Reproduction and Development

Determination of Sex:
Humans have 23 pairs of chromosomes: 22 pairs of autosomes and one pair of sex chromosomes. X and Y chromosomes (lower right) mean that these chromosomes came from a male. The autosomes are arranged in homologous pairs in this figure. X and Y chromosomes determine sex. Each egg produced by a female (X) has an X chromosome. Sperm produced by a male (XY) have either an X chromosome or a Y chromosome.

- 3-hormone Control of Gonads
  
Abbreviations: Gn = gonadotropin, GnRH = gonadotropin releasing hormone.
- Route taken by sperms for ejaculation
- Seminiferous tubules → rete testis – a network of spaces → efferent ductules in Epididymis → single highly convoluted duct in Epididymis → vas deferens passes superiorly into abdomen through Spermatic Cord and joins Seminal Vesicle → Ejaculatory Duct – passes through Prostate gland → Urethra – enters penis and opens to outside at its tip.

- Spermatogenesis
  - Androgonial Cells → → androgonial cells by mitosis; 2n → 2n
  - Androgonial cell → Primary Spermatocyte (bigger in size); 2n → 2n
  - Primary Spermatocyte → Secondary Spermatocyte (Meiosis-1); 2n → n
  - Secondary Spermatocyte → spermatid (Meiosis-2); n → n
  - Spermatid → sperm by spermiogenesis

Role of Sertoli Cells

Sertoli cells
- nourish sperms
- secrete MIS in fetus for inhibition of Mullerian duct system = female reproductive system
- secrete Inhibit protein hormone to inhibit FSH secretion by anterior pituitary
- serve as Sertoli barrier = Testes-Blood Barrier to chemicals in plasma
- phagocytosis on defective sperms.

- Erectile Dysfunction
- Erection requires dilation of arteries and constriction of veins in penis. Erectile dysfunction is failure to achieve or maintain erection
- Autonomic neurons secrete Nitric Oxide, the gaseous neurotransmitter. It causes dilation of arteries and results
in a rigid penis. Nitric Oxide activates guanylyl cyclase and converts GTP → cGMP, a 2nd messenger that after several steps causes the relaxation of smooth muscles in arteries. The cycle ends by the breaking of cGMP by enzyme PDE5 (Phosphodiesterase Type 5).

- PDE5 (Phosphodiesterase type 5) inhibitors – Orally active Drugs, like Viagra or Cialis or Levitra, block the action of enzyme responsible for breaking cGMP. It allows higher levels of cGMP and normal erection. However, these drugs cannot be taken by people with hypertension or weak heart; if taken the consequences can be serious including death.
  - Oogenesis

- Is formation of eggs from follicles in ovaries.
- Oogonia → oogonia by mitosis; 2n → 2n
- Oogonia → primary oocyte by mitosis/differentiation; 2n → 2n
- Primary oocyte → meiotic arrest till puberty
- Primary oocyte → secondary oocyte + 1st polar body; 2n → n; completed in ovary just before ovulation
- Secondary oocyte → Ovum + 2nd polar body; n → n; in fallopian tube, completed just after fertilization

Ovarian Follicles:

- Primordial follicles (in fetus) – primary oocyte covered by single layer of granulosa cells → Primary follicles (at the time of birth to puberty) – primary oocyte enlarges and gets surrounded by thick material zona pellucida → Secondary follicles (very small # continue to develop during childhood) develop several layers of granulosa cells that secrete estrogen, and get surrounded by connective tissue cells – Theca → Early Mature follicles – granulosa cells secrete a fluid to form a cavity Antrum, surrounded by granulose cells → Mature follicle = Graafian follicle gets huge and can be seen at the surface of ovary and has antrum surrounding the primary oocyte from all sides except one = cumulus oophorus, follicle is ready to ovulate.

- Ovarian Cycle:

  **Ovarian Cycle:** usually has 28 days but can vary a lot in some women. It has 2 phases Follicular and Luteal separated by ovulation – usually on 14th day. At the beginning of follicular phase several (10-25) follicle start developing. Around 7th day one follicle becomes dominant others degenerate; the process is called Atresia, an example of programmed death = Apoptosis. Dominant follicle matures in 2nd week. Ovulation occurs. Secondary oocyte is released. Empty follicle regresses around antrum but under the influence of LH its granulosa cells enlarge in size and follicle develop into endocrine gland – Corpus Luteum. It secretes estrogen, progesterone and inhibin. If no pregnancy takes place, corpus luteum degenerates from 25 – 28 day and sets on menstruation.
Regulation of Hormones

- Hypothalamus $\rightarrow$ GnRH $\rightarrow$ Anterior Pituitary $\rightarrow$ LH $\rightarrow$ Theca Cells $\rightarrow$ androgens
- Hypothalamus $\rightarrow$ GnRH $\rightarrow$ Anterior Pituitary $\rightarrow$ FSH $\rightarrow$ Granulosa cells $\rightarrow$ androgens to estrogen, secrete inhibin and influence oocytes
- Fertilization:
  - Egg membrane changes to form block to polyspermy.
  - Egg completes meiotic-2 division.
  - Chromosomes of sperm and ovum intermingle to change from n $\rightarrow$ 2n.
- Placenta:
  - Uterine wall – outer myometrium and inner endometrium.
  - Maternal placenta – endometrium
  - Fetal placenta – chorion and its Villi
  - Chorionic Villi exchange materials with pool of maternal blood between endometrium and chorion.
  - Umbilical cord having arteries and veins join fetus naval to chorion / endometrium.

<table>
<thead>
<tr>
<th>Days After LH Peak</th>
<th>Event</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ovulation</td>
<td>Ovary</td>
</tr>
<tr>
<td>2</td>
<td>Fertilization</td>
<td>Fallopian tube</td>
</tr>
<tr>
<td>2–4</td>
<td>Cell division to ~32 cells</td>
<td>Fallopian tube</td>
</tr>
<tr>
<td>5</td>
<td>Blastocyst enters the uterine cavity</td>
<td>Uterus</td>
</tr>
<tr>
<td>6–7</td>
<td>Implantation</td>
<td>Uterus</td>
</tr>
<tr>
<td>9–10</td>
<td>Human chorionic gonadotropin (hCG) from implanted blastocyst (trophoblast cells) rescues corpus luteum (see Figure 17–29)</td>
<td>Trophoblast $\rightarrow$ maternal ovary</td>
</tr>
</tbody>
</table>

Hormone Levels during Pregnancy:

1. hCG = human chorionic goandrotropin secreted by trophoblast 9-10 days after LH surge. Pregnancy kits have chemicals that bind to hCG and change color to confirm pregnancy.
2. hCG protects corpus luteum from degeneration. Corpus luteum is maintained during 1st trimester.

3. During 2nd and 3rd trimesters, Placenta secretes and maintains high level of progesterone and estrogens; corpus luteum degenerates.

**Labor and Parturition**

- Labor is a + feedback process.
- Posterior pituitary releases Oxytocin that initiates uterine contractions. Uterus releases prostaglandins that act on uterus to increase uterine contractions. Uterine contractions result in cervical stretch. Cervical stretch has a + feedback effect on both release of more Oxytocin as well as uterine contraction. Uterine contractions become stronger and faster overtime.
- Amnion ruptures to release amniotic fluid.
- Oxytocin relaxes pubic symphysis to facilitate birth.
- Baby comes out head first; birth is called parturition.
- Placenta comes out later.