Lecture 8: The Onset of Puberty

Development of Hypothalamus and GnRH Release Centers

Males and Females are Different!!!

Hypothalamus GnRH Control Centers in the Female

Why does the male only have tonic control centers develop?

Male Brain Development

Female Brain Development

Female Brain Development
Puberty

The ability to accomplish reproduction successfully.

Puberty in the Female

• Age at first estrus (heat)
• Age at first ovulation
• Age at which the female can support pregnancy

Puberty in the Male

• Age when behavioral traits are expressed
• Age at first ejaculation
• Age when sperm first appear in the ejaculate
• Age when sperm first appear in the urine
• Age when the ejaculate contains a threshold number of sperm

Average Age of Puberty (Range)

<table>
<thead>
<tr>
<th>Species</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bovine</td>
<td>11 mo (7-18)</td>
<td>11 mo (9-24)</td>
</tr>
<tr>
<td>Ovine</td>
<td>7 mo (6-9)</td>
<td>7 mo (4-14)</td>
</tr>
<tr>
<td>Porcine</td>
<td>7 mo (5-8)</td>
<td>6 mo (3-7)</td>
</tr>
<tr>
<td>Equine</td>
<td>14 mo (10-24)</td>
<td>18 mo (12-19)</td>
</tr>
<tr>
<td>Human</td>
<td>13 yr</td>
<td>12 yr</td>
</tr>
<tr>
<td>Canine</td>
<td>9 mo (5-12)</td>
<td>12 mo (6-24)</td>
</tr>
<tr>
<td>Feline</td>
<td>9 mo (8-10)</td>
<td>8 mo (4-12)</td>
</tr>
</tbody>
</table>

Hormonal

Genetic

Environment

Nutritional
Role of GnRH Pulses

GnRH Pulses Determine Puberty
- Prepubertal period
  - minimal GnRH release
  - FSH and LH low
  - minimal to no folliculogenesis or spermatogenesis
- Puberty
  - increase in the pulse frequency and amplitude of GnRH release
  - increase in FSH and LH pulses
  - folliculogenesis and spermatogenesis occur

Hormonal Changes in the Female

Changes in GnRH Secretion With Puberty

Before Puberty: Low Amplitude and Frequency

After Puberty: Surge and Tonic
Potential Regulators of GnRH Pulses at Puberty

- Development of surge center
- Change in the feedback sensitivity to estradiol

Development of the Hypothalamic GnRH Surge Center

Puberty = 28 - 30 weeks

Positive Feedback is possible prior to puberty

Changes in Feedback Sensitivity to Estradiol

Puberty in the Female
**Silent Ovulation at Puberty**

**Hormonal Changes in the Male**

**Puberty in the Stallion**

- Sertoli cells mature and multiply
- Spermatogonia begin to divide

**Testosterone Remains Low**

- First LH surge
- "Silent" ovulation
- First estrus

**Increased Gonadotropins Caused by GnRH**

**Sperm found in the ejaculate**
Influence of Breed on Age of Puberty

<table>
<thead>
<tr>
<th>Species</th>
<th>Average Age at Puberty (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
</tr>
<tr>
<td>Cattle</td>
<td></td>
</tr>
<tr>
<td>Holstein</td>
<td>8.5</td>
</tr>
<tr>
<td>Brown Swiss</td>
<td>11.6</td>
</tr>
<tr>
<td>Angus</td>
<td>12.4</td>
</tr>
<tr>
<td>Hereford</td>
<td>13.0</td>
</tr>
<tr>
<td>Brahman</td>
<td>19.0</td>
</tr>
<tr>
<td>Swine</td>
<td></td>
</tr>
<tr>
<td>Meishan</td>
<td>3.1</td>
</tr>
<tr>
<td>Large White</td>
<td>6.3</td>
</tr>
<tr>
<td>Yorkshire</td>
<td>7.0</td>
</tr>
<tr>
<td>Sheep</td>
<td></td>
</tr>
<tr>
<td>Rambouillet</td>
<td>9.2</td>
</tr>
<tr>
<td>Finish Landrace</td>
<td>8.6</td>
</tr>
</tbody>
</table>

Availability of Energy Changes with Growth

Effect of 2-deoxyglucose on LH Pulses

Decreased Amplitude and Frequency
Metabolic Signals Influence GnRH Neurons

**Metabolic Signals**
- Blood Glucose
- Leptin
- Adipocytes (Fat)
- Blood Fatty Acids
- Glucose sensing neurons
- Neuropeptide Y neurons
- GnRH neurons
- Fatty Acid sensing neurons

**Effect of Nutrition on Puberty**

- 2.0 lb/day
- 1.5 lb/day
- 1.2 lb/day

% Mature Weight at Puberty

- Dairy Cattle: 30-40%
- Beef cattle: 55-65%
- Sheep: 40-63%

Environmental and Social Conditions

Effect of the Number of Females Housed Together and Exposure to A Male

- 28 Weeks
- 32 Weeks
- 24 Weeks
Influence of Growth Rate and Bull Exposure on Age of Puberty

<table>
<thead>
<tr>
<th>Age at Puberty (days)</th>
<th>Heifers only</th>
<th>Bull Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate Growth Rate</td>
<td>449</td>
<td>428</td>
</tr>
<tr>
<td>High Growth Rate</td>
<td>422</td>
<td>375</td>
</tr>
</tbody>
</table>

Recommended Age to Breed

- Heifer 15 months (65% mature BW)
- Bull 15 natural mating, 12 months AI
- Filly 2-3 years
- Colt 2 years
- Boar 9 months

Puberty

- Hormonal
- Genetic
- Nutritional
- Environment