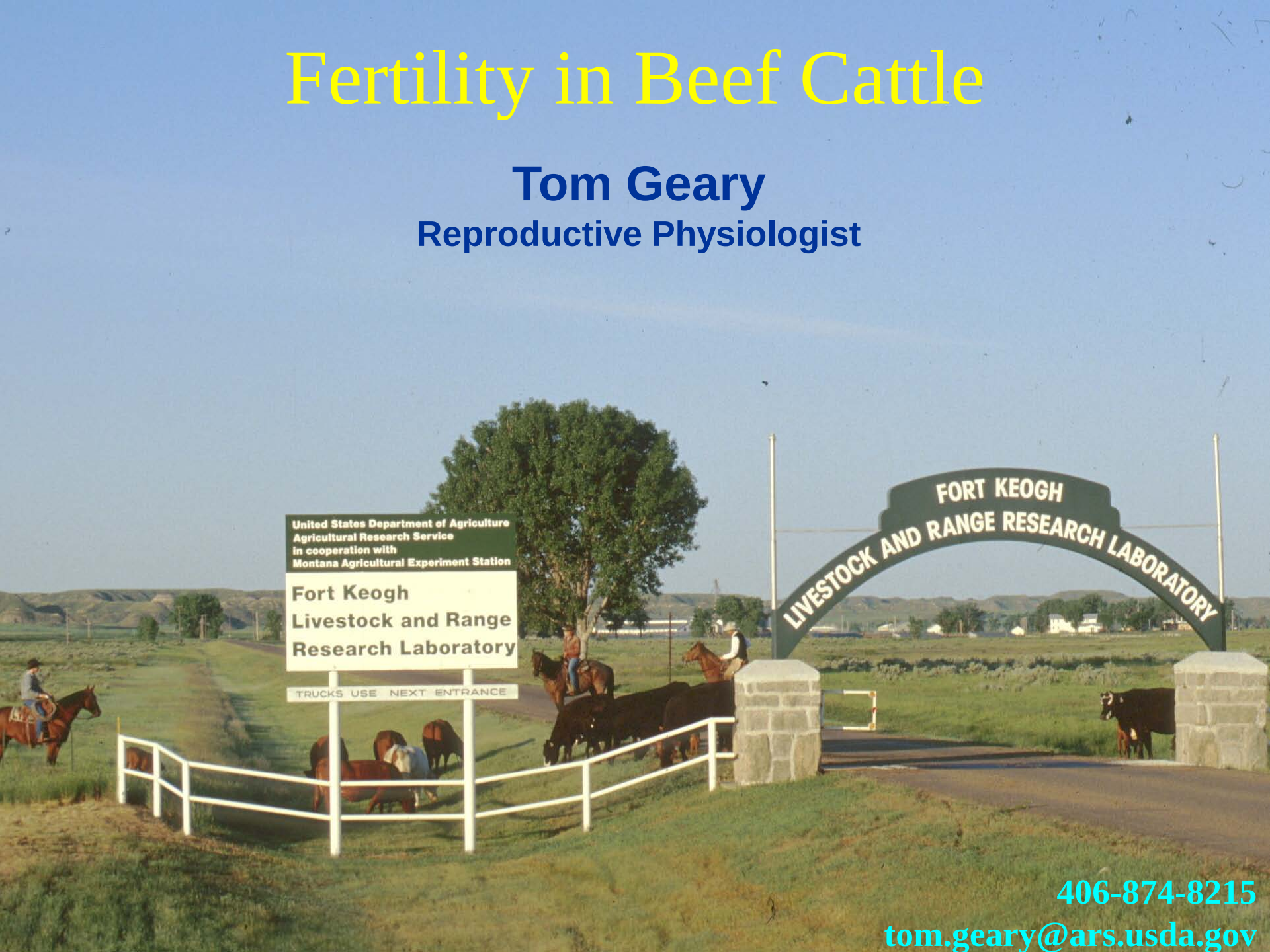
Fertility in Beef Cattle

Tom Geary
Reproductive Physiologist



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Pregnancy Diagnosis

Cow Fertility

Vibrio

Trich

Neospora

EBA (Foothills)

Nitrates

IBR

Breeding Season

Calving Season

Lepto

Stress

BVD

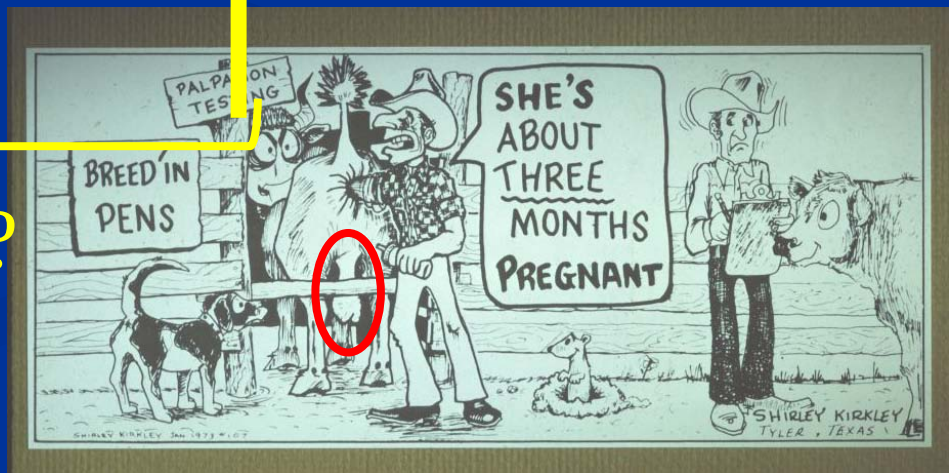
Bull Fertility

Mycotoxins

Pine Needle

Plant / Water Toxins

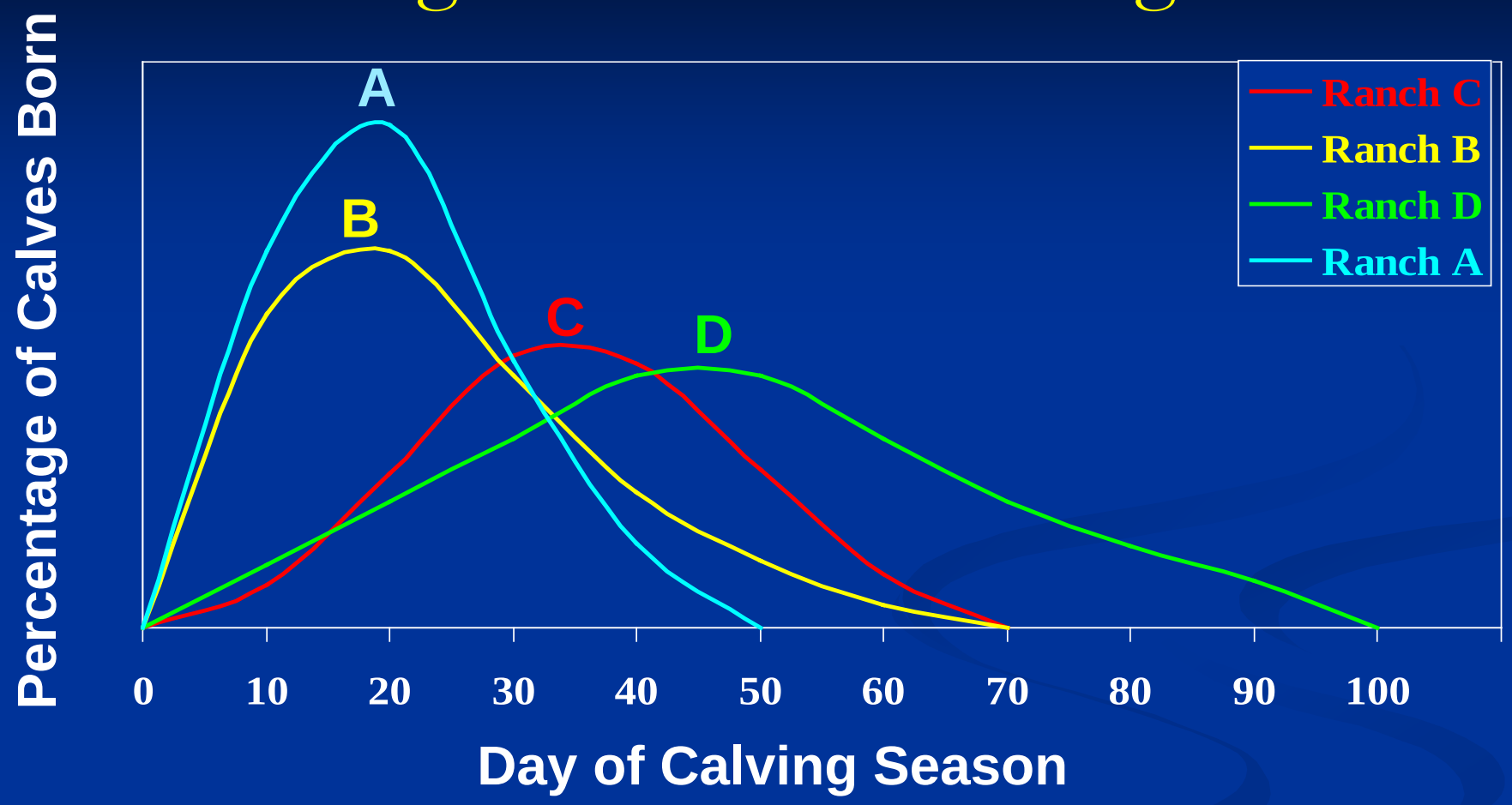
When?



Factors affecting Individual Pregnancy

- Cow Fertility
  - Postpartum interval (PPI)
  - Age
  - Body Condition Score (BCS)
  - Genetics
  - Dystocia
  - Nutrition
- Bull Fertility
- Stress
- Disease
- Toxins

Calving Distribution Management



Shorter calving season improves ability to manage cattle in your environment & increase profitability of cowherd!

Nutrient Partitioning

1. Maintenance
2. Activity
3. Growth
4. Milk production
5. Body reserves (FAT)
6. Reproduction

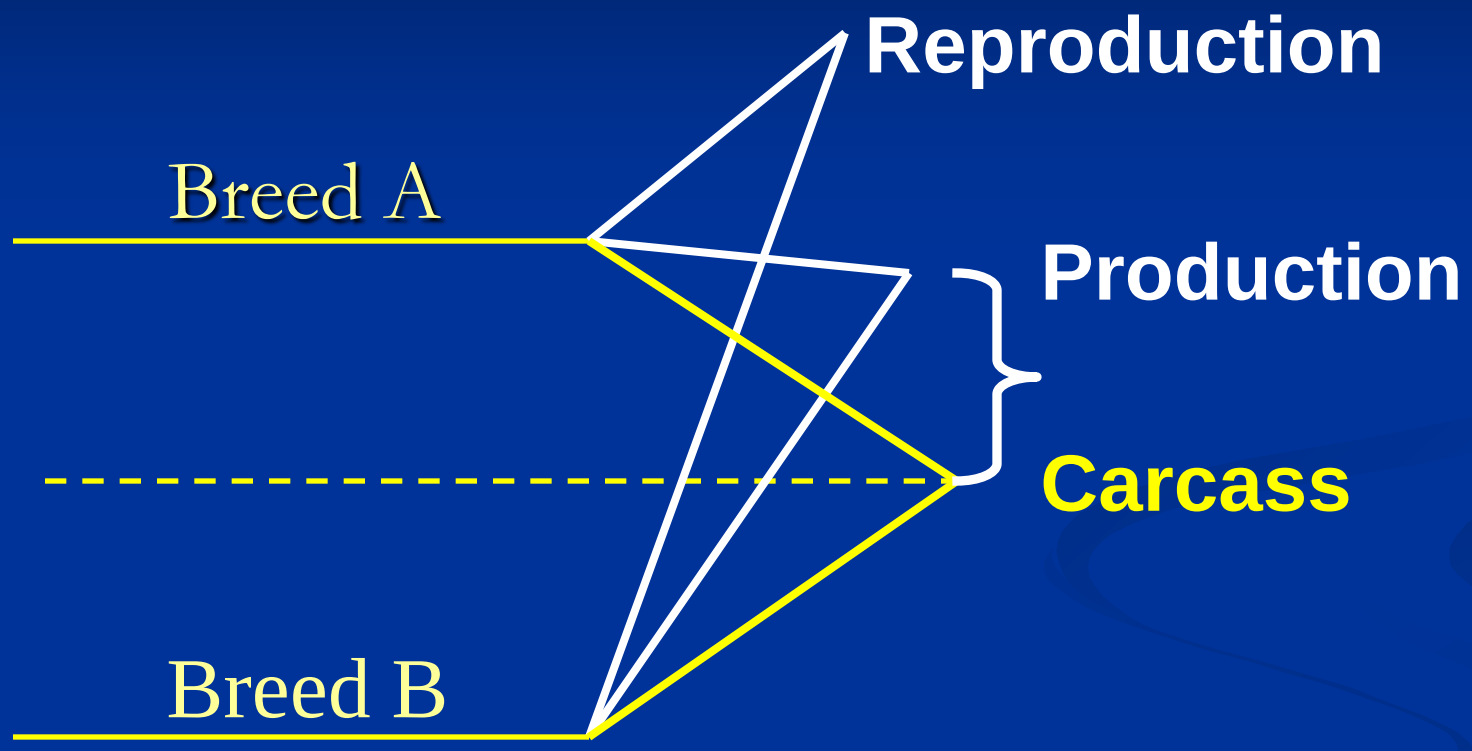
Proper nutrition is obligatory to reproductive success, but not focus of presentation.

Improve Cowherd Reproduction with Genetics

Crossbreeding!!!

Animal Breeding 101

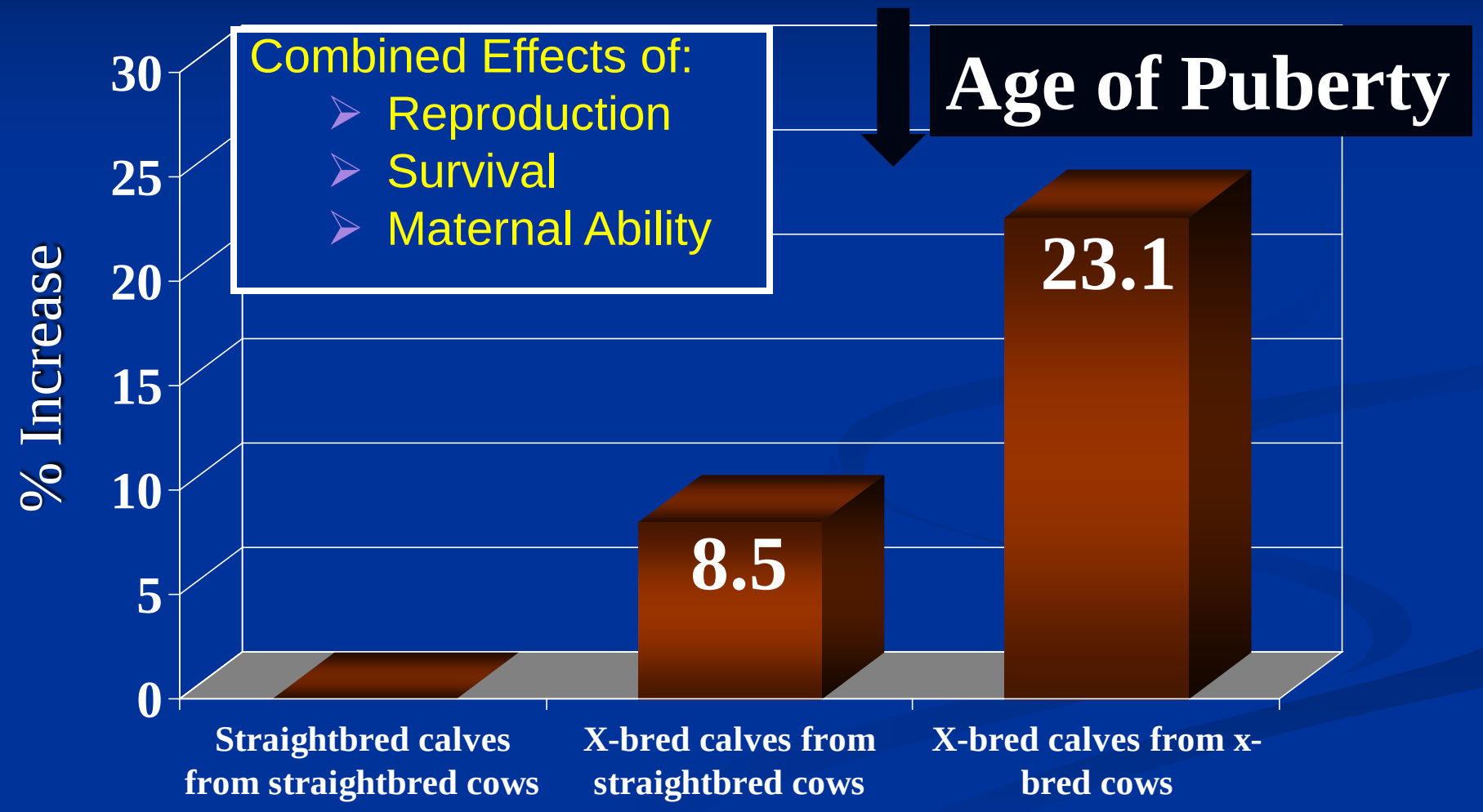
Crossbreeding



Additive genetic value
✓Selection

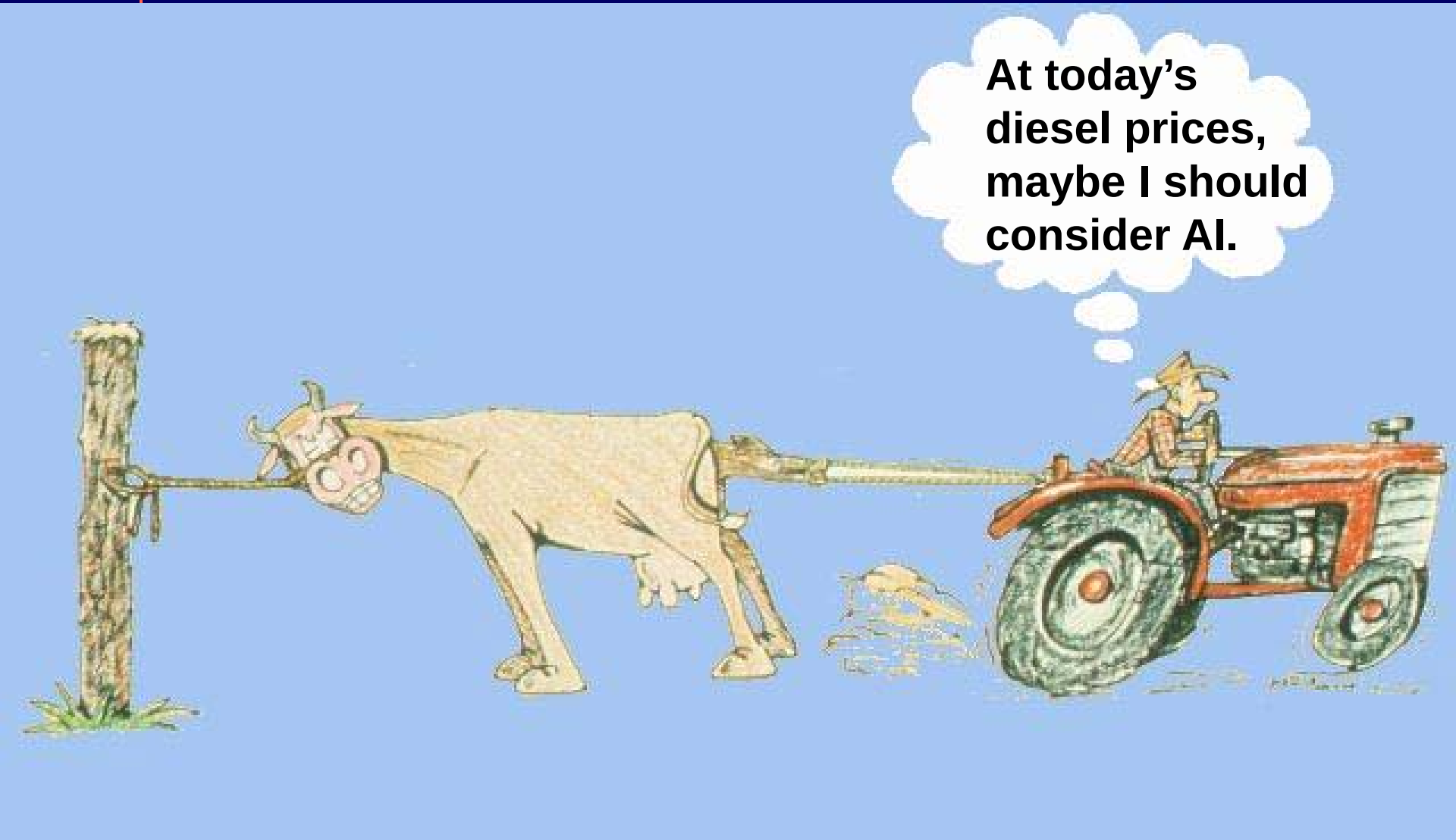
Non-additive genetic value
✓Hybrid Vigor

Cumulative hybrid vigor effects on weight of calf weaned per cow exposed

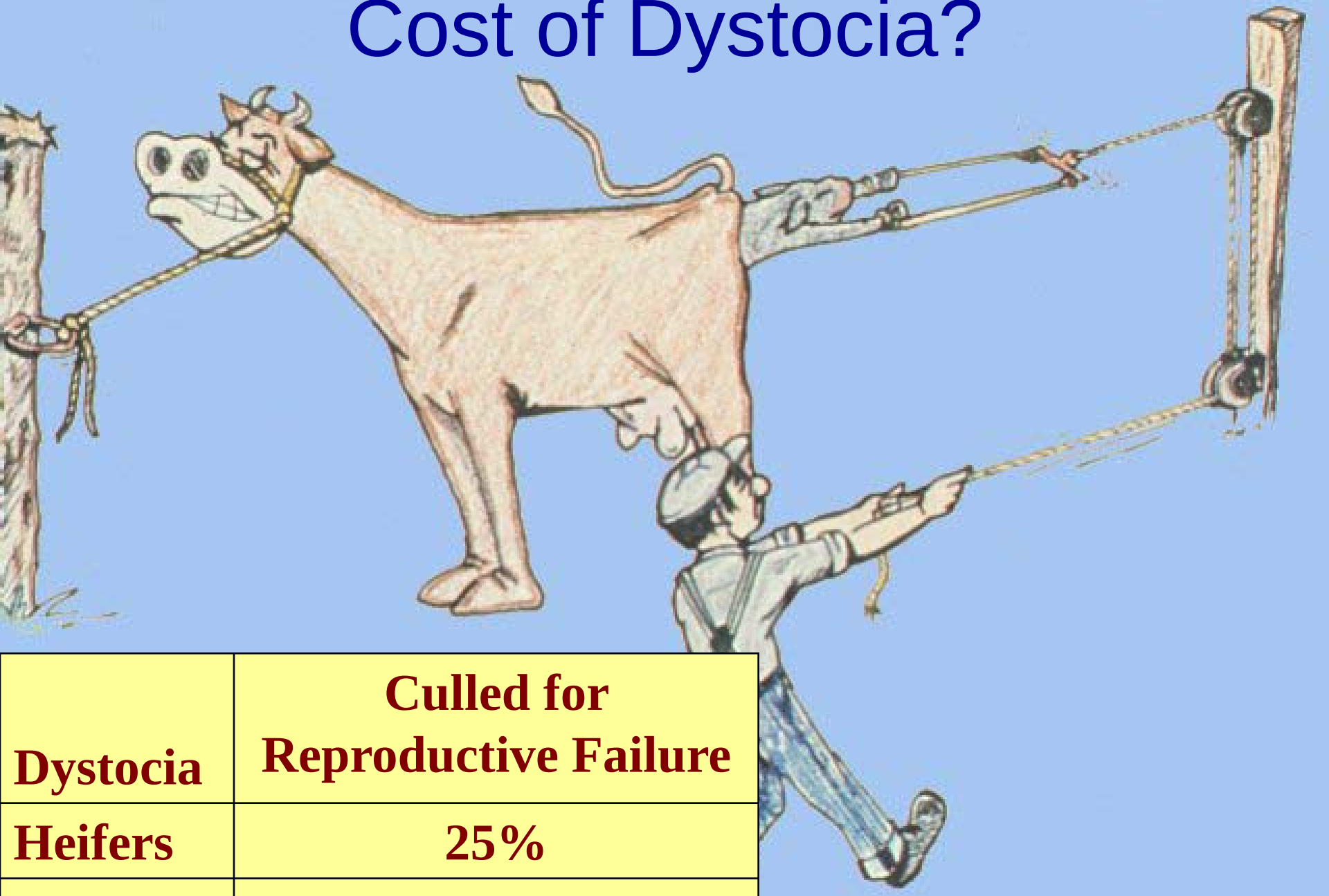


Cundiff et al., 1974; Hereford, Angus, & Shorthorn

AI Heifers to “Calving Ease” Proven Sires



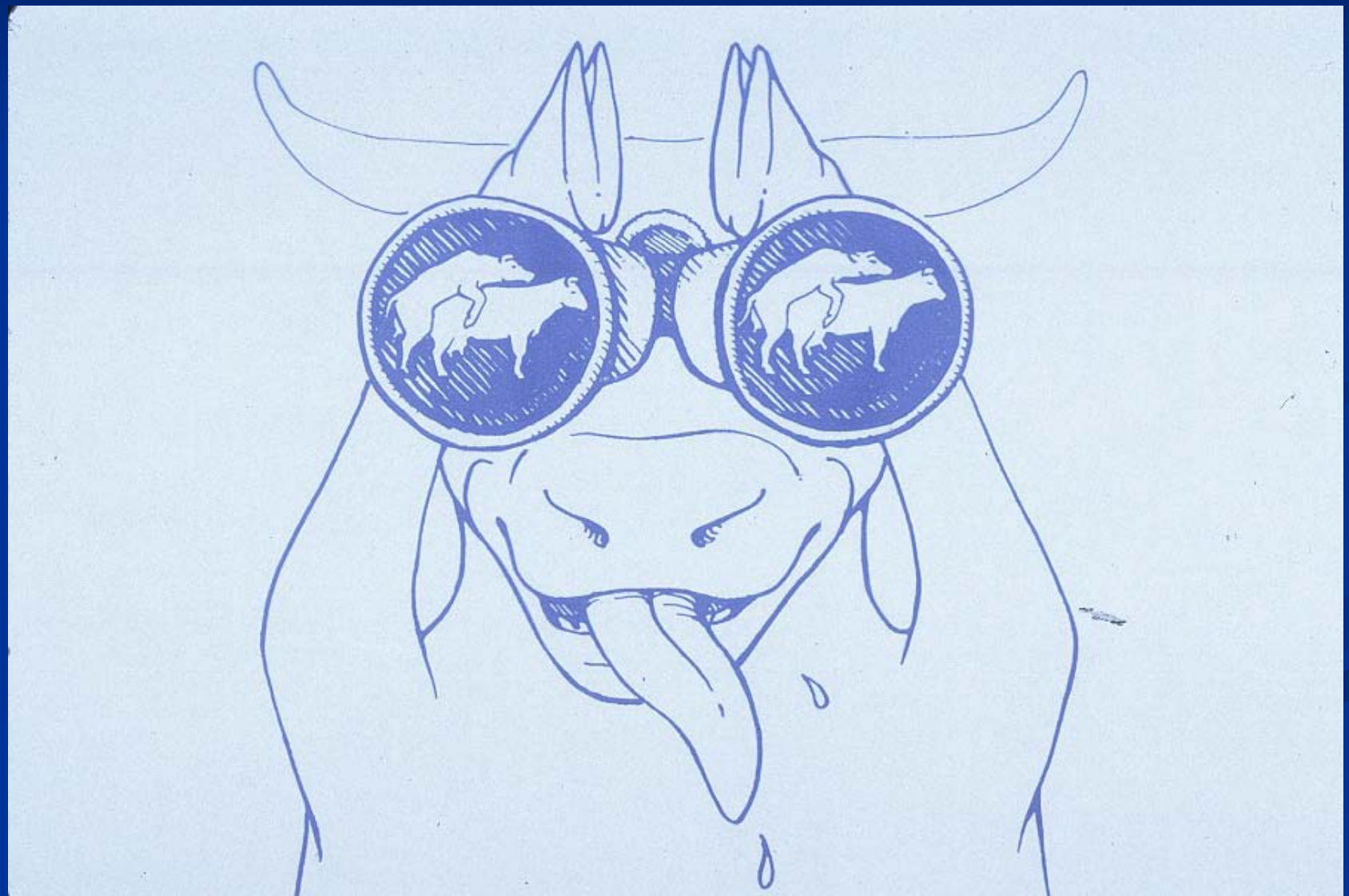
Cost of Dystocia?



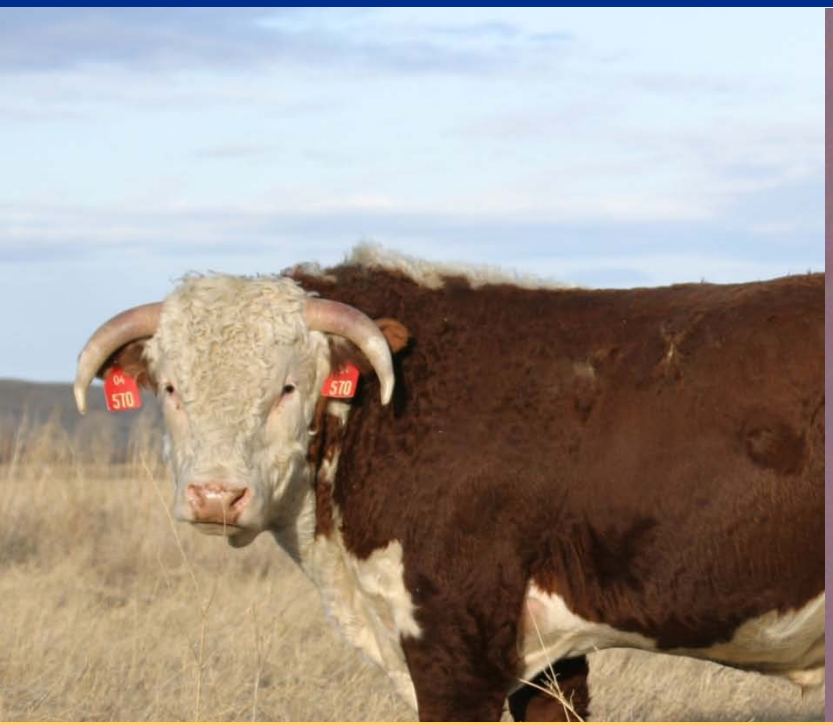
Dystocia	Culled for Reproductive Failure
Heifers	25%
Cows	58%

Rogers et al., 2004

Reproductive Measures that Result in Pregnancy



Single most important measure of fertility for cow/calf producer?



Each bull is expected to contribute to the production

Limitations: Fertility measure on that given day
Only about 1/3 of the "Fertility Picture"

at least 10 times more important than a cow.

Effect of Social Dominance on Percentage of Calves Sired

Bull		Year 1	Year 2	Year 3	Year 4	Year 5
A	Age	10	11	12	13	14
	Percent					
B	Age	4	5	6	7	8
	Percent					
C	Age	3	4	5	6	7
	Percent					
D	Age	2	3	4	5	6
	Percent					

Effect of Social Dominance on Percentage of Calves Sired

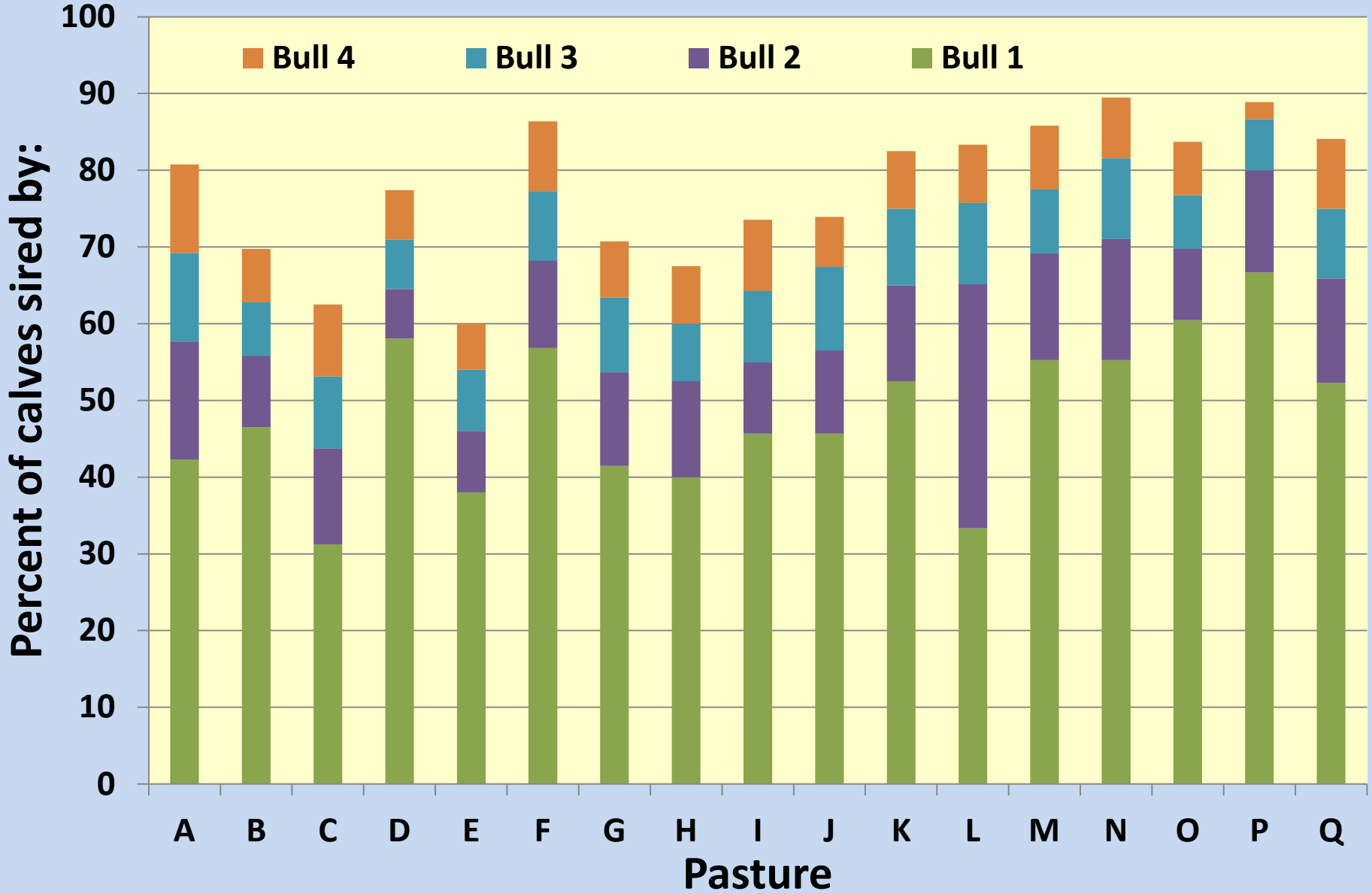
Bull		Year 1	Year 2	Year 3	Year 4	Year 5
A	Age	10	11	12	13	14
	Percent	70				
B	Age	4	5	6	7	8
	Percent	17				
C	Age	3	4	5	6	7
	Percent	7				
D	Age	2	3	4	5	6
	Percent	6				

Effect of Social Dominance on Percentage of Calves Sired

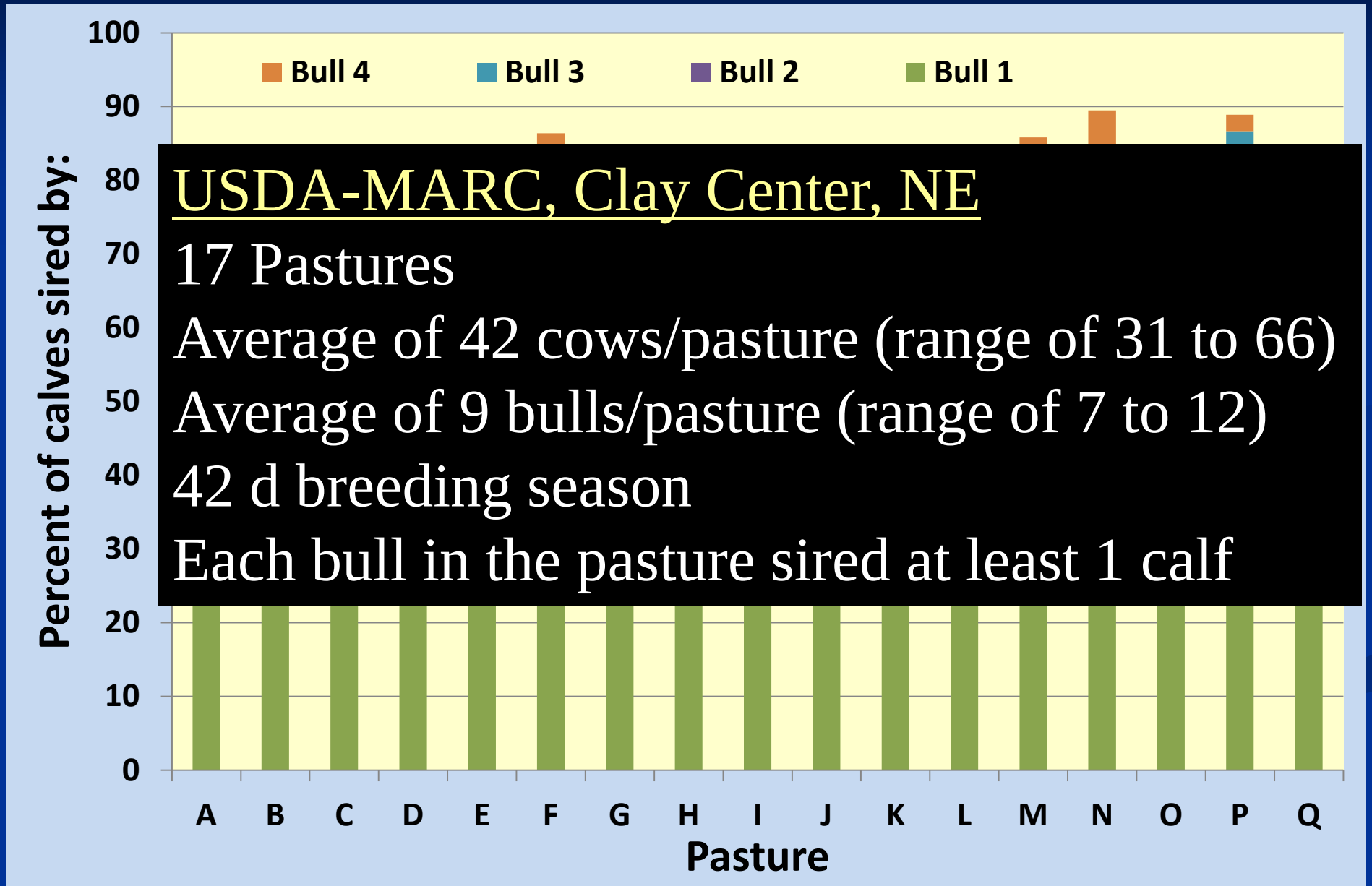
Bull		Year 1	Year 2	Year 3	Year 4	Year 5
A	Age	10	11	12	13	14
	Percent	70	76	12	0	0
B	Age	4	5	6	7	8
	Percent	17	18	63	73	25
C	Age	3	4	5	6	7
	Percent	7	6	12	13	63
D	Age	2	3	4	5	6
	Percent	6	0	12	15	12

- ✓ What if the dominant bull is sterile?

Bull Dominance or Bull Fertility?



Bull Dominance or Bull Fertility?



USDA-MARC, Clay Center, NE

17 Pastures

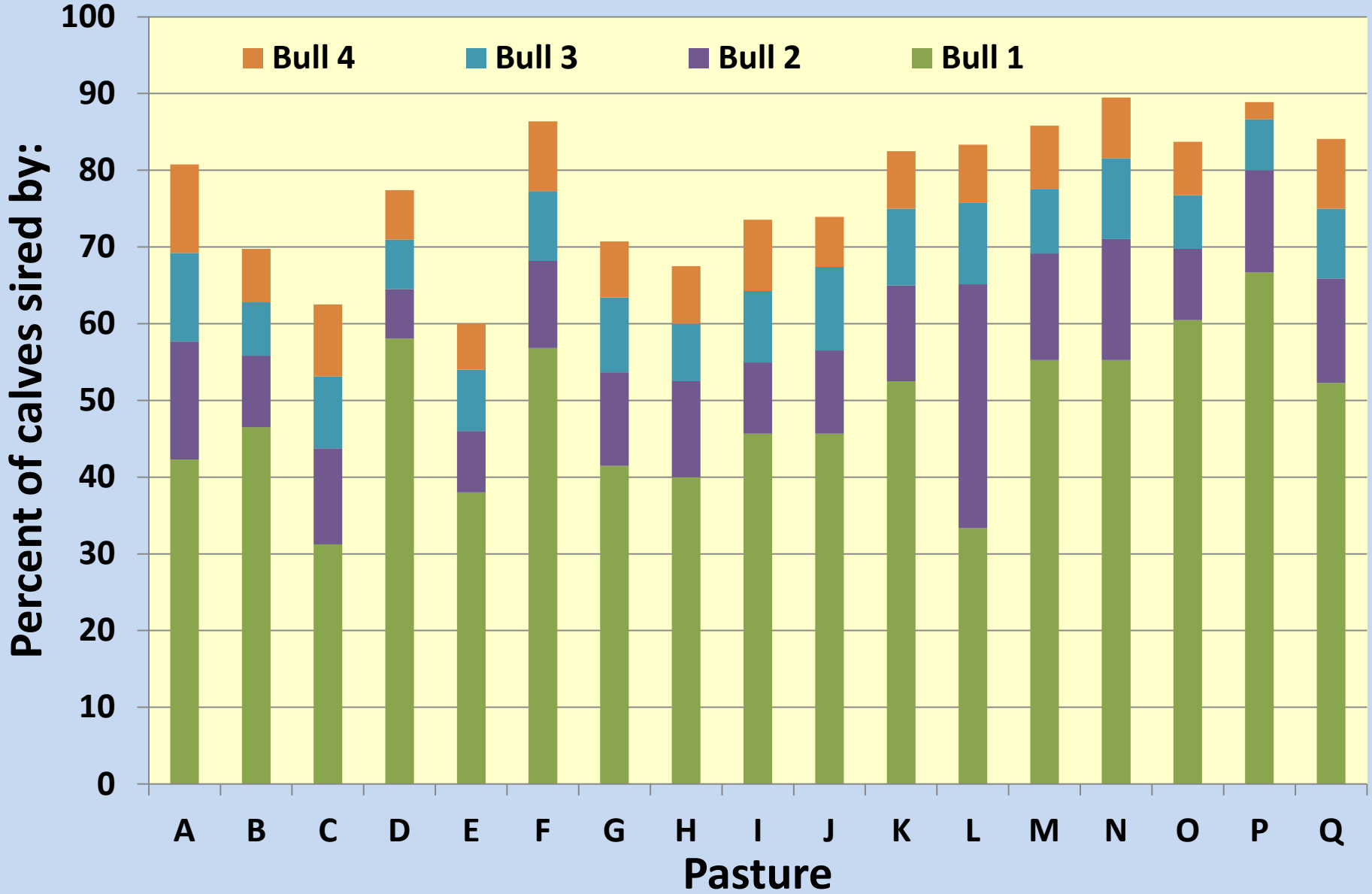
Average of 42 cows/pasture (range of 31 to 66)

Average of 9 bulls/pasture (range of 7 to 12)

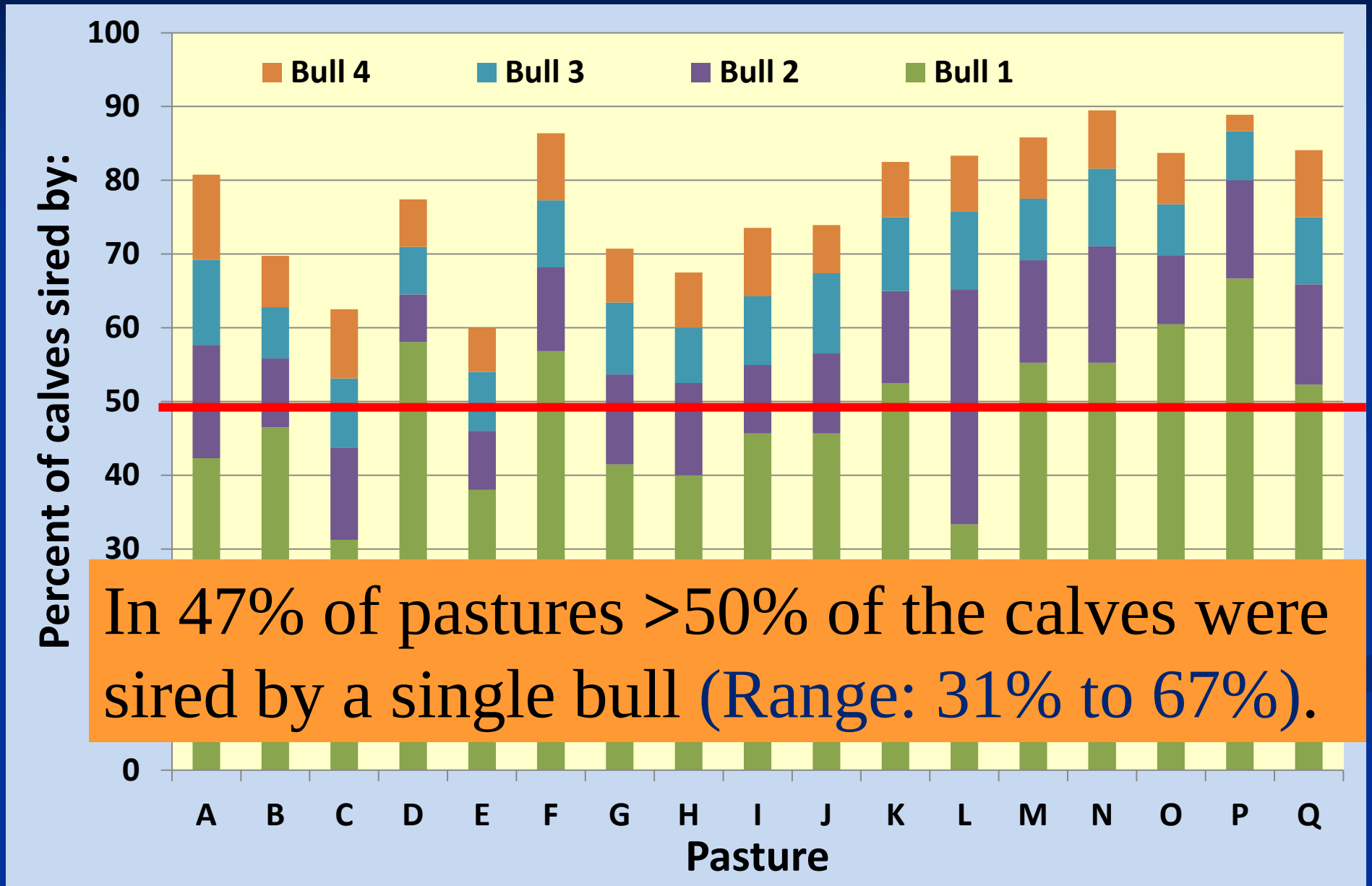
42 d breeding season

Each bull in the pasture sired at least 1 calf

Bull Dominance or Bull Fertility?

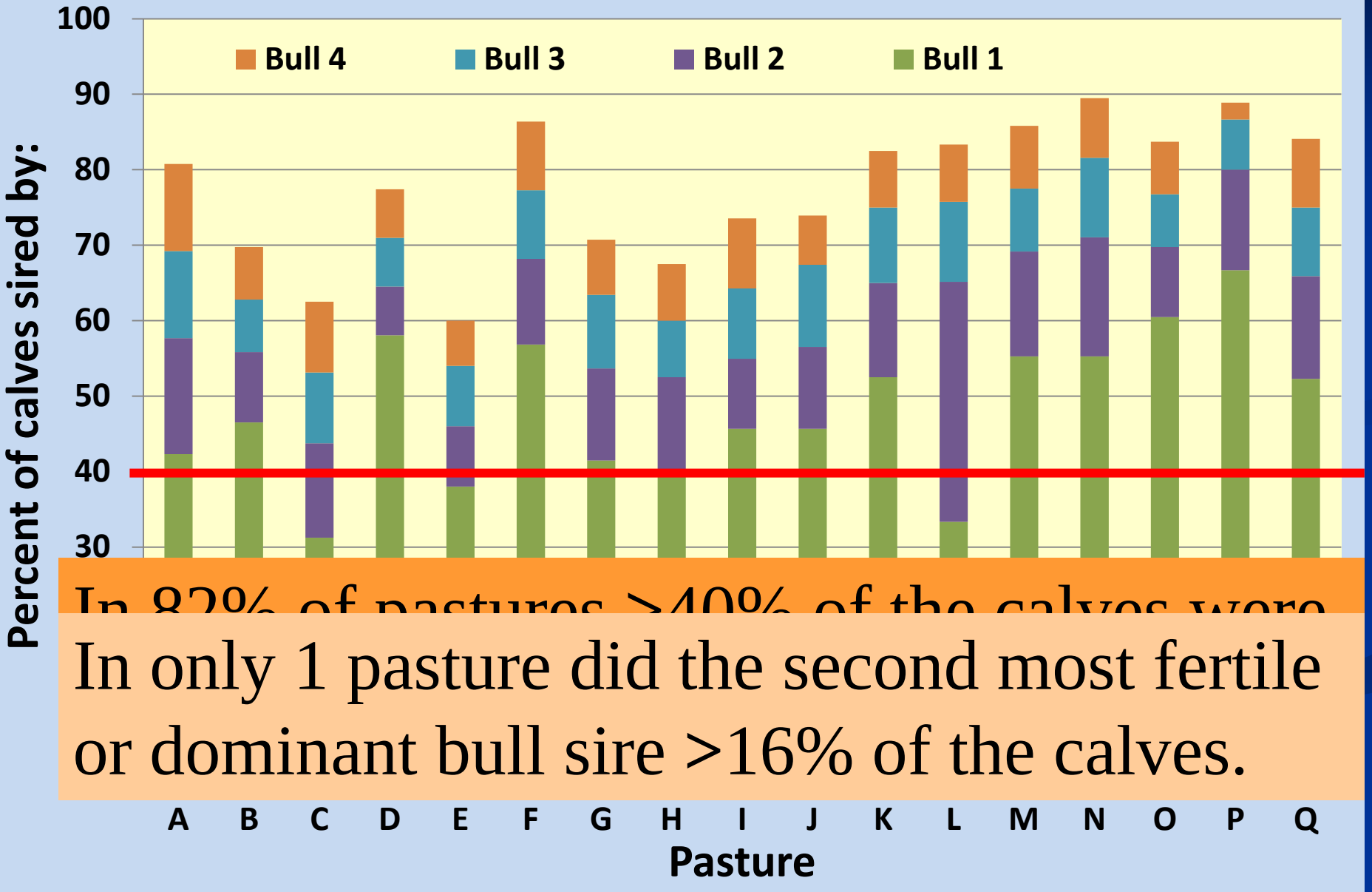


Bull Dominance or Bull Fertility?



In 47% of pastures >50% of the calves were sired by a single bull (Range: 31% to 67%).

Bull Dominance or Bull Fertility?



In 82% of pastures >40% of the calves were

In only 1 pasture did the second most fertile or dominant bull sire >16% of the calves.

Key Parameters of Sperm Fertility

MEMBRANE INTEGRITY (1)
•BROKEN, OPENS THE DOOR TO DNA

CAPACITATION (5)
•PREPARE SPERM TO FERTILIZE

ACROSOME (3)
KEY ROLE IN FERTILIZATION

DNA CONTENT (2)
•CONTROL DNA FRAGMENTATION

MITOCHONDRIAL STATUS (4)
•INFLUENCE MOTILITY

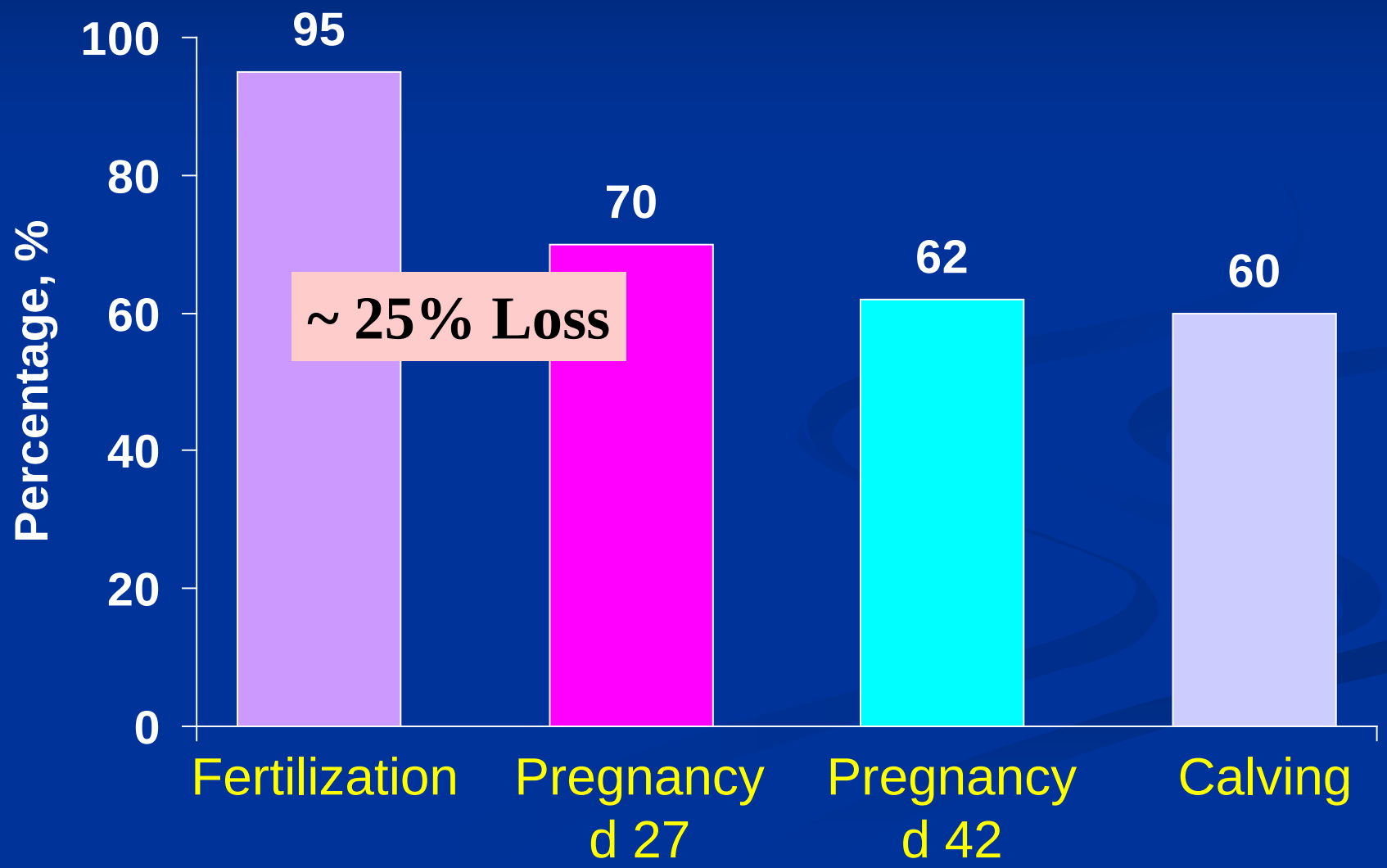
Bacterial count
•CONTAMINATION ALTERS FERTILITY

EasyCyte Flow Cytometer

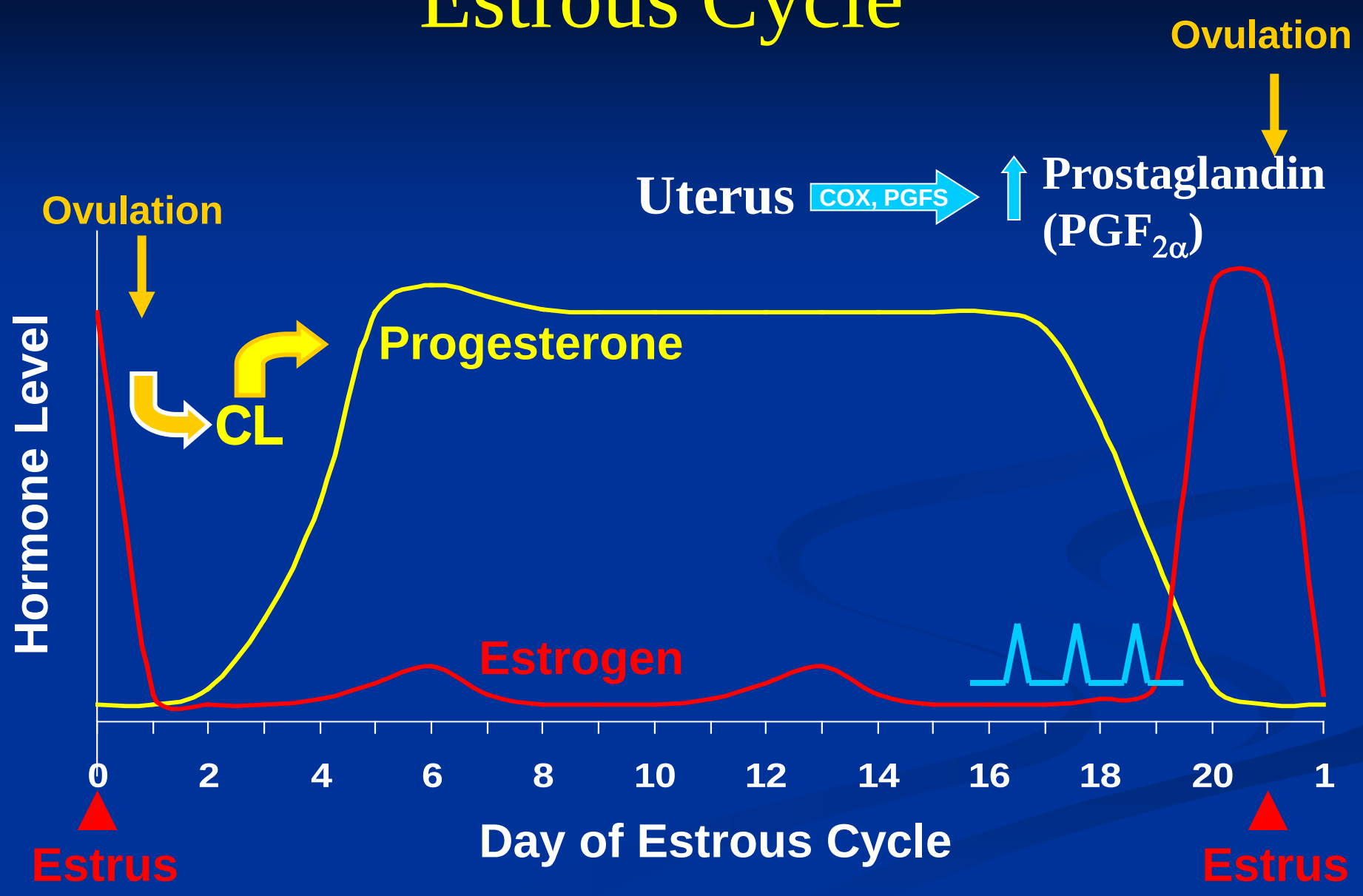
Evaluates 5000 sperm/min

Measuring these key physiological functions provides insight into the fertilization potential of sperm.

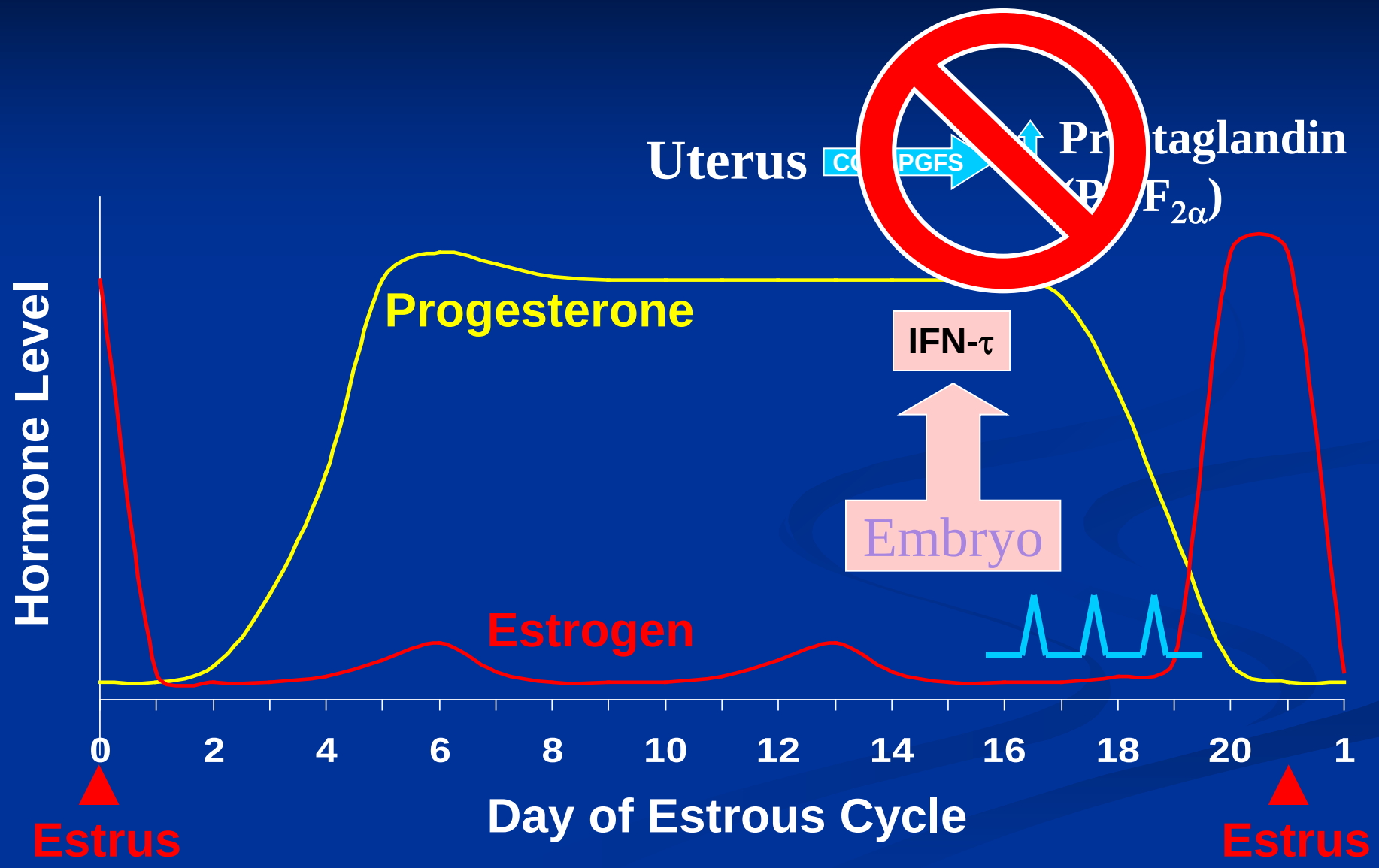
Fertility of a Single Service: Beef Cattle



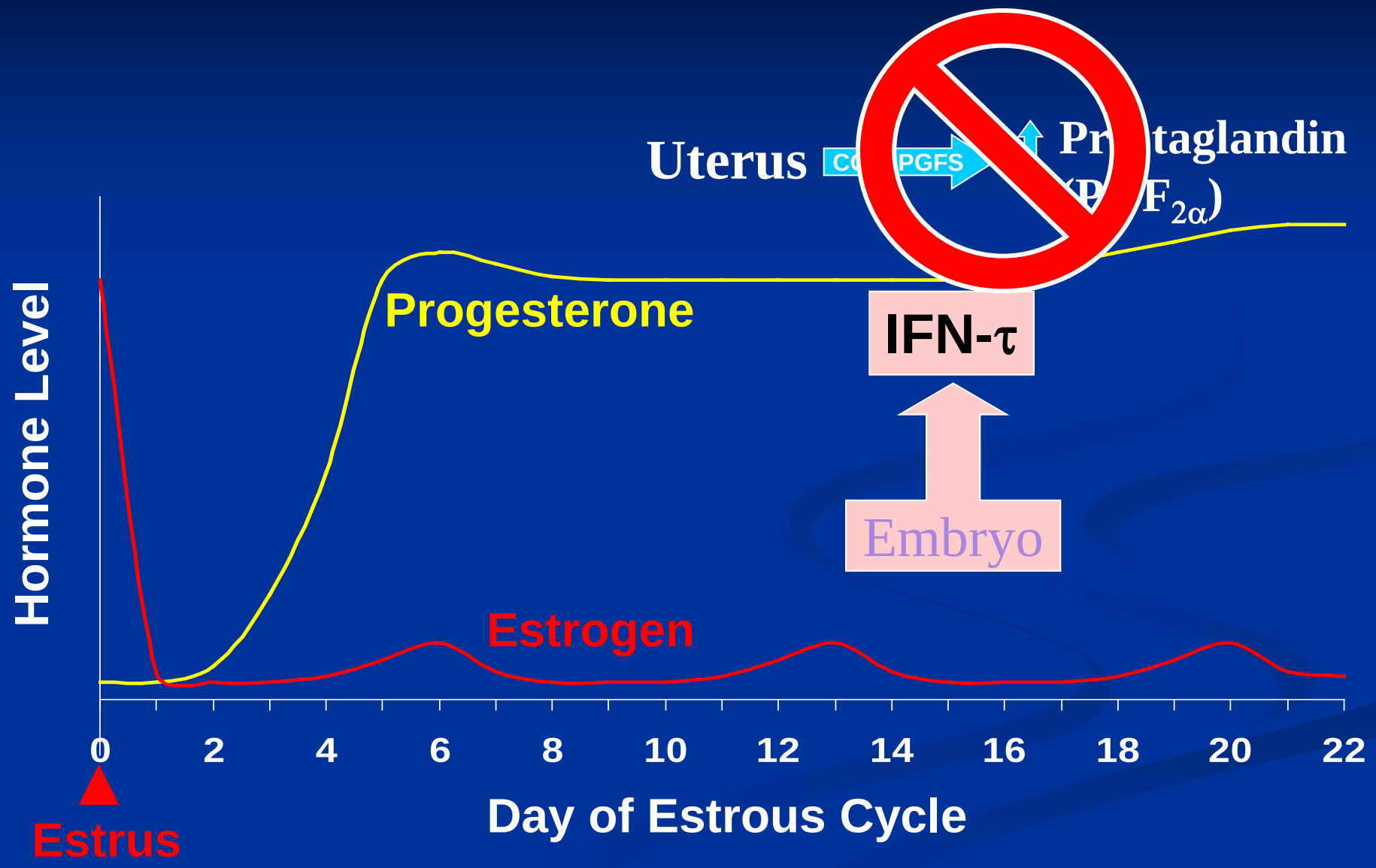
Estrous Cycle



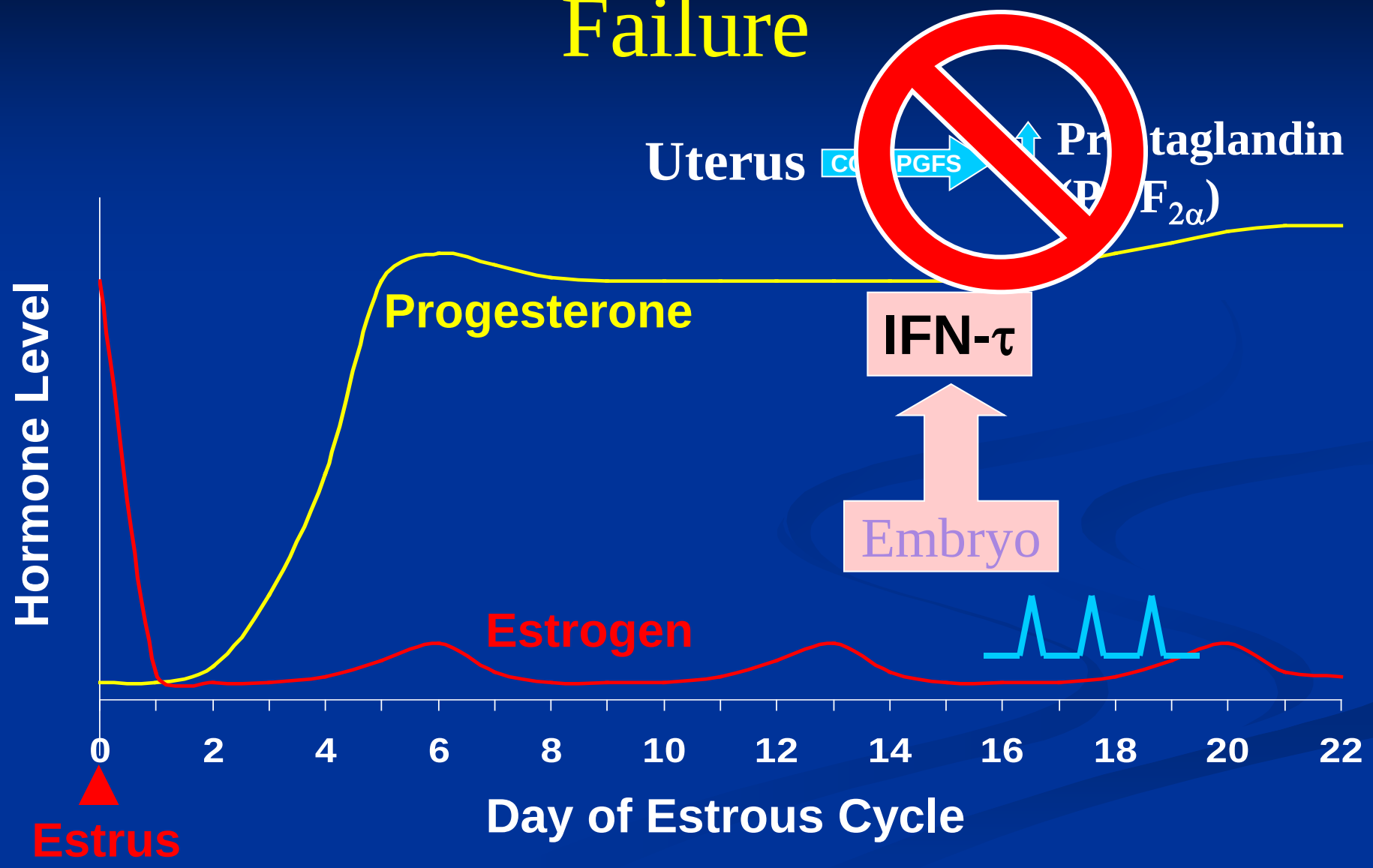
Maternal Recognition of Pregnancy



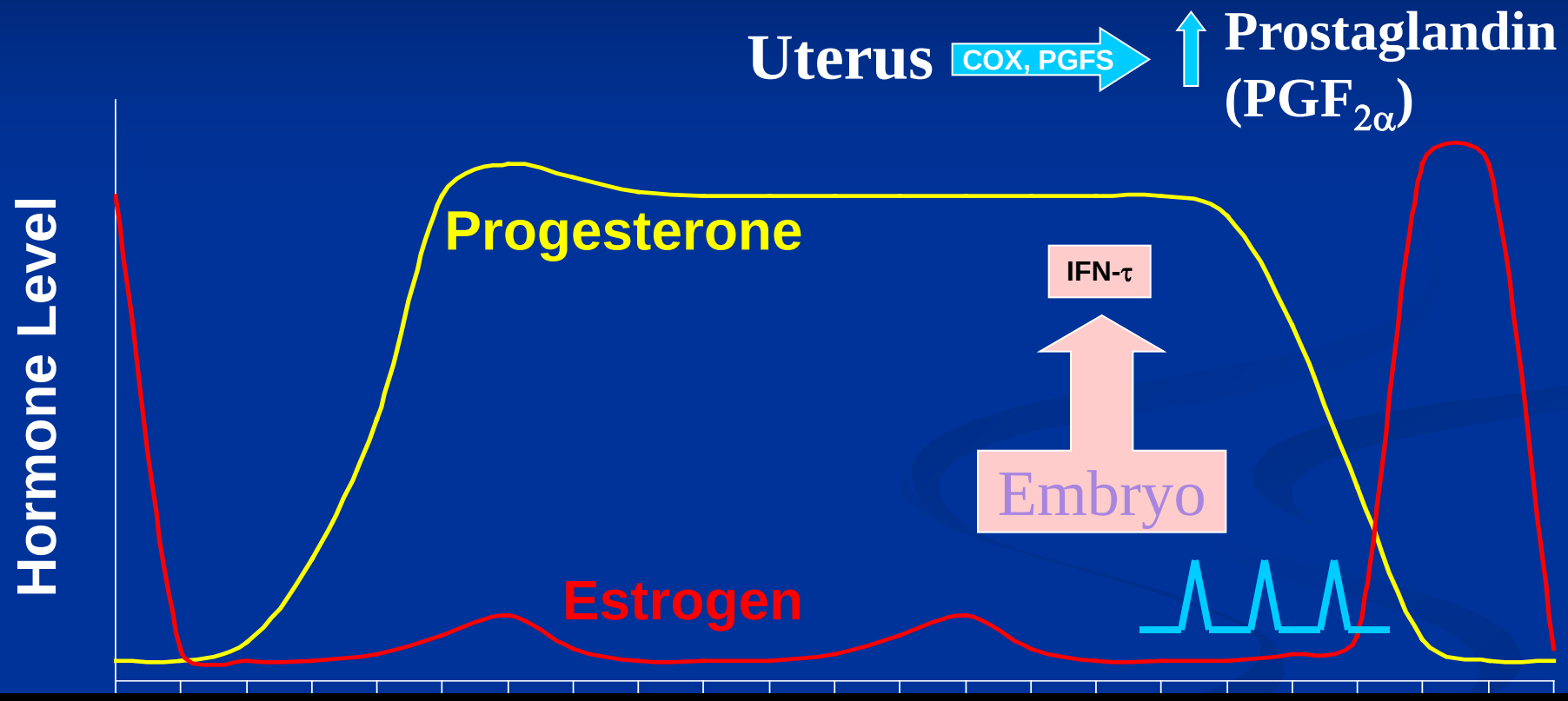
Maternal Recognition of Pregnancy



Maternal Recognition of Pregnancy Failure



Maternal Recognition of Pregnancy Failure



Management can cause this scenario:
ANYTHING that delays embryo growth can affect pregnancy establishment!

Why / Where is pregnancy failing?

Day 1

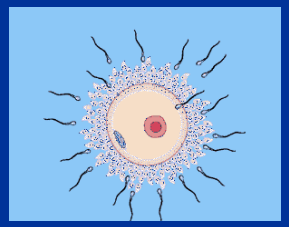
95%

Progress difficult without earlier pregnancy diagnosis

Day 27

70%

Oocyte Competence

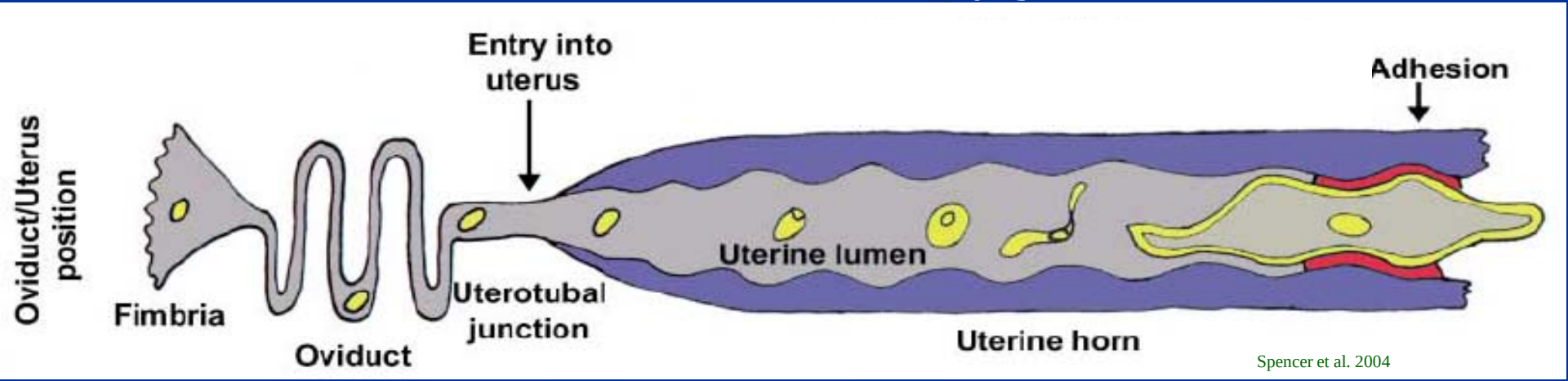


Oviductal support — **d 1 - 4**

Embryo Elongation — **d 5 - 14**

MRP (IFN-τ) — **d 15 - 17**

Uterine dependent period — **d 18 - 27**

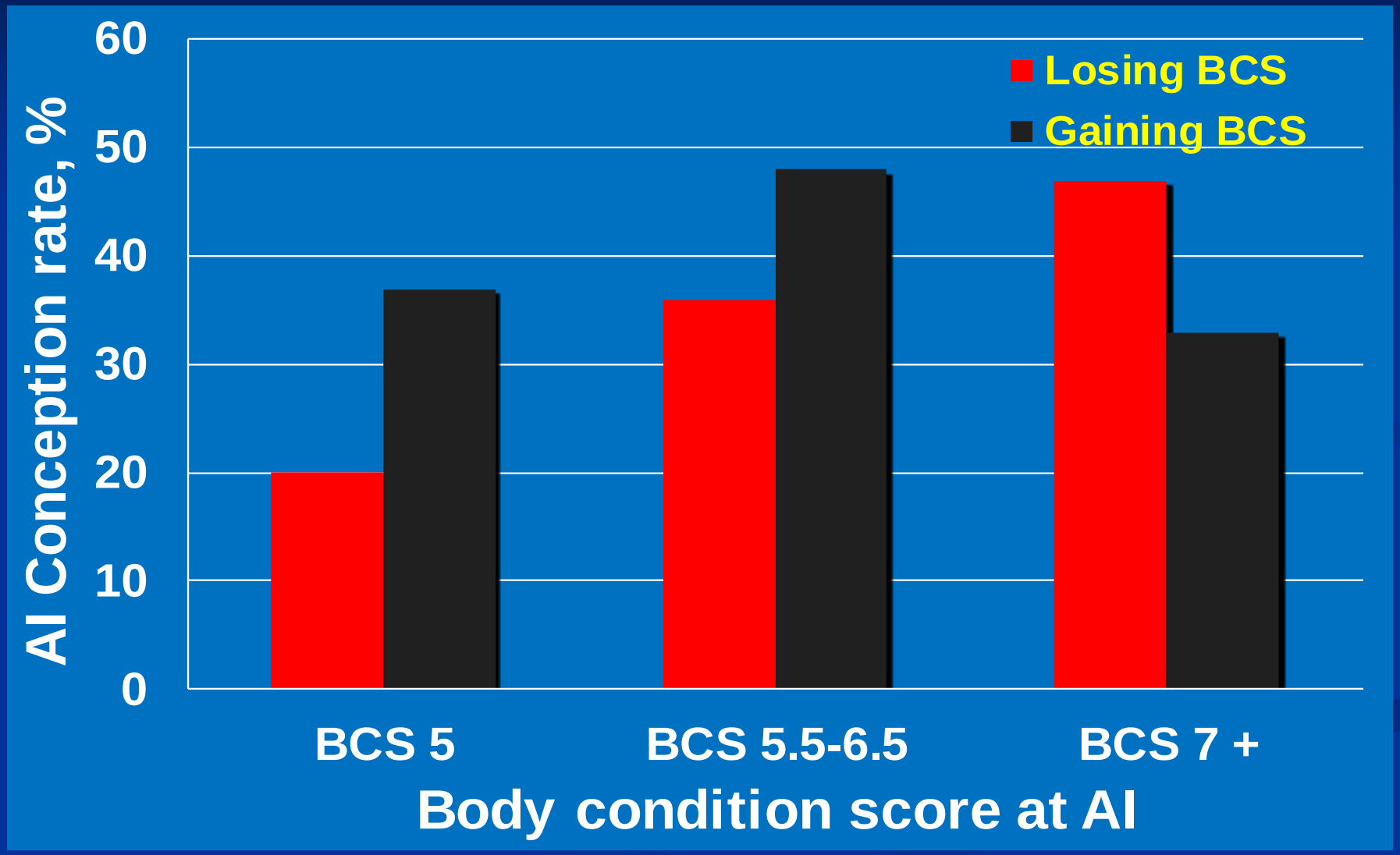


Spencer et al. 2004

Post AI Management

- Anecdotal evidence
- Heifers developed in feedlots (high energy diet) to facilitate AI
  - Conception rates vary tremendously (40-70%)
- Does Post-AI nutritional management play a role?
  - Green grass????

Feedlot AI, then to Grass (~30 d)



Data from George Perry (SDSU)

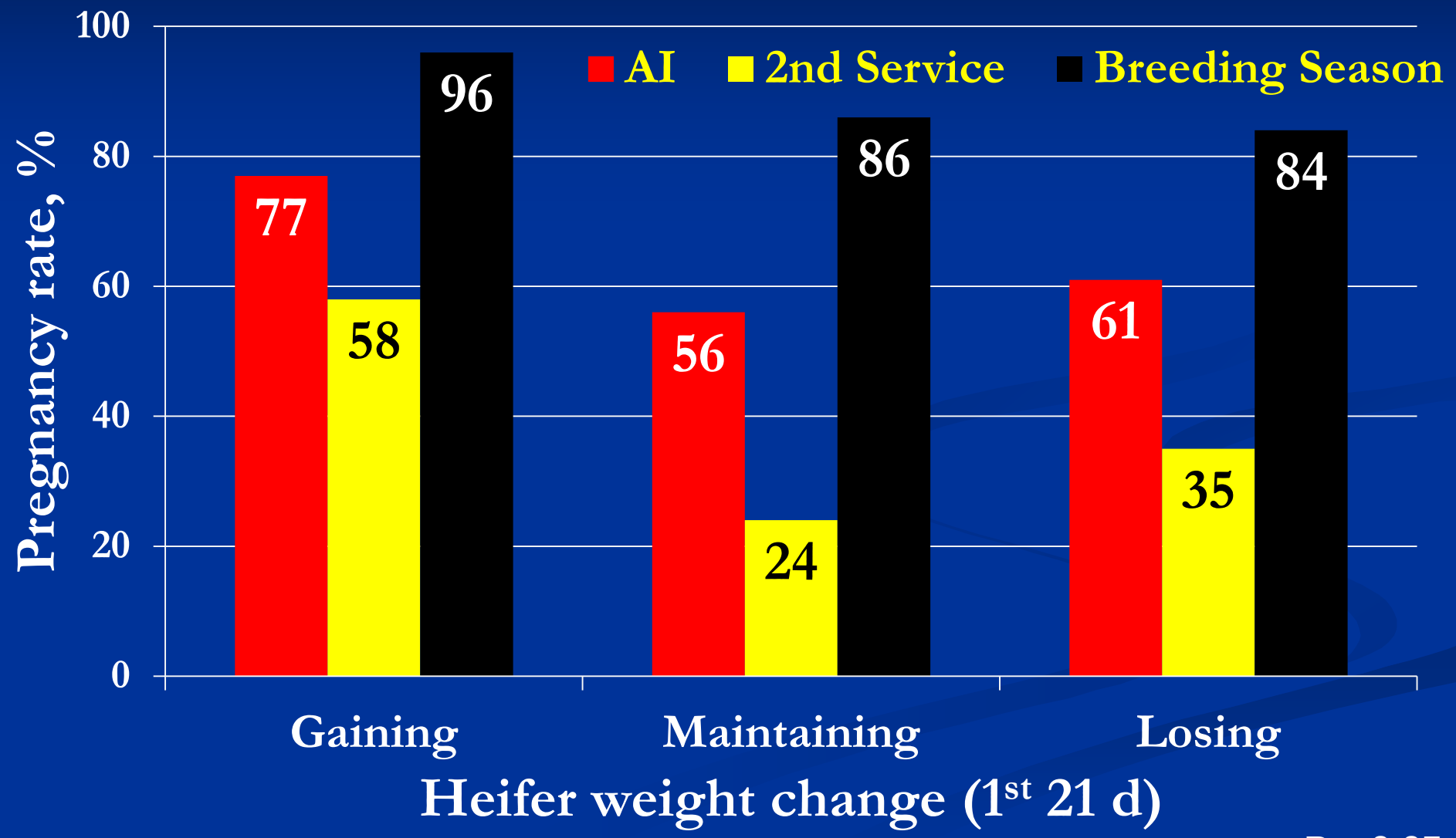
Post AI Nutrition Study

- All heifers gaining 1.5 lbs/d from mid-winter to breeding
  - 21 d after breeding:

	Post AI Weight:
Control (continue 1.5 lbs/d)	**= Gaining**
Drop to maintenance	**= Maintaining**
80% of maintenance	**= Losing**

- Scott Lake (UW) & Ron Lemanger (Purdue), 2012

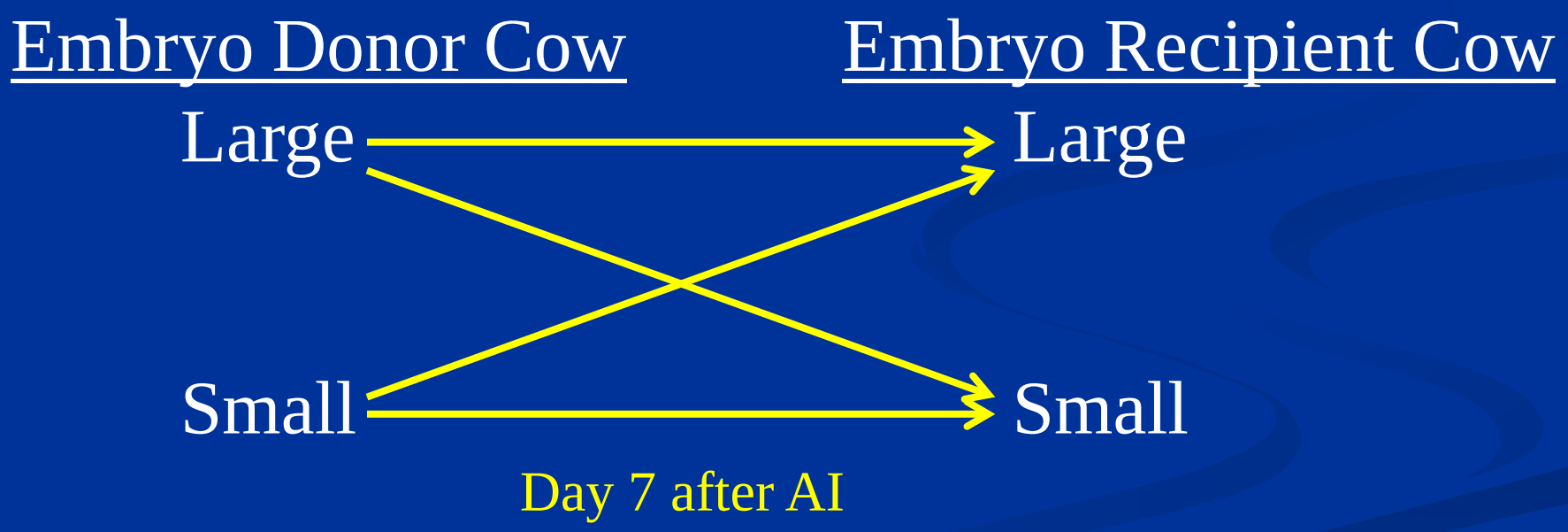
21 d Post-AI Nutrition



$P < 0.05$

Recent Reciprocal ET Study Identified Key Elements of Fertility

GnRH-induced Ovulatory Follicle Size

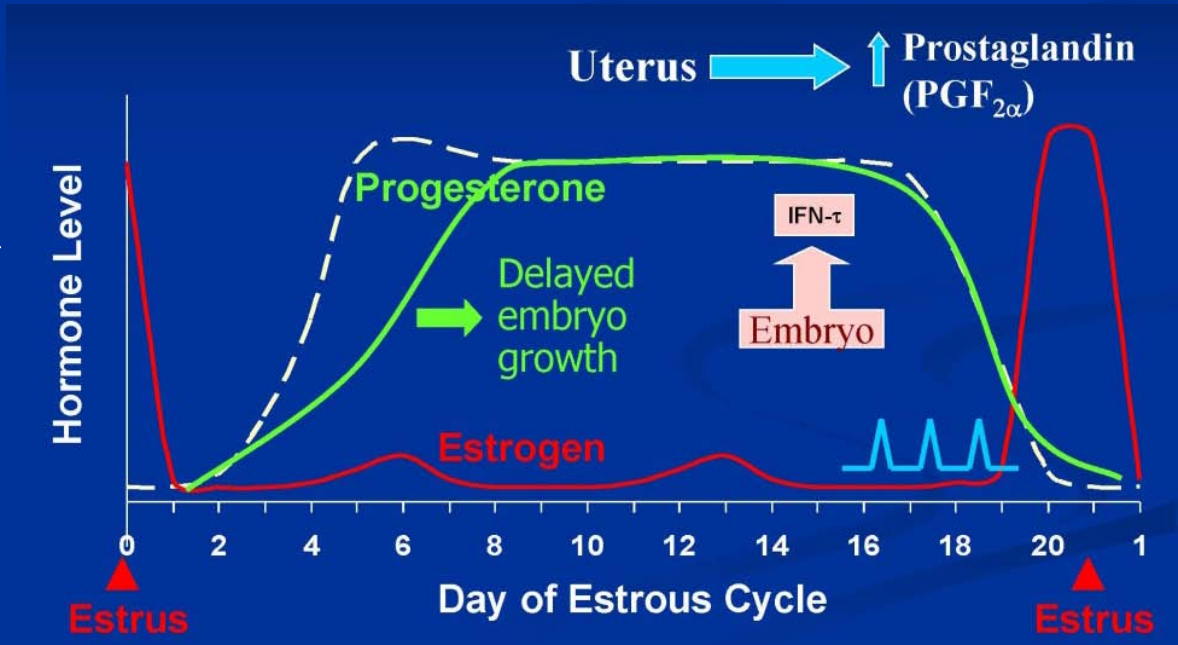


Reciprocal ET Study - Summary

- 3 Primary Measures of Fertility:
  - Fertilization Success
  - Embryo Survival to day 27
  - Embryo Survival to day 72

Recent Reciprocal ET Study Identified Key Elements of Fertility

- High Progesterone after breeding
- What decreases Progesterone?
  - Negative energy balance
  - Increased milk
  - Excess protein
  - Stress
  - ???

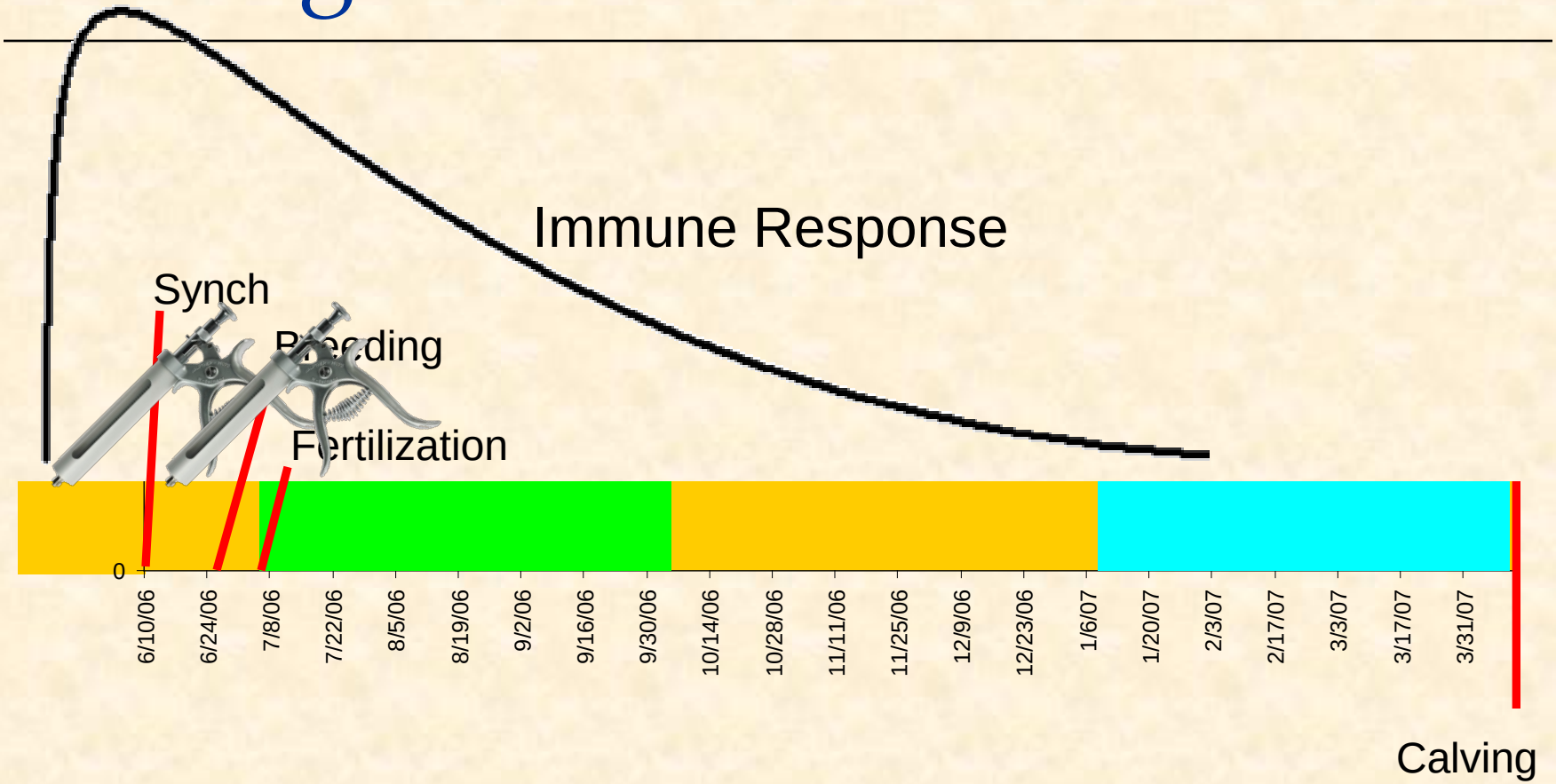


Vaccination Program

- Cow Herd
- Calves
- Bull
- Feeder Cattle

Effects on fertility?

Timing of Vaccination



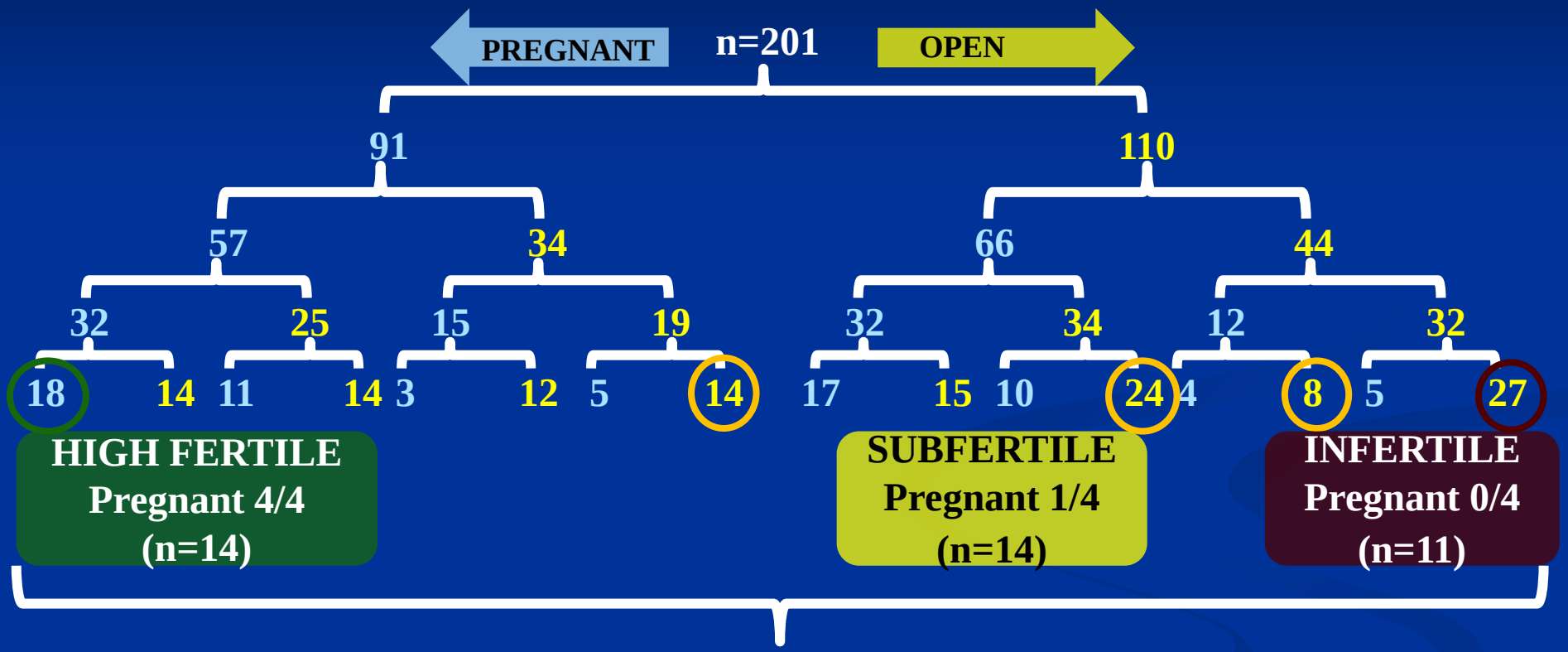
Dr. Russ Daly
South Dakota State University
Cooperative Extension Service

Conclusions

- Pre-breeding vaccination starts before weaning
- Best time for repro vaccines = 30 days pre-breeding
  - Avoid using MLV vaccines in naïve animals < 30 d before breeding

Dr. Russ Daly
South Dakota State University
Cooperative Extension Service
SDSU

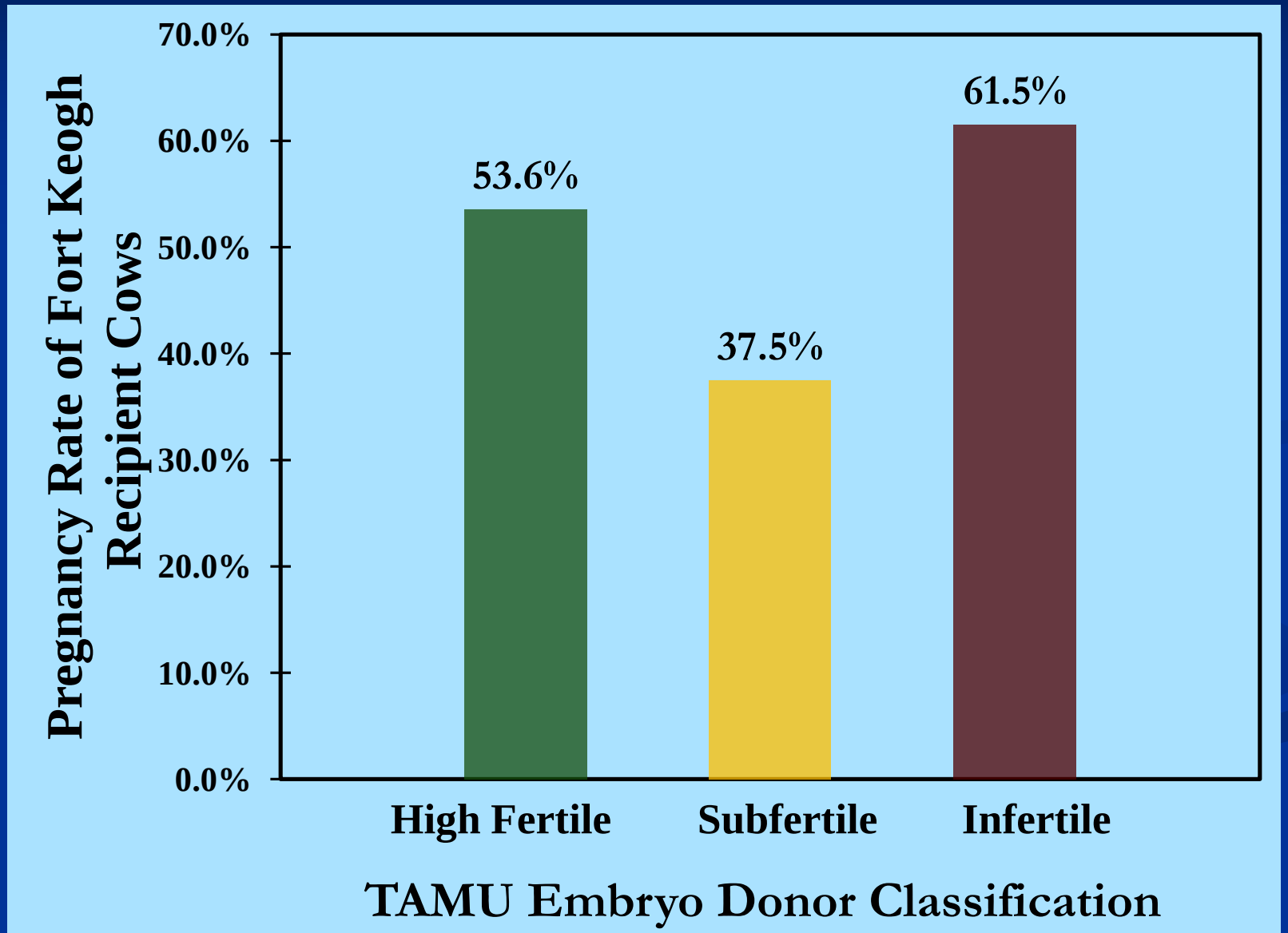
Heifer Fertility: Genetic Markers?



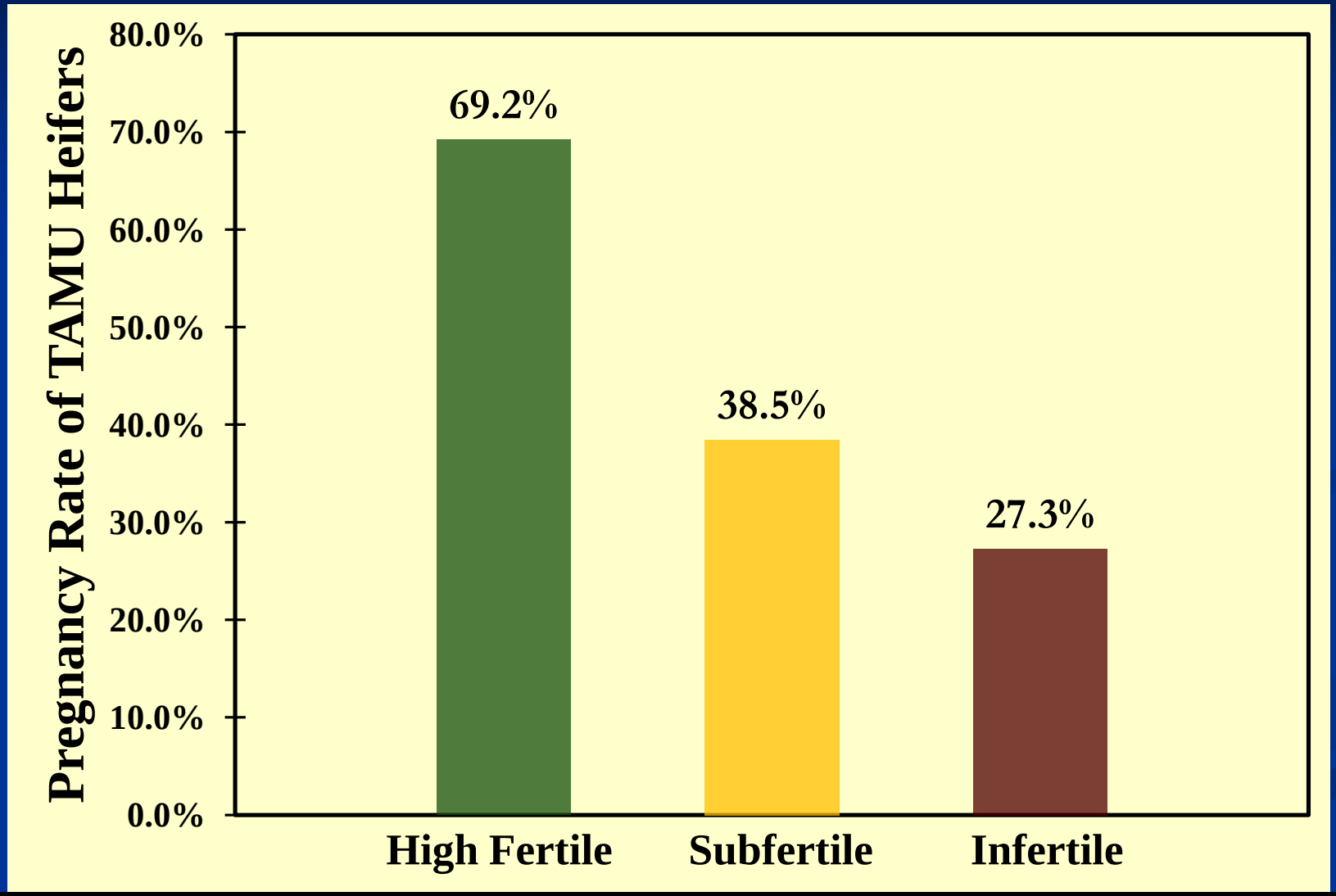
TAMU Heifers to Fort Keogh

1. Embryo donors – oocyte problem
2. Embryo recipients – uterine problem

TAMU Heifers as Embryo Donors



TAMU Heifers as Embryo Recipients



Infertile heifers had compromised maternal environment.

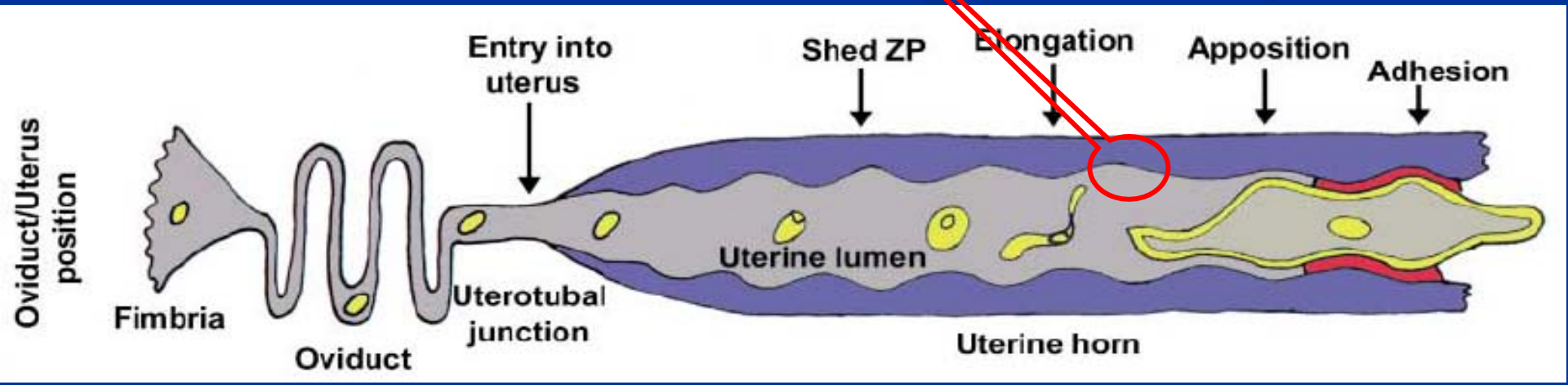
TAMU Heifers

Sent to WSU

1. Uterine Biopsies – expression profiles
2. Genetic Markers?

7 genes identified related to fertility

High Fertile
Subfertile
Infertile



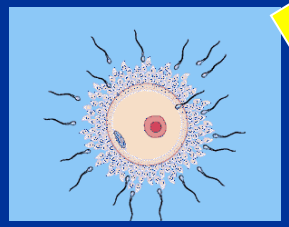
Why / Where is pregnancy failing?

Day 1

95%

What role does the bull have in pregnancy success?

Oocyte Competence



Day 27

70%

Oviductal support

Embryo Elongation

MRP (IFN-τ)

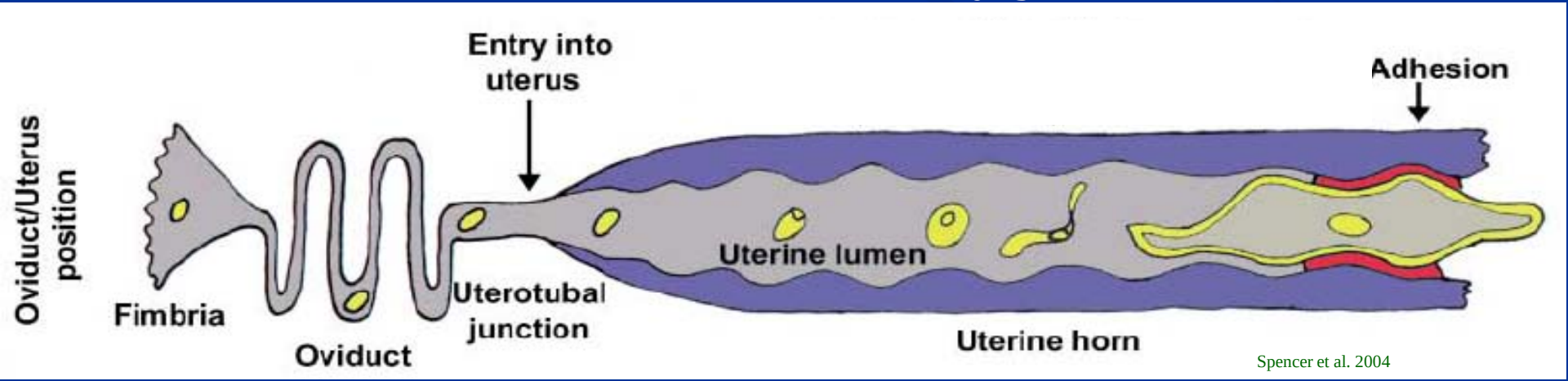
Uterine dependent period

d 1 - 4

d 5 - 14

d 15 - 17

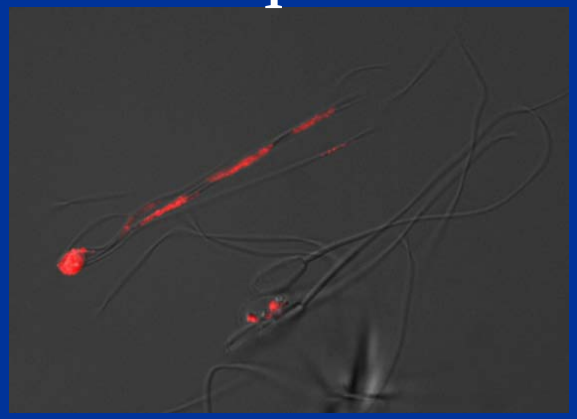
d 18 - 27



Spencer et al. 2004

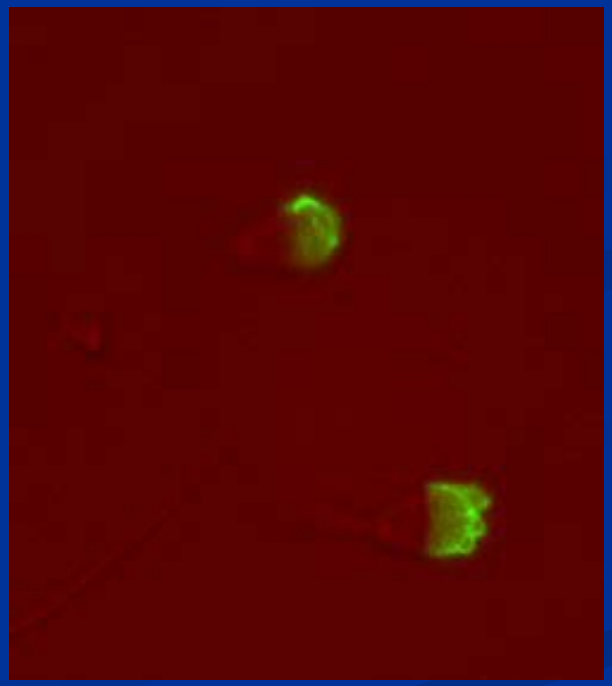
Biological Markers Associated with Fertility

Ubiquitin



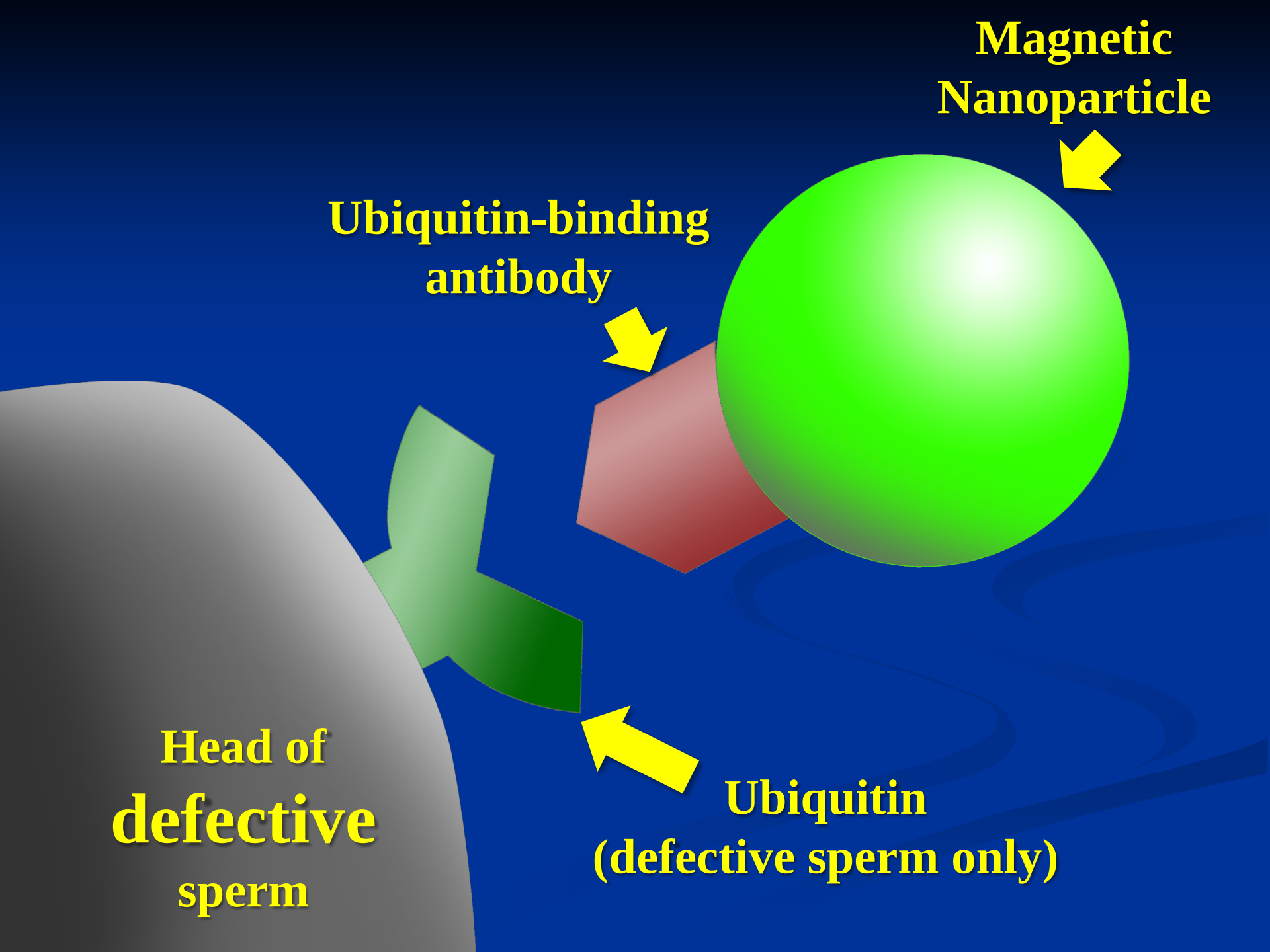
Cellular damage

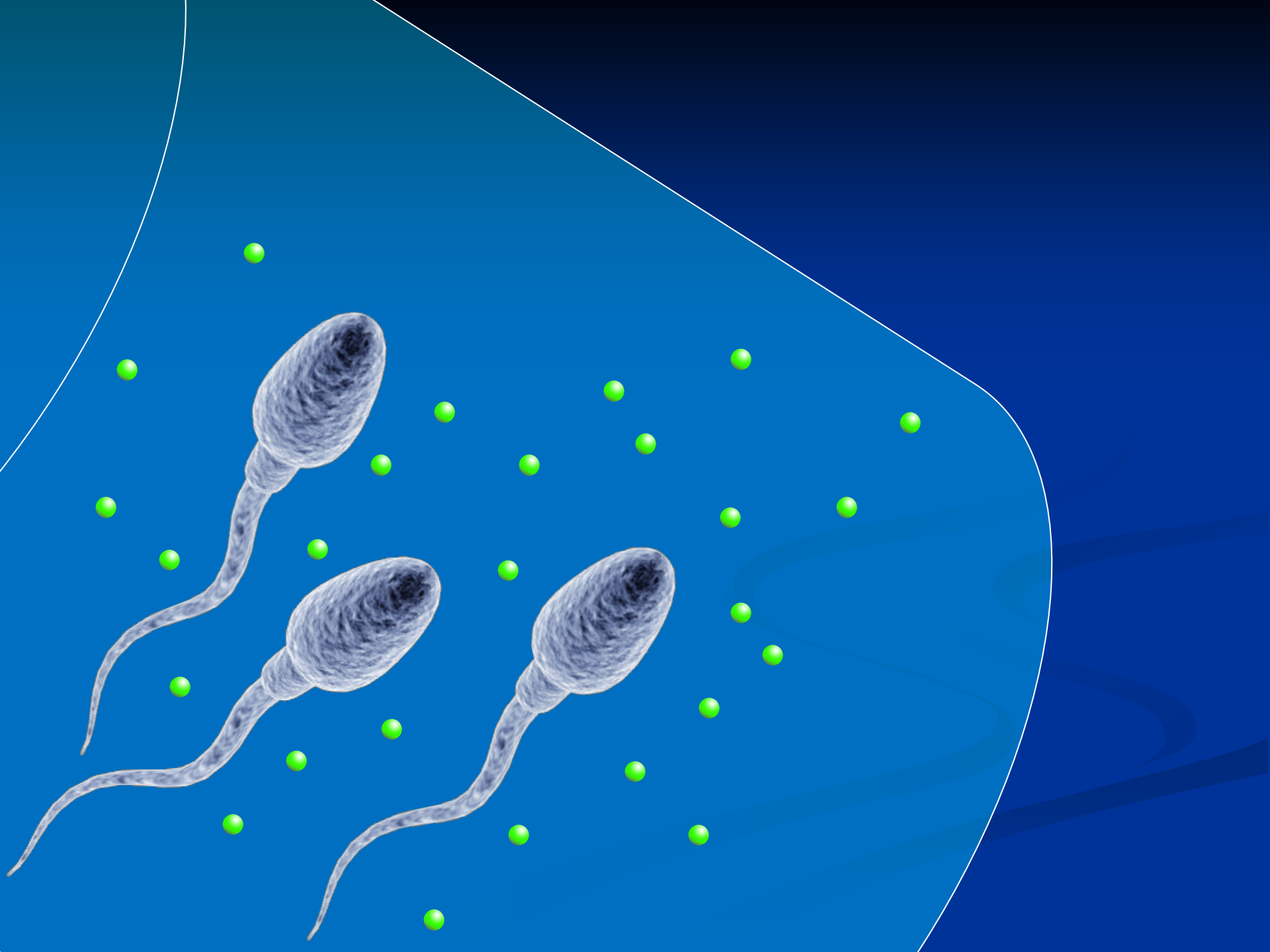
PNA

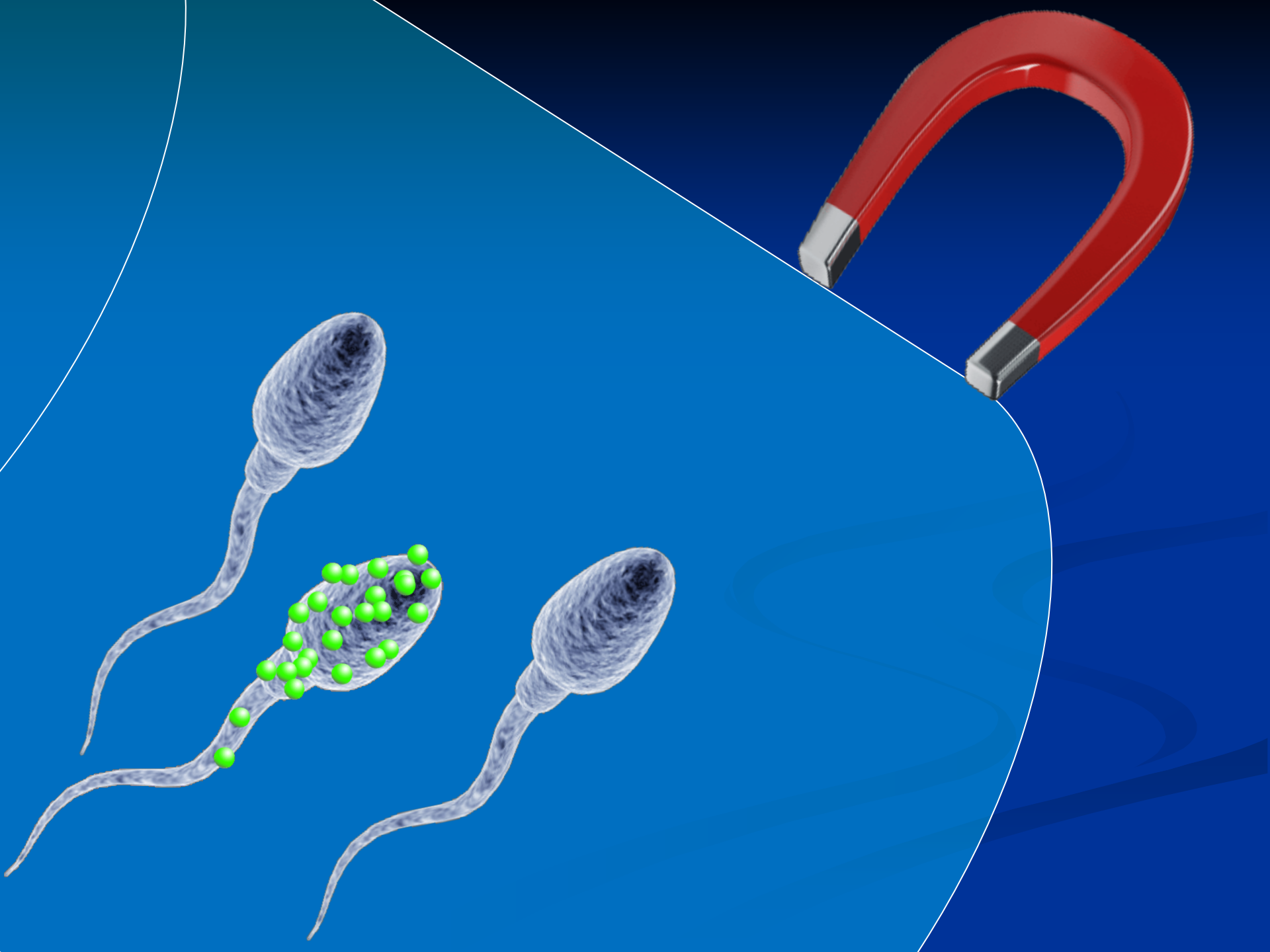


Acrosome reacted sperm

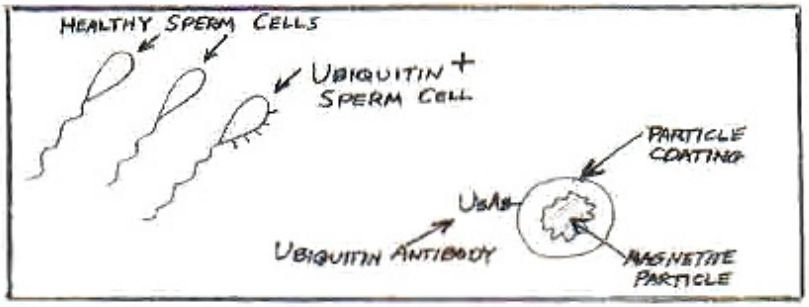
Peter Sutovsky
University of Missouri


Magnetic Nanoparticle
Ubiquitin-binding antibody
Head of defective sperm
Ubiquitin (defective sperm only)





IVF Using Magnetic Sperm Depletion



Magnetic particle containing ubiquitin antibodies are added to semen sample

Ubiquitin antibody recognizes and attaches to Ubiquitin+ sperm cells

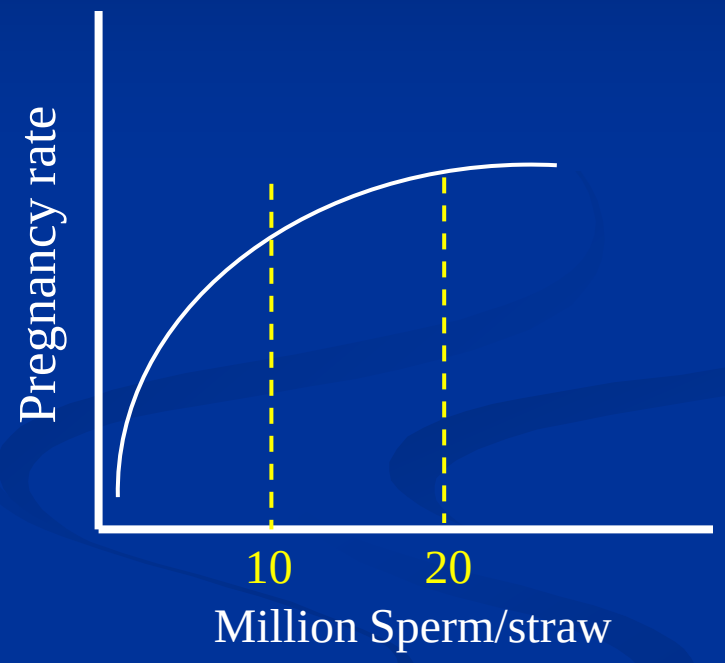
Ubiquitin+ cells removed by external application f permanent magnet

Sperm sorted with Ubiquitin or PNA antibody resulted in greater fertilization & cleavage rate.

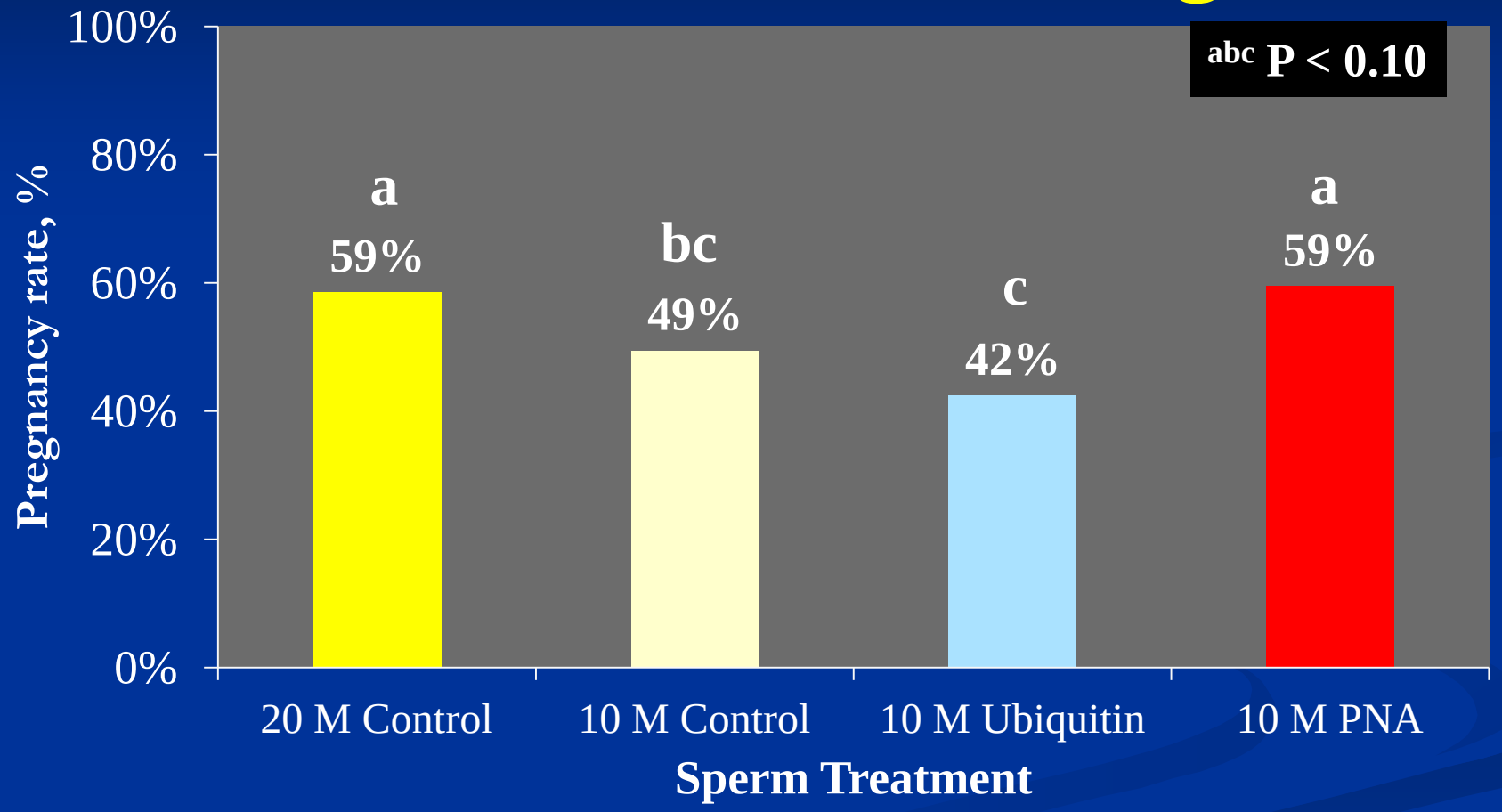
Peter Sutovsky
University of Missouri

Ubiquitin / PNA Nano-Particle Field Trial – Fort Keogh

- 390 Cows + 110 Heifers
- 3 Sires
- 4 Treatments
  - Control 20 x 10^6 Sperm
  - Control 10 x 10^6 Sperm
  - Ubiquitin Sorted 10 x 10^6 Sperm
  - PNA Sorted 10 x 10^6 Sperm



Ubiquitin / PNA Nano-Particle Field Trial – Fort Keogh



Male fertility may account for more than 10% of pregnancy failures. 10% of the time, fertilization achieved by less optimal sperm.

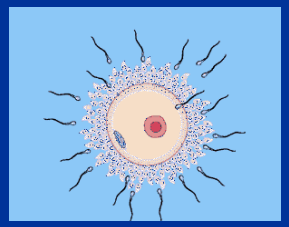
Early pregnancy diagnosis to identify causes of pregnancy failure at Fort Keogh.

Day 1

95%

- d 19 with very good accuracy
  - Endometrial echotexture
  - CL blood flow

Oocyte Competence



Oviductal support

En
Elon

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Day 30

70%

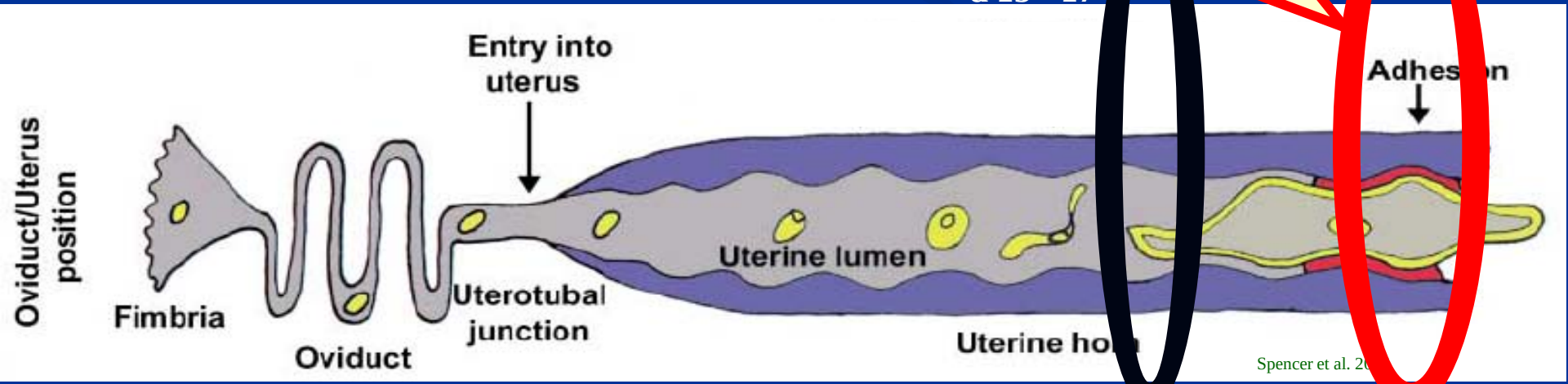
Current Technology (d 27)
Ultrasound
Blood – Pregnan specific proteins

d 1 - 4

d 5 - 14

d 15 - 17

28



Spencer et al. 2

Fertile Mating?

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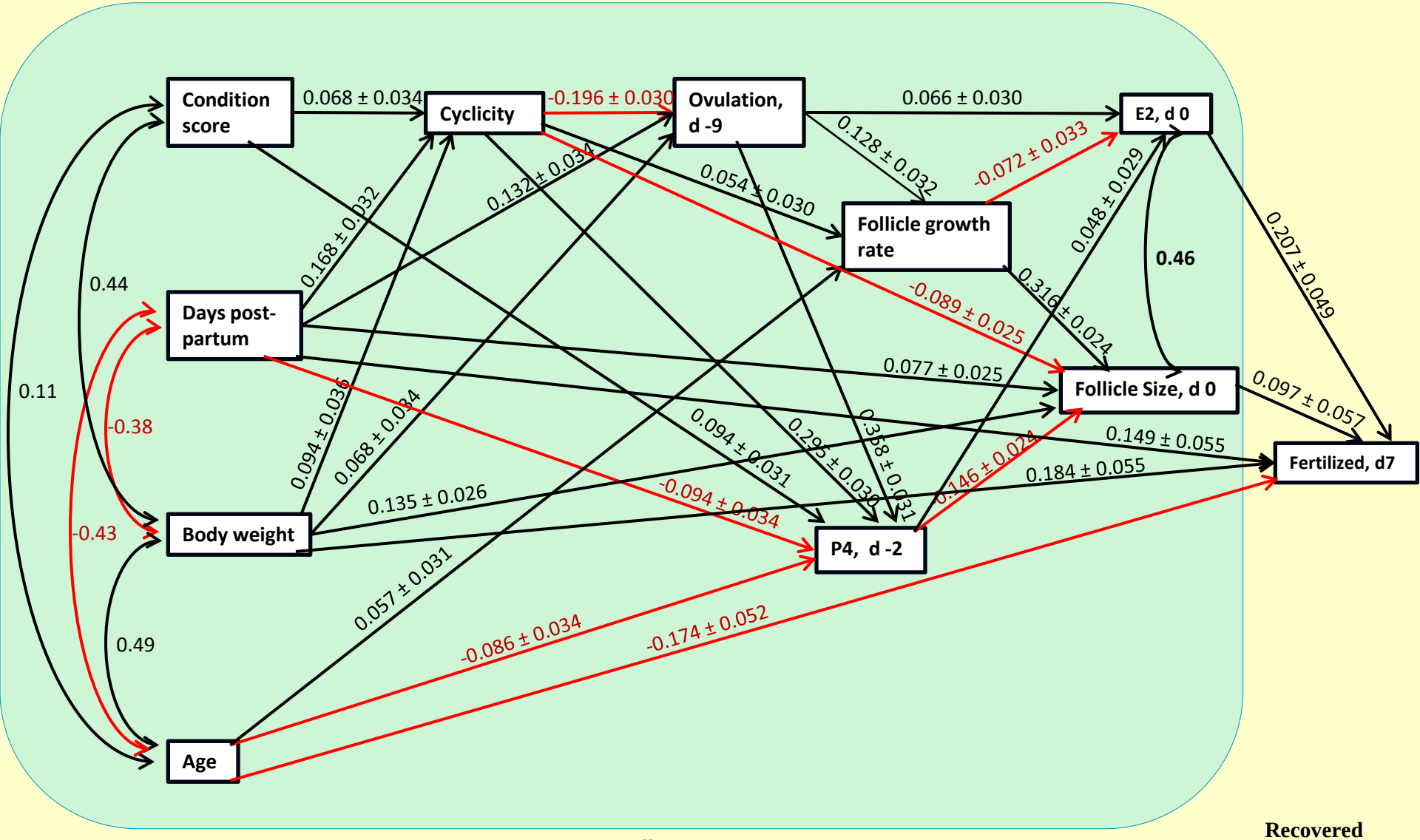
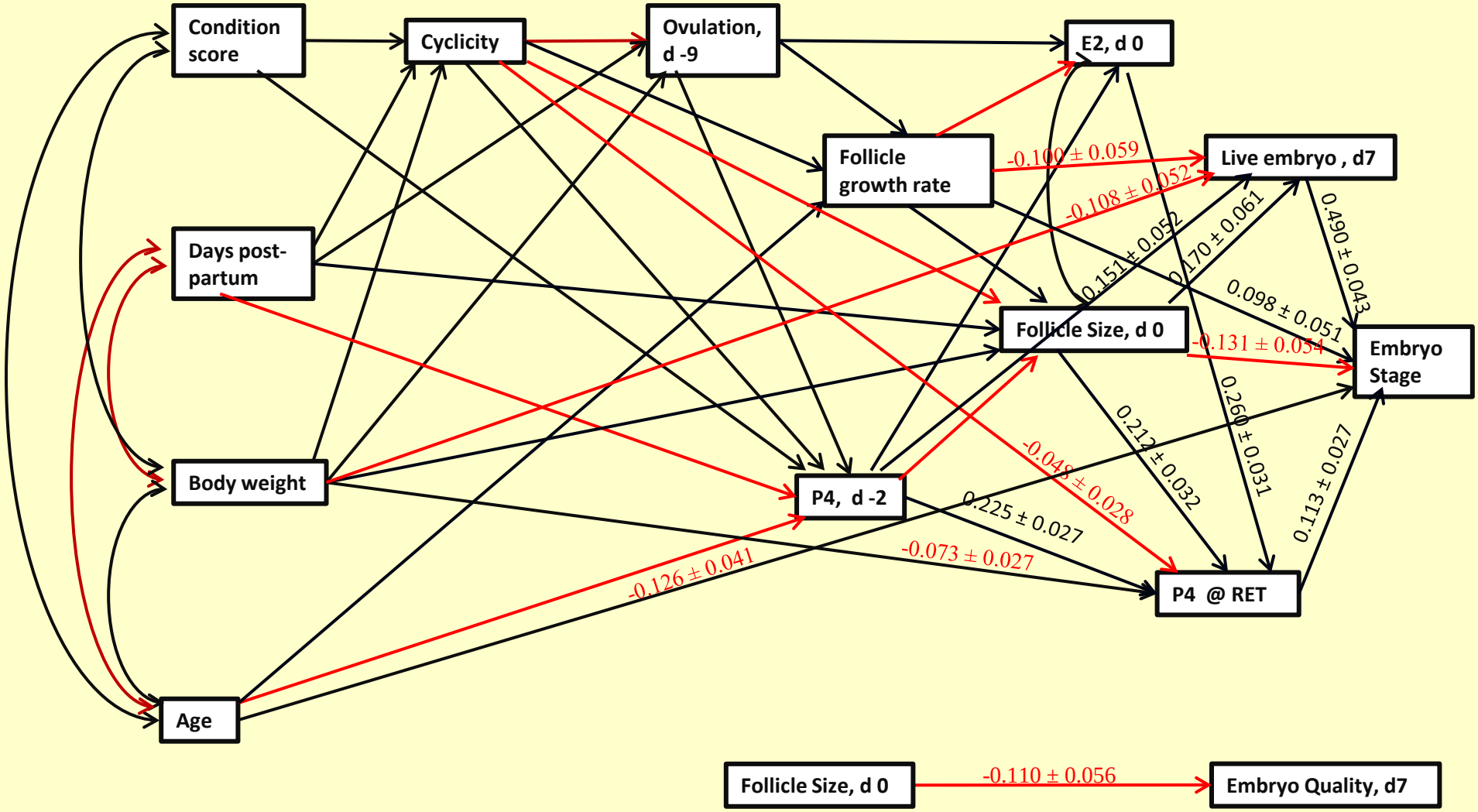
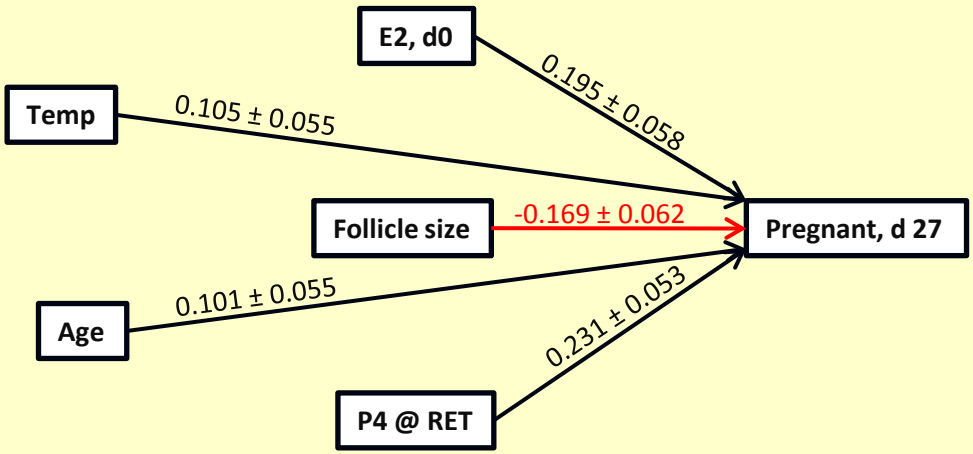
Path Diagram: Embryo Donor Cow



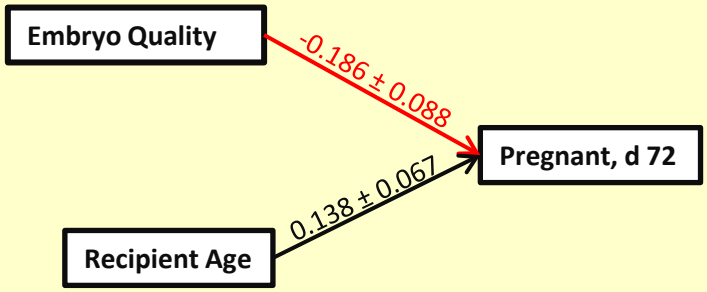
Path Diagram: Additional Fertility Measures – Embryo Donor Cow



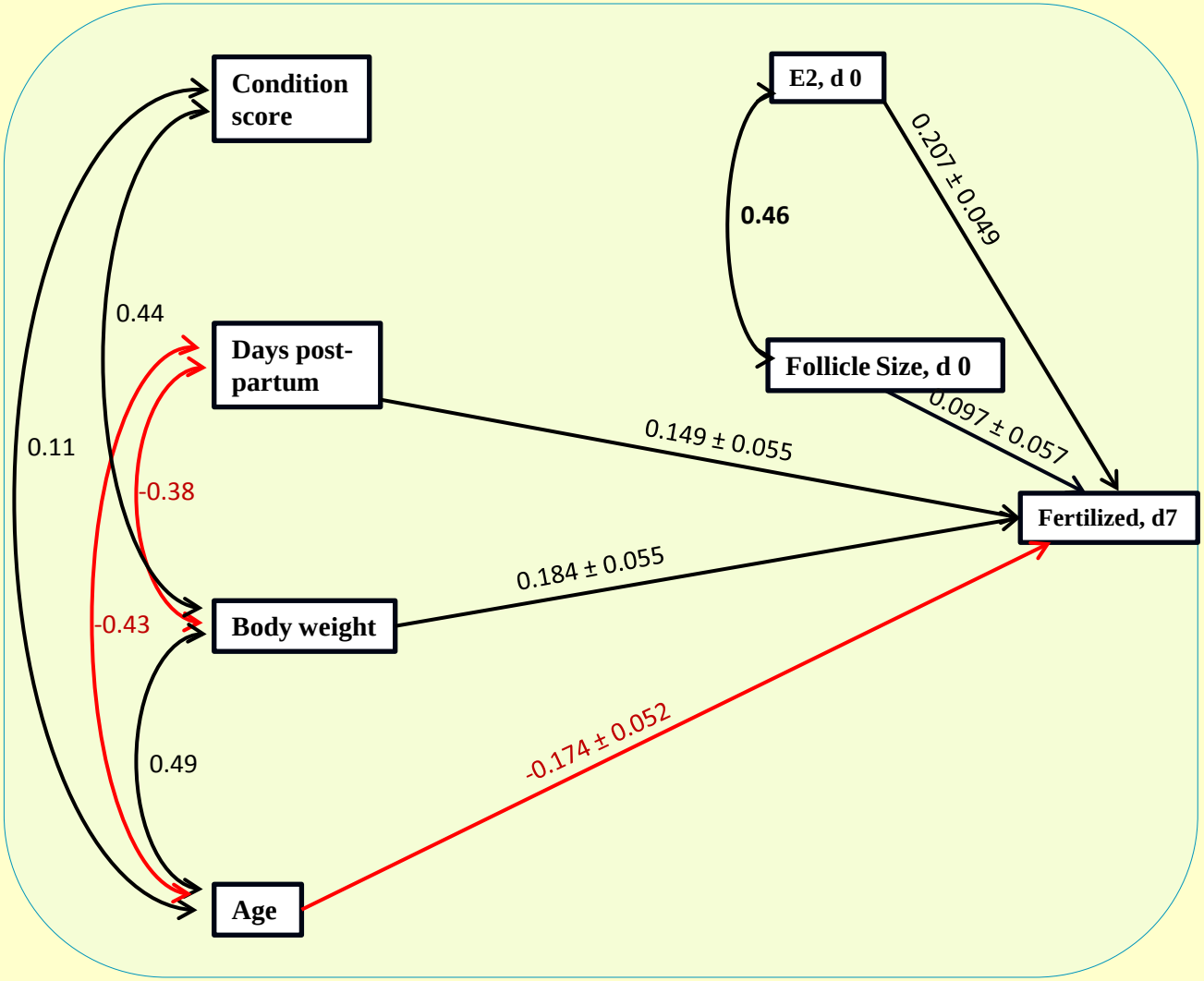
Path Diagram: Embryo Recipient Cow



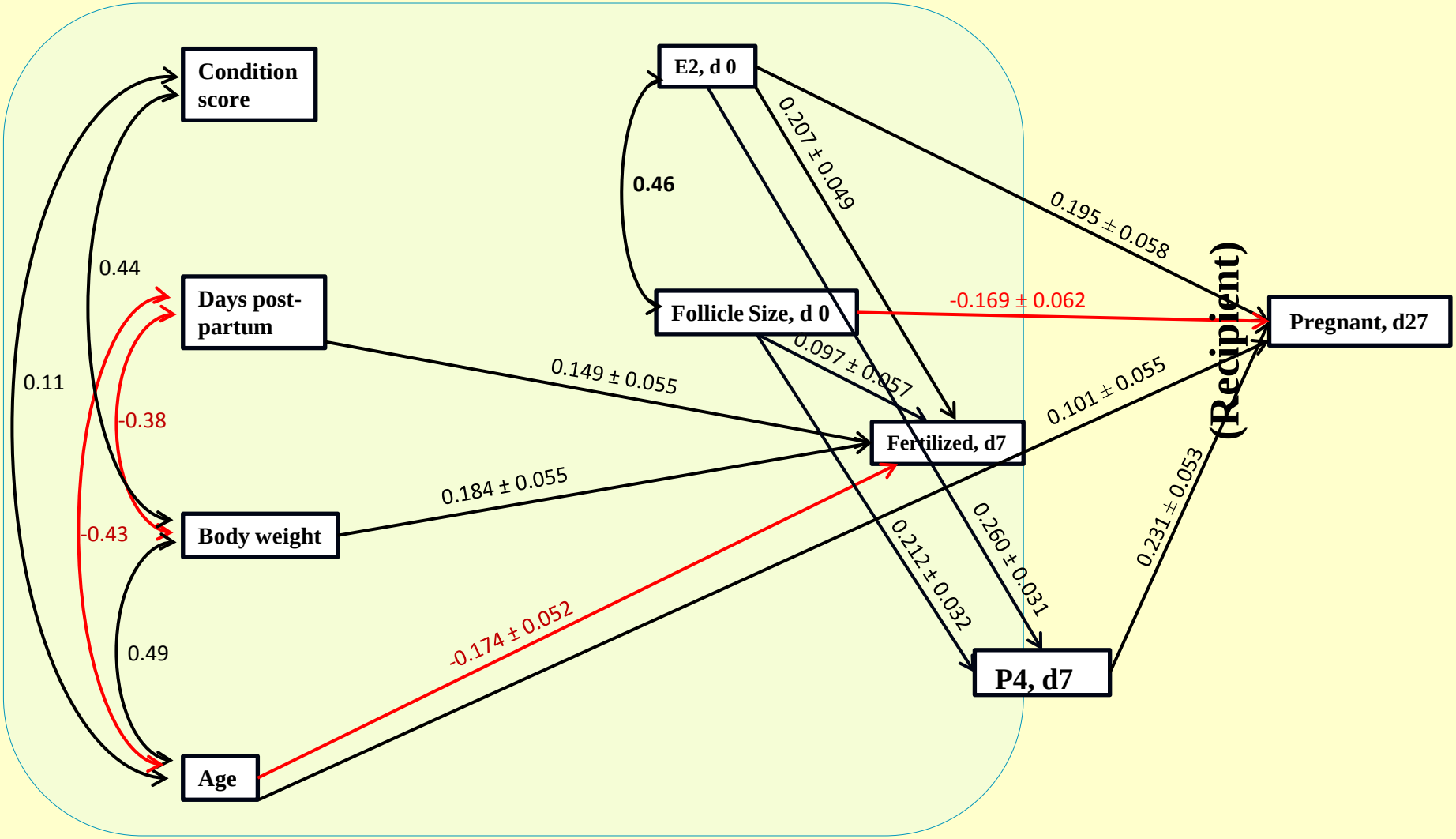
All the preceding stuff back here



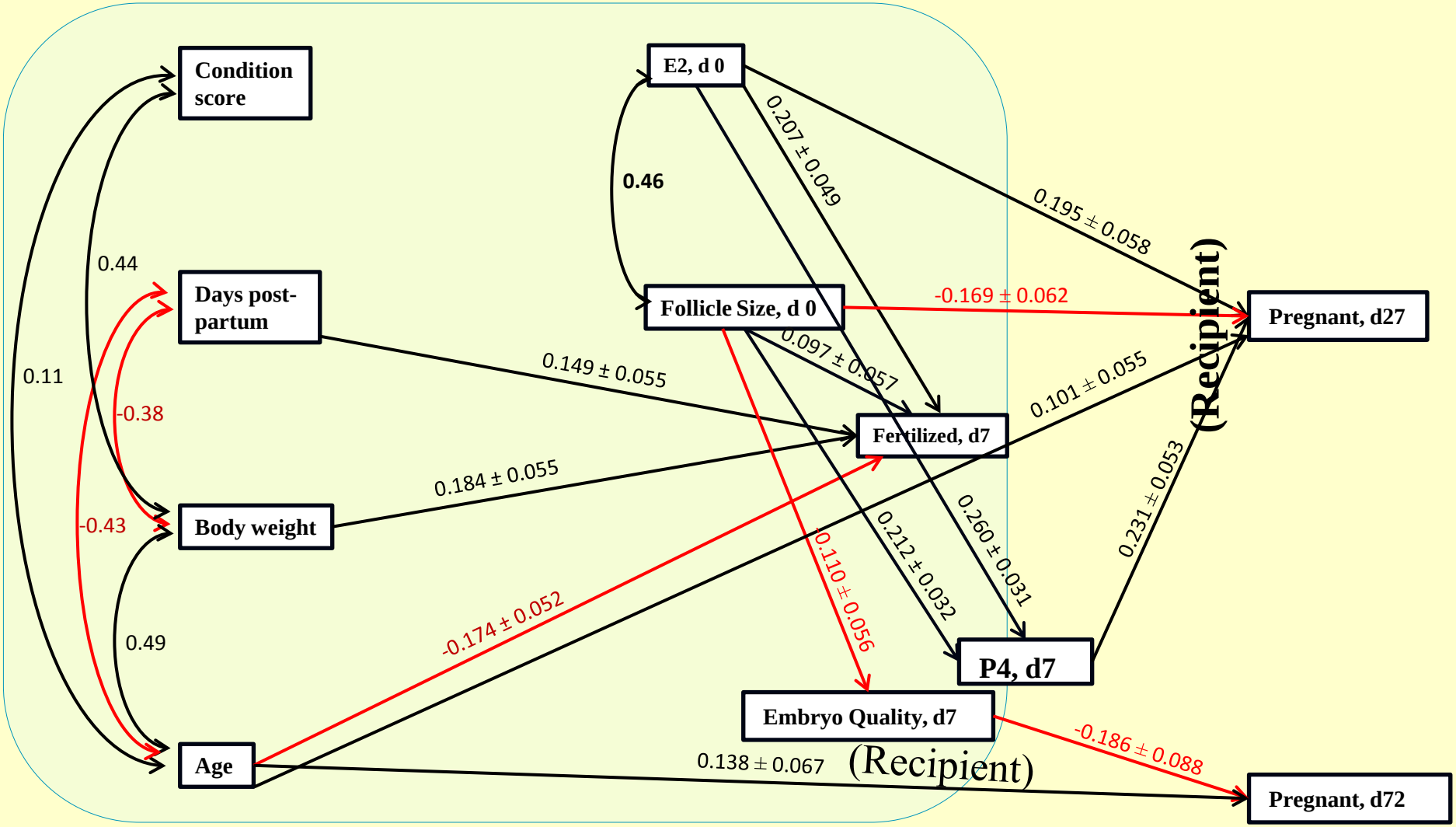
Some Summary Effects: Fertilization



Some Summary Effects: Pregnant d 27



Some Summary Effects: Pregnant d 72



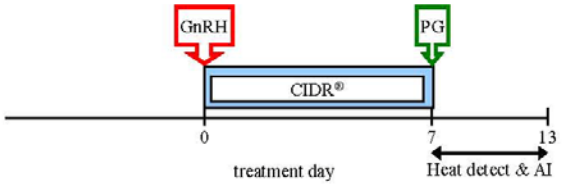
Cow Protocols - 2012

Beef Cow Protocols - 2012

Heat Detection

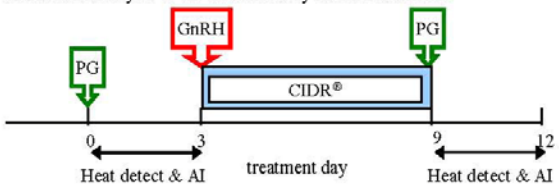
Select Synch

Select Synch + CIDR®



PG 6-day CIDR®

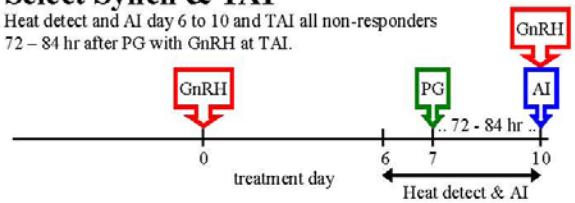
Heat detect and AI days 0 to 3. Administer CIDR to non-responders and heat detect and AI days 9 to 12. Protocol may be used in heifers.



Heat Detect & Time AI (TAI)

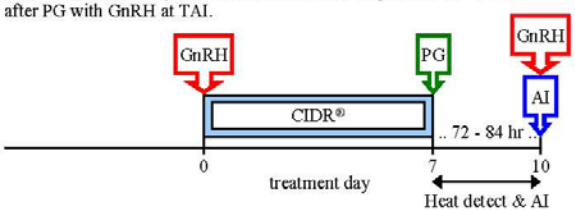
Select Synch & TAI

Heat detect and AI day 6 to 10 and TAI all non-responders 72 – 84 hr after PG with GnRH at TAI.



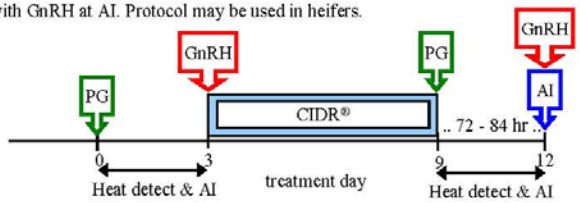
Select Synch + CIDR® & TAI

Heat detect and AI day 7 to 10 and TAI all non-responders 72 - 84 hr after PG with GnRH at TAI.



PG 6-day CIDR® & TAI

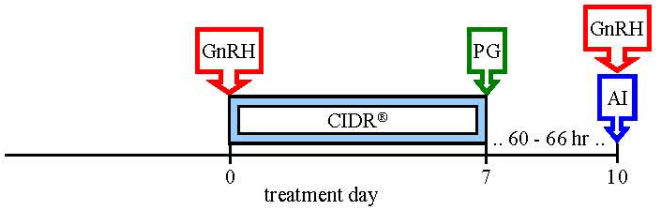
Heat detect & AI days 0 to 3. Administer CIDR to non-responders & heat detect and AI days 9 to 12. TAI non-responders 72 - 84 hr after CIDR removal with GnRH at AI. Protocol may be used in heifers.



Fixed-time AI (TAI)*

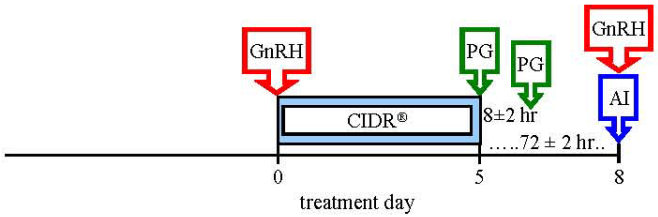
7-day CO-Synch + CIDR®

Perform TAI at 60 to 66 hr after PG with GnRH at TAI.



5-day CO-Synch + CIDR®

Perform TAI at 72 ± 2 hr after 1st PG with GnRH at TAI.
Two injections of PG 8 ± 2 hr apart are required for this protocol.



Comparison Of Protocols For Beef Cows

Heat Detection	Cost	Labor
Select Synch	Low	Medium/High
Select Synch + CIDR®	High	Medium
PG 6-day CIDR®	Medium	Medium/High

Heat Detect & TAI	Cost	Labor
Select Synch (TAI non-responders 72-84 hr after PG)	Low	Medium/High
Select Synch + CIDR® (TAI non-responders 72-84 hr after PG)	High	Medium
PG 6-day CIDR® (TAI non-responders 72-84 hr after PG)	Medium	Medium/High

Fixed-Time AI (TAI)	Cost	Labor
7-day CO-Synch + CIDR® (TAI 60 to 66 hr after PG with GnRH at TAI)	High	Medium
5-day CO-Synch + CIDR® (TAI 72 ± 2 hr after 1st PG with GnRH at TAI)	High	High

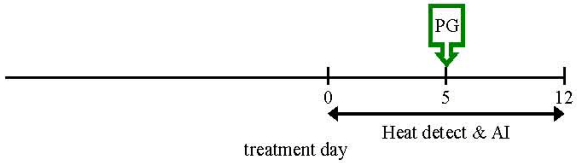
- The times listed for "Fixed-time AI" should be considered as the approximate average time of insemination. This should be based on the number of cows to inseminate, labor, and facilities.

Heifer Protocols

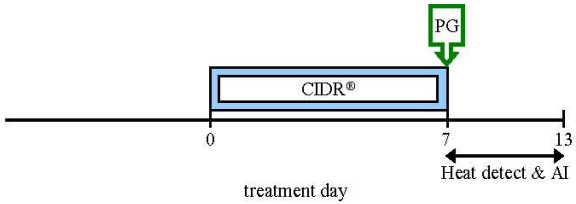
BEEF HEIFER PROTOCOLS - 2012

HEAT DETECTION

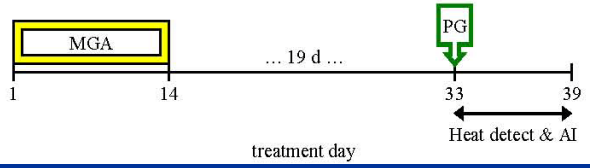
1 Shot PG



7-day CIDR®-PG



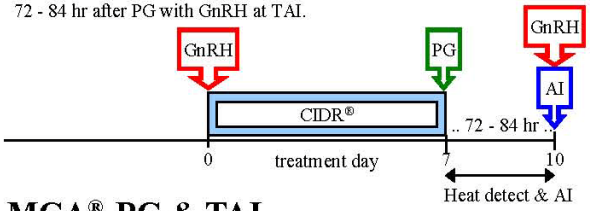
MGA®-PG



HEAT DETECT & TIME AI (TAI)

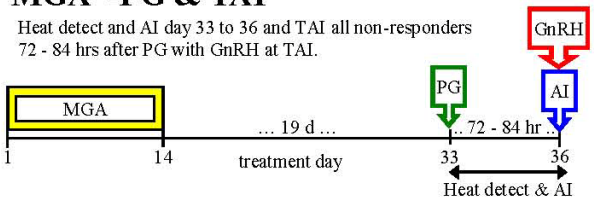
Select Synch + CIDR® & TAI

Heat detect and AI day 7 to 10 and TAI all non-responders 72 - 84 hr after PG with GnRH at TAI.



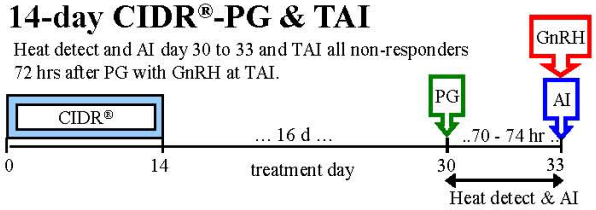
MGA®-PG & TAI

Heat detect and AI day 33 to 36 and TAI all non-responders 72 - 84 hrs after PG with GnRH at TAI.



14-day CIDR®-PG & TAI

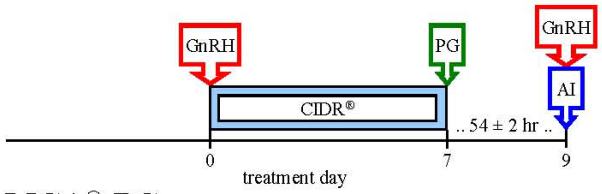
Heat detect and AI day 30 to 33 and TAI all non-responders 72 hrs after PG with GnRH at TAI.



FIXED-TIME AI (TAI)*

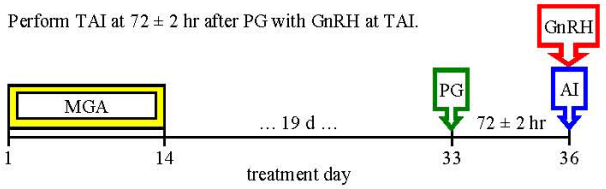
7-day CO-Synch + CIDR®

Perform TAI at 54 ± 2 hr after PG with GnRH at TAI.



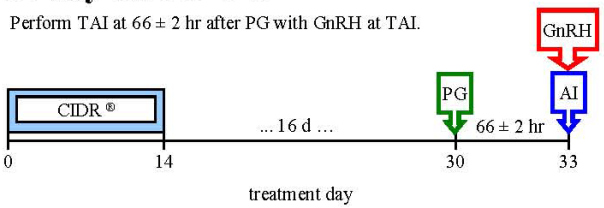
MGA®-PG

Perform TAI at 72 ± 2 hr after PG with GnRH at TAI.



14-day CIDR®-PG

Perform TAI at 66 ± 2 hr after PG with GnRH at TAI.



COMPARISON OF PROTOCOLS FOR BEEF HEIFERS

HEAT DETECTION	COST	LABOR
1 Shot PG	Low	High
7-day CIDR®-PG	High	Medium
MGA®-PG	Low	Low/Medium

HEAT DETECT & TAI	COST	LABOR
Select Synch + CIDR® (TAI non-responders 72-84 hr after PG)	High	Medium
MGA®-PG (TAI non-responders 72-84 hr after PG)	Medium	Medium
14-day CIDR®-PG (TAI non-responders 70-74 hr after PG)	High	Medium

FIXED-TIME AI (TAI)	COST	LABOR
CO-Synch + CIDR® (TAI 54 ± 2 hr after PG with GnRH at TAI)	High	Medium
MGA®-PG (TAI 72 ± 2 hr after PG with GnRH at TAI)	Medium	Medium
14-day CIDR®-PG (TAI 66 ± 2 hr after PG with GnRH at TAI)	High	Medium

Synchronization Products

GnRH = Gonadotropin Releasing Hormone

GnRH

Cystorelin®, Factrel®, Fertagyl®, OvaCyst®

PG

estroPLAN®, Estrumate®, In-Synch®, Lutalyse®, ProstaMate®

Identical
$ 2.00

Equal
$ 2.00

PG = PGF = Prostaglandin $F_{2\alpha}$

5 cc

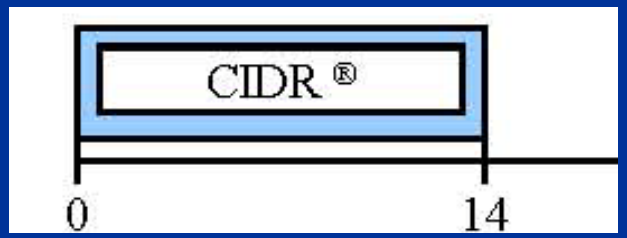
2 cc

Synchronization Products

MGA = Melengestrol Acetate

Feed Additive

Progestin = “Progesterone Like”



Intra-vaginal Device

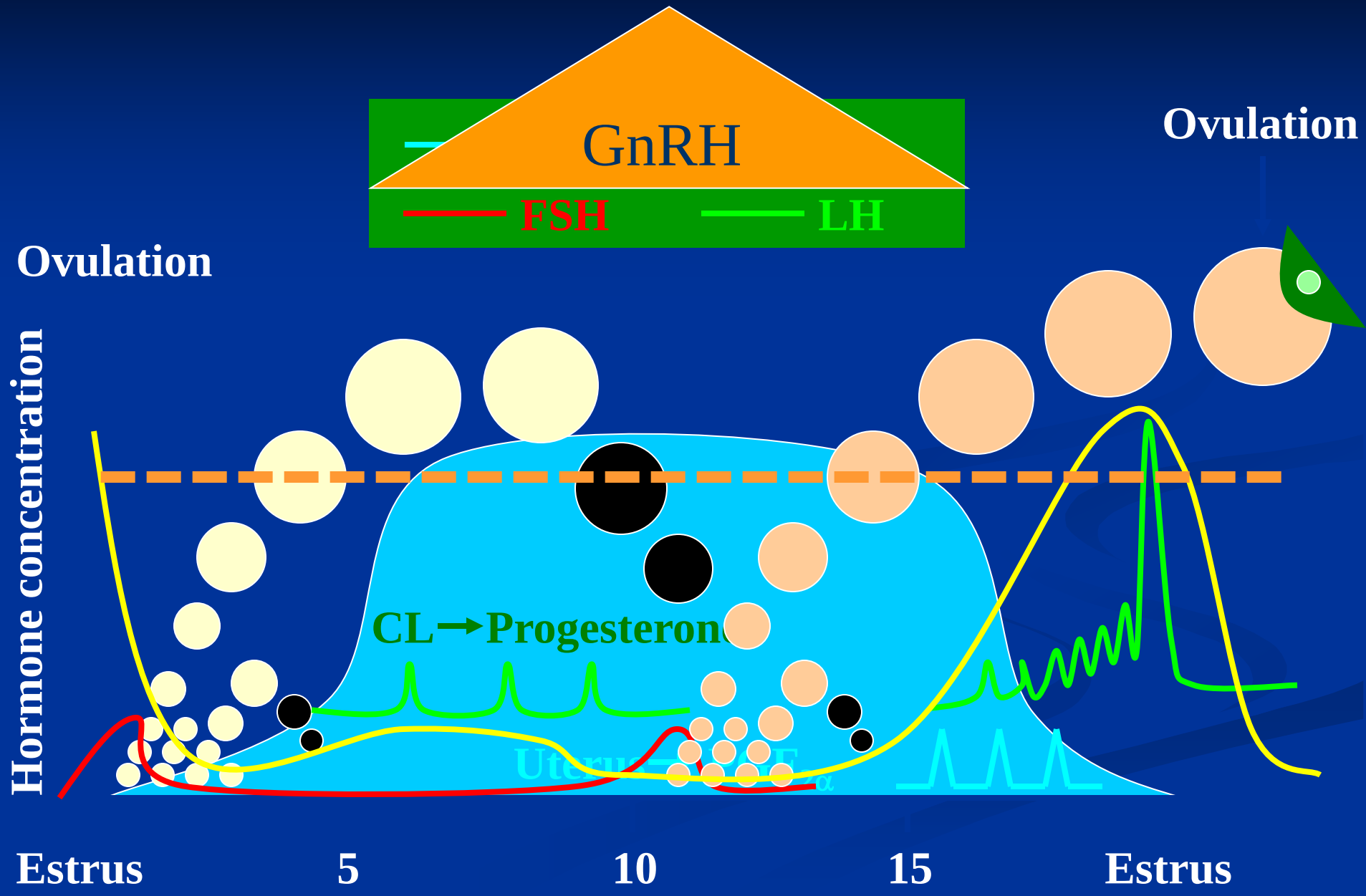
Progesterone

Not Equal

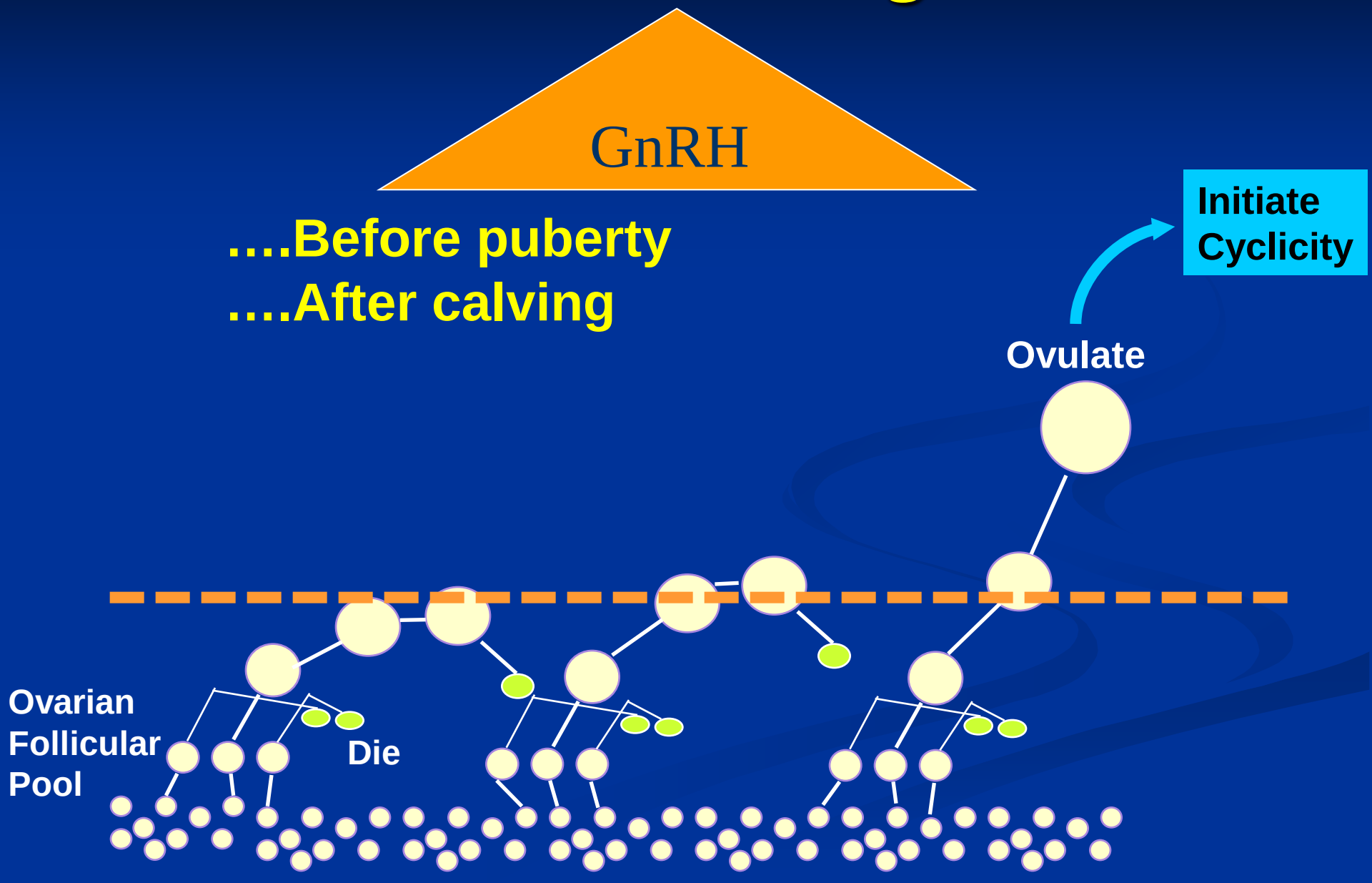
CIDR = Controlled Internal Drug Releaser

CIDR = Much better job of inducing estrous cycles

THE ESTROUS CYCLE

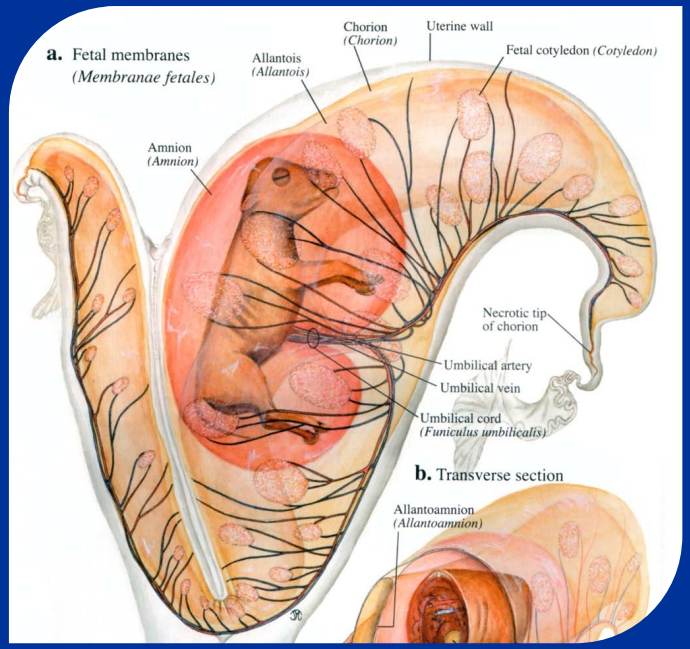


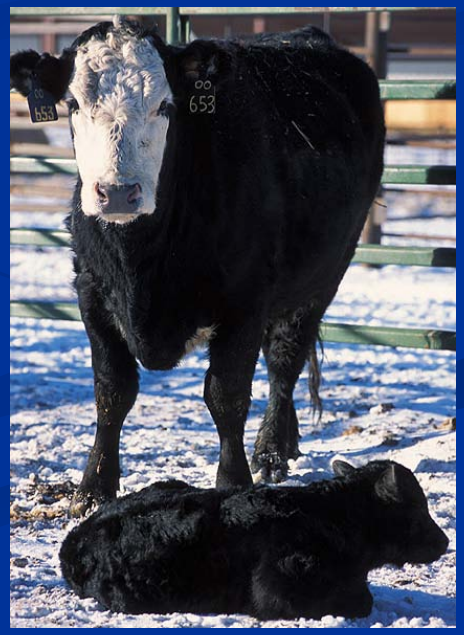
Follicular Waves during Anestrus



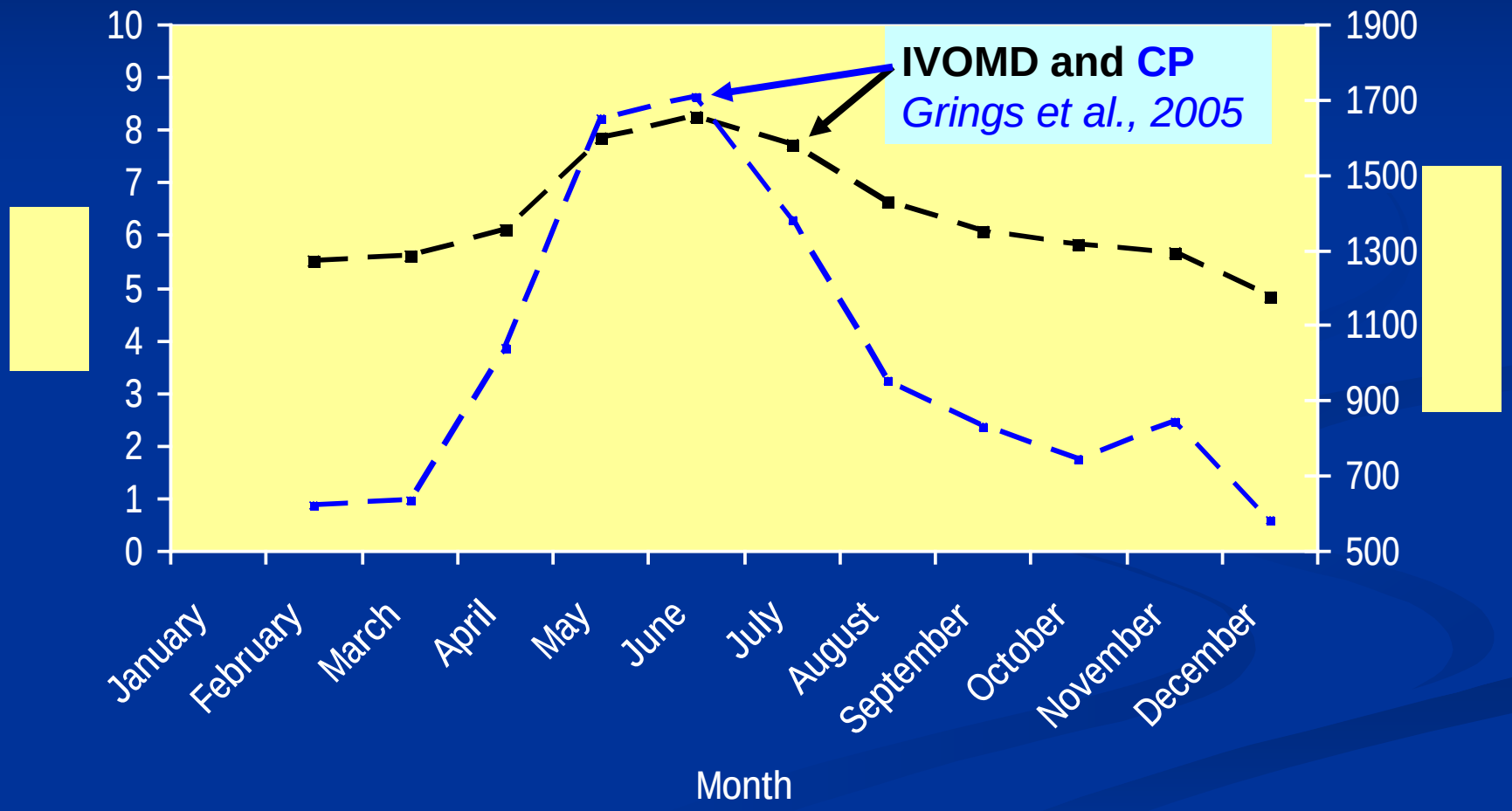
In Utero Influence on Development of Replacement Heifers

- Uterine environment: Dam's nutrition during embryo & fetal development = lifelong effects.

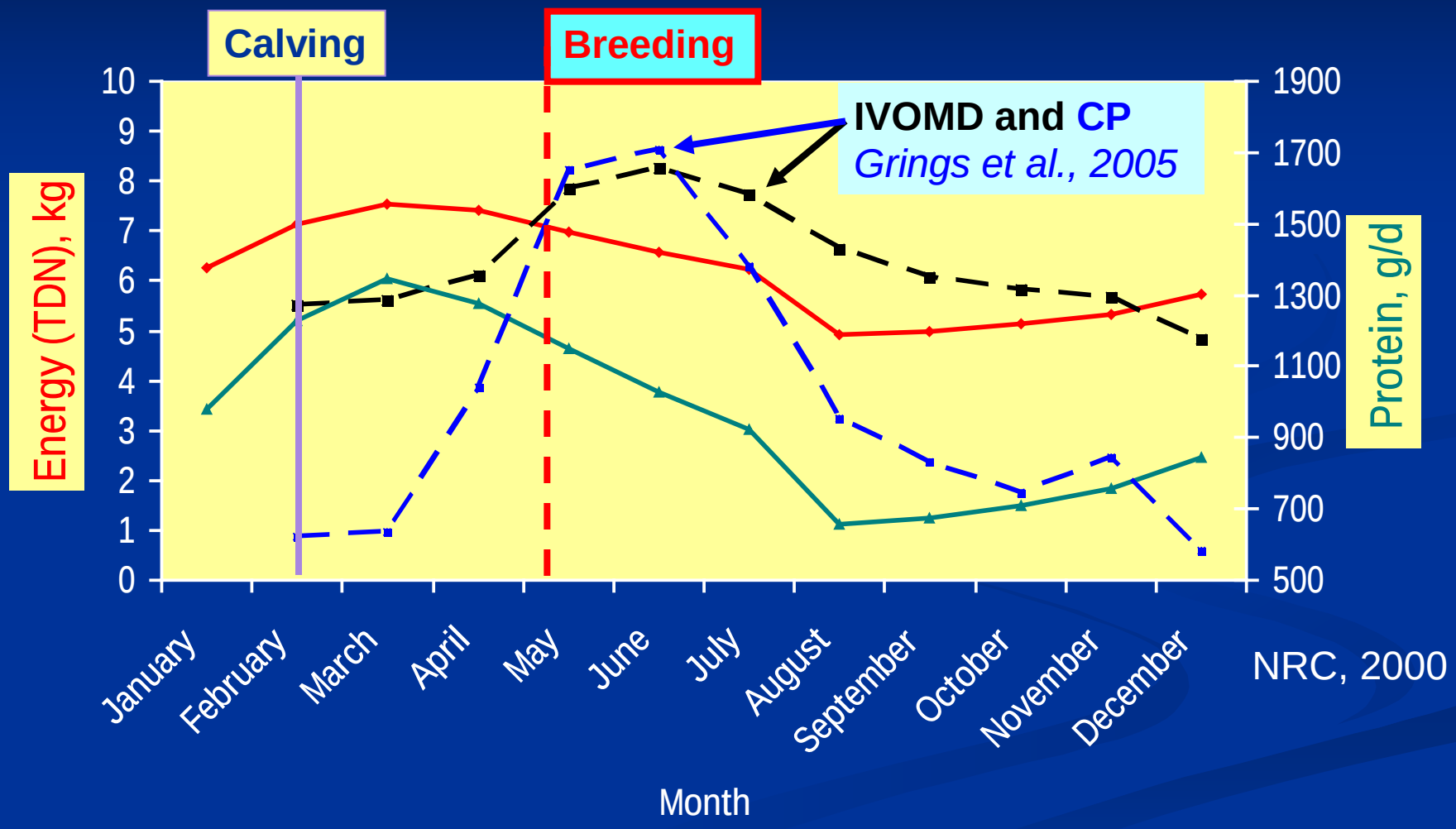




IVOMD and CP Availability: Montana



Cow Energy & Protein Requirements



Possible Mechanism(s)?