Animal Science 434
Reproductive Cycles in the Female

Terminology
- Estrus is a noun.
  - The cow is displaying estrus.
- Estrous is an adjective.
  - The length of the estrous cycle is 21 days.
- Oestrus and Oestrous
  - British and European spellings
- Estrus and Heat are synonymous

Terminology (cont.)
- Anestrus
  - When the female is not having repeated estrous cycles.

Types of Cyclicity

Polyestrus
- Queen
- Cow
- Sow

Seasonally Polyestrus

Short day breeders
  (Fall)

Long day breeders
  (Spring)

Monoestrus

Dog
Wolf
Bear
### Average Reproductive Cycles

<table>
<thead>
<tr>
<th>Species</th>
<th>Length of Estrous Cycle</th>
<th>Length of Estrus</th>
<th>Ovulation &amp; CL Formation</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>
</tbody>
</table>

### Average Reproductive Cycles

<table>
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<tr>
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<th>Length of Estrous Cycle</th>
<th>Length of Estrus</th>
<th>Ovulation</th>
<th>Length of Pregnancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitch</td>
<td>6 months</td>
<td>9 days</td>
<td>4 - 24 days after start of estrus</td>
<td>63 days</td>
</tr>
<tr>
<td>Queen</td>
<td>17 days</td>
<td>9 days</td>
<td>Induced</td>
<td>63 days</td>
</tr>
</tbody>
</table>

### Variation in Cycle Types

<table>
<thead>
<tr>
<th>Example</th>
<th>Type of Cycle</th>
<th>Follicular Development</th>
<th>Ovulation &amp; CL Formation</th>
<th>CL Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow, ewe, sow, mare</td>
<td>Long</td>
<td>Spontaneous</td>
<td>Spontaneous</td>
<td>Spontaneous</td>
</tr>
<tr>
<td>Rats, mice, hamsters</td>
<td>Short</td>
<td>Spontaneous</td>
<td>Induced (prolactin)</td>
<td></td>
</tr>
<tr>
<td>Rabbit, cat, mink, ferret, otter, alpaca</td>
<td>Induced</td>
<td>Spontaneous</td>
<td>Induced (LH surge)</td>
<td>Induced</td>
</tr>
</tbody>
</table>

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![Diagram of ovarian cycle](image_url)
**Follicular Phase**

- Follicles grow and mature.
- Estrogen levels rise.
- Endometrial glands develop.
- Uterine lining thickens.
- Vascularization increases.

**Proestrus**

- Estrogen levels peak.
- Vascularization of the uterine lining increases.
- Endometrial glands become more vascular.
- Cervical mucus volume increases.

**Estrus**

- Estrogen levels decrease.
- Uterine motility decreases.
- Cervical mucus volume decreases.
- Gonadotropin surge occurs 2-3 days before estrus.

**Ovulation**

- Ovulation occurs 24-48 hours after LH surge.
- Follicular fluid exits the ovary.
- Eosinophilic granulocytes move towards oviduct.

**Metestrus**

- Estrogen decreases.
- LH surge occurs.
- Uterine motility increases.
- Cervical mucus volume increases.

**Diestrus**

- Estrogen and progesterone levels decrease.
- Gonadotropin surge occurs.
- Uterus in a resting state.

**CL**

- Corpus luteum forms.
- Progesterone is produced.

**PGF**

- Prostaglandin F2α.

**FSH**

- Follicle-stimulating hormone.

**LH**

- Luteinizing hormone.

**CL**

- Corpus luteum.

**CA**

- Corpus albicans.

Days Relative to the Gonadotropin Surge

- Estrus: Days 0-2
- Proestrus: Days -1-2
- Estrus: Days -2-4
- Proestrus: Days -4-6
- Estrus: Days -6-8
- Proestrus: Days -8-10
- Estrus: Days -10-12
- Proestrus: Days -12-14
- Estrus: Days -14-16
- Proestrus: Days -16-18
- Estrus: Days -18-20
- Proestrus: Days -20-22
- Estrus: Days -22-24

- Relative to the Gonadotropin Surge
- Days 0-2: Estrus
- Days -1-2: Proestrus
- Days -2-4: Estrus
- Days -4-6: Proestrus
- Days -6-8: Estrus
- Days -8-10: Proestrus
- Days -10-12: Estrus
- Days -12-14: Proestrus
- Days -14-16: Estrus
- Days -16-18: Proestrus
- Days -18-20: Estrus
- Days -20-22: Proestrus
- Days -22-24: Estrus
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>3-4</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>

Hormonal Changes in the Bitch
Hormonal Changes in the Queen

Queen in Estrus (no mating)

Estrus (9 days)

Queen in Estrus (no mating)

Estrus (8 days)

Mating

 Presence of Offspring

Pregnancy

Gestation Anestrus

Causes of Anestrus

Pregnancy

Presence of Offspring

Season

Nutrition

Stress

Pathology

Parturition

Lactation

Causes of Anestrus
Gestational Anestrus

- Progesterone during pregnancy
  - negative feedback
- After parturition anestrus continues
  - progesterone exposure during pregnancy
  - hypothalamus
    - Lacks estradiol positive feedback
- allows time for uterine involution

Seasonal Anestrus

Horses are long day breeders!

Sheep are short day breeders!

Estradiol

Negative Feedback increases
Decreased Negative Feedback
Seasonal Anestrus

- just like entering puberty
- silent ovulation

Silent Ovulation

<table>
<thead>
<tr>
<th>Anestrus</th>
<th>Estrus</th>
</tr>
</thead>
<tbody>
<tr>
<td>First LH surge</td>
<td>&quot;Silent&quot; ovulation</td>
</tr>
<tr>
<td>30 weeks</td>
<td>6 days</td>
</tr>
</tbody>
</table>

Brain (hypothalamus) must be primed with Progesterone To Express Estrus in Response to Estrogen

Lactational Anestrus

Intact cow

Manmary denervated cow

Suckling Effect on LH

Weeks Postpartum
**Lactational Anestrus**

- Suckling
- Other offspring factors
  - visual encounter
  - olfactory encounter
  - auditory encounter
- Prolactin
  - inhibits GnRH release
  - major infertility problem in women who are not lactating

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**Nutritional Anestrus**

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**Menstrual Cycle**

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**Follicular Phase**
Menstrual Cycle Length

• AGE
  ➢ Length
    ❖ 15 - 19 year olds → 35 days
    ❖ 30 year olds → 30 days
    ❖ 35 year olds → 28 days
  ➢ Variation
    ❖ More in teenagers
    ❖ Less in women in peak reproductive years

Influence of Lactation on Postpartum Menstrual Cycles (US and UK, 1987)

• Not Lactating
  – 50% cycling by 8 months
  – 90% cycling by 12 months

• Lactating (for 24 months)
  – 30% cycling by 12 months
  – 70% cycling by 24 months

Concept Tutor

Rest are extra slides not used in 2012