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**

**Male**

*XY Chromosomal Pair*

1. Testis determining factor (TDF)
2. Testes develop
3. Sertoli cells secrete anti-Mullerian hormone (AMH)
4. AMH causes feytlg cells to differentiate
5. Testosterone
6. Dihydrotestosterone
7. Development of male duct system
8. Development of penis, scrotum and accessory sex glands

**Female**

*XX Chromosomal Pair*

1. No TDF
2. Ovaries develop
3. No AMH
4. Paramesonephric ducts become the oviducts, uterus, cervix and part of the vagina
5. Complete female tract
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

Fetal testis

Testosterone (T)

Surge center is responsible for the follicular ovulation

Brain

Estradiol

Regression of GnRH Surge center

Aromatase enz.
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 lifetime 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
   c. High amounts of **steroid hormones**
Follicle Classification

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   high amounts of **steroid hormones**
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
Stages of the Estrous Cycle

Subdivision of the Follicular and Luteal Phases

Proestrus → Follicular Phase
Estrus
Metestrus
Diestrus → Luteal Phase

Figure 7-1
Follicular phase

Luteal Phase
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* >>>>> *Lute*inizing 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
Luteolysis

LUTE = luteal tissue
LYSIS = break down, decomposition

Chief Hormone for luteolysis is Prostaglandin \( F_2\alpha \)

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. (Graph by Sonja He.)
Luteal oxytocin stimulates PGF2α synthesis

Figure 9-12. Changes in PGF2α secretion during the last 6 days of the estrous cycle as reflected by prostaglandin F2α metabolites (PGF-M). Luteal oxytocin episodes coincide almost perfectly with episodes of PGF-M. When about five pulses of PGF2α 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 corpus luteum is 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

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

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
Four Phases of Spermiogenesis

1) Golgi phase
2) Cap phase
3) Acrosomal phase
4) Maturation phase
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
Fig 12-6

Hyper active Sperms

Capacitating factors
Nucleus

Acrosome reaction and release of enzymes

Cortical reaction

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

**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**
Conceptus
Protein (e.g. IFN-τ)
Oxytocin
Oxy receptor
PGF2α
CL Maintains

PIG

Re-routing PGF2α from the uterine vein into the lumen

Fast metabolism of PGF
No CL regression
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 \( \text{PGF}_2\alpha \) 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

<table>
<thead>
<tr>
<th>Type</th>
<th>Species/Animal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffuse Placenta</td>
<td>Mare, Sow</td>
</tr>
<tr>
<td>Cotyledonary Placenta</td>
<td>Ewe, Cow, Also Goat &amp; Deer</td>
</tr>
<tr>
<td>Discoid Placenta</td>
<td>Human</td>
</tr>
</tbody>
</table>

**Placenta classification**

Based on **Chorionic villi**

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

**Fig 14-1**
Placenta classification Based on Placental Layers

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

Figure 14-10

[Graph showing hormone levels over days leading up to parturition]
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)