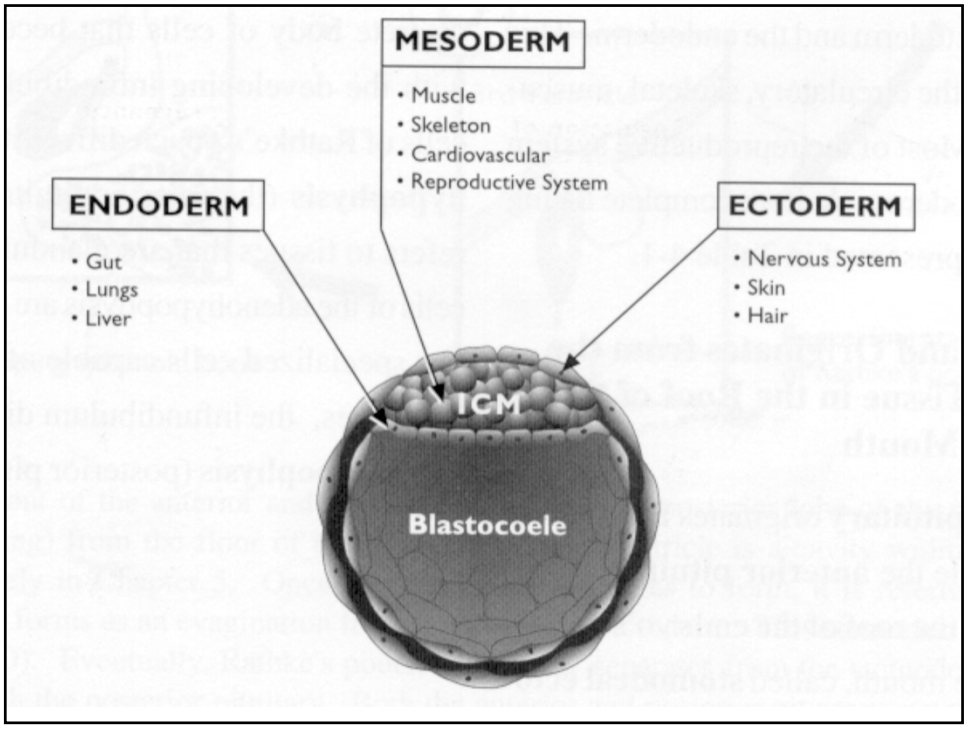


Genetic Differentiation

1. **H-Y Antigen- Histocompatability Y antigen**
   1. **Male specific antigen present on the surfaces of cells**
      XY = H-Y antigen XX = Not present
   2. **NOT the sex determining gene in males.**

2. **Sry Gene - Sex determining region of Y chromosome**

a. Gene for sexual development on the Y chromosome

b. Responsible for TDF- Testis determining factor production

c. Transcription factor which activates other "male" genes

d. Stimulates male development

XY chromosomal pair → TDF production

↓

Testes Formation

↓

A) **Anti Mullerian Hormone** (Sertoli cells)
Blocks development of the Mullerain duct

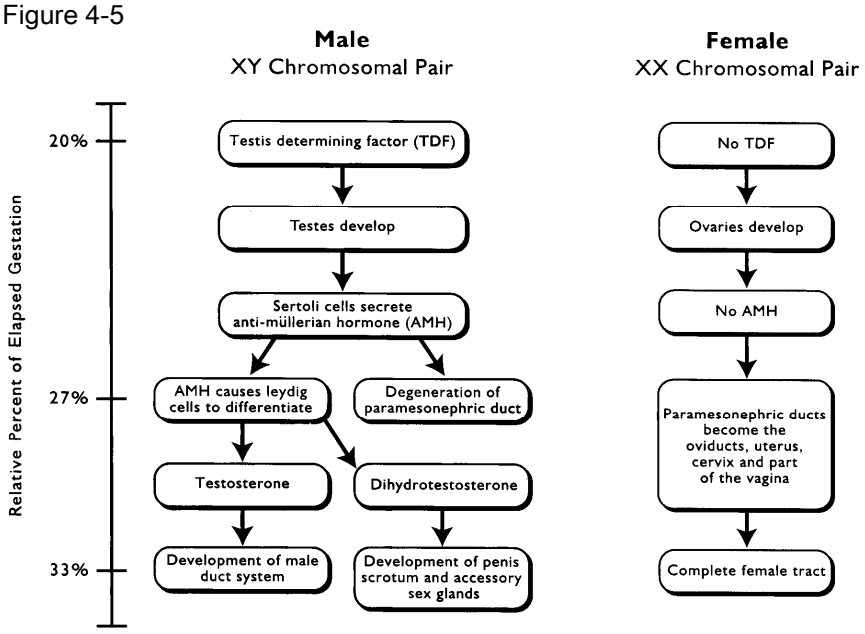
B) Androgens from testis promote Wolffian Duct development
Hormones: testosterone and 5a dihydrotestosterone

↓

Testosterone - stimulates development of Wolffian duct

5a Dihydrotestosterone - stimulates external development of genitalia (scrotum, glands, penis)

Figure 4-5



Brain Sexual Differentiation

Masculinization of the Brain in the male:

testosterone from the fetal testis reaches the brain

↓

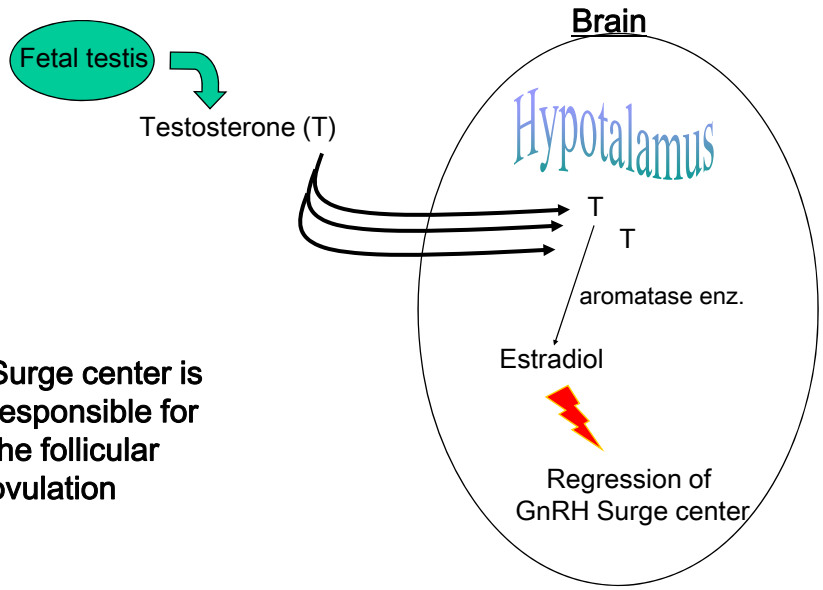
testosterone is converted to estradiol by aromatase enzyme in the hypothalamus

↓

Regression of Hypothalamic GnRH surge center by estradiol

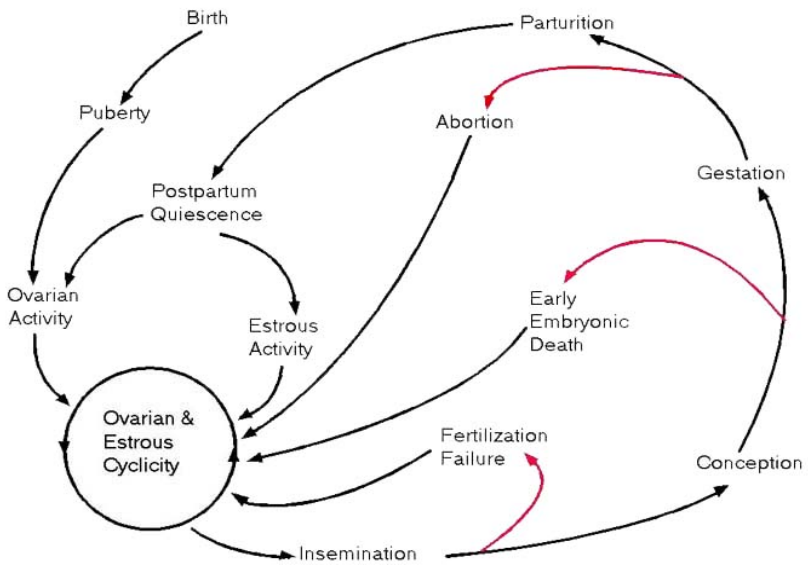
↓

Defeminization of the hypothalamus



Surge center is responsible for the follicular ovulation

Schematic of Bovine Reproductive Cycle (Female)



The Key to Initiation of Puberty

GnRH secretion in high frequency and high amplitude

Enough LH secretion to initiate follicular growth and/or spermatogenesis

High LH pulses and amplitudes and thus LH surge do not occur

Unless

Hypothalamic sensitivity to gonadal estradiol increases

Hypothalamus Sensitivity to E2 changes with age

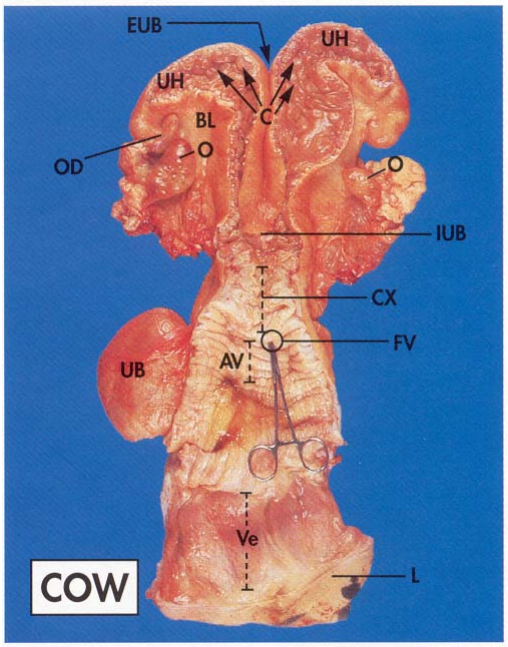
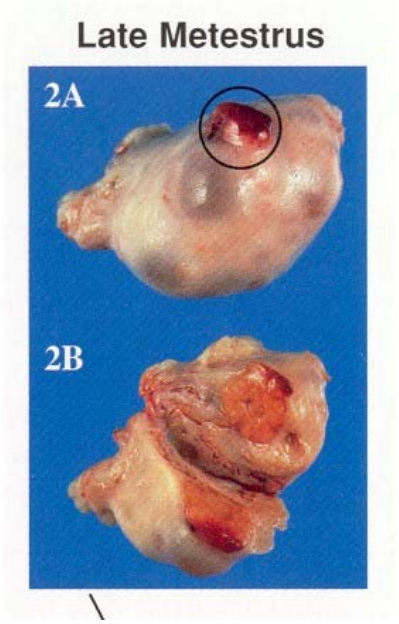


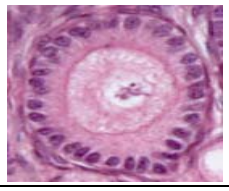
Fig2-2B



Follicle Classification

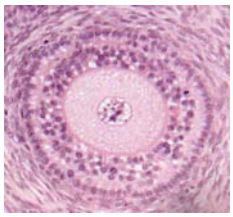
Primary Follicle

1. Least developed follicle
2. Single layer of granulosa cells
3. Females are born with the life time supply of these follicles



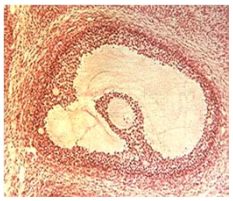
Secondary Follicle

1. At least **2 layers of granulosa cells**
2. **Absence of antrum** (cavity)
3. Zona pellucida, a tick protein layer formed



Tertiary Follicle or Antral Follicle

1. Many layers of granulosa cells
2. **Antrum**
   a. Fluid-filled cavity
   b. Liquor folliculi
   high amounts of **steroid hormones**



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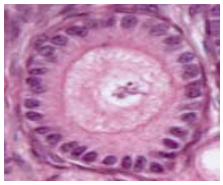

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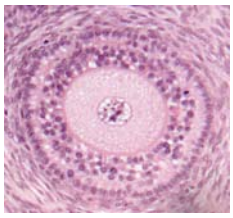

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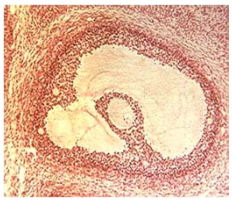
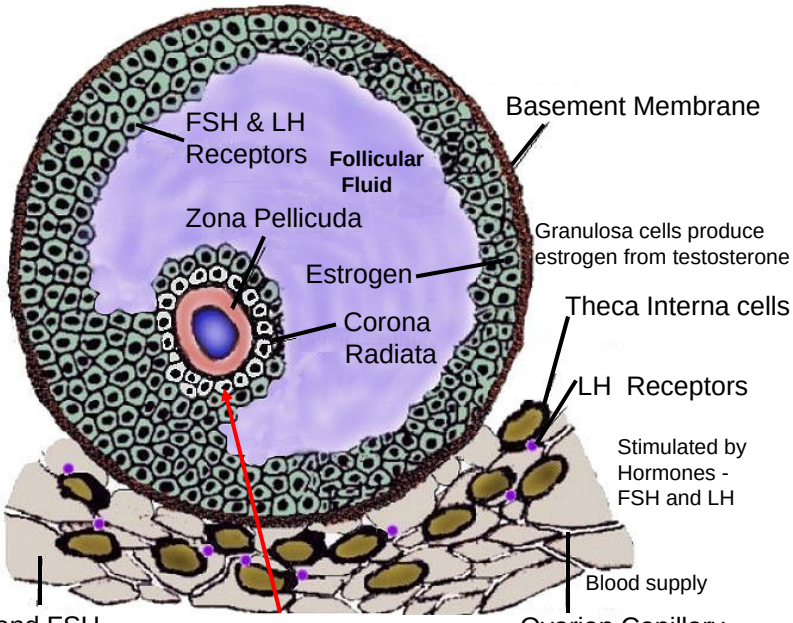
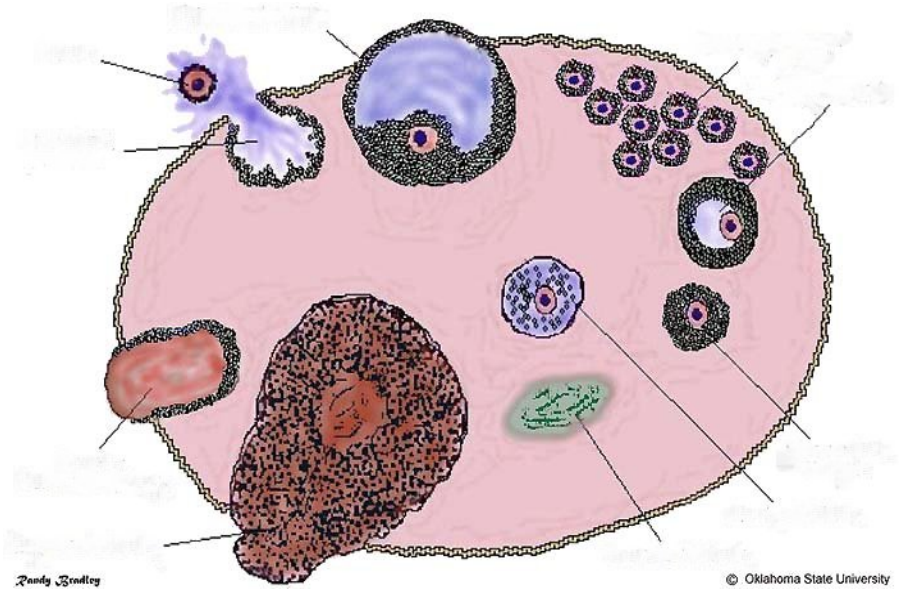






Oviduct

THE OVIDUCT (FALLOPIAN TUBE) (Figure 2-9)

A. Three Main Segments: Infundibulum, Ampulla, Isthmus

1. Infundibulum

a. Funnel shaped structure closest to ovary

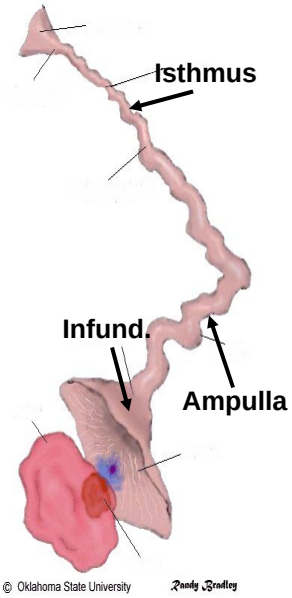
b. Has fimbria on edge (finger-like projections)

- captures the newly ovulated oocyte

2. Ampulla

a. Middle section

b. Site of fertilization



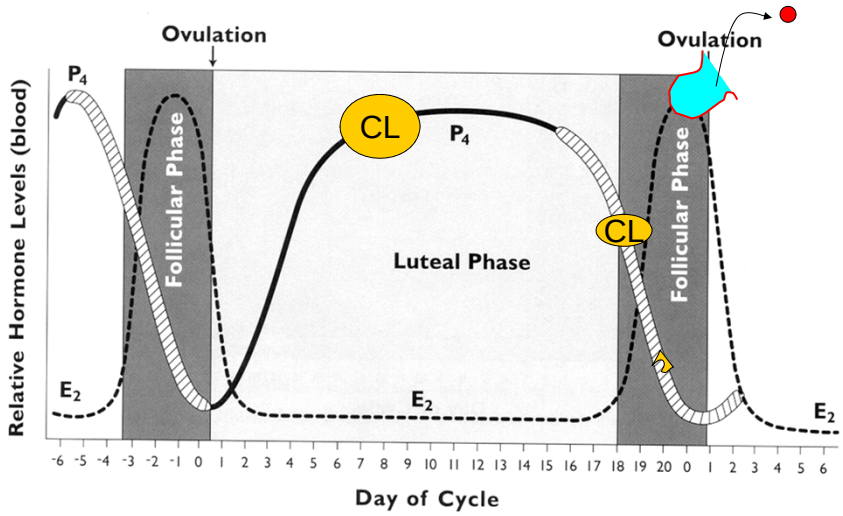


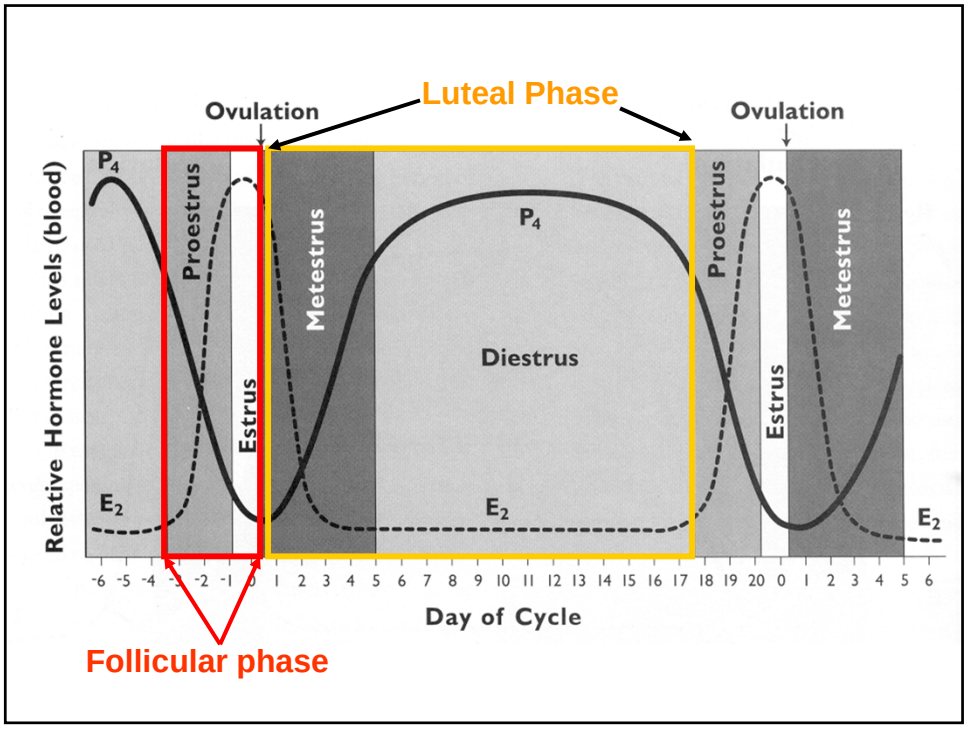
Figure 7-1

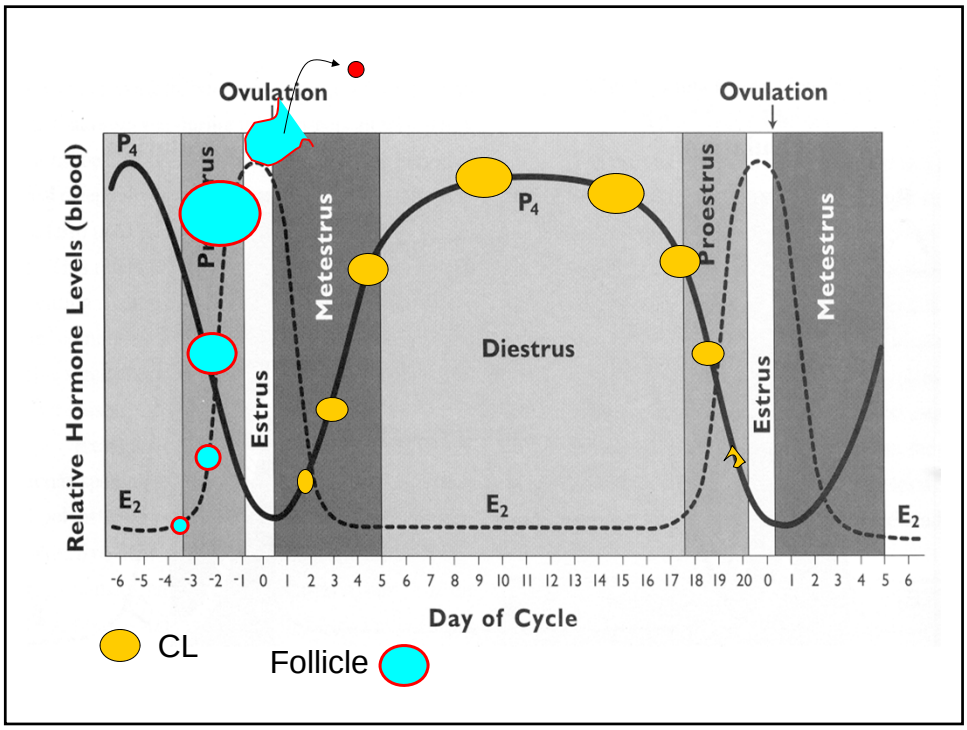
Stages of the Estrous Cycle

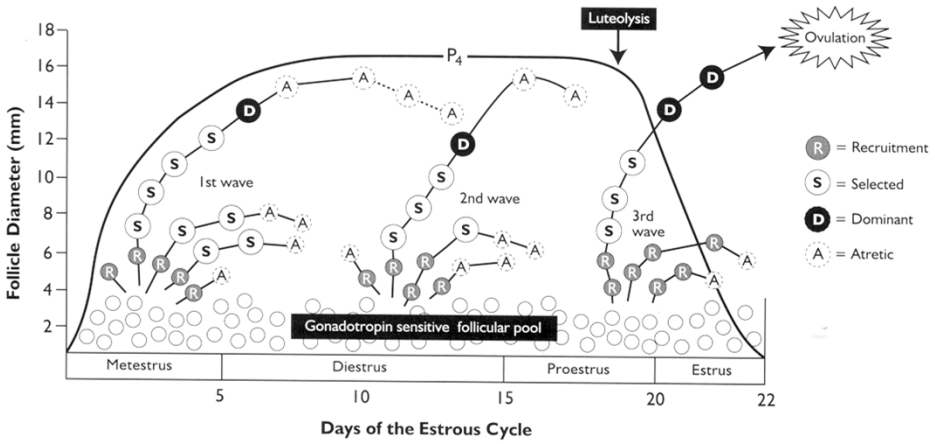
Subdivision of the Follicular and Luteal Phases

Proestrus
Estrus → **Follicular Phase**

Metestrus
Diestrus → **Luteal Phase**


Luteal Phase
Ovulation
Ovulation
Relative Hormone Levels (blood)
P4
E2
Proestrus
Estrus
Metestrus
Diestrus
Proestrus
Estrus
Metestrus
-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 0 1 2 3 4 5 6
Day of Cycle
Follicular phase


Ovulation
Ovulation
Relative Hormone Levels (blood)
P4
E2
Estrus
Metestrus
Diestrus
Proestrus
Estrus
Metestrus
-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 0 1 2 3 4 5 6
Day of Cycle
CL
Follicle



FACTS

The corpus luteum originates from the ovulatory follicle

After ovulation

Theca interna and granulosa cells undergo a dramatic transformation

Transformation is governed by Luteinizing hormone

Corpus Luteum >>>>> Luteinizing hormone

Cells of the corpus luteum

Cells of Theca and granulosa become luteal cells

Theca cells >>> small luteal cells

Granulosa cells >>> large luteal cells

Both luteal cells can make progesterone
But
Large luteal cells make the majority of progesterone

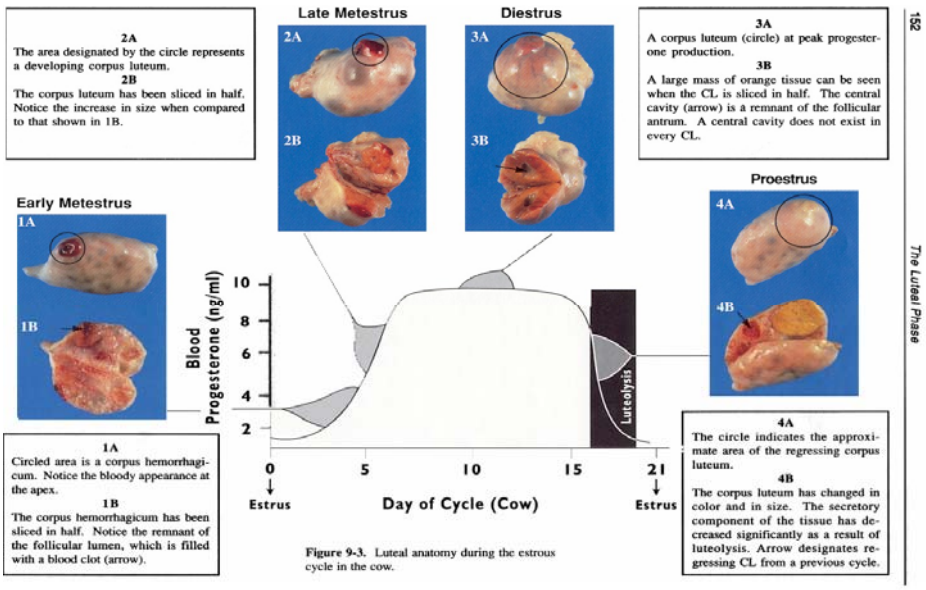


Figure 9-3. Luteal anatomy during the estrous cycle in the cow.

Luteolysis

LUTE = luteal tissue

LYSIS = break down , decomposition

Chief Hormone for luteolysis is

Prostaglandin F2α

But without uterus luteolysis cannot take place !!

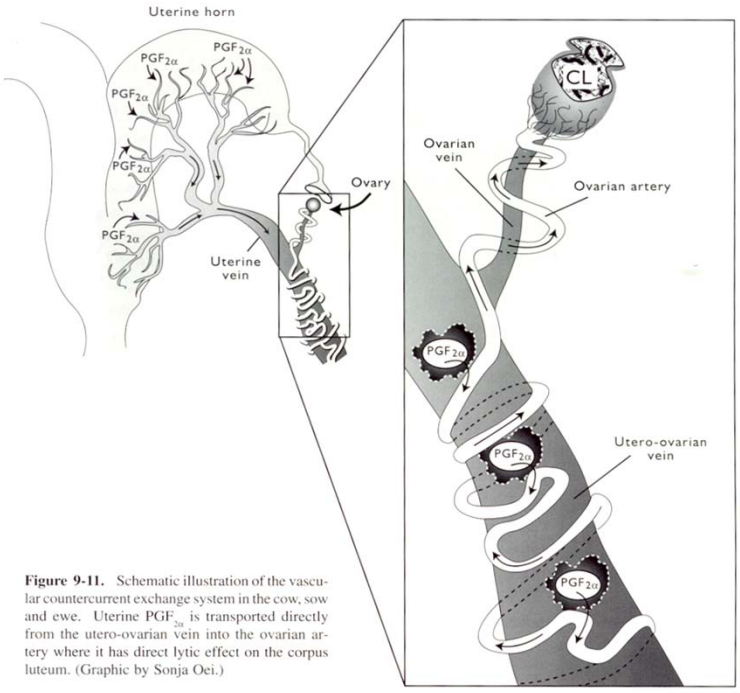


Figure 9-11. Schematic illustration of the vascular countercurrent exchange system in the cow, sow and ewe. Uterine $PGF_{2\alpha}$ is transported directly from the utero-ovarian vein into the ovarian artery where it has direct lytic effect on the corpus luteum. (Graphic by Sonja Oei.)

Luteal oxytocin stimulates PGF2α synthesis

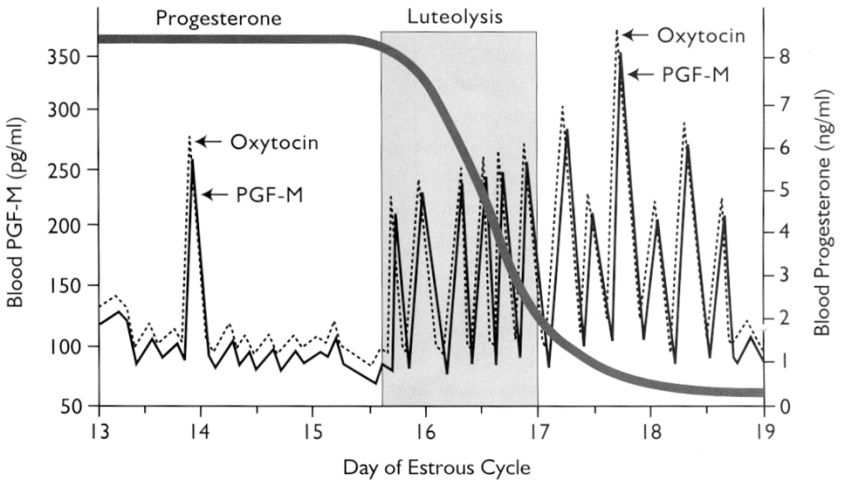


Figure 9-12. Changes in $PGF_{2\alpha}$ secretion during the last 6 days of the estrous cycle as reflected by prostaglandin $F_{2\alpha}$ metabolites (PGF-M). Luteal oxytocin episodes coincide almost perfectly with episodes of PGF-M. When about five pulses of $PGF_{2\alpha}$ occur in a 24-hour period, luteolysis will occur.

Diestrus

Two scenarios

If embryo is not present, uterus releases PGF2α to cause CL regression

The cycle ends when the corps luteum us destroyed (luteolysis)

New estrous cycle starts over!!!!

If embryo is present, Embryo signals the uterus - no **PGF2α and no** CL regression

Ovarian Events at Ovulation

LH Surge

Function 1 & 2

1) Increase in PGE2

2) Elevated blood flow to ovarian tissue (Hyperemia)

3) Inflammation of the theca layer and increase in intra-follicular pressure

4) Start of progesterone synthesis and breakdown of connective tissue of the follicular wall

Collagenase enzyme eats up the collagen tissues

Ovarian Events at Ovulation

LH Surge

1) Increase in PGE2

2) Elevated blood flow to ovarian tissue (Hyperemia)

3) Inflammation of the theca layer and increase in intra-follicular pressure

4) Start of progesterone synthesis and breakdown of connective tissue of the follicular wall

5) Contraction of ovarian smooth muscle by LH-induced increase in PGF >>> Further increase in follicular pressure and weakening of the follicular wall

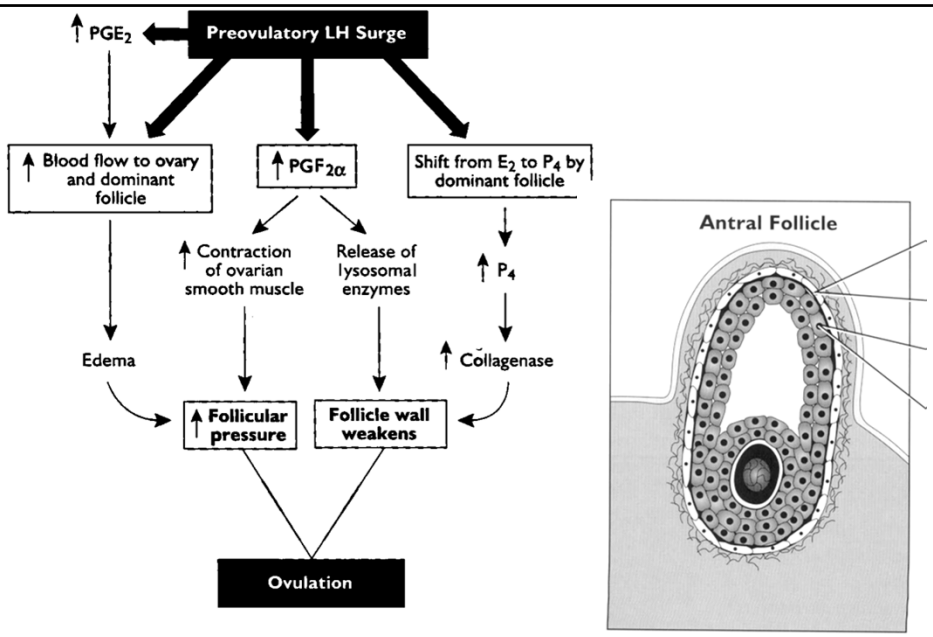


Figure 8-9. Summary of ovarian events caused by the preovulatory LH surge which leads to ovulation.

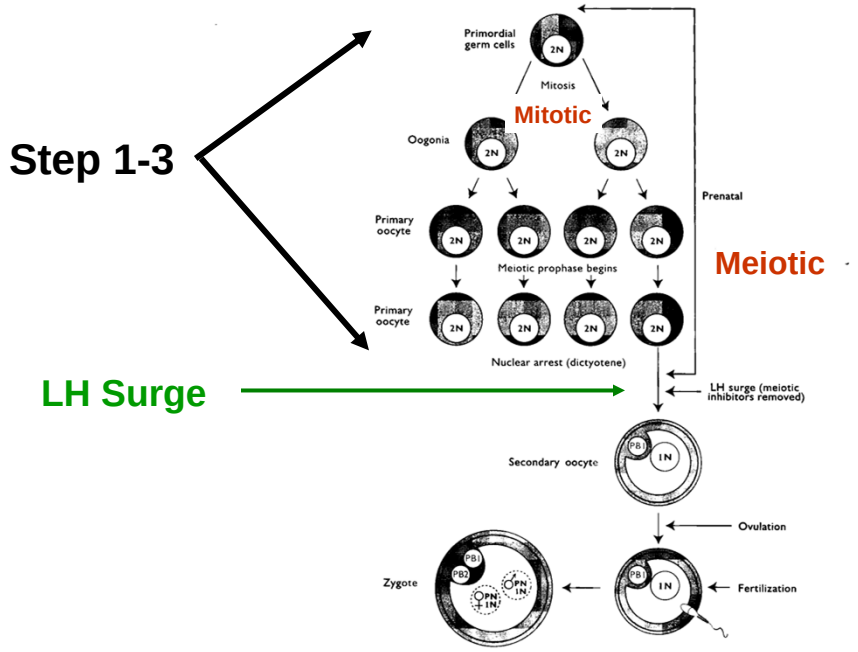
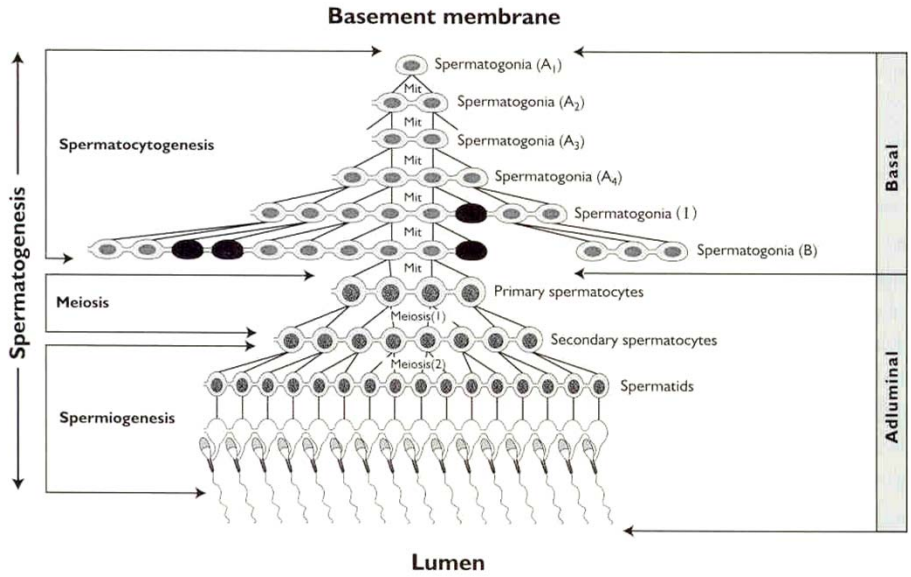
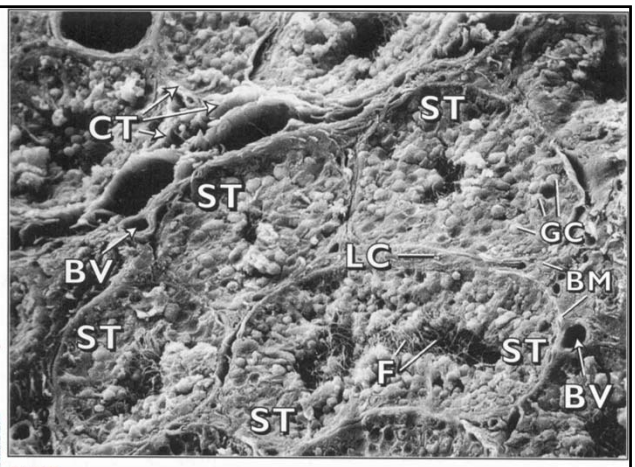
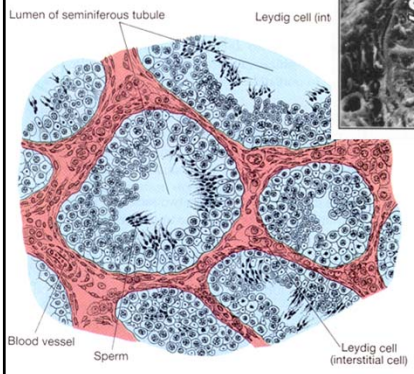


Figure 8-11. Schematic of the major steps of oogenesis.

Spermatogenesis = spermatocytogenesis + meiosis + spermiogenesis





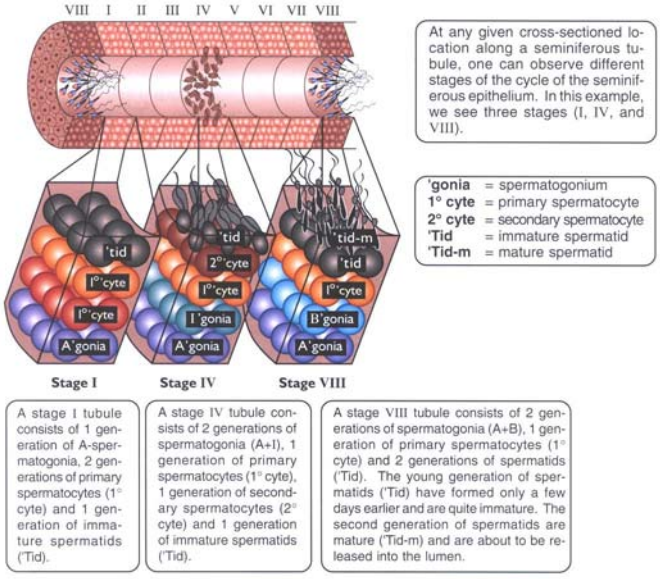


Spermiogenesis Cont.

Four Phases of Spermiogenesis

1) Golgi phase
2) Cap phase
3) Acrosomal phase
4) Maturation phase

Figure 10-10. Associations of Developing Germ Cells That Represent Various Stages of the Cycle of the Seminiferous Epithelium



Cycle of SE = The progression through a complete series of cellular associations (stages) at one location of the SE

- ✓**The length of one cycle vary among species**
  - ✓**Bull = 13.5 days**
  - ✓**Ram = 10.5 days**
  - ✓**Stallion = 12.2 days**

Figure 10-11. Cycle of the Seminiferous Epithelium in the Bull
(Modified from Amann, R.P. *Am. J. Anat.* 110:69)

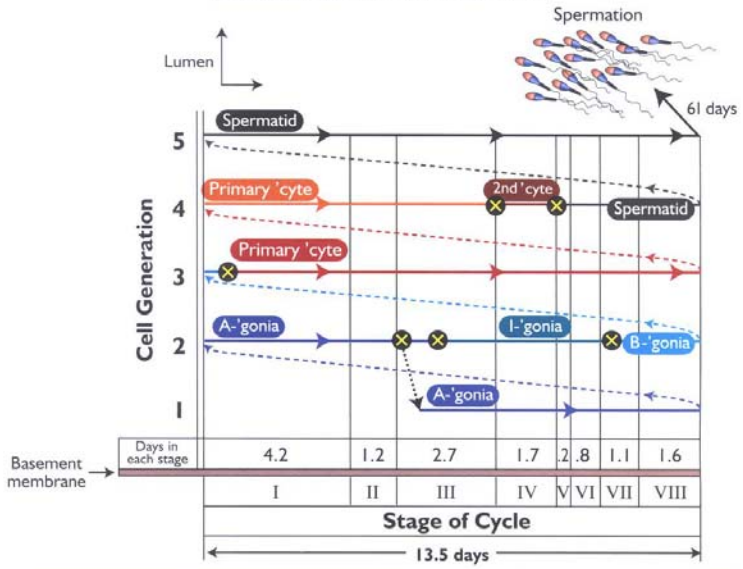
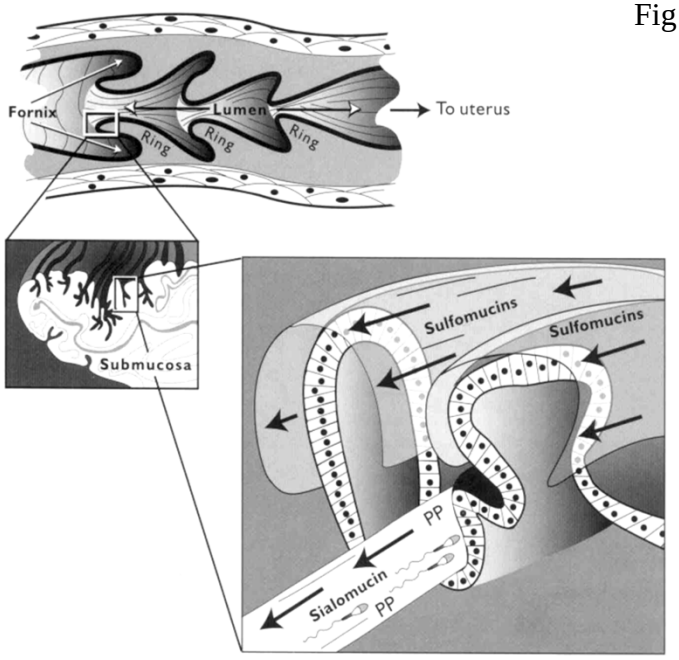
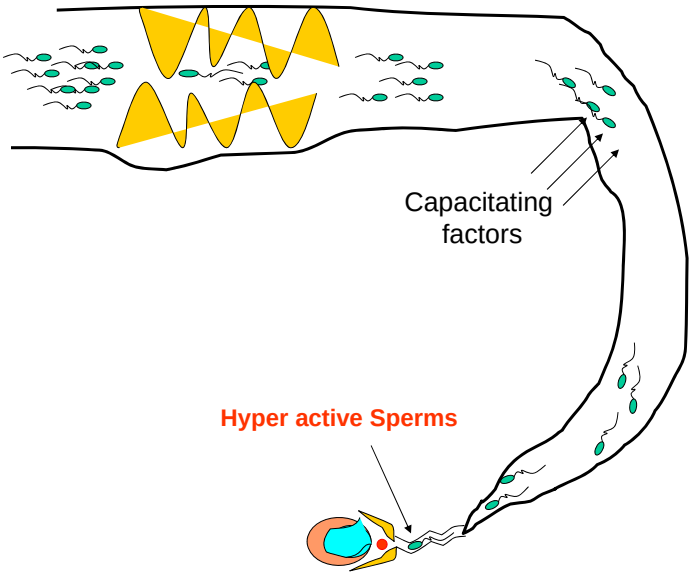
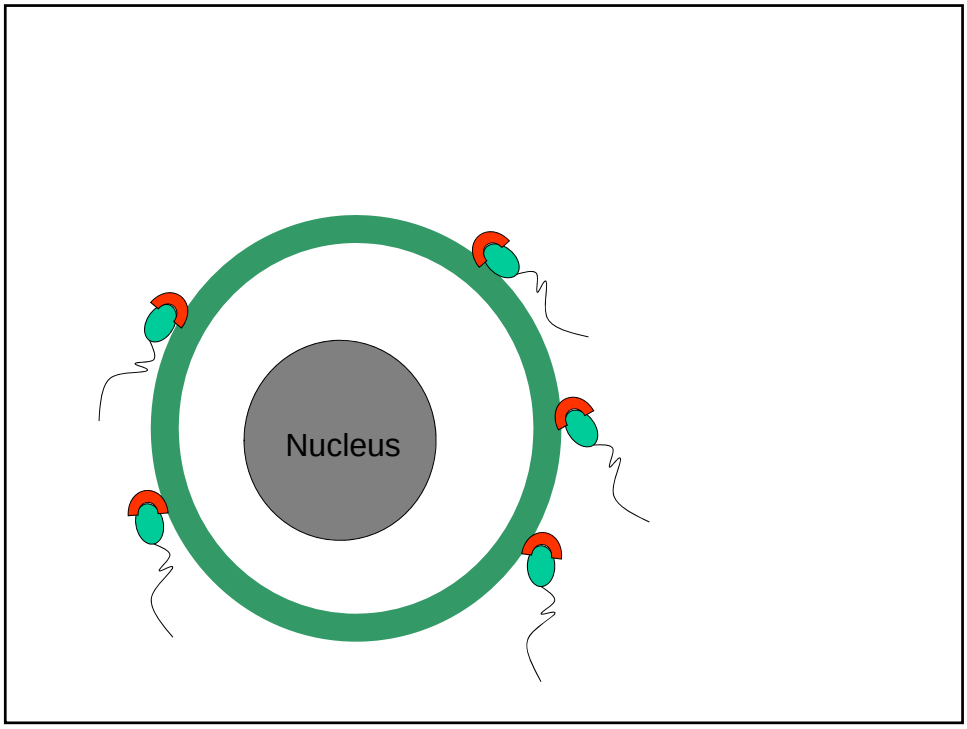
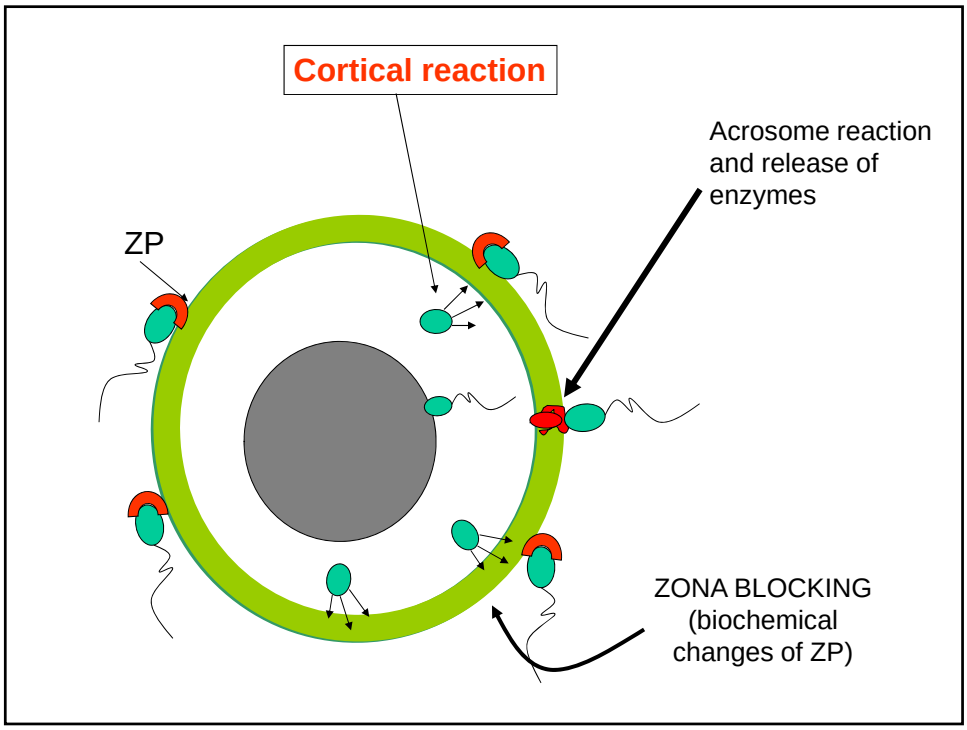


Fig 12-6


Fornix
Lumen
To uterus
Ring
Ring
Ring
Submucosa
Sulfomucins
Sulfomucins
PP
Sialomucin
PP


Capacitating
factors
Hyper active Sperms


Nucleus


Cortical reaction
Acrosome reaction and release of enzymes
ZP
ZONA BLOCKING (biochemical changes of ZP)

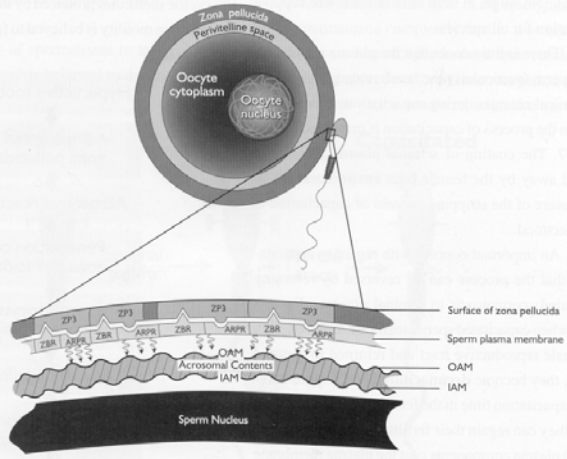
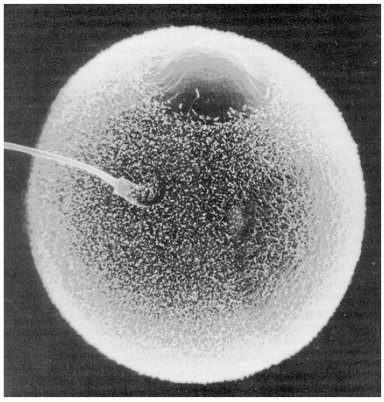
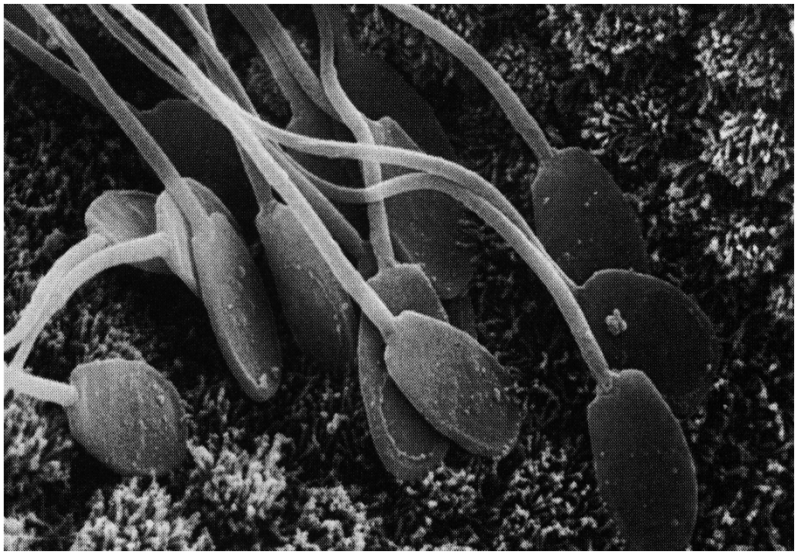
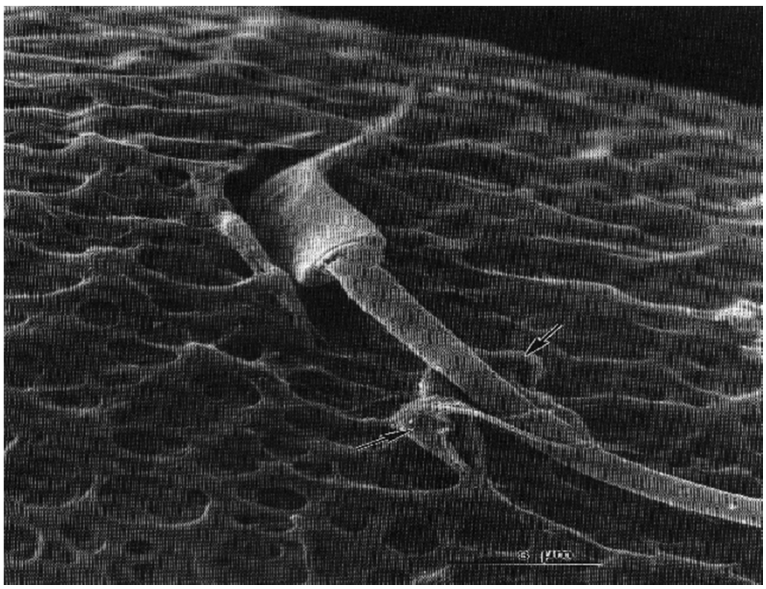
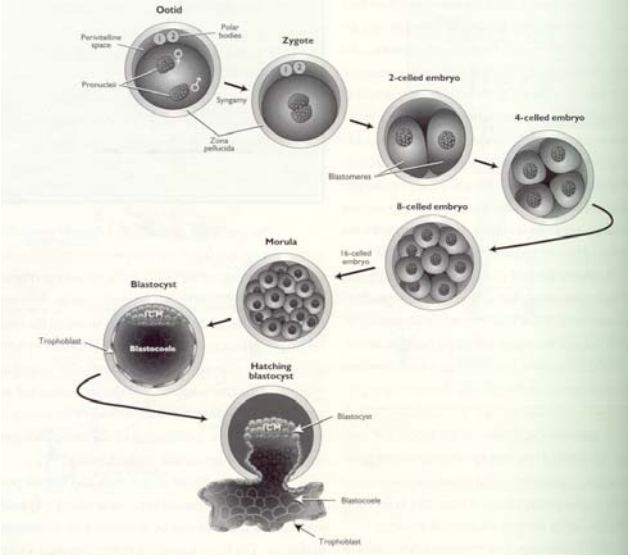


Figure 12-9. Proposed model for zona binding and acrosome reaction initiation in mammalian spermatozoa. The plasma membrane overlying the acrosome contains two receptor-like regions. The first, called the zona binding region (ZBR) reacts with ZP3 to cause physical attachment of the sperm to the zona. A second membrane region, the acrosome reaction promoting region (ARPR) binds to ZP3 and initiates the acrosome reaction by causing the plasma membrane to fuse (arrows) with the outer acrosomal membrane. ARPR= Acrosome Reaction Promoting Region; IAM= Inner Acrosomal Membrane; OAM= Outer Acrosomal Membrane; ZBR= Zona Binding Region. (Graphic by Sonja Oei.)









Maternal Recognition of Pregnancy

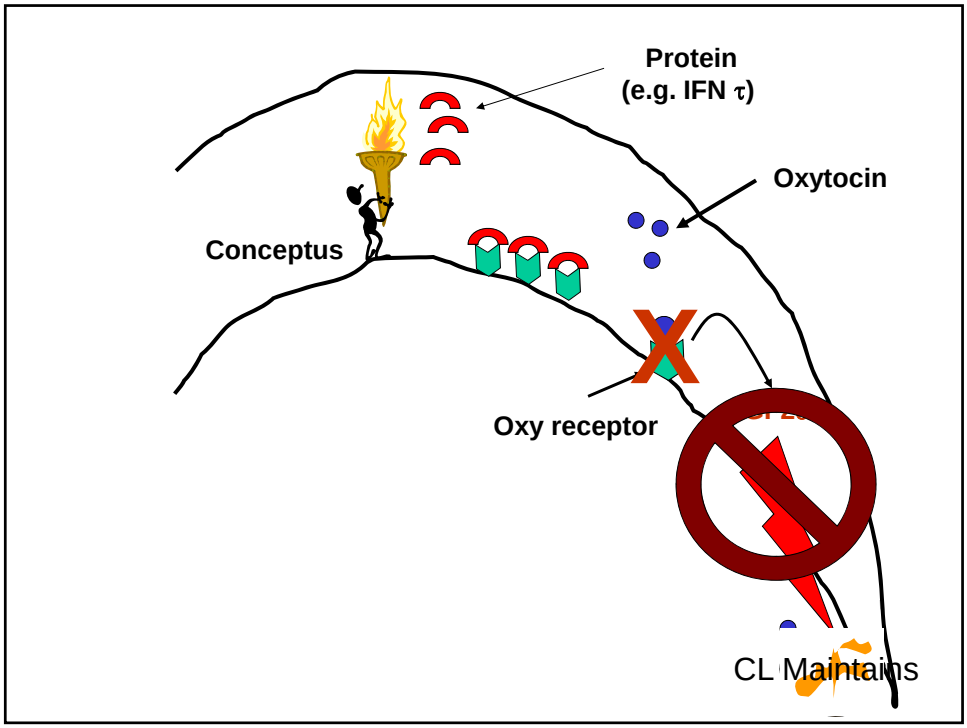
For the early embryo to become an established pregnancy, the corpus luteum must be maintained

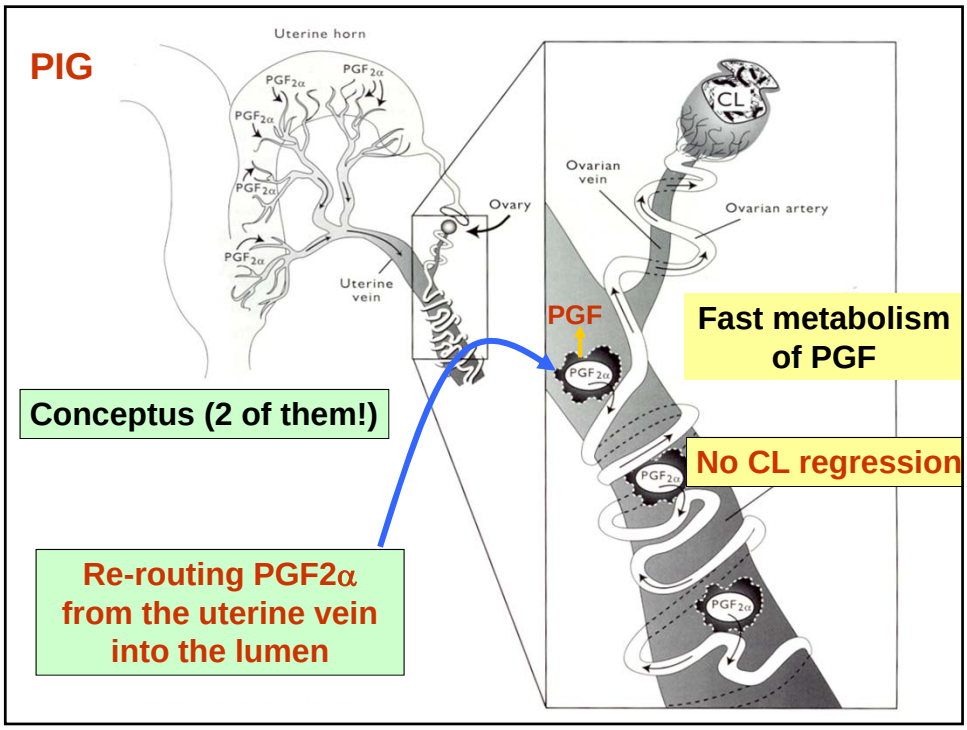
Two major events have to take place:

1) PGF2α synthesis and secretion must be stopped

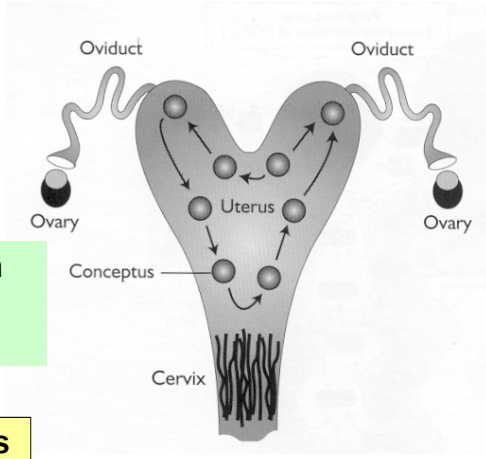
2) Progesterone must be maintained

THE CORPUS LUTEUM MUST BE MAINTAINED


Protein
(e.g. IFN τ)
Oxytocin
Conceptus
Oxy receptor
CL Maintains


PIG
Uterine horn
PGF2α
Ovary
Uterine vein
Ovarian vein
Ovarian artery
CL
PGF
Fast metabolism of PGF
No CL regression
Conceptus (2 of them!)
Re-routing PGF2α from the uterine vein into the lumen

MARE



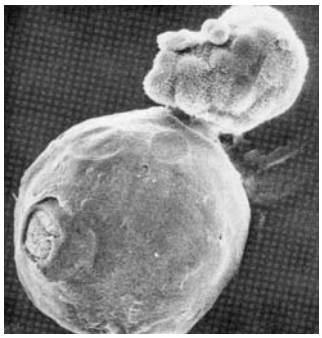
The conceptus migrate within the uterus between 12 to 14 times per day

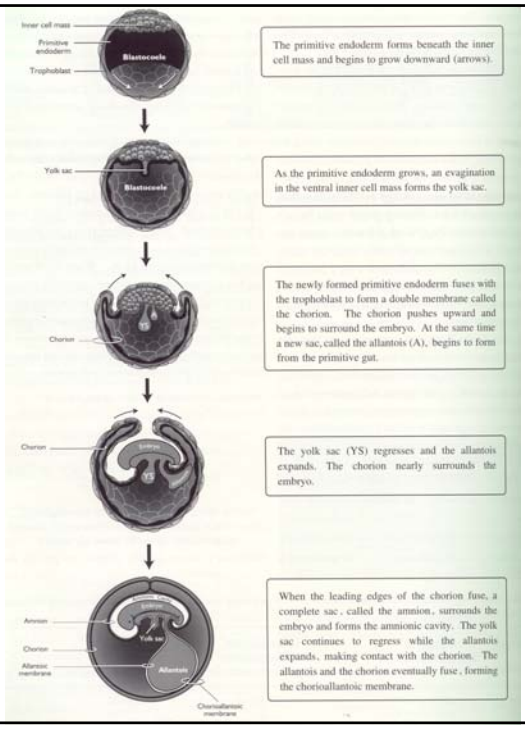
↓

Conceptus touches receptors in the endometrium and initiates the signaling

↓

Inhibition of **PGF2α secretion** → Maintenance of CL





Post Hatching events

- *Development of extra-embryonic Membranes*
- **Massive growth of the conceptus**
  - **Cow: from 3 mm to 250 mm in 4 days**
- **Development of :**

  - Yolk sac = Site of primordial germ cells

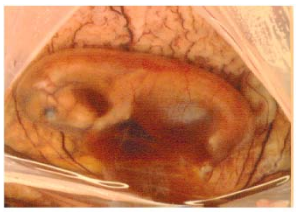
  - Chorion = Give rise to Placenta

  - Amnion = protective sac

  - Allantios = waste house

Types of Placenta

Diffuse Placenta



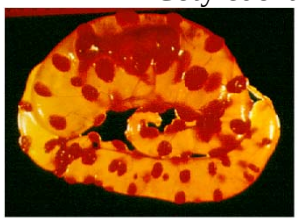
Mare

Sow

Discoid Placenta

Human

Cotyledonary Placenta



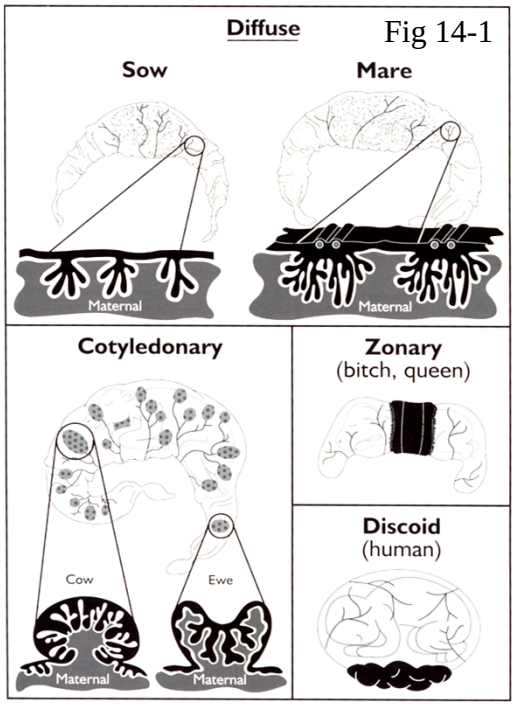
Ewe

Cow

Also Goat & Deer

Placenta classification
Based on
Chorionic villi

1. Diffuse
2. Cotyledonary
3. Zonary
4. Discord



Placenta classification Based on Placental Layers

- Epitheliochorial
- Endothelio chorial
- Hemo chorial
- Hemo endothelial ??

Figure 14-10

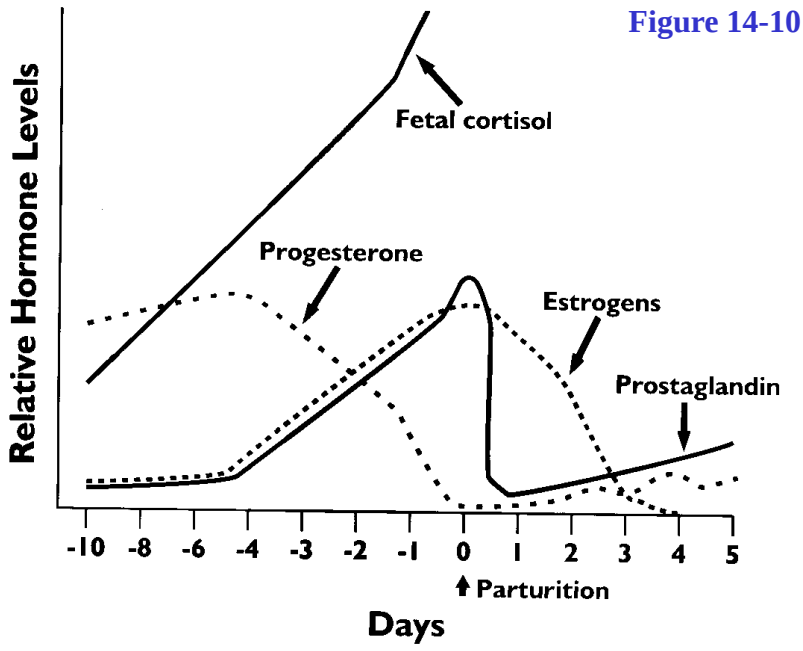


Fig 45-2. Mechanical calf jacks can generate over 1700 pounds of force on the calf and should only be utilized in extreme situations and with extreme care (Courtesy of Iowa State University, Iowa State Univ.)

The desired outcome of a successful reproductive program is a health, live calf (Courtesy of Mark Kirkpatrick, Pfizer Animal Health)