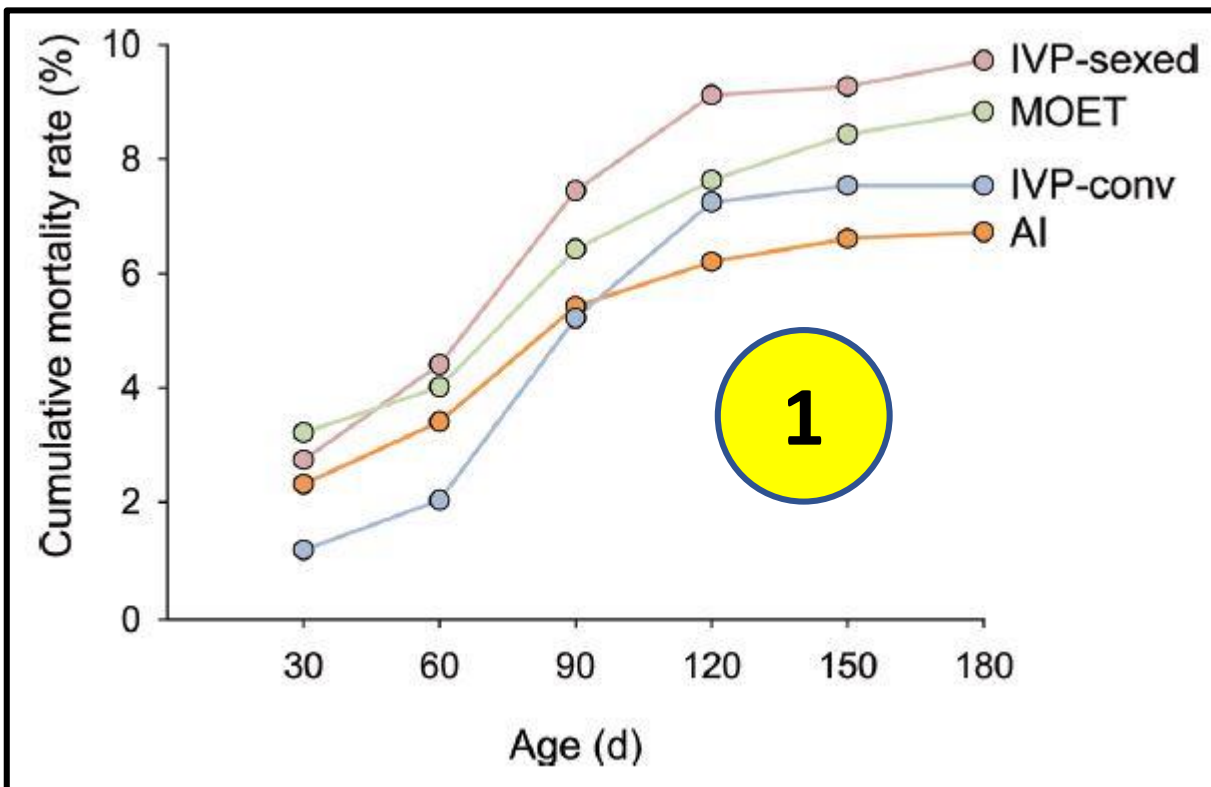


	High	Low
Days open	167	150
Concep rate all, %	32.5	42.1

2

3

Manipulating embryos may cause epigenetic developmental effects



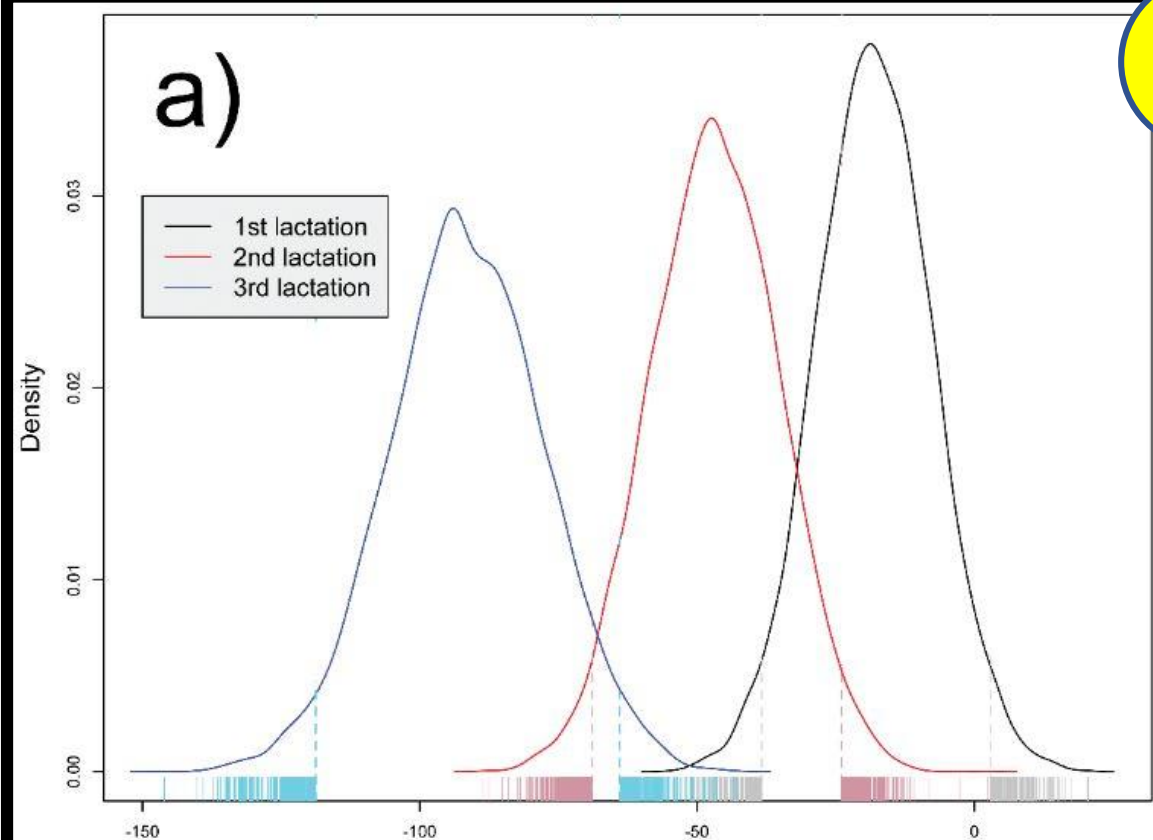
2

	Estrus & A.I.	I.V.P. Conve'l	I.V.P. Sexed	MOET
<i>Gestation length, d</i>	276.3	276.5	276.2	275.5
<i>Birth weight, lbs.</i>	85	87	86	85
<i>Wt. first breeding, lbs.</i>	757	772	782	762
<i>Projected 305 milk, lbs.</i>	24,207	24,081	23,577	24,158

Lactation exerts negative epigenetic effects on future of developing fetus

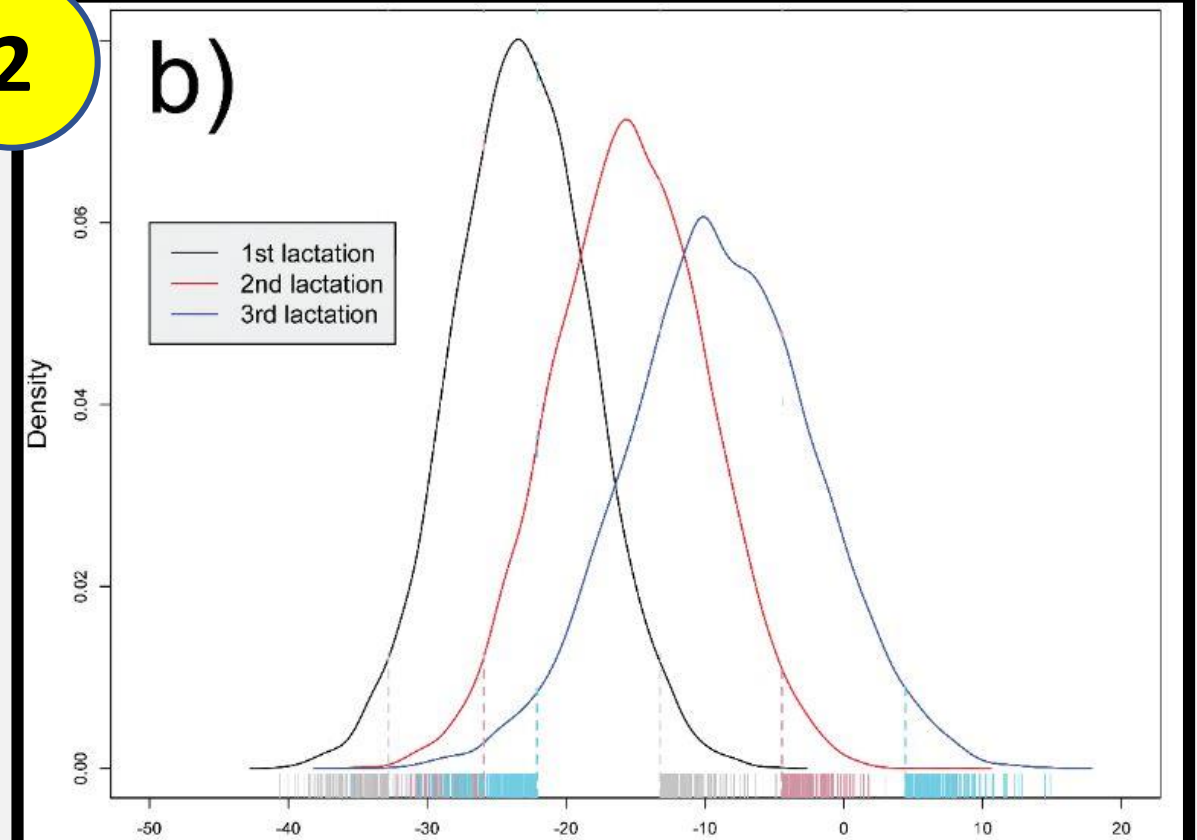
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16,288 heifers from **Non-lactating dams** versus 13,979 heifers born from **lactating dams** [all studied for 3 lactations]



Difference in milk yield vs dam not lactating

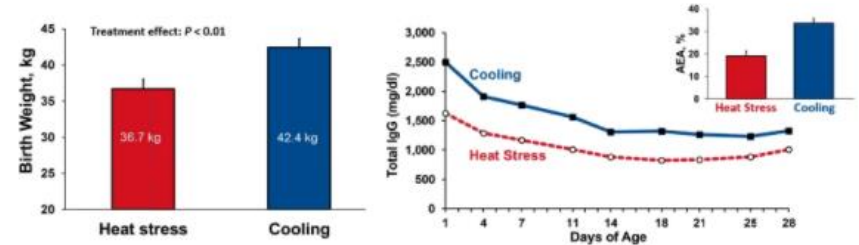
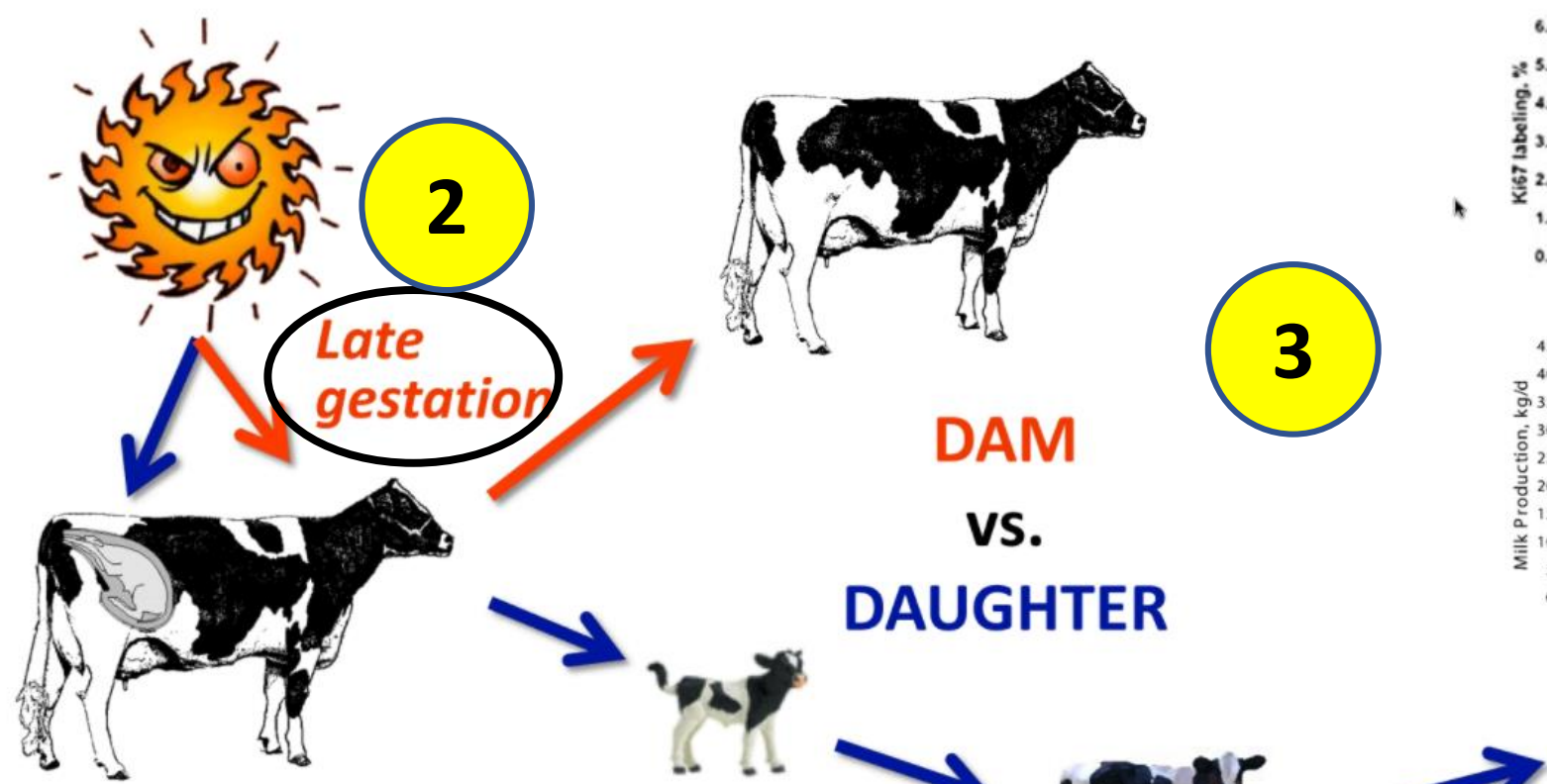
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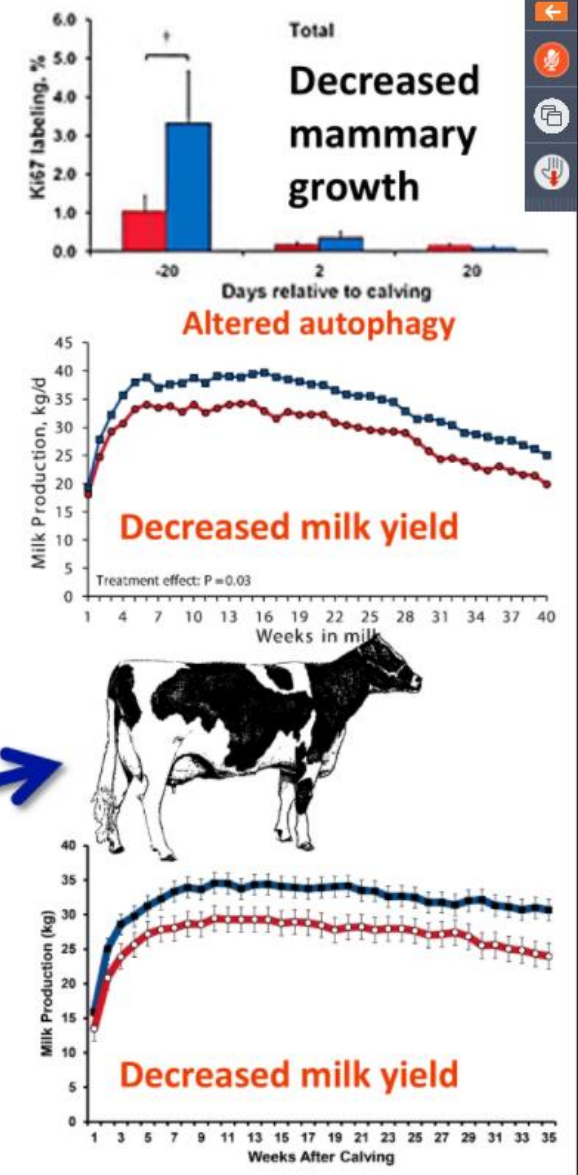
Difference in lifespan vs dam not lactating

Heat stress epigenetic effects are transmitted to subsequent generations

1
Courtesy
Of
Geoff Dahl



Lower body weight
Decreased IgG absorption



1

Disruptive: Open sources massive data, research and dissemination

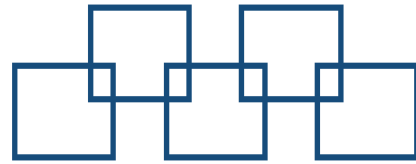
Dairy Farmers



Cloud Computing



Blockchain



Dairy Research Ctrs.



On-cow Sensors



USDA ARS Scientists

USDA United States Department of Agriculture
Agricultural Research Service

Animal Genomics and Improvement Laboratory

Data Centers



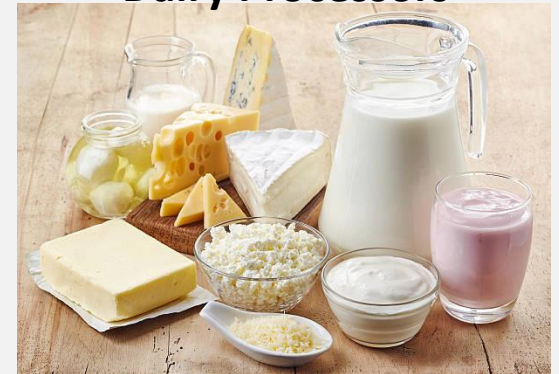
Parlor Sensors



Dairy Scientists



Dairy Processors



2

Sensors, robotics & artificial Intelligence to manage epigenetics

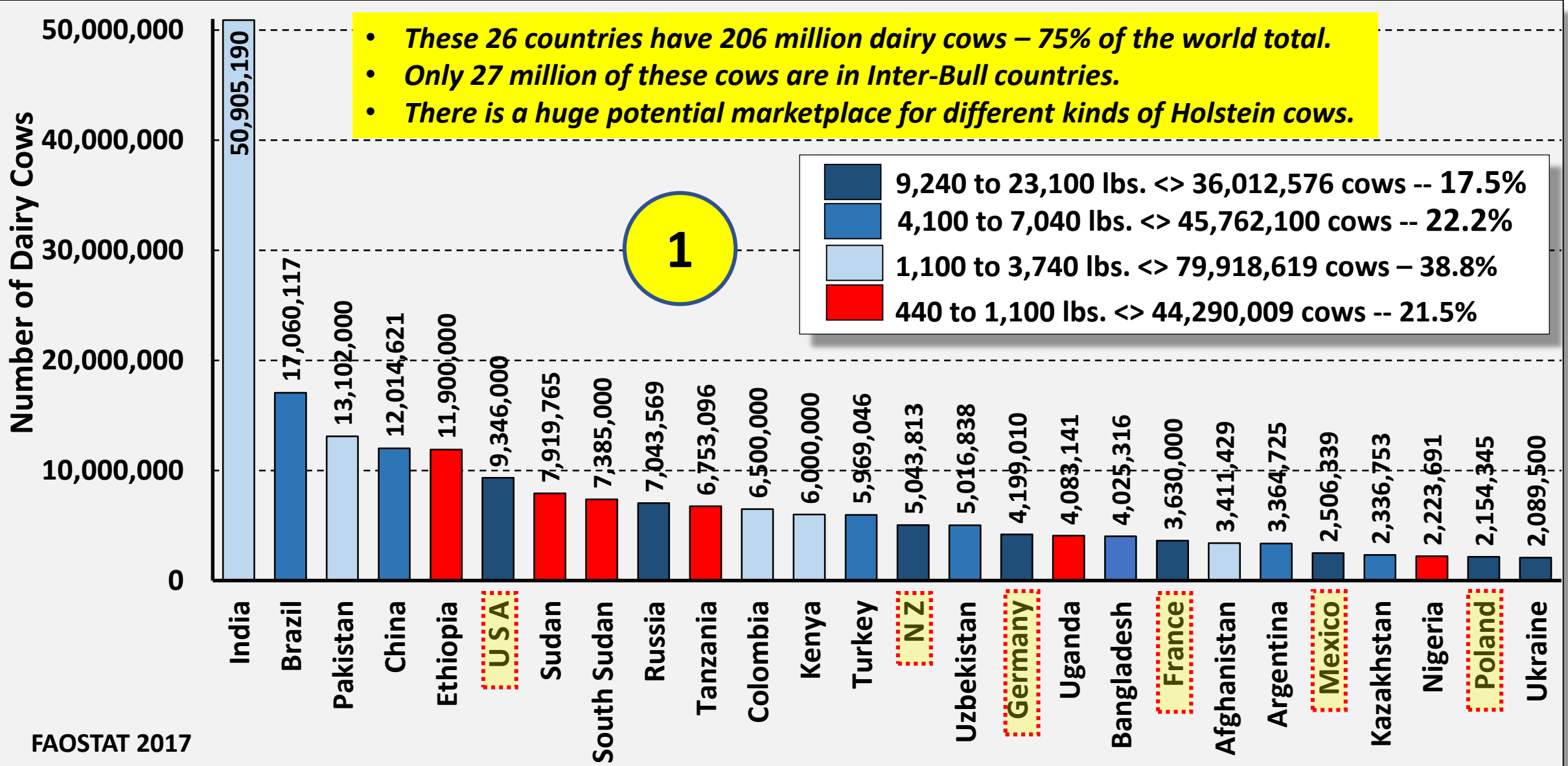
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Maximizing weight gain before and after weaning using automated milk and starter feeders.



Creating Holstein markets for different environments?

- These 26 countries have 206 million dairy cows – 75% of the world total.
- Only 27 million of these cows are in Inter-Bull countries.
- There is a huge potential marketplace for different kinds of Holstein cows.



Genetic and epigenetic Holstein lines for the future?

1

4

Tropical

3

Dry/Desert

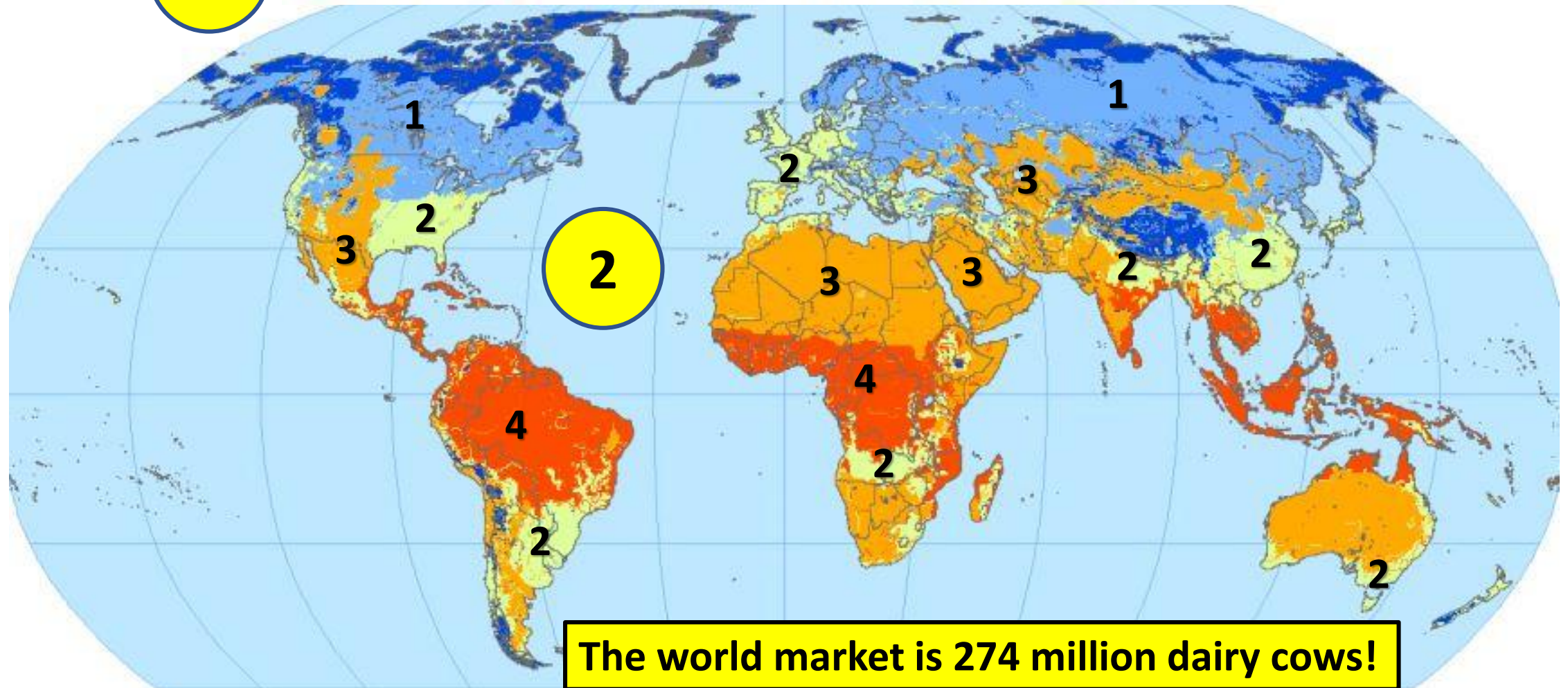
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Temperate

1

Cold

Polar/Tundra

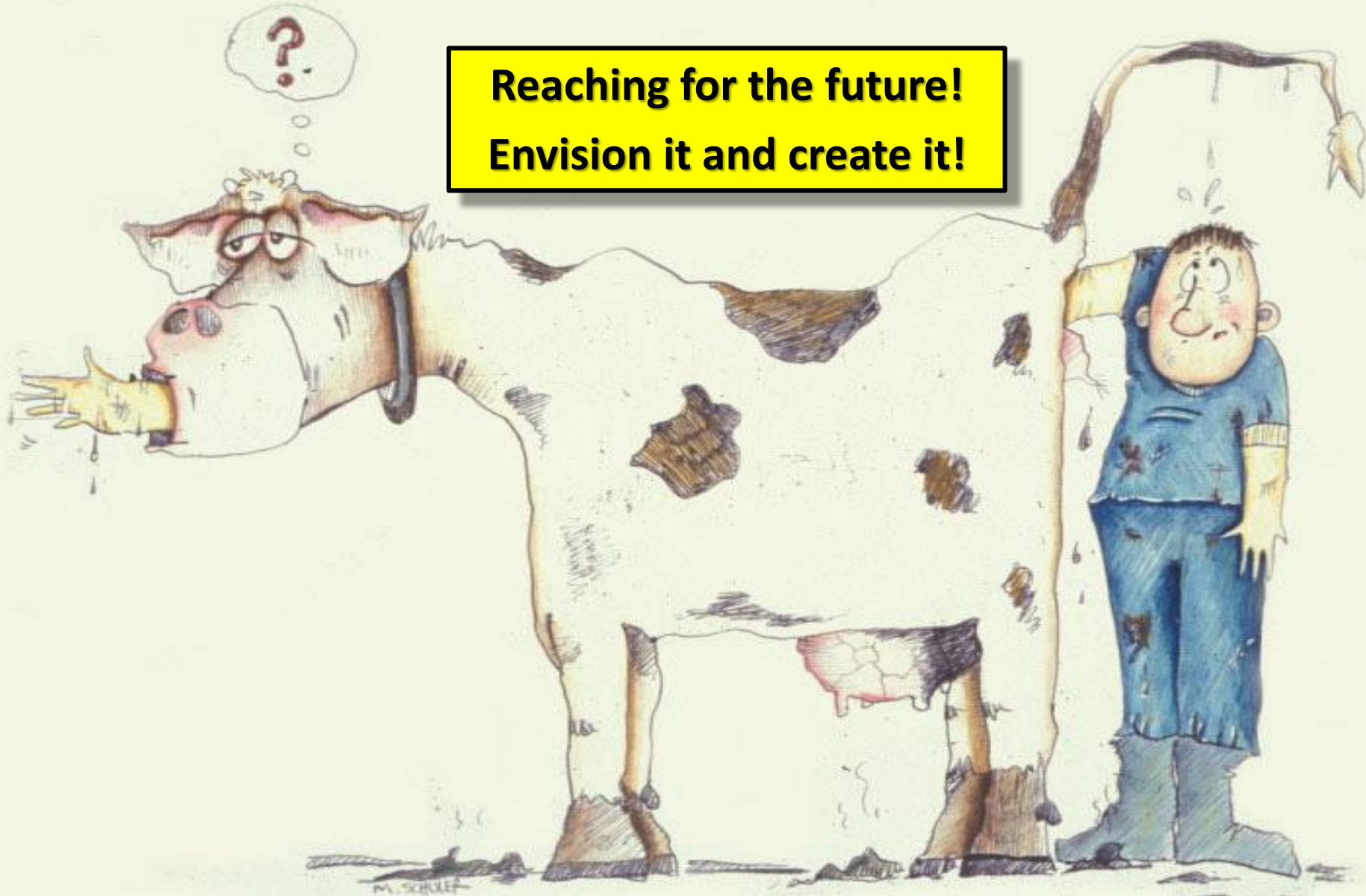


The world market is 274 million dairy cows!

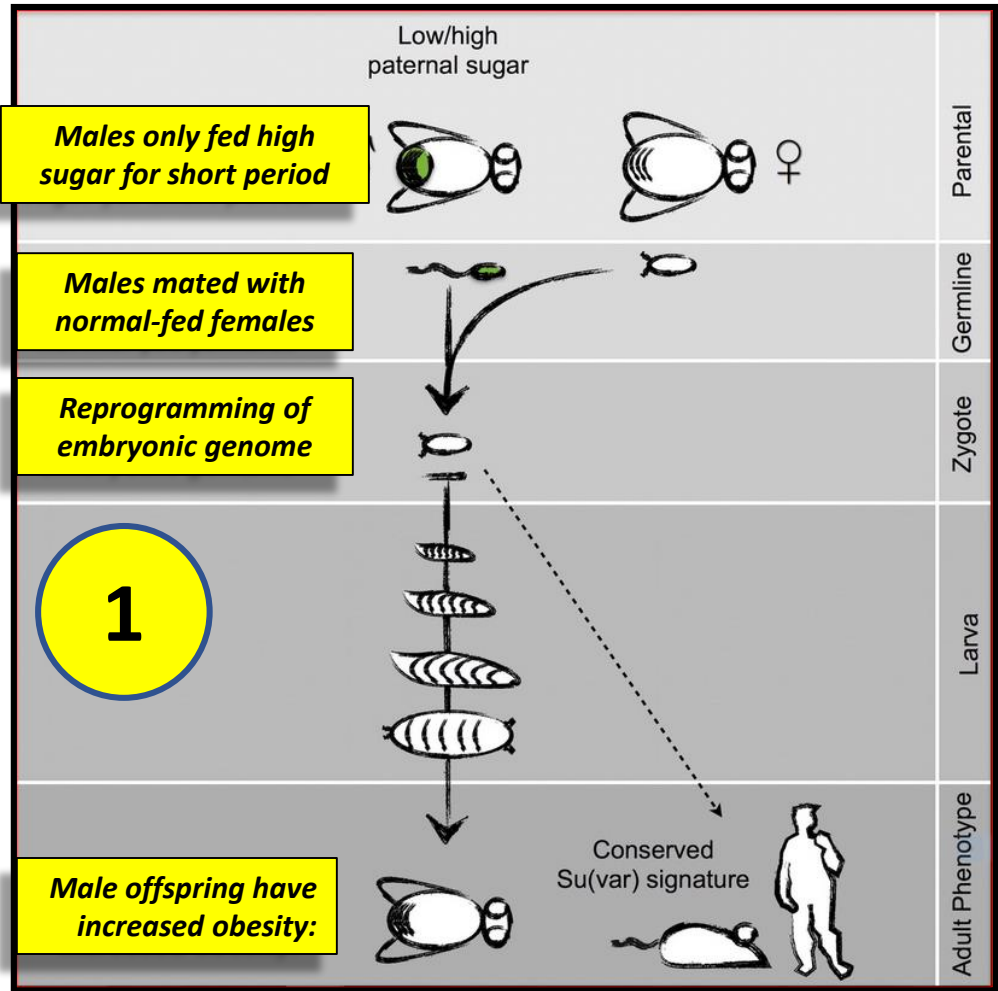
<http://sedac.ciesin.columbia.edu/maps/gallery/search/6?facets=theme:climate>

Thank You for this Opportunity

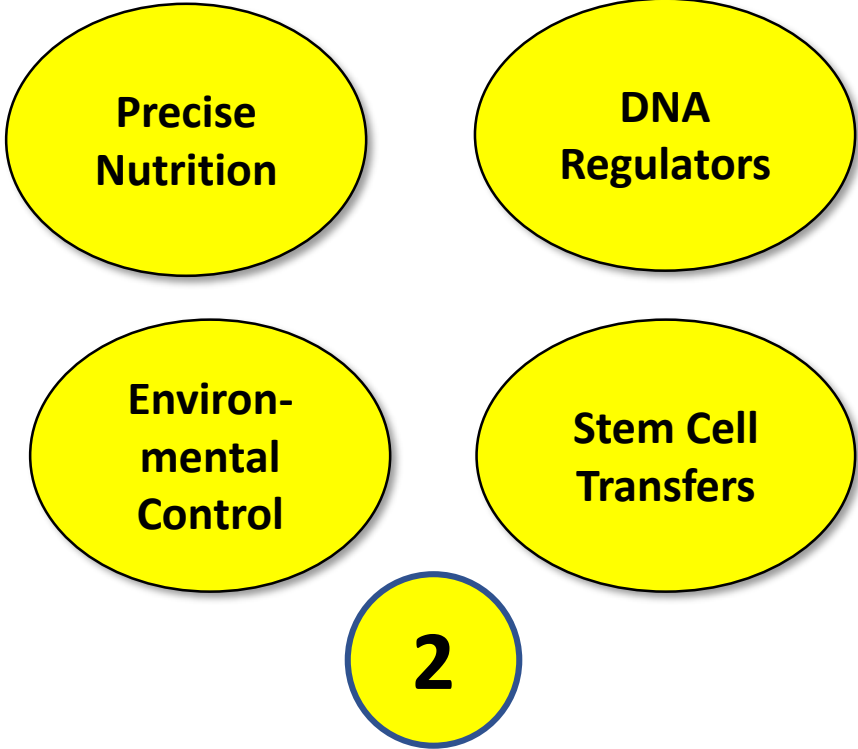
**Reaching for the future!
Envision it and create it!**



Would feeding AI bulls differently affect epigenome of their progeny?



Many epigenetic strategies



Ost, A. et al (2014). Paternal Diet Defines Offspring Chromatin State and Intergenerational Obesity. *Cell* 159(6): 1352–1364.