Animal and Veterinary Science Department

University of Idaho

AVS 222 (Instructor Dr. Amin Ahmadzadeh)

PLACENTATION & ENDOCRINOLOGY OF GESTATION

CHAPTER 14

I. TYPES OF PLACENTAL ATTACHMENT

The chorion is the fetal contribution to the placenta. The functional unit of the fetal placenta is the chorionic villus which are small, finger-like projections that appear on the surface of the chorion.

A. Placenta type based on based on anatomical appearance and chorionic villi distribution:

(Figure 14-1)

1. **Diffuse**
   - Horses and pigs
   - Entire placenta attaches to the uterus
2. **Cotyledonary**
   - Ruminants (sheep, cattle, goats)
   - Allantochorion attaches to uterus at specialized areas called placentomes

     Placentomes consist of

     Cotyledons: Located on the placenta

     Caruncles: Located in the endometrium
3. **Zonary**
   - Carnivores (dogs and cats)
   - Placenta attaches to uterus by a zone (belt) that circles the placenta
   - Attach by villi located only in the zone
4. **Discoid**
   - In primates, rodents and rabbits and HUMANS
   - Area of attachment is small disc-shaped area
   - Umbilical cord runs from the disc

B. Placenta classification based on type based on microscopic appearance and placenta layers that separate fetal blood from the maternal blood

(Figure 14-3)

- ***The placenta consists of two components: the FETAL (chorionic) and MATERNAL (endometrial) component***

- ***The number of layers within the fetal and maternal components varies among species***

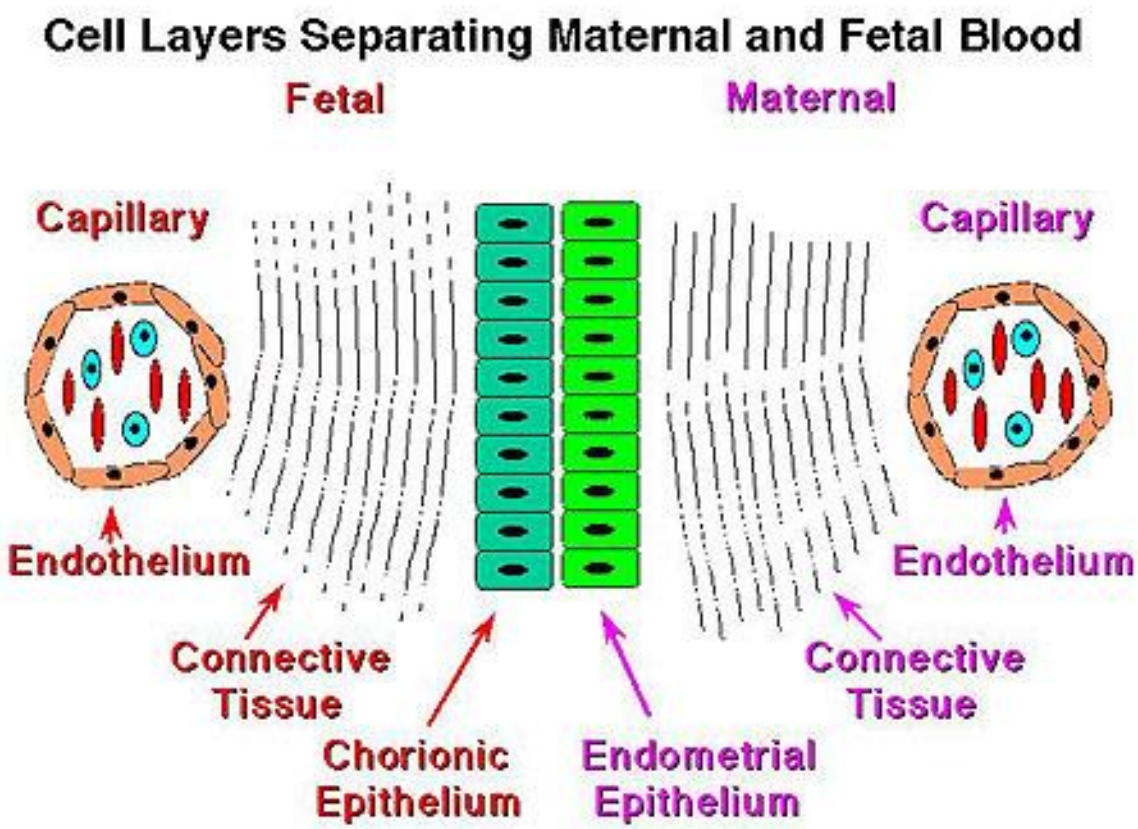
LAYERS OF THE PLACENTA (6 layers: MAXIMUM)

Fetal

1. **Chorionic Endothelium:** Lines fetal blood vessels (capillary)
2. **Chorionic Interstitium (*Connective tissue*):** Surrounds blood vessels (Basement membrane)
3. **Chorionic Epithelilum**

Maternal

4. **Endometrial Epithelium**
5. **Endometrial Interstitium (*Connective tissue*):** Surround maternal blood vessels (basement membrane)
6. **Endometrial Endothelium:** Lines maternal blood vessels (capillary)



Classes of placentas based on the placenta layers:

A. Epitheliochorial – 6 layers

- Six layers separate maternal and fetal blood
- Fetal chorionic epithelium contacts epithelium of uterus
- Found in **horses, pigs, and ruminants**

B. Endothelial chorial – 5 layers

- Maternal epithelial layers are eroded away
- Endothelium of maternal blood vessels in contact with the chorion epithelium

Found in **dogs and cats**

C. Hemochorial – 3 layers

- Maternal epithelium, connective tissue and endothelium are lost
- Fetal chorion epithelium is in direct contact with maternal blood
- Found in **primates, including humans**

D. Hemoendothelial – 1 layer

- Maternal epithelium, connective tissue, endothelium, fetal epithelium and connective tissue lost
- Walls of placental blood vessels (capillaries) are in direct contact with maternal blood
- Found in **rodents and rabbits**

II. ENDOCRINOLOGY OF PREGNANCY

GENERAL PROFILE

A. Progesterone

1. High during most of pregnancy
2. Prevents uterine contractions **(Progesterone block)**
3. Levels decline a few days prior to birth

B. Estrogen

1. Usually low until just before birth
2. Increase the excitability of the uterus

C. *Exceptions to the General Profile*

- Horses:
  - Progesterone levels high until after foal is born
  - Unknown why uterus contracts with high progesterone
- Humans
  - Have high progesterone levels until after birth like horses

D. Relaxin

1. Produced by the ovary
   - Also the placenta in mares
2. Functions
   - Cervical dilation
   - Relax pelvic ligaments
3. Levels increase just prior to parturition
   - Horses may show high levels during last 1/2 of pregnancy

E. Placental lactogen

1. Produced by the placenta
2. Has actions similar to growth hormone & prolactin
3. Possible roles
   - Fetal growth
   - Mammary development
   - .Milk production

F. eCG (equine chorionic gonadotropin or Pregnant Mare Serum Gonadotropin, PMSG)

1. Produced by the **endometrial cups** of the placenta
2. Produced at the time of fetal attachment to the endometrium wall
3. Important for the **CL maintenance**
4. Responsible for controlling the formation and maintenance of accessory CLs During pregnancy

   (eCG-induced ovulation during 40-70 days of pregnancy)

G. hCG (Human chorionic gonadotropin)

1. It can be detected in blood and urine as early as days 8-10 of gestation
2. It is produced by **trophoblastic cells** immediately after blastocyst hatching
3. Its presence in the uterus constitutes the basis for the home pregnancy test

D. Role of the corpus luteum (Table 14-1)

1. **Cattle:**
   - CL removal causes abortion up to 7 months of pregnancy
   - Placenta produces **small** amounts of progesterone
2. **Sheep:**
   - CL needed only during **first half of pregnancy**
   - After the first ½ of gestation, placenta make enough progesterone to support pregnancy
3. **Pig**: CL is needed for the entire pregnancy
4. **Horses**

- CL required only very early in pregnancy
- Placenta produces enough progesterone to support pregnancy

5. **Humans**
   - CL required only until the placenta forms

III. PARTURITION

(Figures 14-10 and 14-11)

A. Fetal stress due to increase in size and limited space in the uterus is KEY:

1. Corticotropin releasing hormone is released from the fetal hypothalamus

2. ACTH is released from the fetal pituitary

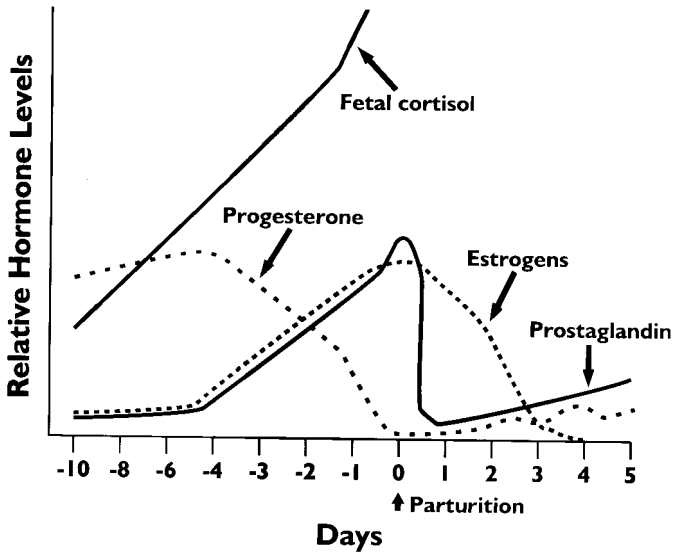
3. Cortisol is released from the fetal adrenals

4. Fetal cortisol promotes the removal of the "progesterone block"

- Enzymes **(aromatase, 17-20 lyase,** and **17alpha hydroxylase)** are synthesized by the placenta which convert placental progesterone to estradiol (therefore, the level of progesterone goes down; the level of estradiol goes up)
- The formation of prostaglandins is promoted by enzymes sensitive to the decrease in progesterone and the increase in estradiol. Therefore, PGF2α is produced and luteolysis begins, resulting in a further decrease in progesterone.

5. Estradiol and PGF2α promote myometrial contractions and release of **relaxin**

6. Relaxin helps to soften the cervix to allow for dilation



IV. THE STAGES OF PARTURITION IN THE COW:

The preparatory stage:

- Increased mammary development, increased size of the vulva, increase in udder and abdominal edema, and relaxation of the pelvic ligaments, and the symphysis pubis

A. Initiation of myometrial contractions/cervical dilation **(1st stage)**

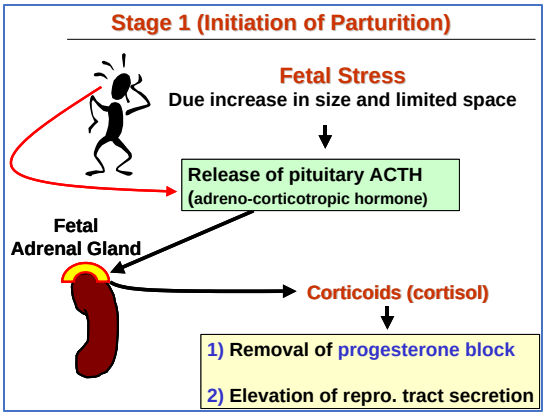
1. Initiated by the fetus: usually 2 to 6 h in duration
2. Uterine contractions push the fetus towards the cervix
3. Pressure by fetal fluids from the 1st water bag (**chorioallantois**) assists in dilation of the cervix
4. Interval between rupture of the 1st water bag and the 2nd water bag (**amnion**) averages about 1 h; "slimy fluid" from the amnion helps with lubrication
5. Complete dilation occurs when the presenting part of the fetus enters and exerts pressure on the cervix; therefore oxytocin is released (Ferguson's reflex) from the posterior pituitary causing an increase in myometrial contractions

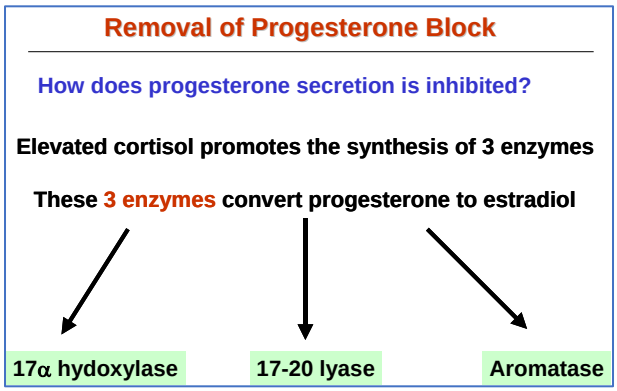
B. Expulsion of the fetus **(2nd stage)**

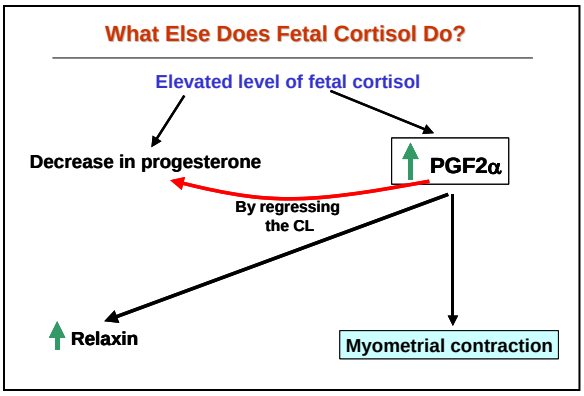
1. Usually .5 to 1 h in duration
2. Distention of the cervix and vagina by the fetus increases abdominal straining; therefore oxytocin is released from the posterior pituitary causing an increase in myometrial contractions
3. Once the head is past the vulva, usually the rest of the body follows easily

C. Expulsion of the fetal membranes **(3rd stage)**

1. Usually within 12 h of calving
2. Separation of the fetal cotyledons from the maternal caruncles due to:
    - Structural changes in the placenta following rupture of the umbilicus
    - Decreased blood flow leading to a collapse of the placentome


Stage 1 (Initiation of Parturition)
Fetal Stress
Due increase in size and limited space
Release of pituitary ACTH
(adreno-corticotropic hormone)
Fetal
Adrenal Gland
Corticoids (cortisol)
1) Removal of progesterone block
2) Elevation of repro. tract secretion


Removal of Progesterone Block
How does progesterone secretion is inhibited?
Elevated cortisol promotes the synthesis of 3 enzymes
These 3 enzymes convert progesterone to estradiol
17α hydoxylase
17-20 lyase
Aromatase


What Else Does Fetal Cortisol Do?
Elevated level of fetal cortisol
Decrease in progesterone
PGF2α
By regressing
the CL
Relaxin
Myometrial contraction