The estrous cycle

- **Definition**
  - Sexual Puberty in the females is defined as the age at the first expressed estrous with ovulation.
  - Sexual Maturity in the females is defined as the age at the expressed estrous with ovulation and normal parturition.
Definition

• **Estrous cycle**: reproductive cycle of female generally defined as period from one estrous to the next. It two phase
  
  • 1- follicular phase (proestrus and estrus)
  
  • 2- luteal phase (metestrus and diestrus)

• **Estrous**: period of sexual receptivity commonly referred to as “heat”

• **Anestrous**: period when female does not have cycles occurring during pregnancy, season, pathology
Animals classified according to estrous cycle

1 - Poly estrous; cow, sow
TYPES OF ESTROUS CYCLE

2 - Seasonal poly estrous
A - short day breeder; ewe, doe

B - long day breeder; mare, queen
TYPES OF ESTROUS CYCLE

3 – monoestrous; bitch, wild animals
Causes of Anestrus

- Pregnancy
- Presence of Offspring
- Season
- Nutrition
- Pathology
- Stress
Hypothalamus

GnRH

Anterior Pituitary

LH, FSH

Inhibin (–)

Estradiol (+)

Progesterone (–)

LH

CL

Ovary

Follicle

LH, FSH

Estradiol
Stage of heat

- Proestrus
- Estrus
- Diestrus
- Metestrus
## Average Reproductive Cycles

<table>
<thead>
<tr>
<th>Species</th>
<th>Length of Estrous Cycle</th>
<th>Length of Estrus</th>
<th>Ovulation</th>
<th>Length of Pregnancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>cow</td>
<td>21 days polyestrus</td>
<td>18 hr</td>
<td>11 hr after end estrus</td>
<td>282 days</td>
</tr>
<tr>
<td>ewe</td>
<td>17 days seasonal (fall)</td>
<td>29 hr</td>
<td>near end estrus</td>
<td>148 days</td>
</tr>
<tr>
<td>sow</td>
<td>21 days polyestrus</td>
<td>48-72 hr</td>
<td>35-45 hr after start estrus</td>
<td>115 days</td>
</tr>
<tr>
<td>mare</td>
<td>21 days seasonal (spring) polyestrus</td>
<td>4-8 days</td>
<td>3-6 day of estrus (1-2 days before end of estrus)</td>
<td>335 days</td>
</tr>
<tr>
<td>Doe</td>
<td>21 days seasonal(fall)</td>
<td>30-40 hrs</td>
<td>few hrs after ovulation</td>
<td>149 days</td>
</tr>
</tbody>
</table>
### Characteristics of Estrous Cycles

<table>
<thead>
<tr>
<th></th>
<th>Cow</th>
<th>Ewe</th>
<th>Sow</th>
<th>Mare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estrous cycle (days)</td>
<td>21</td>
<td>17</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Proestrus (days)</td>
<td>3-4</td>
<td>2-3</td>
<td>3-4</td>
<td>2-3</td>
</tr>
<tr>
<td>Estrus</td>
<td>12-18 hr</td>
<td>24-36 hr</td>
<td>48-72 hr</td>
<td>4-8 days</td>
</tr>
<tr>
<td>Metestrus (days)</td>
<td>3-4</td>
<td>2-3</td>
<td>2-3</td>
<td>2-3</td>
</tr>
<tr>
<td>Diestrus (days)</td>
<td>10-14</td>
<td>10-12</td>
<td>11-13</td>
<td>10-12</td>
</tr>
</tbody>
</table>
Follicular Phase

Stage of heat

A. Proestrus

- day 19 - 21
- period for preparation of sexual activity

<table>
<thead>
<tr>
<th>Proestrus</th>
</tr>
</thead>
<tbody>
<tr>
<td>• FSH level increase</td>
</tr>
<tr>
<td>• follicle enlarges</td>
</tr>
<tr>
<td>• estrogen increases</td>
</tr>
<tr>
<td>• vascularity of the female reproductive tract increases</td>
</tr>
<tr>
<td>• endometrial glands begin to grow</td>
</tr>
<tr>
<td>• estrogen levels peak</td>
</tr>
</tbody>
</table>
Follicular Phase

Stage of heat

B. Estrus (heat, sexual desire)

- period of sexual activity, female permit mating
- duration: 6 - 30 hrs (heifer 15, cows 18hrs)

Estrus

- allows male to mount
- estrogen decreases
- LH surge occurs
- ovulation 24-48 hr after surge of LH
- uterine motility high with contractions moving toward oviduct
- sperm transport is optimal
Signs of Estrus

• Primary Sign of Estrus

  – Stands immobile when mounted.
  – Bellowing
  – Red vulva
  – Swollen vulva
  – Clear mucus discharge from vulva
Secondary Signs of Estrus

• Behavioral
  – Increased Activity
  – Walking the fence line
  – Charging
  – Butting
  – Licking

  – Sniffing
  – Flehmen posture (inverted nostrils)
  – Circling
  – Chin-resting
  – Mounting
• **Miscellaneous Signs** of Estrus
  – Depressed appetite
  – Depressed milk production
  – Frequent Urination
Arborization

Glassy, viscous One strand, shiny Clear and has the character of Fernerization increased

Vaginal findings
Hyperemia, congestion
Viscous, red, slightly dilated
Rose shaped external os
• **During rectal palpation**
  
  • Uterus is turgid
  
  • Presence of GF
Follicular Waves in Cattle

Progestrone

Follicular Size

Recruitment

Dominance

Selection

Atresia

FSH Sensitive Pool

Ovulation

Day After Ovulation

9

16

21
Mating Behavior (Estrus signs)

• The mare will allow the stallion to smell and bite.
• She will
  – extend her hind legs,
  – lift her tail to the side and
  – lower her rump.
  – The erect clitoris will be exposed frequently by contractions (winking) of the labia.
  – The vulva will be elongate and swollen, with the labia partly everted.
• The mare should be teased by a stallion for accurate detection.
  – Attempts to fight the stallion indicate she is not in estrus even though some other signs of estrus are apparent.
Estrous Cycle (Non-Pregnant)

• Proestrus (9 days)
  – Vulva swollen
  – Bloody discharge
  – Attracted to male but does not mate

• Estrus (9 days, ovulation day 2)
  – Accepts male
  – Straw-colored discharge

• Metestrus or Diestrus (90 days)
  – False pregnancy

• Anestrus (5 months)
  – Sexual inactivity
Estrous Cycle - Pregnant

• Proestrus (9 days)
  » Vulva swollen
  » Bloody discharge
  » Attracted to male but does not mate

• Estrus (9 days, ovulation day 2)
  » Accepts male
  » Straw-colored discharge

• Pregnant Metestrus/Diestrus (50 - 60 days)
  » Pregnancy
  » Parturition (63 days from ovulation)

• Anestrus (5 months)
  » Sexual inactivity
**Estrous Cycle**

- **Pro-estrus**
  - 1 - 2 days
  - Attracted to males
  - Rubs head and neck on objects
  - Vocalization, posturing and rolling

- **Estrus**
  - Accepts male
  - 4 - 6 days if male present, 10 days if no male
  - Ovulation 27 hours after mating (induced)
  - Affectionate to aggressive towards owners
Estrous Cycle! (Queen)

- Proestrus if queen did not ovulate
  - 8 - 10 days
- Diestrus after ovulation
  - Pseudopregnancy - 40 days
  - Pregnancy - 60 days
- Anestrus 3 - 4 months
Luteal Phase

Stage of heat

C. Metestrus (after heat)
- day 1-5 of cycle
- not permit mounting
- 50% cow, 90% heifer - metestral bleeding
- corpus luteum begins to develop

Metestrus
- estrogen low
- ovulation in cow
- corpus hemorrhagicum present
- uterus
  - contractions subside
  - endometrial glands continue to grow and become coiled
  - in cattle bleeding occurs
- FSH increases
  - triggering growth of follicles
Luteal Phase

Stage of heat

D. Diestrus (between heat)

• day 5 - 19
• complete lack of sexual desire

Diestrus

• progesterone high
• FSH
  ➢ Increases at some point to cause growth of ovulatory follicle
• Uterus
  ➢ secrets fluid but volume gradually decreases
  ➢ contraction stop
  ➢ CL regresses at the end of this period if female is not pregnant due to PGF release
Rapid growth to Graafian follicle
High Estrogen

Prepare for future cycles - continues growth

Graafian Follicle

Ovulation of oocyte

Expression of heat, stands to be mounted

Corpus Albicans

Developing large Tertiary follicle

19-21

Days of the Bovine Estrous Cycle

18

10-17

Early Corpus Luteum

If not pregnant release of PGF2α from uterus causes CL death

Corpus Hemorrhagicum

Filled with blood and lymph

Progesterone is still low

Mature CL - Progesterone high

21 Days

2-3

4-5

6-7

7-10

Increasing Progesterone in blood

Regressed CL - No progesterone production

Developing Tertiary Follicle

Secondary Follicle
Estrous Cycle

- **Progesterone (P₄)**
- **Estradiol (E₂)**

**Day of Estrous Cycle**

- New CL Forming
- Mature CL Present
- Fol. Size & CL Size

**Hormone Level**
Days Relative to the Gonadotropin Surge

CL

Progesterone

PGF$_{2\alpha}$

Estradiol

FSH

LH

Ovulation

Metestrus

Diestrus

Proestrus

Estrus

Diestrus

Estradiol

Progesterone

PGF$_{2\alpha}$

Follicles

 Corpora Lutea (CL)

Ovulation

CA

-7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8

Diestrus

Proestrous

Estrus

Metestrous

Diestrous
Ovary - CL and Follicle

- Graafian Follicle
- Corpus Luteum
- Tertiary Follicles
Animals induced ovulation
Spontaneous Ovulators

• Retain some neural control of ovulation
  – heifers can alter the timing of the LH surge by clitoral stimulation
Induced Ovulators

Nerve endings sensing copulation

Sensory Neurons

Copulation

Penis
GnRH

Blood LH

Time (hr)

Stimulation

Hypothalamus

Posterior Pit.

Anterior Pit.

Spinal Chord
Sensory Neurons

Nerve endings
sensing copulation

Copulation

Penis

Sensory Neurons

LH
Female reproductive parameters in domestic animals

<table>
<thead>
<tr>
<th></th>
<th>Cow</th>
<th>mare</th>
<th>ewe</th>
<th>doe</th>
<th>sow</th>
<th>bitch</th>
<th>queen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of puberty (month)</td>
<td>10 – 12</td>
<td>15 – 24</td>
<td>7 - 10</td>
<td>6 - 8</td>
<td>5 - 8</td>
<td>6 - 12</td>
<td>5 - 12</td>
</tr>
<tr>
<td></td>
<td>breed</td>
<td>seasonal</td>
<td>effect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age of sex maturation</td>
<td>30</td>
<td>36</td>
<td>10</td>
<td>8(if born in early ears)</td>
<td>10</td>
<td>5 - 12</td>
<td>6 - 12</td>
</tr>
<tr>
<td>Type of estrous cycle</td>
<td>Poly estrous</td>
<td>Seasonal</td>
<td>poly estrous</td>
<td>Seasonal poly estrous</td>
<td>poly estrous</td>
<td>monestrous</td>
<td>polyestrous</td>
</tr>
<tr>
<td>Length of estrous cycle</td>
<td>21 day</td>
<td>22 day</td>
<td>17 days</td>
<td>21 days</td>
<td>21 days</td>
<td>15 -65 weeks</td>
<td>2 – 3 weeks (if no mated)</td>
</tr>
<tr>
<td>Duration of estrous</td>
<td>24 (hours)</td>
<td>4 -7 days</td>
<td>36 hours (24 -48)</td>
<td>18 – 36 hours</td>
<td>48-72 hours</td>
<td>9 -10 days</td>
<td>3 -6 days</td>
</tr>
<tr>
<td>Optimal breed time( hours after onset of estrous)</td>
<td>10 -16</td>
<td>48 -72</td>
<td>18 - 24</td>
<td>24 - 36</td>
<td>12 - 30</td>
<td>48 -96</td>
<td>During estrous</td>
</tr>
<tr>
<td>Time of ovulation</td>
<td>4 -16 after estrous</td>
<td>24 -48 hours before end of estrous</td>
<td>24 hours after onset estrous</td>
<td>12 – 36 hours after onset estrous</td>
<td>24 – 42 hours after onset estrous</td>
<td>1 -3 day after onset estrous</td>
<td>25 – 50 hours after coitus</td>
</tr>
<tr>
<td>Mechanism of ovulation</td>
<td>spontaneou s</td>
<td>spontaneou s</td>
<td>spontaneou s</td>
<td>spontaneou s</td>
<td>spontaneou s</td>
<td>spontaneou s</td>
<td>induced</td>
</tr>
<tr>
<td>Ovulation rate (number of ova)</td>
<td>1</td>
<td>1</td>
<td>1 -2</td>
<td>2 -3</td>
<td>10 -20</td>
<td>6 -8</td>
<td>4</td>
</tr>
</tbody>
</table>
GnRH to pituitary gland causes FSH release and begins the cycle

- Luteinizing hormone (LH)
- Follicle stimulating hormone (FSH)

- CL breakdown
- Pregnant

- Estrogen
- Progesterone

- Decreasing progesterone
- Out of heat (not receptive)

- Mature follicle
- No fertilization

- Primary follicles in ovary
- Fertilization

- Ovulation from follicle
- CL (corpus luteum) forms at ovulation site

- In heat (receptive)
Met estrous Bleeding