VET-114
Animal Anatomy and Physiology 2

Webinar
Chapter 18

Pregnancy, Development, and Lactation
A Warm Welcome from My Faculty TEAM and Me!!! 😊
The Pledge of Allegiance

"I pledge allegiance to the flag of the United States of America, and to the republic for which it stands, one nation under God, indivisible, with liberty and justice for all."
Tribute to Our Military Students and Their Spouses!
Are You Using the Course Spaces?
New “Medical Terminology Game”!
Let’s Check it Out!!!
On the Floor at Dove!
https://www.atdove.org/welcome
Ovarian Physiology
Figure 17-17, Page 401

- Follicle
  - 1 egg (ovum)
  - **Estrogen** production
    - Prepares animal for breeding & pregnancy
- **Graafian follicle** (mature)
- **Ovulation** – follicle rupture
  - Egg “caught” by oviduct
  - Ruptured follicle become corpus luteum
- **Corpus luteum** produces progesterone
  - Maintains pregnancy
Oogenesis in Ovaries

During fetal development, meiosis I begins but stops in prophase.

After puberty, primary oocytes complete meiosis I, which produces a secondary oocyte and a first polar body that may or may not divide again.

The secondary oocyte begins meiosis II but stops in metaphase.

A secondary oocyte (and first polar body) is ovulated.

After fertilization, meiosis II resumes. The oocyte splits into an ovum and a second polar body.

The nuclei of the sperm cell and the ovum unite, forming a diploid (2n) zygote.
Corpus Luteum

• If pregnancy occurs, remains for entire pregnancy
• If pregnancy does not occur, degenerates after a short period
• False pregnancy (pseudocyesis)
  ▪ Common in dogs
Ovarian Cycle

• Development of ovum, ovulation, formation of corpus luteum, and degeneration of unripeened follicles and corpus luteum

• Influenced by follicle stimulating hormone (FSH) and luteinizing hormone (LH)
Ovulation

- Rupture of mature follicle and release of secondary oocyte into oviduct
  - Becomes ovum if fertilization occurs
- Surface of mature follicle weakens, ruptures
- Fluid released from antrum along with oocyte (still surrounded by corona radiata)
- Empty follicle fills with blood (corpus hemorrhagicum)
Ovulation

- Occurs spontaneously in most species as a result of rising levels of LH
- **Induced ovulators**: ovulation occurs after breeding
  - Cat
  - Rabbit
  - Ferret
Corpus Luteum

- Formed by divisions of granulosa cells that line the blood-filled follicle
- Influenced by continued stimulation of LH
- Produces progestins (primarily progesterone)
  - Necessary for maintenance of pregnancy
- Endocrine signal to ovary causes corpus luteum to be maintained if ovum implants in uterus
List the stages of the estrous cycle and describe the events that occur during each stage.

A Dog’s Menstrual (Heat) Cycle

Introduction

While dogs may seem to have a menstrual cycle that is very similar to a woman’s menstrual cycle, dogs do not experience an actual menstrual cycle. Primates are the only mammals that have a true menstrual cycle. Instead, dogs have what is called an estrus cycle.
Female Reproductive Physiology

• **Puberty** – age at which reproductive organs become functional

• **Males**
  - Quite often mature later than female
  - Always ready for breeding

• **Females**
  - Usually mature first
  - Are only fertile and receptive for a brief time
Estrous Cycle

- Time from the beginning of one heat period to the beginning of the next
- Controlled by 2 anterior pituitary hormones
  - Follicle stimulating hormone (FSH)
    - Oogenesis
  - Luteinizing hormone (LH)
    - Ovulation, corpus luteum production
Estrous Cycle Stages

- Proestrus
- Estrus
- Metestrus
- Diestrus
- Anestrus (in some species)
Proestrus

- The “building up” phase (7 days)
- Blood spotting starts (Day 1)
- Follicles begin developing
- Estrogen output increases
- Blood supply to ovaries increases
Estrus

- “True heat” (7 days)
- Estrogen level production peaks
- Female sexually receptive
- Bloody discharge lighter (straw colored?)
- Ovulation! (one or multiple ova)
  - Ovulation occurs near end of estrus in some species
- Induced ovulator species (e.g., cat, rabbit) remain in a prolonged state of estrus if not bred
Metestrus

- 7 days
- Time when corpus luteum develops
- Lining of uterus thickens for implantation
- **Progesterone** produced by corpus luteum temporarily inhibits follicular development in the ovary
- Cornified epithelial lining that developed in the vagina during proestrus and estrus is lost
Diestrus

- **Corpus luteum at maximum size** and exerting maximum effect
- If *fertilized ovum* implants, corpus luteum is retained well into the pregnancy
- If *no pregnancy* occurs, corpus luteum degenerates at the end of diestrus
  - Animal then either goes back into proestrus or ovary shuts down and animal goes into anestrus
- Seen in *seasonally polyestrus animals* (cat, horse, cattle, swine)
Anestrus

• Period of temporary ovarian inactivity
• Seen in seasonally polyestrus, diestrous, and monoestrous animals
• Ovary temporarily shuts down
• Ovarian inactivity (5+ months in dogs)
• Period between breeding cycles
Types of Estrous Cycles

- **Polyestrous**: animals that cycle continuously throughout the year if they are not pregnant (cattle and swine)
- **Seasonally polyestrous**: animals with seasonal variations in estrous cycles (horse, sheep, cat)
- **Diestrous**: animals with two cycles per year, usually spring and fall (dog)
- **Monoestrous**: animals with one cycle per year (fox and mink)
Why Are There Soooo Many Cats?

• **Seasonally polyestrus** (10 months)
• Anestrus (2 months)
• **Induced ovulators**
  ▪ Need 2 stimuli
• **Post-partum estrus**
  ▪ Can have 3 litters per year!
• Female cats left alone for 30 minutes outside...................... pregnant!
• Rabbits the same
### The Numbers!

**Table 18-1, Page 409**

<table>
<thead>
<tr>
<th>Female</th>
<th>Length of Cycle</th>
<th>Length of Estrus</th>
<th>Gestation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitch</td>
<td>21 days</td>
<td>7 days</td>
<td>2 months</td>
</tr>
<tr>
<td>Queen</td>
<td>18-21 days</td>
<td>Induced Ovulator</td>
<td>2 months</td>
</tr>
<tr>
<td>Mare</td>
<td>~21 days</td>
<td>5 days</td>
<td>11 months</td>
</tr>
<tr>
<td>Cow</td>
<td>21 days</td>
<td>18 hours!</td>
<td>9 months</td>
</tr>
</tbody>
</table>
Pregnancy, Development, and Lactation
Chapter 18
Pages 404-413
• Describe the processes of capacitation of spermatozoa and fertilization of the ovum.
• Describe the events that occur between fertilization of the ovum and implantation of the zygote.
• Describe the structure and functions of the placenta and explain the relationship between the fetus and the amniotic and allantoic sacs of the placenta.
• Describe the structures and functions of the components that make up the umbilical cord.
• Differentiate between diffuse, cotyledonary, zonary, and discoid attachments.
• List the stages of and describe the events that occur in each stage.
• Describe the structure and development of mammary glands.
• Describe the general composition of colostrum and explain its importance to the health of the neonate.
• Describe the overall process of lactation.
My brother from another mother.
Describe the events that occur in the female during pregnancy, development, and lactation.
Fertilization & Implantation

Figure 18-1, Page 407

- **Copulation** – the act of breeding
- **Fertilization** – in oviduct
- **Capacitation**
  - Sperm must arrive first in order to mature
  - Acrosome becomes “armed”
- **Cleavage** – cell division of zygote
- **Implantation** – zygote attaches to endometrium
Fertilization

• **Copulation**: act of breeding; intromission, thrusting, and ejaculation
  - Copulation triggers oxytocin release from posterior pituitary gland of the female
  - Oxytocin causes contraction of smooth muscle of the female reproductive organs

• Semen is usually deposited in the upper portion of the vagina
  - Spermatozoa transported by swimming, by contractions of uterus and oviducts, and by action of cilia in oviducts
Fertilization

• **Capacitation**: series of changes spermatozoa undergo in the female reproductive tract
  ▪ Changes in ion movement through the cell membranes; increase in cells' metabolic rates
  ▪ Release of digestive enzymes from **acrosome**
    • Help the spermatozoa penetrate through layers surrounding the ovum to accomplish fertilization
Fertilization

• Large number of spermatozoa find and swarm around the ovum in the oviduct
• Some begin tunneling through the layers surrounding the ovum
  ▪ Aided by the digestive enzymes of their acrosomes
• Once a single spermatozoon penetrates cell membrane of the ovum, a change in the membrane blocks other sperm from entering
Sperm

Female nucleus

Male nucleus

Zona pellucida becomes impermeable to other sperm

Sperm tail left outside ovum
Cleavage
Figure 18-2, Page 407

• Rapid mitosis of zygote
• Overall size of zygote does not change
• **Morula**: solid mass of cells
• **Blastocyst**: hollow ball of cells
• Enzymes produced by the **blastocyst** dissolve away a small pit in the endometrium

• Blastocyst attaches to **endometrium** in this pit
Implantation

- In *multiparous (litter)* species, the multiple blastocysts randomly space along the horns and body of the uterus.
- Placenta begins to form as soon as the blastocyst implants in the uterus.
The Placenta
Figures 18-3 & 18-4, Page 408

- Multi-layered fluid-filled sac around embryo
- Connected to embryo by umbilical cord
- Where attached to uterus lining, exchange of nutrients & waste takes place
- 2 sacs
  - Amniotic sac
  - Allantoic sac
Placenta

- Multilayered, fluid-filled, membranous sac
- Outermost layer of placenta attaches to uterine lining in some areas
  - Fetal and maternal blood vessels are in close proximity to each other in this area
  - Site of exchange of blood nutrients and wastes
Placenta

- **Amnion**: membranous layer immediately surrounding the fetus
  - Forms the amniotic sac
  - Fetus floats in amniotic fluid inside the amniotic sac
- **Allantois**: layer surrounding amniotic sac; forms the allantoic sac, which accumulates wastes
Placental Attachments
Figure 18-4, Page 408

(A) Diffuse attachment – horse and pig
(B) Cotyledonary attachment – ruminants
Placental Attachments
Figure 18-4, Page 408

(C) Zonary attachment – dog & cat
(D) Discoid attachment – primates, rodents
Pregnancy

- **Gestation period**: time from fertilization of ovum to delivery of newborn
- Divided into three segments (trimesters):
  - First trimester – **embryonic** period
    - Placenta develops
  - Second trimester – **fetal** period
    - Body tissues, organs, & systems develop
  - Third trimester – fetal **growth period**
# Average Gestation Periods

**Table 18-1, Page 409**

<table>
<thead>
<tr>
<th>Species</th>
<th>Gestation Period (Months)</th>
<th>Average No. of Young</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bovine</td>
<td>9 months</td>
<td>1</td>
</tr>
<tr>
<td>Canine</td>
<td>2 months</td>
<td>4–10</td>
</tr>
<tr>
<td>Equine</td>
<td>11 months</td>
<td>1</td>
</tr>
<tr>
<td>Feline</td>
<td>2 months</td>
<td>4–6</td>
</tr>
<tr>
<td>Ovine</td>
<td>5 months</td>
<td>1–2</td>
</tr>
</tbody>
</table>
Pregnancy Diagnosis

• Rectal palpation
  ▪ Horses, cows
Horse

25 - 30 days

35 - 40 days

45 - 50 days

Last trimester of pregnancy
RECTAL EXAMINATION OF A COW AT THE END OF THE THIRD MONTH OF GESTATION.
RECTAL EXAMINATION OF A COW APPROACHING TERM. RUMINANT STOMACH REMOVED.
Dogs & Cats

- Absence of heat (cats)
- Abdominal palpation – ~28 days after breeding
- X-rays in last 8-10 days
- Blood tests?
Parturition (Labor)

• The birthing process
• Multiple factors trigger parturition
  ▪ Size and weight of uterus
  ▪ Hormonal changes
• Fetal changes at birth
  ▪ Lungs expand and start functioning
  ▪ Foramen ovale and ductus arteriosus close
Parturition

- 2 hormones
  - **Estrogen** – increases myometrium sensitivity to oxytocin
  - **Oxytocin**
    - Myometrium contractions
    - Milk letdown
## Labor – Comparative Physiology

<table>
<thead>
<tr>
<th>Species</th>
<th>Term</th>
<th>Newborn</th>
<th>Litter?</th>
<th>Breach OK?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canine</td>
<td>Whelping</td>
<td>Pups</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Feline</td>
<td>Queening</td>
<td>Kittens</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Equine</td>
<td>Foaling</td>
<td>Foals</td>
<td>Twins bad</td>
<td>No</td>
</tr>
<tr>
<td>Bovine</td>
<td>Calving</td>
<td>Calf</td>
<td>Twins ok</td>
<td>No</td>
</tr>
<tr>
<td>Ovine</td>
<td>Lambing</td>
<td>Lambs</td>
<td>Twins good</td>
<td>No</td>
</tr>
<tr>
<td>Porcine</td>
<td>Farrowing</td>
<td>Piglets</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Kidney

Large bowel (compressed)

Perineal bulge

Bony pelvic floor

Urinary bladder compressed

Umbilical cord
Stages of Labor

First stage – uterine contractions
Second stage – delivery of the newborn
Third stage – delivery of the placenta
Uterine Contractions

- Myometrium contracts and presses fetus down against the cervix
- Sustained contractions cause the cervix to gradually dilate
Delivery of the Newborn

• Results from combination of strong uterine and abdominal muscle contractions
• Rupture of amniotic and allantoic sacs of the placenta usually precedes actual delivery of the newborn
Delivery of the Placenta

• Placenta separates from wall of the uterus and is expelled by weaker uterine contractions

• **Post-partum examination – very important!**
Involution of the Uterus

• Uterus gradually returns to its non-pregnant size
• Endometrium sloughs into lumen of uterus at sites of placental attachment
• Myometrium continues mild contractions to move remaining uterine contents out through birth canal
• May take from a few weeks to a month or more for involution to be complete
Mammary Glands & Lactation

- Specialized skin glands
  - Colostrum – passive immunity
  - Milk
- Present in both males & females
- Undeveloped until puberty
- Lactation
  - Milk production
  - Begins towards end of pregnancy
  - Continues as long as gland is emptied
# Mammary Glands – Comparative Anatomy

**Table 18-2, Page 411**

<table>
<thead>
<tr>
<th>Species</th>
<th>Usual Number of Glands</th>
<th>Location of Glands</th>
<th>Number of Openings in Teats or Nipples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cats</td>
<td>10</td>
<td>Inguinal, abdominal, and thoracic regions</td>
<td>3–7</td>
</tr>
<tr>
<td>Cattle</td>
<td>4</td>
<td>Inguinal</td>
<td>1</td>
</tr>
<tr>
<td>Dogs</td>
<td>10</td>
<td>Inguinal, abdominal, and thoracic regions</td>
<td>8–20</td>
</tr>
<tr>
<td>Goats</td>
<td>2</td>
<td>Inguinal region</td>
<td>1</td>
</tr>
<tr>
<td>Horses</td>
<td>2</td>
<td>Inguinal region</td>
<td>2–4</td>
</tr>
<tr>
<td>Humans</td>
<td>2</td>
<td>Thoracic region</td>
<td>15–24</td>
</tr>
<tr>
<td>Pigs</td>
<td>14</td>
<td>Inguinal, abdominal, and thoracic regions</td>
<td>2–3</td>
</tr>
<tr>
<td>Sheep</td>
<td>2</td>
<td>Inguinal region</td>
<td>1</td>
</tr>
</tbody>
</table>
Four mammary glands (quarters)

Quarters are completely separate units from each other

Each quarter has its own milk-secreting systems and ducts leading down to separate teats
Cow Udder
Figure 18-5, Page 412

- 4 separate mammary glands (quarters)
- Nipples are called “teats”
• 2 mammary glands in one udder
Mammary Gland Development

- Mammary glands develop in response to hormones produced at puberty
- Prolactin and growth hormone directly encourage mammary gland development
- Estrogen and progesterone encourage the mammary alveoli and duct systems to develop
Colostrum

• Pre-milk secretion
• Contains large amounts of proteins, lipids, amino acids, and vitamins
• Supplies important nutrients to newborn
• Imparts "passive immunity" – transfer of preformed antibodies from dam to newborn
Lactation

- **Physical stimulation of teat or nipple** and regular removal of milk from the gland stimulates anterior pituitary to continue production of hormones that keep lactation going.

- Lack of hormonal stimulation combined with increased pressure in the mammary gland gradually causes lactation to cease.
Milk Letdown

- Milk accumulates high up in the mammary gland in mammary alveoli and small ducts
- Physical stimulation of the nipple or teat sends sensory nerve impulses that cause release of oxytocin from posterior pituitary
Test Yourself
KNOW THESE IN EVERY CHAPTER!

Pages 407, 409, 410, 413
Clinical Applications

Pages 408, 410, 413