

# The Estrous Cycle in Cattle

Physiology and Endocrinology

# Overview

- Estrous cycle
- Synchronization and benefits
- Selecting heifers
  - RTS
  - Conditioning
- Products and prices
- Summation

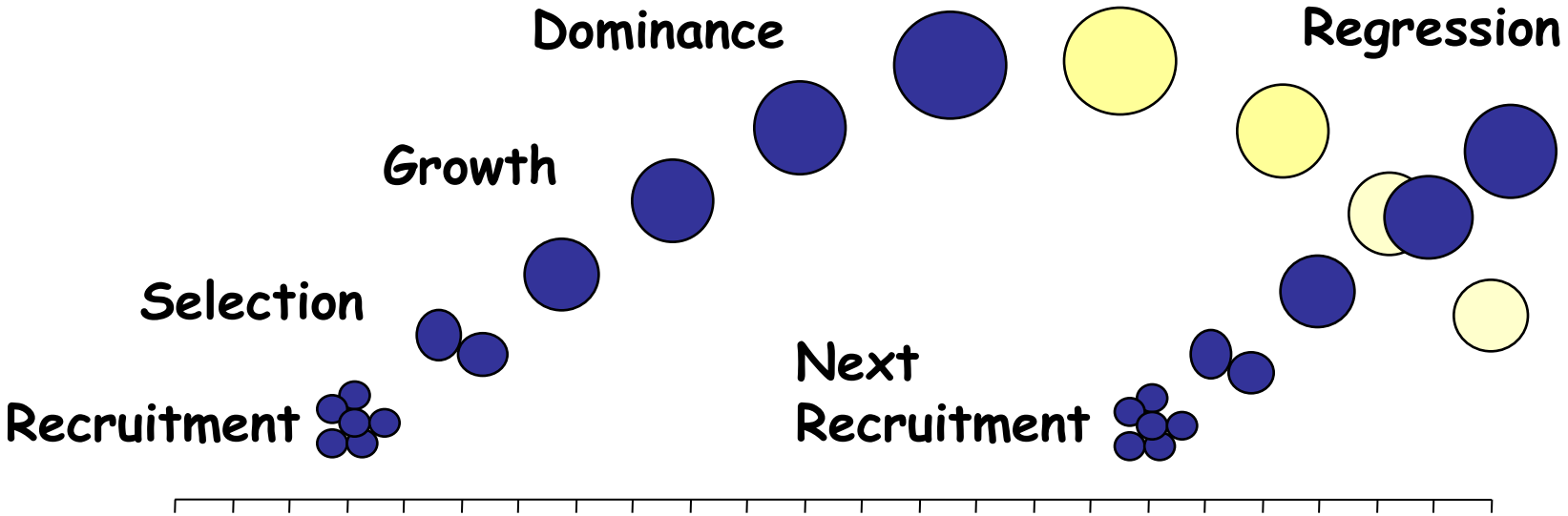
# Estrous Cycle

- ❑ Length of the estrous cycle
  - ❑ Average 21 days (range 18 to 24 days)
- ❑ Estrus (standing heat)
  - ❑ 12 to 18 hours (range 8 to 30 hours)
- ❑ Ovulation
  - ❑ Approximately 30 hours after the beginning of standing heat (or 12 to 18 hours after the end of standing heat)

# Estrous Cycle

- ❑ Major structures on the ovary are ...
  - ❑ Follicle ... a blister-like structure containing the egg (referred to as oocyte); produces hormone "estrogen"
    - ❑ High amount of estrogen causes "standing heat" and "ovulation"
  - ❑ Corpus luteum (referred to as "CL") ... looks like a hard yellow structure and produces hormone "progesterone" that is responsible for maintenance of pregnancy

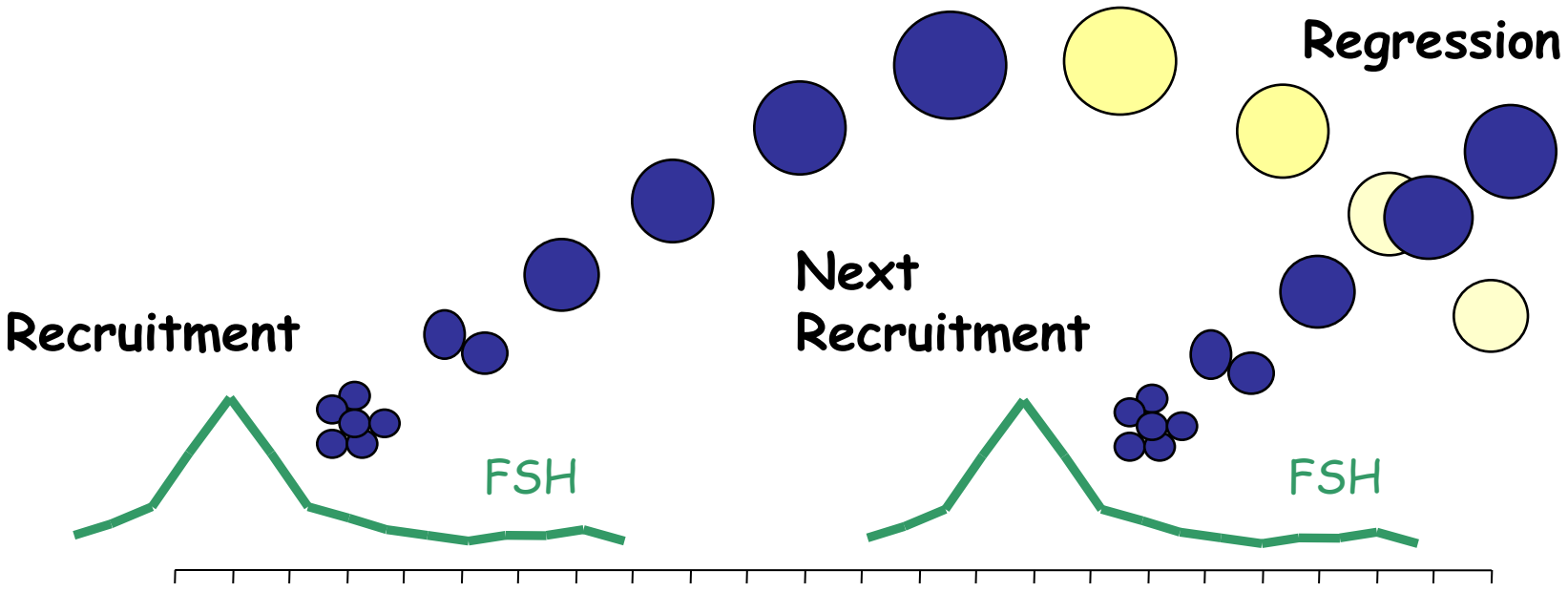
# Follicle Development Follicular Wave



- ❑ Follicle development occurs as a wave-like pattern consisting of "Recruitment", "Selection", "Growth", "Dominance", and "Regression" phases
- ❑ Usually 2 to 4 follicular waves occur during the estrous cycle in cattle

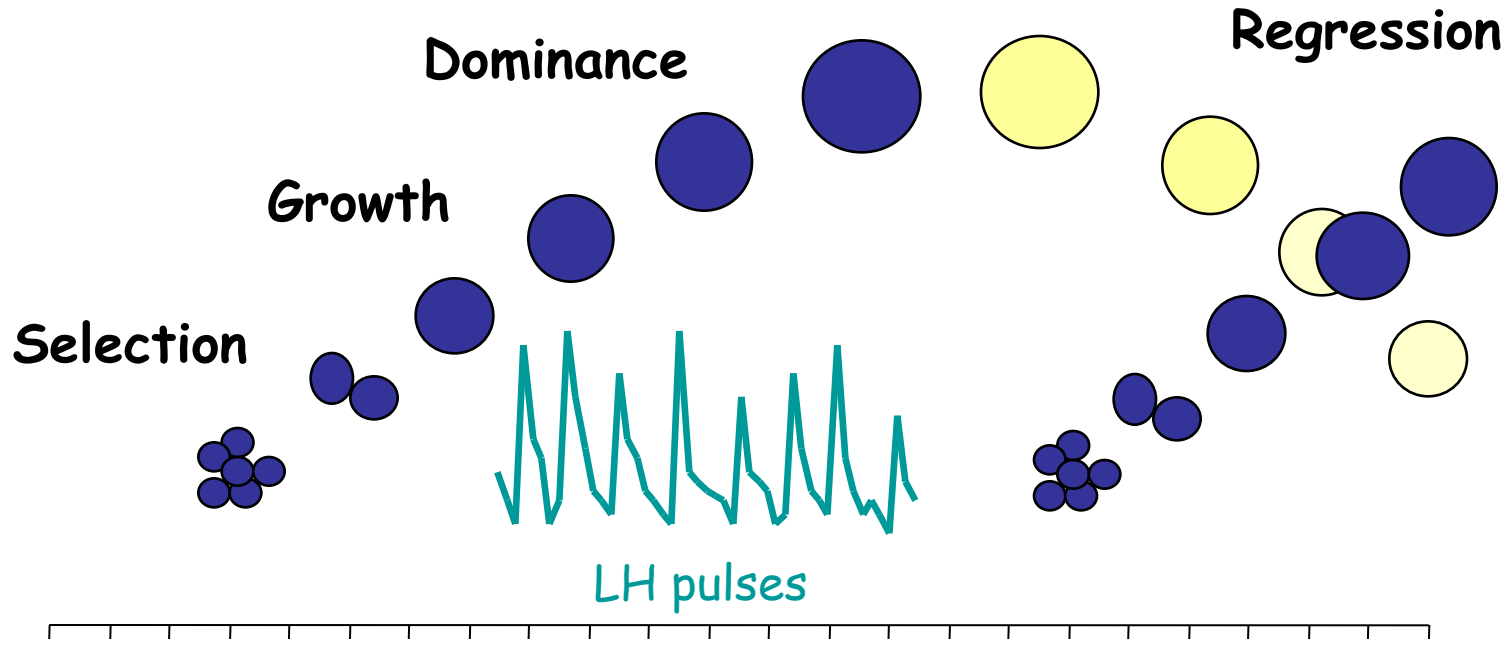
# Follicle Development

## Follicle Stimulating Hormone (FSH)



- ❑ FSH precedes recruitment of follicles (causes follicles to start growing)
- ❑ FSH is the same hormone used for superovulation and embryo transfer in cattle

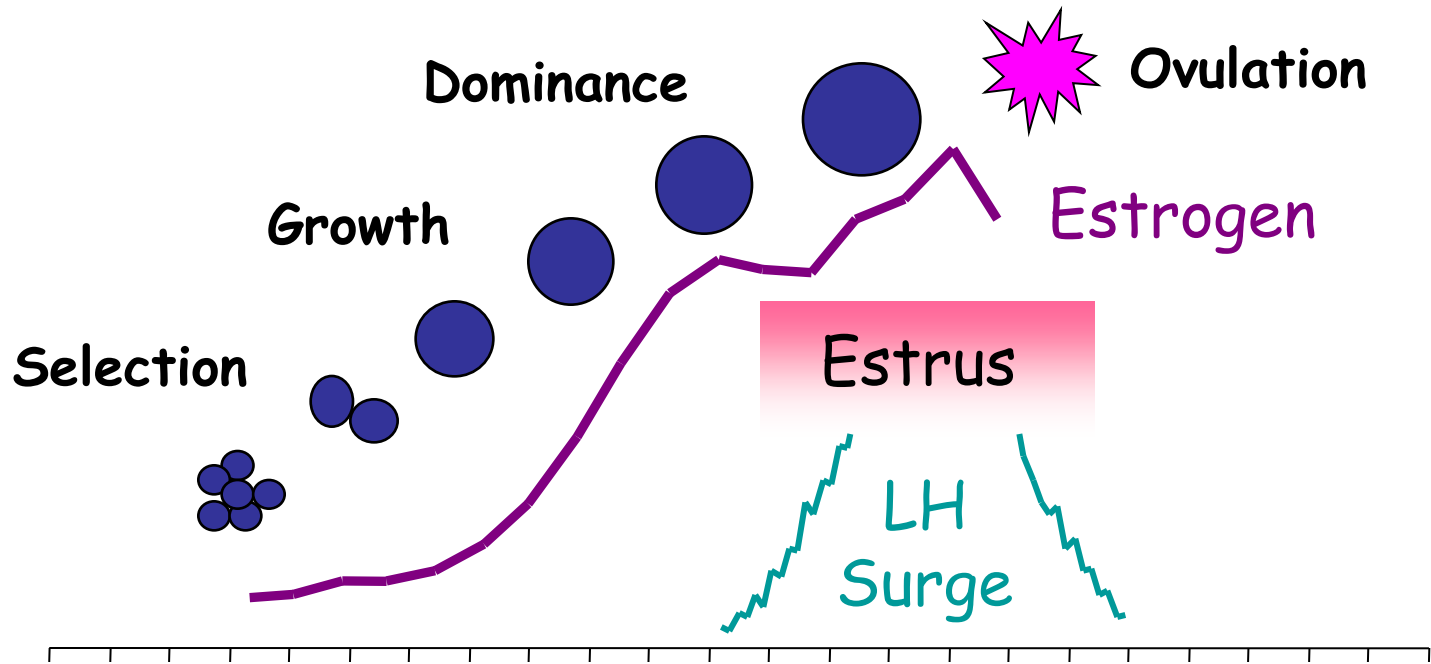
# Follicle Development Luteinizing Hormone (LH)



□ LH promotes further follicle growth and maturation of egg

# Follicle Development and Ovulation

## Luteinizing Hormone (LH) and Estrogen

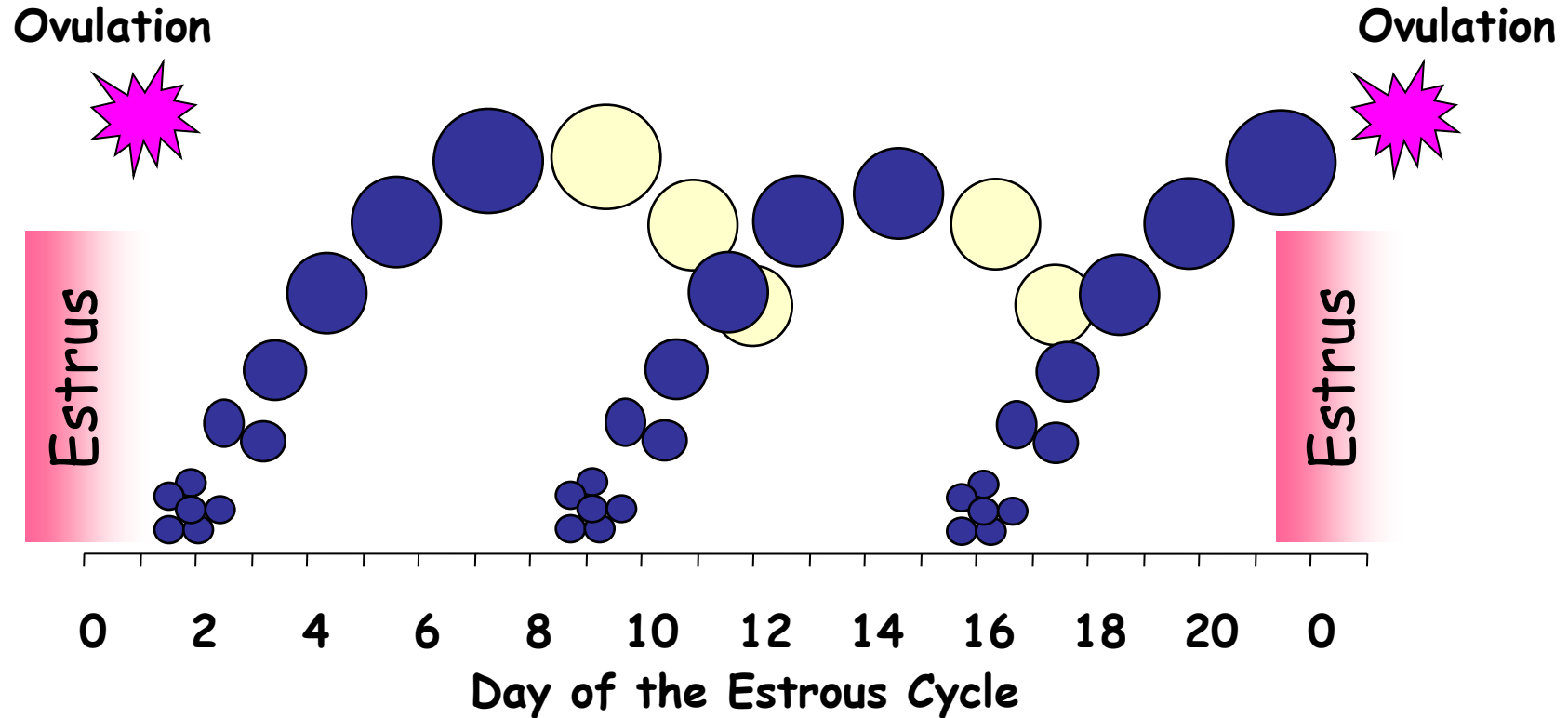


- ❑ LH stimulates follicle growth and a growing follicle produces high levels of estrogen
- ❑ High levels of estrogen, in turn, cause estrus and surge release of LH that triggers ovulation



# Follicle Development During the Estrous Cycle

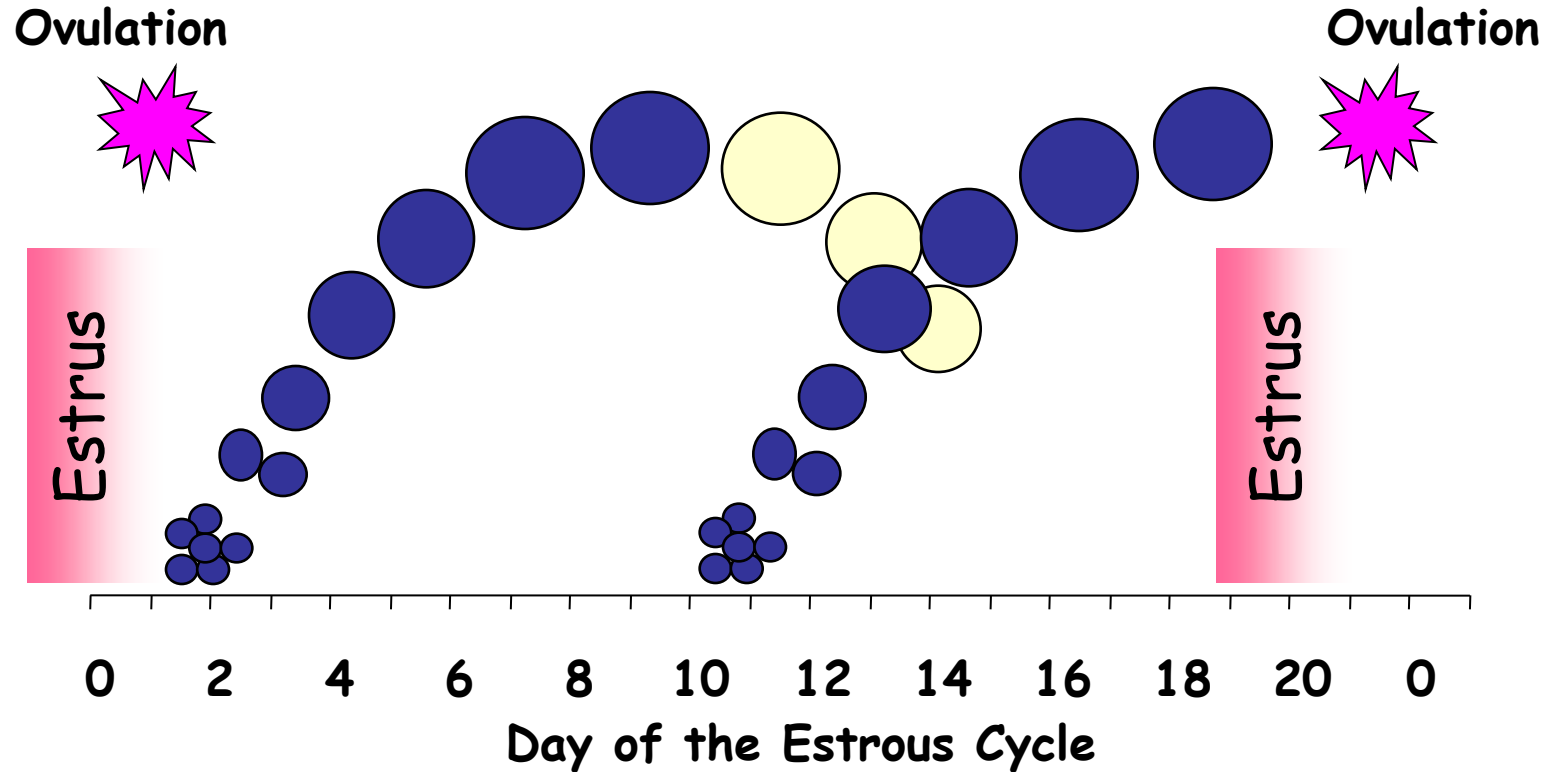
## Example for 3 Follicular Waves



- Length of the estrous cycle in cattle with 3 follicular waves is typically 20 to 24 days

# Follicle Development During the Estrous Cycle

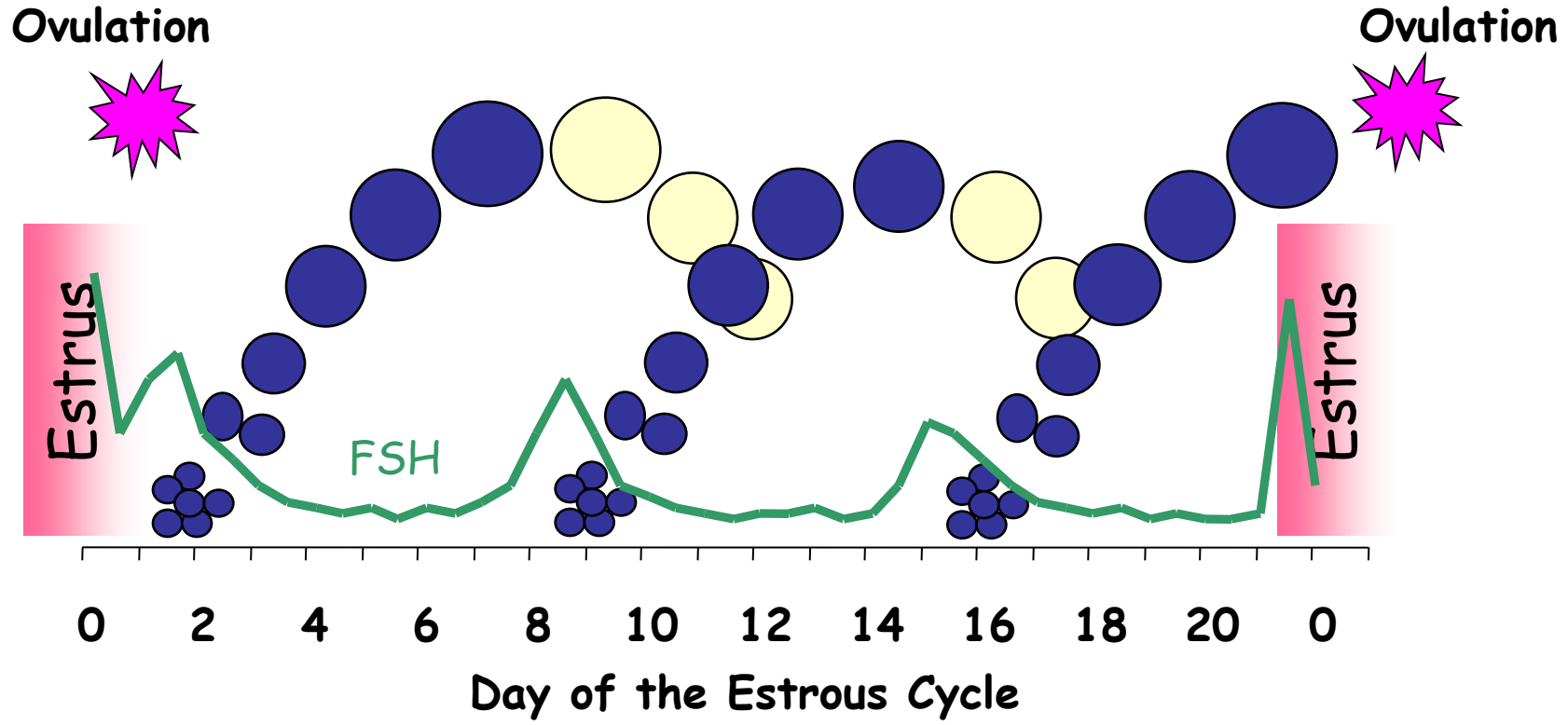
## Example for 2 Follicular Waves



- Length of the estrous cycle in cattle with 2 follicular waves is typically 18 to 20 days, slightly shorter than the estrous cycle with 3 follicular waves

# Endocrinology During the Estrous Cycle

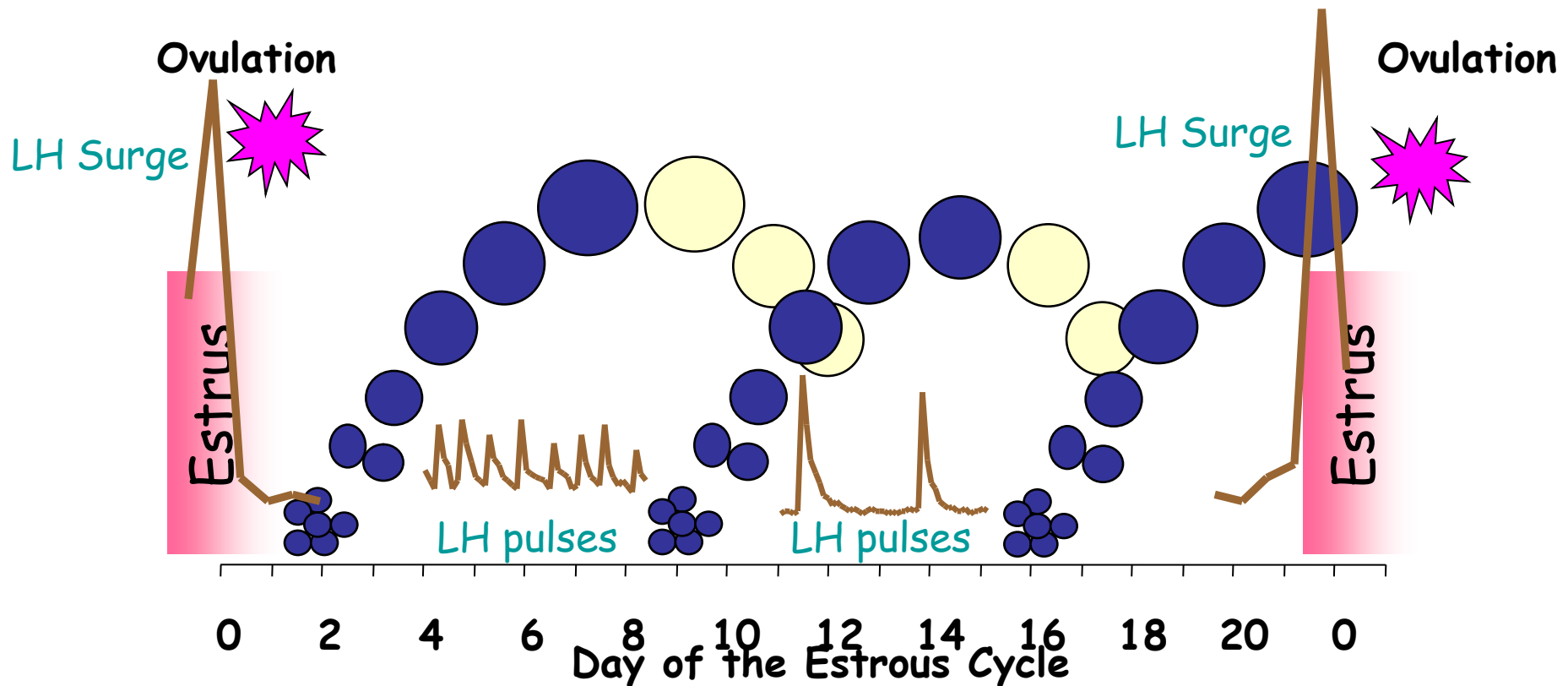
## Follicle Stimulating Hormone (FSH)



□ Example shown for cattle having 3 follicular waves during a 21-day estrous cycle

# Endocrinology During the Estrous Cycle

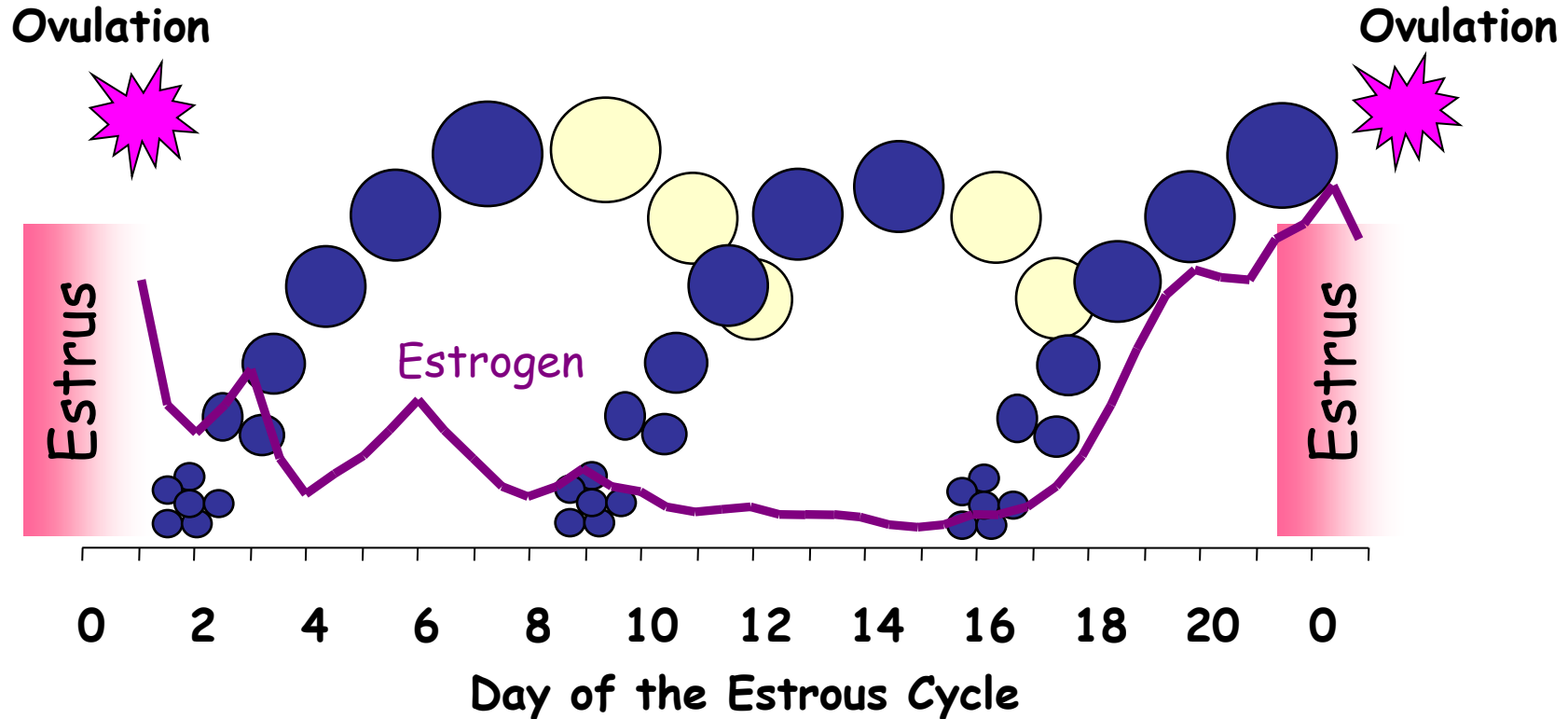
## Luteinizing Hormone (LH)



- Example shown for cattle having 3 follicular waves during a 21-day estrous cycle

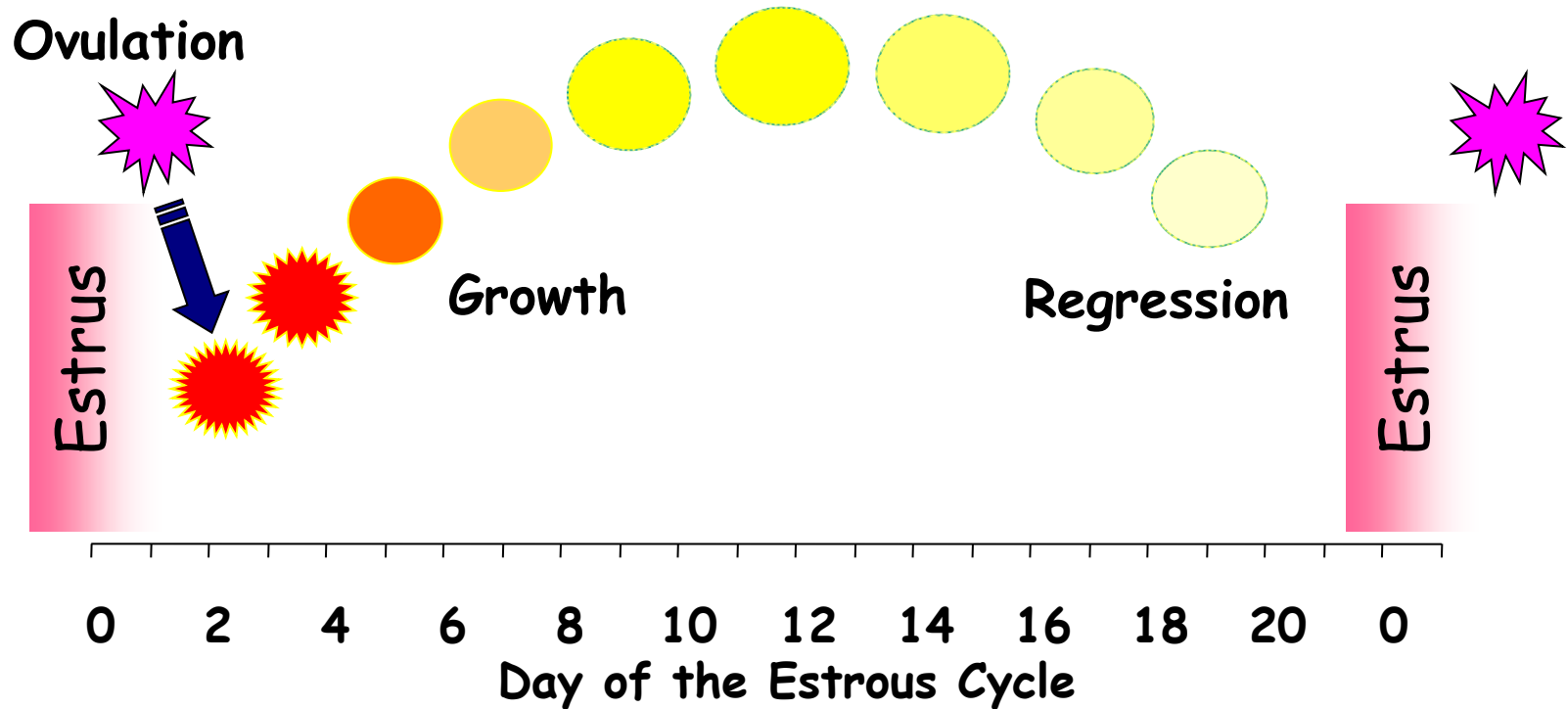
# Endocrinology During the Estrous Cycle

## Estrogen



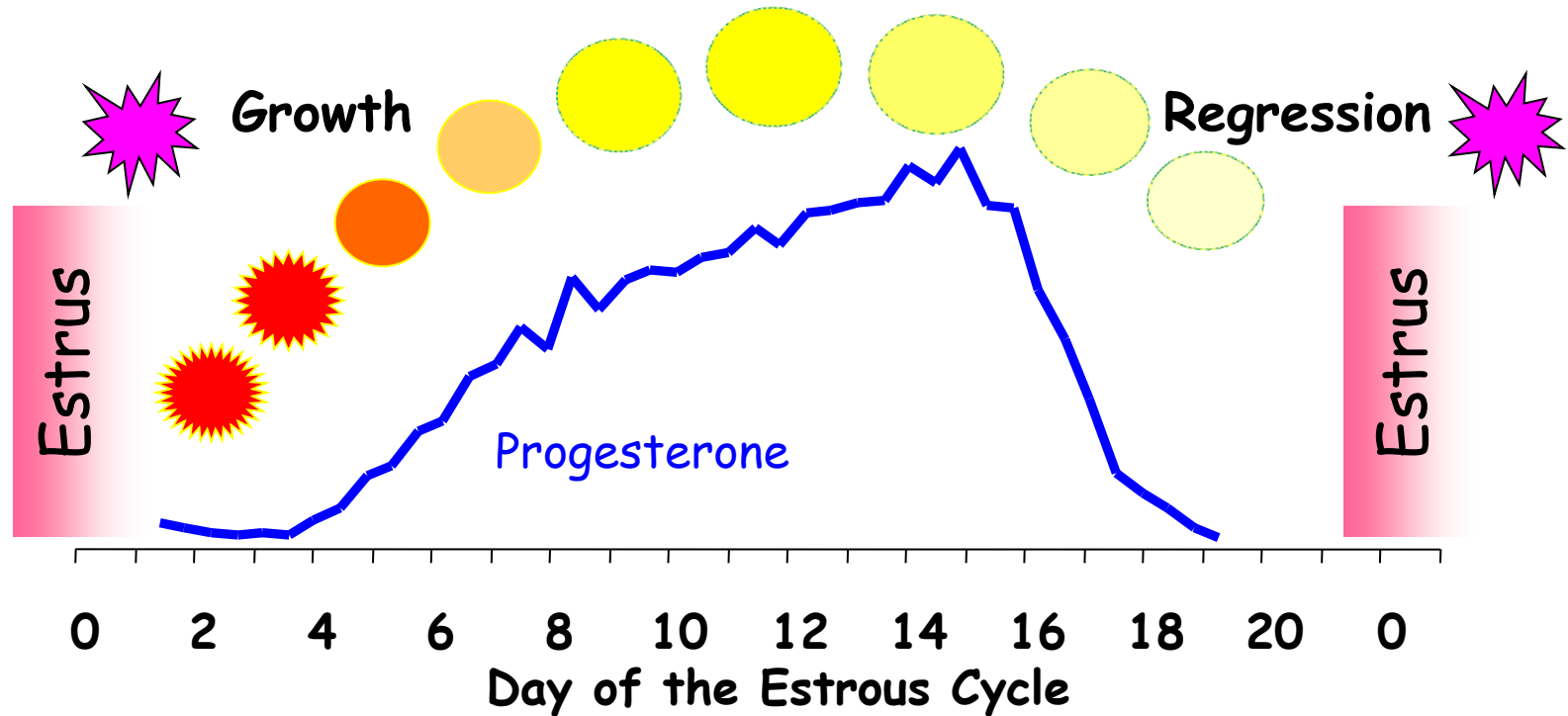
□ Example shown for cattle having 3 follicular waves during a 21-day estrous cycle

# Corpus Luteum (CL) Growth and Regression



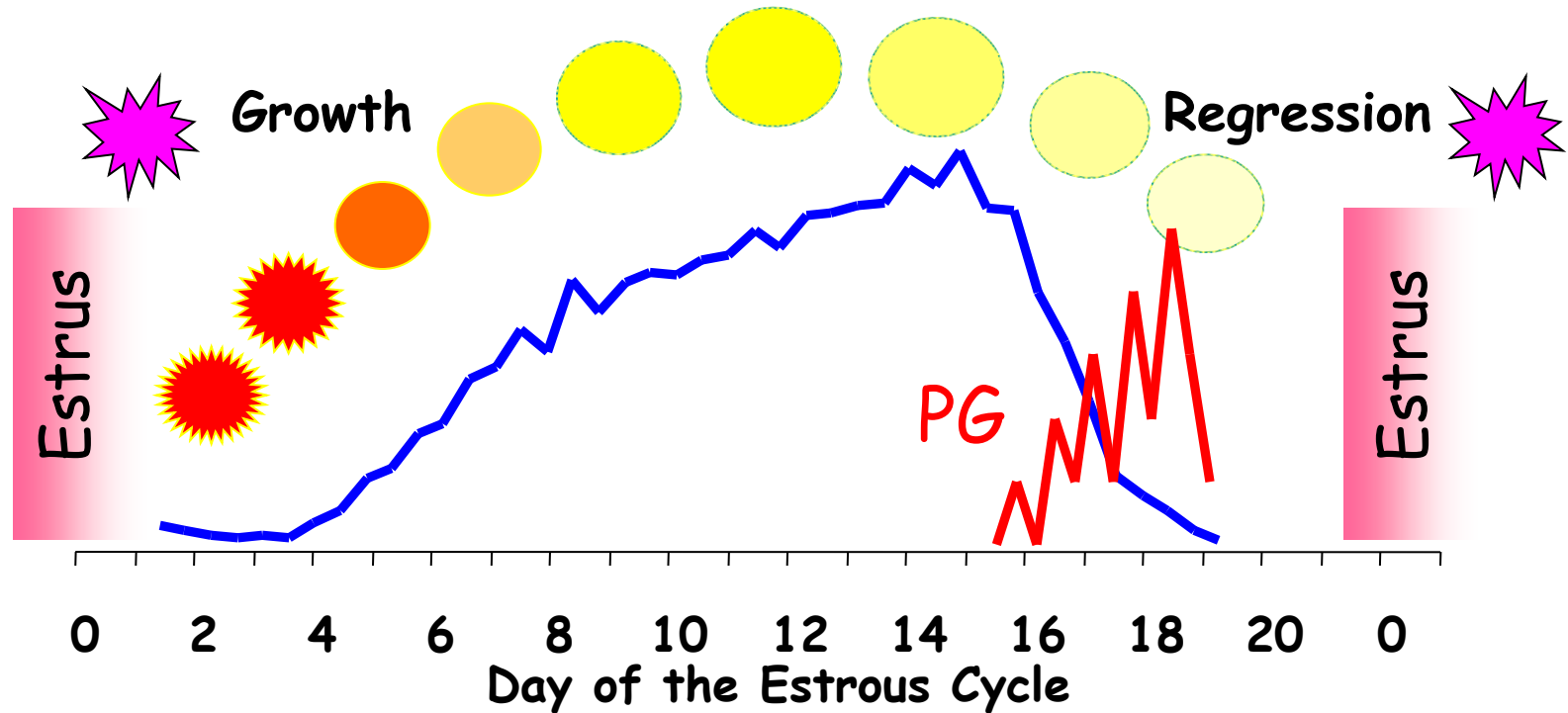
- Corpus luteum develops from the ovulated follicle and takes approximately 10 days to reach mature size

# Corpus Luteum (CL) Progesterone



- Corpus luteum produces progesterone
- Progesterone is responsible for maintenance of pregnancy after conception occurs

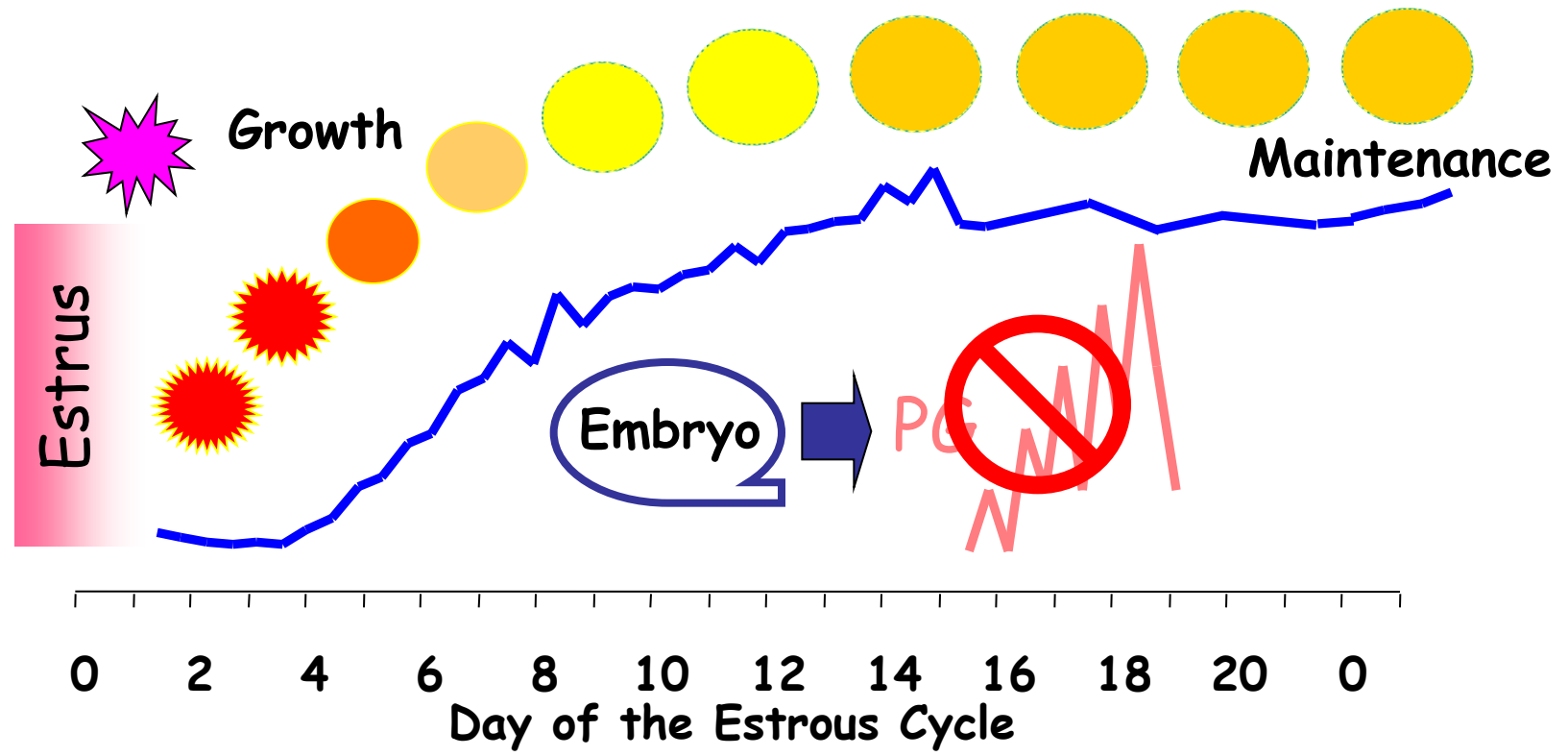
# Corpus Luteum (CL) Regression Prostaglandin F<sub>2α</sub> (PG)



- ❑ Late in the estrous cycle, uterus produces PG which causes regression of corpus luteum
- ❑ PG is the same or similar hormone in "Lutalyse<sup>®</sup>", "Estrumate<sup>®</sup>", "ProstaMate<sup>®</sup>", and "In Synch<sup>®</sup>"

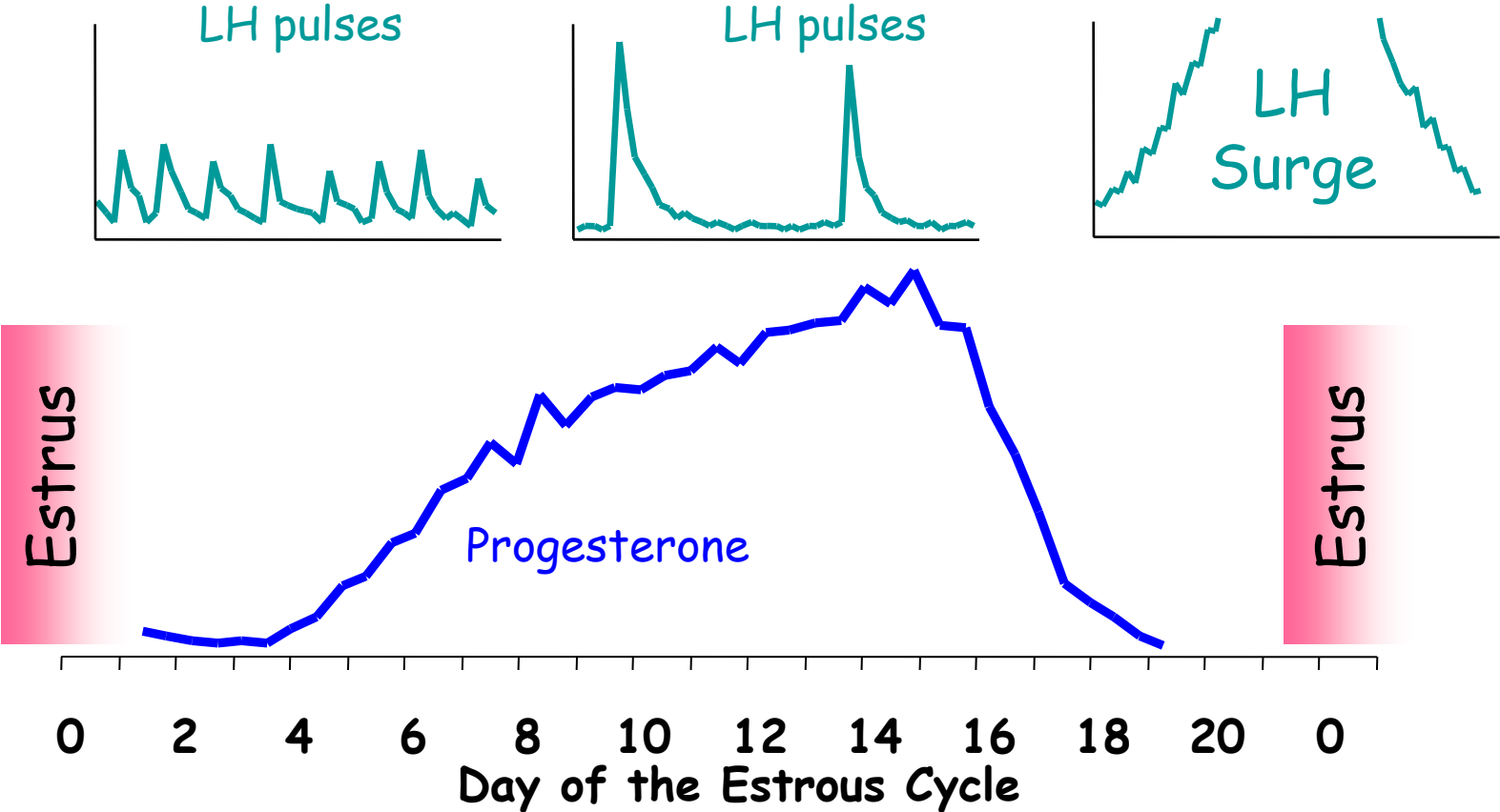


# Corpus Luteum (CL) Maintenance When cow becomes pregnant ...



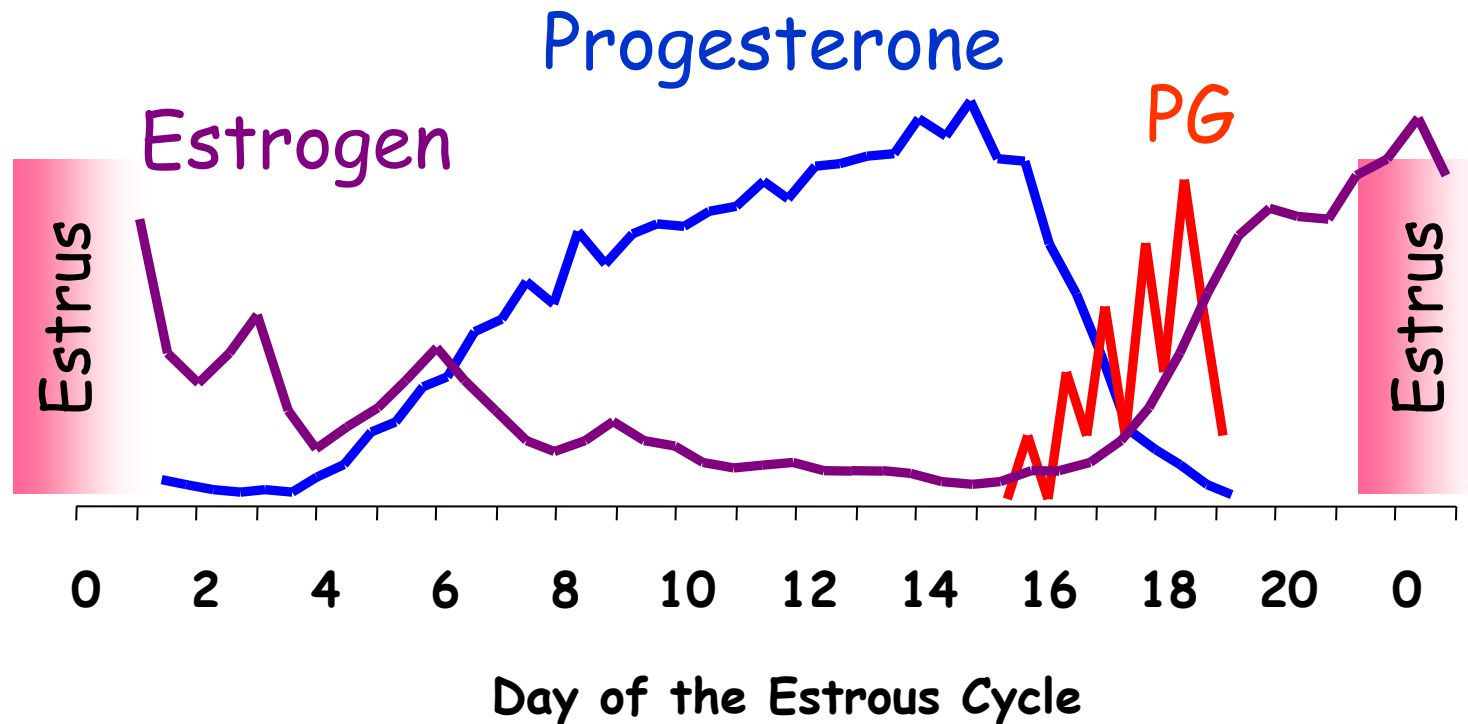
- Presence of embryo blocks uterus to produce PG late in the estrous cycle which causes maintenance of corpus luteum and production of progesterone for pregnancy

# Progesterone regulates LH Pulses Luteinizing Hormone (LH)



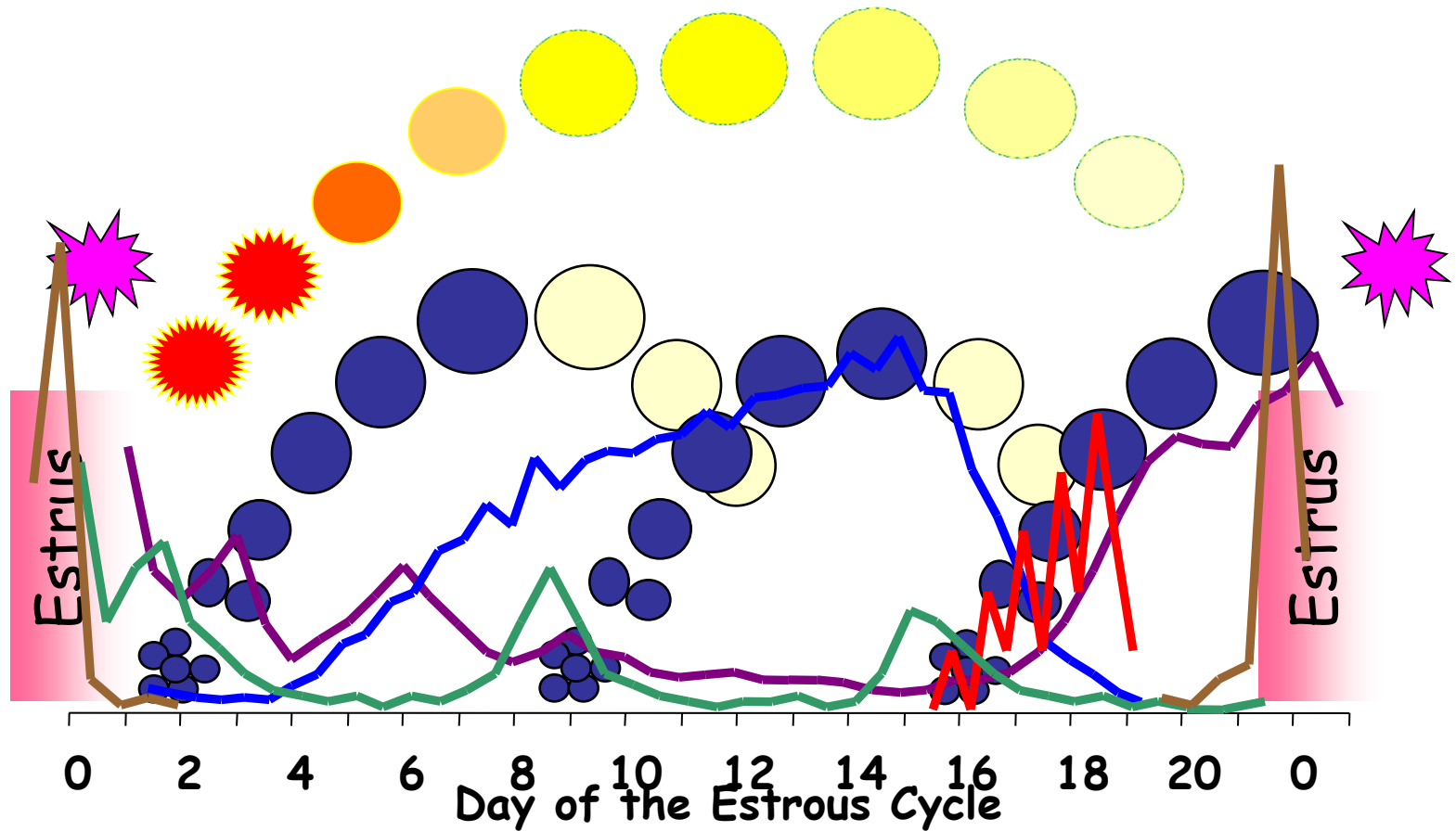
□ Progesterone regulates secretion pattern of LH pulses and hence, follicular development

# Endocrinology of the Estrous Cycle



- Relationships among estrogen, progesterone, and PG during the 21-day estrous cycle

# Physiology and Endocrinology of the Estrous Cycle



- Relationships among structural and hormonal changes during the 21-day estrous cycle (example shown for cattle having 3 follicular waves)

# Estrus Synchronization

# Effective Estrus Synchronization Programs

- ❑ Shorten the AI breeding season
  - ❑ Cows or heifers are in estrus during a predictable interval that facilitates AI
  - ❑ Reduce time and labor required to detect estrus
- ❑ Result in more cows and heifers becoming pregnant early during the breeding season
  - ❑ Progestin-based programs can induce estrous cyclicity in anestrus cows and prepubertal heifers (For example: MGA, or CIDR)\*

\* Progestins are progesterone-like compounds that act like progesterone

# Effective Estrus Synchronization Programs

- ❑ Result in older and heavier calves at weaning
- ❑ Will have beneficial effects on the next breeding season
  - ❑ More cows and heifers calve early
  - ❑ More days postpartum at the next breeding season
  - ❑ Replacement heifers will be older

# Effective Estrus Synchronization Programs

- ❑ Consider what happens during a restricted breeding season, based on the average 21-day estrous cycle:
  - ❑ If cows or heifers are cycling when an estrus synchronization treatment is implemented and they exhibit estrus during the synchronized period, they would have **3 opportunities** to conceive during a 45-day period or **4 opportunities** during a 65-day period
  - ❑ If cows or heifers are cycling but no estrus synchronization treatment is implemented, then they have only **2** (45-day) or **3** (65-day) **opportunities** to conceive
  - ❑ If cows or heifers are not cycling at the beginning of the breeding season, they have even less opportunity to conceive



# Points to Consider When Using Estrus Synchronization

- ❑ Estrus synchronization is never a substitute for:
  - ❑ Nutrition
  - ❑ Herd health
  - ❑ Proper management
  
- ❑ Estrus synchronization should not be used as a crutch for poor management
  
- ❑ When administered appropriately, estrus synchronization is an effective reproductive management tool that can be used to facilitate AI

# Points to Consider When Using Estrus Synchronization

- ❑ Determine which females would make the best candidates before beginning estrus synchronization
- ❑ Successful application of estrus synchronization is easier to accomplish with heifers (no calves to work with)

# Selecting Heifers for Estrus Synchronization

- ❑ Heifers should be of adequate age (cycling or close to reaching puberty)
- ❑ Heifers should be of adequate weight
  - ❑ Developed to 65 % of projected mature weight
  - ❑ Do you know the mature weight of your cows?
- ❑ Utilize reproductive tract score (RTS) to assess reproductive maturity

## Timing of Puberty in Heifers

- ❑ Target weight:  
Heifers reach puberty at approximately 65% of their mature body weight
- ❑ Determine your desired weight at breeding, calculate the gain needed to meet that weight, and feed to meet it

## Management Considerations for Heifers

- ❑ DO NOT use growth promoting implants in replacement heifers
- ❑ Implants may disrupt or impair normal development of reproductive organs
  - ❑ Developing uterus is especially sensitive to growth promoting implants

# Management Considerations for Heifers

- ❑ Reproductive Tract Scores (RTS) are determined by rectal palpation of the ovaries and uterus
- ❑ The RTS should be performed approximately 6 to 8 weeks prior to breeding season and/or approximately 2 weeks prior to beginning an estrus synchronization treatment

# Reproductive Tract Scores (RTS)

RTS	Uterine horns	<u>Ovarian Measurement (mm)</u>			Ovarian Structures	Description
		Length	Height	Width		
1	Immature < 20 mm diameter No tone	15	10	8	No palpable follicles	<b>Infantile</b>
2	20-25 mm diameter No tone	18	12	10	8 mm follicles	<b>Prepubertal</b> (more than 30 days to puberty)
3	20-25 mm diameter Slight tone	22	15	10	8-10 mm follicles	<b>Peripubertal</b> (within 30 days to puberty)
4	30 mm diameter Good tone	30	16	12	> 10 mm follicles CL possible	<b>Cycling</b> (Follicular Phase)
5	> 30 mm diameter	> 32	20	15	CL present	<b>Cycling</b> (Luteal Phase)

Adapted from Anderson et al., 1991

## RTS Measurements

RTS	No. of Heifers	Weight (lb)	Pelvic Height (cm)	Pelvic Width (cm)	Pelvic Area (cm <sup>2</sup> )	Estrous Response
1	61	594 <sup>a</sup>	13.9 <sup>a</sup>	10.9 <sup>a</sup>	152 <sup>a</sup>	54 % <sup>a</sup>
2	278	620 <sup>b</sup>	14.1 <sup>a</sup>	11.2 <sup>a</sup>	158 <sup>a</sup>	66 % <sup>b</sup>
3	1103	697 <sup>c</sup>	14.5 <sup>b</sup>	11.4 <sup>b</sup>	166 <sup>b</sup>	76 % <sup>c</sup>
4	494	733 <sup>d</sup>	14.7 <sup>c</sup>	11.7 <sup>c</sup>	172 <sup>c</sup>	83 % <sup>d</sup>
5	728	755 <sup>d</sup>	14.7 <sup>c</sup>	11.7 <sup>c</sup>	172 <sup>c</sup>	86 % <sup>d</sup>

a, b, c, d = P < 0.05

- Note the relationship between increasing RTS, weight, and skeletal development determined by pelvic area
- Estrous response increased among heifers that were more reproductively mature at the beginning of estrus synchronization and/or breeding season

Adapted from Patterson et al., 1999a



## Relationship Between RTS and Pregnancy

RTS	No. of Heifers	Pregnant	Open	Pregnancy Rate
1	53	31	22	58 %
2	762	610	152	80 %
3	3458	3014	444	87 %
4	3398	3006	392	89 %
5	2613	2331	282	89 %

- Higher pregnancy rates at the end of the breeding season were achieved among heifers that were more reproductively mature at the beginning of estrus synchronization and/or breeding season

# Prepubertal Anestrus

- ❑ Timing of puberty is controlled by ...
  - ❑ Age
  - ❑ Weight
  - ❑ Breed
  - ❑ Season

} Many factors involved
- ❑ Develop heifers to approximately 65% of mature weight by the breeding season
- ❑ This will help them to attain puberty at the right time

# Nutritional Anestrus

- ❑ Nutritionally stressed cattle will experience delays in return to estrus after calving
- ❑ Can be "managed" through
  - ❑ Improvement in BODY CONDITION
    - ❑ Proper feeding management

# Postpartum Anestrus

## Induction of Estrous Cyclicity

### ❑ Bull exposure

#### ❑ Prepubertal heifers

Exposure of prepubertal heifers to sterile bulls (for example, vasectomized, epididymectomized ... etc) for 60 to 80 days before the breeding season may hasten the onset of puberty (ranges from no effect to 70 days earlier)

Izard and Vandenberg, 1982; Berardinelli et al., 1978;  
MacMillan et al., 1979; Roberson et al., 1991

#### ❑ This procedure also shortens the postpartum period in anestrus cows however my concentration is on heifers

Foote, 1974; MacMillan et al., 1979;  
Zalesky et al., 1984; Gifford et al., 1989

## Products Currently Utilized in Protocols to Synchronize Estrus

\*\*\* Price may vary depending on suppliers \*\*\*

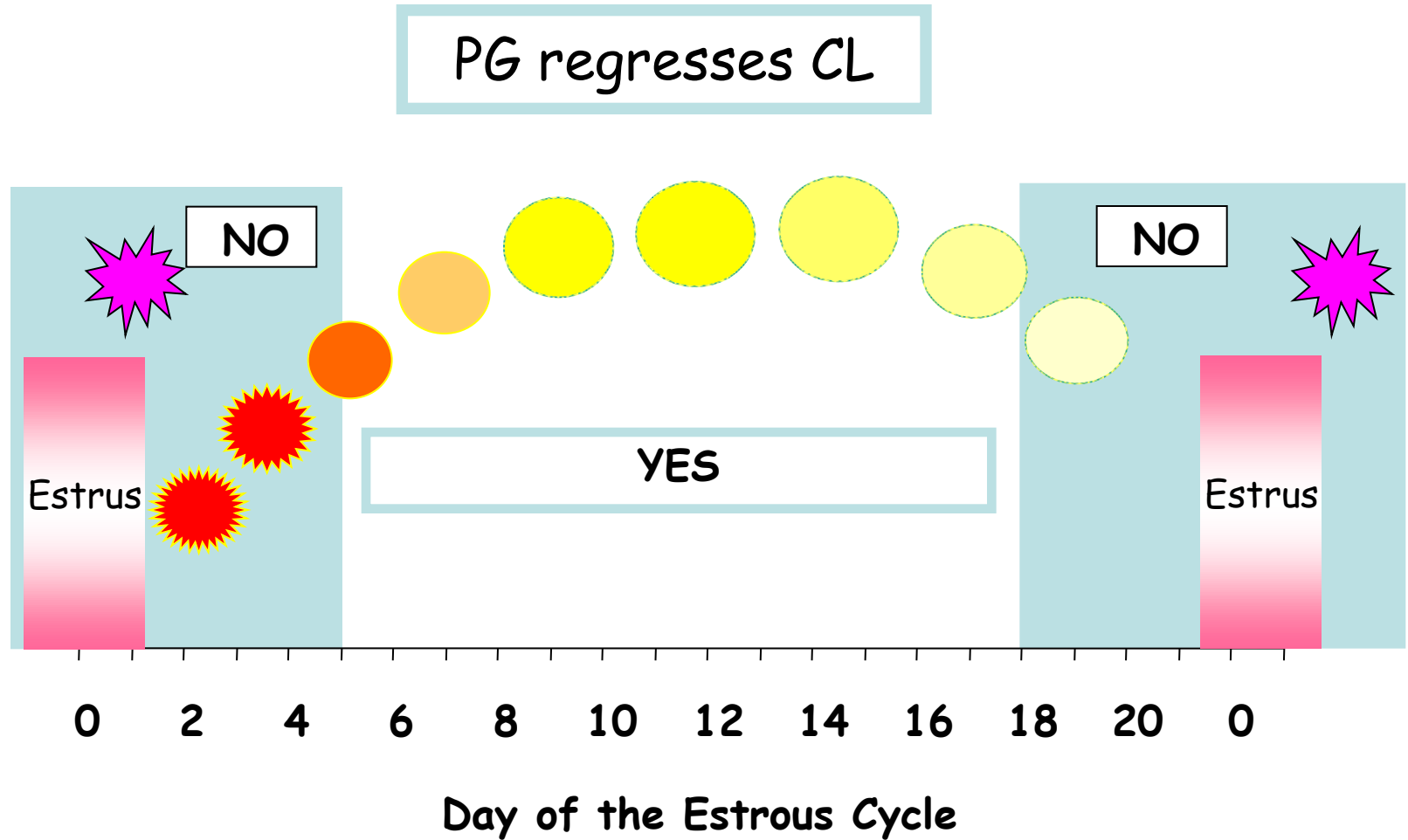
- ❑ Prostaglandin  $F_{2\alpha}$  (PG)
  - Lutalyse<sup>®</sup>, Estrumate<sup>®</sup>, ProstaMate<sup>®</sup>, In Synch<sup>®</sup>
  - ❑ Approximate cost is \$3.00/dose (range \$2.50-\$4.00)
- ❑ Gonadotropin-Releasing Hormone (GnRH)
  - Cystorelin<sup>®</sup>, Factrel<sup>®</sup>, Fertagyl<sup>®</sup>
  - ❑ Approximate cost is \$5.00/dose (range \$4.00-\$6.00)
- ❑ Melengestrol Acetate (MGA<sup>®</sup> Premix)
  - ❑ Approximate cost ranges \$0.14 - \$0.40/day/head including carrier
    - ❑ 14 days (\$2.00-\$5.60/head) or 7 days (\$1.00-\$2.80/head)
- ❑ EAZI-BREED<sup>™</sup> CIDR<sup>®</sup> Cattle Insert (CIDR)
  - ❑ Approximate cost is \$8.00 (range \$8.00-\$10.00)
- ❑ Syncro-Mate-B<sup>®</sup> (off the market)

Prostaglandin  $F_{2\alpha}$  (PG)

# Prostaglandin $F_{2\alpha}$ (PG)

- PG causes CL regression
- No effect on anestrous cattle
- No induction of estrous cyclicity  
... No Jump-start
- Only effective during Days 6 (6 days after estrus) to 16 of the estrous cycle

# Prostaglandin $F_{2\alpha}$ (PG)

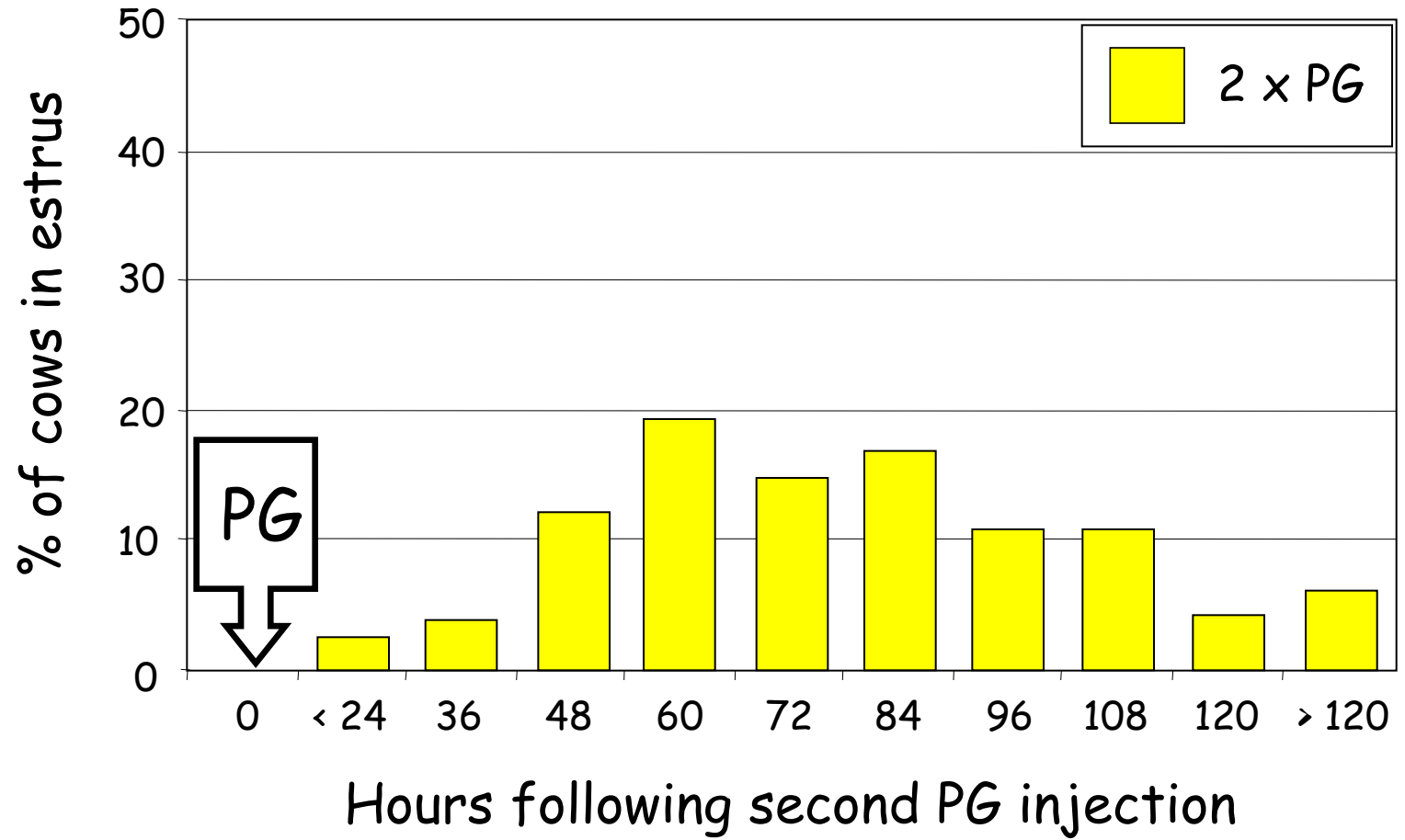




# Estrous Response

## Double Injection PG Program

Example shown is 14-day interval for PG injections



# Single or Double Injection PG Programs

74

\$3.00 or \$6.00 (\$3.00/one dose)

- Advantages:
  - Cost effective (\$3.00 or \$ 6.00)
  - Easy to use
  - Good fertility

# Single or Double Injection PG Programs

75

\$3.00 or \$6.00 (\$3.00/one dose)

- ❑ Disadvantages:
  - ❑ No effect between days 0 to 4 or 16 to 21 of the estrous cycle
  - ❑ Improved effectiveness after day 10 of the estrous cycle
  - ❑ **Require heifers and cows to have CL (cycling)**
  - ❑ Require extensive estrus detection (minimum 7 days)
  - ❑ **No induction of estrous cyclicity (No Jump-start)**

# Possible Outcomes

## Single or Double Injection PG Programs

- ❑ Estrous response:
  - ❑ Varies depending on the degree of estrous cyclicity in the herd and the stage of the estrous cycle of an individual animal
  - ❑ Single injection of PG ... up to 40 to 60 %
  - ❑ Double injection of PG ... up to 50 to 80 %
  
- ❑ Timing of estrus:
  - ❑ Before PG injection to 7 to 10 days after PG injection
  - ❑ Peak response ranges from 48 to 96 hours after PG injection

# Melengestrol Acetate (MGA<sup>®</sup>)

MGA is a registered trademark of Pfizer Animal Health

# Melengestrol Acetate (MGA)

- ❑ Orally active progestin, administered as a feed additive
- ❑ Blocks estrus and ovulation
  - ❑ Acts similar to progesterone from CL
- ❑ MGA can induce estrous cyclicity in peripubertal (within 30 days to attain puberty) heifers and postpartum anestrous cows
- ❑ Currently, MGA and CIDR are the only progestins commercially available in the U.S.

# Intake Considerations

## What type of carrier to use?

- ❑ Mix with grain source (example: cracked or ground corn)  
For example: MGA with ground corn (\$0.15/day/head)
  - ❑ Top dressing does not work well
- ❑ If cattle are on lush pasture, remove salt from pasture and include salt in MGA carrier  
0.5 oz. Salt per cow and MGA in carrier (\$0.30/day/head)
- ❑ Pellet form (very palatable)  
For example: MFA Cattle Charge<sup>®</sup> with MGA  
(\$0.40/day/head)

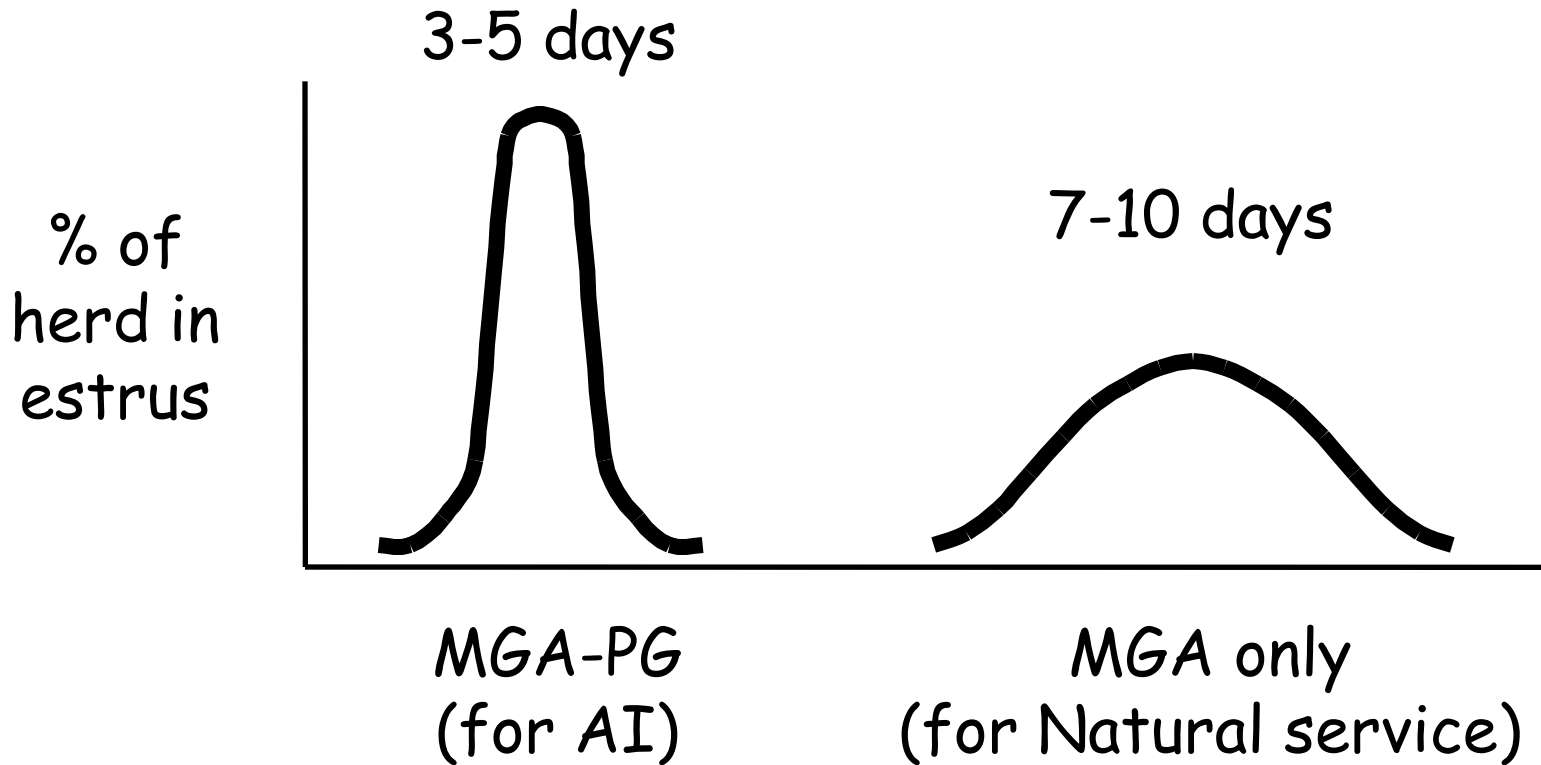
# Intake Considerations

- ❑ Need to provide adequate bunk space (18 inches per heifer, and 24 inches per cow)
- ❑ Make sure cattle come to bunk before start of feeding MGA
  - ❑ If cattle are not used to bunk feeding, 1-2 weeks of warm-up bunk feeding is recommended
- ❑ MGA should be fed one time per day at approximately the same time every day
- ❑ Separate heifers from cows for MGA feeding
  - ❑ Late-term pregnant cows should not be fed MGA



- MGA can be combined with PG to improve results

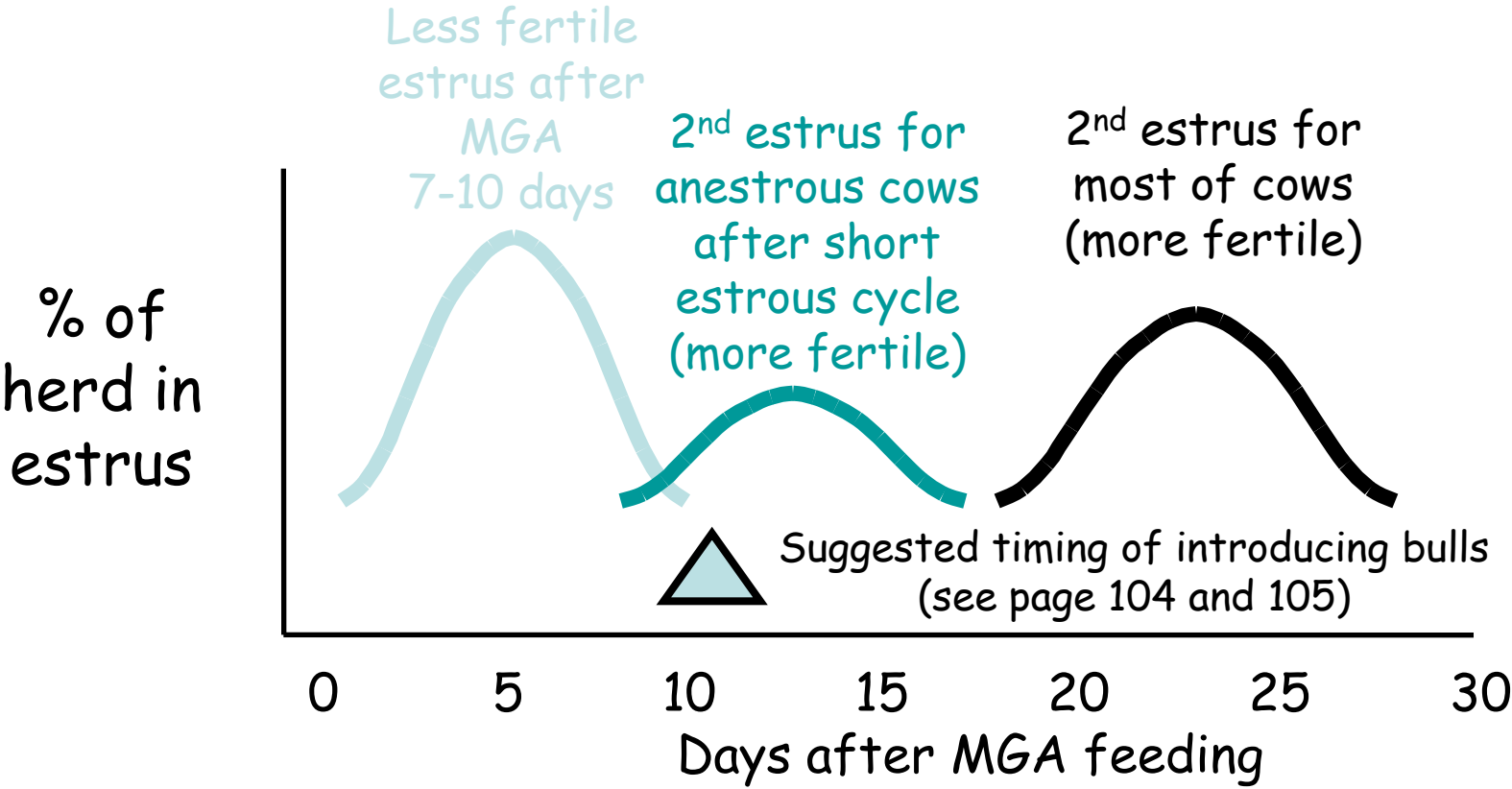
# Distribution of Estrus



- Adding the PG injection to the MGA program results in a much tighter synchronization of estrus

# Management Considerations

## Why Not Introduce Bulls Right After MGA Withdrawal?



- ❑ If bulls were introduced to the herd right after MGA withdrawal, they may be overworked during the less fertile estrous period after MGA withdrawal, but before cows express fertile estrus

# Natural Service with MGA Program

\$2.00-\$5.60 (MGA cost)

- ❑ Advantages:
  - ❑ Easy to use
  - ❑ Shortens the next calving season  
(ideal way to start AI program in the following year)
  - ❑ MGA can induce estrous cyclicity in postpartum anestrus cows (Jump-start)
  - ❑ Does not require cattle to be handled

# Natural Service with MGA Program

\$2.00-\$5.60 (MGA cost)

- ❑ Disadvantages:
  - ❑ Must have adequate bull-power
    - ❑ At least 1:15 to 20 bull:female ratio for 2-year or older bulls
    - ❑ Yearling bulls ... consider decreasing the bull:female ratio
  - ❑ Resulting calves may be of inferior quality and provide less genetic improvement for the herd compared to AI calves (depends on the genetic quality of the clean-up bulls)

# Summation

- Lots of programs
  - Many combinations of programs
- Many prices
- The numbers definitely show results
  - Earlier calving season
  - More time to return to Estrus
  - Increased opportunity to become pregnant
- However due to expense and labor intensity this is not for everyone

# Bibliography

- **"Guide to Estrus Synchronization of Beef Cattle" CD**

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