Animal Reproduction & Development

Female Reproductive System

Similarities
- 2 pouches
  - Testicles
  - Ovaries
- Start out inside body
  - Testicles “descend” before birth
- Fetus begins with “starter parts” that could develop into either gender.

Male Reproductive System

Ovary (Ovaries)
- Two solid egg-shaped structures
- They are attached to the uterus by ligaments. They are the counterpart of the male testicles.
- Ovaries have two main functions:
  1. Store and release the ova or female egg cell. Some of the ova disappear; others are dormant until each is ripened and released after puberty.
  2. Produce female sex hormones ESTROGEN and PROGESTERONE.

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**Ova**
- The female reproductive cell.
- They are the largest cells in the female body. (about the size of a grain of sand.)
- The female baby is born with all the ova she will ever have (about 200,000 in each ovary).
- About 400-500 ova mature and are released over a lifetime.

**Oogenesis**
- Unequal meiotic divisions
  - unequal distribution of cytoplasm
  - 1 egg
  - 2 polar bodies
- Meiosis 1 completed during egg maturation
- Meiosis 2 completed triggered by fertilization
- Put all your eggs in one basket!

**Female Sex Hormones:**
- Estrogen is responsible for the secondary sex characteristics and the sex drive in females. It spurs the onset of puberty and is responsible for ovulation.
- Progesterone builds up the lining of the uterus called the endometrium in preparation for a fertilized ovum.
- LH and FSH stimulate secondary oocyte development during menstruation for the next cycle.

**Estrogen Receptors Trigger Gene Activation**

**Ovulation**
- When the egg is released from the ovary.
- At the age of puberty
- The ovum moves to the surface of the ovary in bursts out
- The ova falls into the fallopian tube and waits for fertilization
- This happens every 28 days
- It happens at about the 14th day of the cycle
After Ovulation

- Egg pushed along by cilia through fallopian tubes
- Few days travel time to arrive in uterus

Cervix – Opening between uterus & vagina—strongest muscle in the female body
- Normally tiny and plugged by mucus
- At birth – muscles pull open (dilation) cervix to allow baby to pass through = Labor

Menstrual Cycle

- Complex combination of 10-12 chemicals (hormones)
- Usually one egg once a month
- All about timing!
  - Uterus must be ready when egg gets there in case it was fertilized
  - If no fertilization, tear down lining of uterus and rebuild for next month

28-Day Cycle (average)

- Three Stages
  1. Tear Down
  2. Rebuild
  3. Extra nutrients/blood for potential baby

- No Baby?
  - Back to #1

Day 1

- First menstrual blood & tissue
- No baby = breaks down lining of uterus
- 5-7 days of blood/tissue exits body

~Day 14

- Ovulation = Egg released
- Temp spikes slightly
- Most fertile in next few days!
  - Able to get pregnant
- Egg gets fertilized while traveling through fallopian tubes.
Fertilization
- fertilization
- cleavage
- gastrulation
- neurulation
- organogenesis

Cleavage
- Repeated mitotic divisions of zygote
  - 1st step to becoming multicellular
  - unequal divisions establishes body plan
    - different cells receive different portions of egg cytoplasm & therefore different regulatory signals

Fertilization
- Joining of sperm & egg
  - sperm head (nucleus) enters egg

Cleavage
- zygote → morula → blastula
  - establishes future development
**Gastrulation**
- Establish 3 cell layers
  - **ectoderm**
    - outer body tissues
    - skin, nails, teeth
    - nerves, eyes, lining of mouth
  - **mesoderm**
    - middle tissues
    - blood & lymph, bone & notochord, muscle
    - excretory & reproductive systems
  - **endoderm**
    - inner lining
    - digestive system
    - lining of respiratory, excretory & reproductive systems

**Neurulation**
- Formation of notochord & neural tube
  - develop into nervous system
- Notochord develops into vertebral column
- Neural tube develops into CNS (brain & spinal cord)

**Organogenesis**
- Umbilical blood vessels
- Mammalian embryo
- Bird embryo
- Yolk sac
- Allantois
- Chorion
- Amnion
- Fetal blood vessels
- Placenta
- Maternal blood vessels

**Placenta**
- Materials exchange across membranes
- Maternal blood vessels
- Fetal blood vessels
- Placenta
- Amniotic cavity
- Uterus
- Allantois
- Yolk sac
- Chorion
- Umbilical cord
- Umbilical arteries
- Placental disk

**Human fetal development**
- 4 weeks
- 7 weeks
- 10 weeks
Human fetal development

- 12 weeks
- 20 weeks

The fetus spends much of the 2nd & 3rd trimesters just growing...and doing various flip-turns & kicks inside amniotic fluid.

Week 20

- 24 weeks (6 months; 2nd trimester)
- Fetus is covered with fine, downy hair called lanugo. Its skin is protected by a waxy material called vernix.

- 30 weeks (7.5 months)
- Umbilical cord

Getting crowded in there!!

- 32 weeks (8 months)
- The fetus sleeps 90-95% of the day & sometimes experiences REM sleep, an indication of dreaming.

Birth

Positive feedback

- Estrogen from ovaries
- Oxytocin from fetus and mother’s posterior pituitary
  - Induces oxytocin receptors on uterus
  - Stimulates uterus to contract
  - Stimulates placenta to make Prostaglandins
  - Stimulate more contractions of uterus
The Male Reproductive Tract and Birth Control

Male reproductive development

- Puberty
- Burst of hormones activate maturation of the gonads: testes
- Begins: 9 – 14 yrs of age

Testes

- Each testis is an oval structure about 5 cm long and 3 cm in diameter
- Located in the scrotum
- There are about 250 lobules in each testis. Each contains 1 to 4 -seminiferous tubules that converge to form a single straight tubule, which leads into the rete testis.
- Interstitial cells produce male sex hormones, are located between the seminiferous tubules within a lobule.
Epididymis

- a long tube (about 6 meters) located along the superior and posterior margins of the testes.
- Sperm that leave the testes are immature and incapable of fertilizing ova.
- Sperm mature and become fertile as they move through the epididymis.
- Mature sperm are stored in the lower portion, or tail, of the epididymis.

Spermatogenesis

- Begins in seminiferous tubules of the testes
- Takes 65 to 70 days
- Diploid spermatagonia in the germinal epithelium divide by mitosis
  - The ones that grow much larger are primary spermatocytes
  - Haploid division makes secondary spermatocytes
  - Divide into two haploid spermatids

Sperm development

- Spermatids line up with heads attached to tubules
- Sperm are nourished and developed by Sertoli cells (nurse cells)

Accessory Glands

- Seminal vesicles: Each has a short duct that joins with the vas deferens to form an ejaculatory duct, which empties into the urethra.
  - Makes a fructose, protein rich fluid
- Prostate: short ducts from the prostate gland empty into the prostatic urethra.
  - Secretions thin, milky colored, and alkaline and enhance the motility of the sperm.
- Bulbourethral glands: sexual stimulation releases an alkaline mucus-like fluid
**Semen**
- Sperm cells bathed in fluid mostly from seminal vesicles
- Volume in a single ejaculation may vary from 1.5 to 6.0 ml
- 50 to 150 million sperm per milliliter of semen
- Sperm counts <10 to 20 million/ml usually present fertility problems

**Hormones**
- Follicle-stimulating hormone (FSH) stimulates spermatogenesis
- Interstitial Cell Stimulating Hormone (ICSH) stimulates the production of testosterone
- Testosterone stimulates the development of male secondary sex characteristics & spermatogenesis.

**Birth Control**
- Can be anti-implantation or contraceptive (prevent fertilization)
- Either chemical (usually in the female body) or mechanical

**The birth control pill**
- Steroid hormones that suppress ovulation
- Synthetic rather than natural for longer chemical life in the body
- Combinations of progesterone and estrogen most common—different concentrations for different needs
- DOES NOT PREVENT STI'S!!
Morning After Pill
- Prevents implantation after unprotected sex
- Many reasons why it might be necessary—failed BC, sexual assault, etc.
- Works for about 72 hours after fertilization/unprotected sex

Infertility
- 50% female reproductive tract
- 35% male related
- 15% inexplicable (curses? BAD vibrations? Who knows…)

IVF
- Ovulation stimulated by high doses of hormones
- Secondary oocytes collected via a tube through the cervix, uterus, and fallopian tubes
- Sperm collected, cleaned, and provided nutrients to activate them
- Fertilized in vitro
  - 10,000 sperm added to ovum OR injected with a microneedle (intracytoplasmic sperm injection)
- Three days later, two fertilized zygotes are inserted via a tube through the cervix and uterus
  - Increases likelihood of implantation, but no triplets/etc
  - Ethical issues with excess fertilized zygotes

Questions?
Fertilized embryos may…
- Be frozen for future treatment of IVF
  - If a woman’s ovaries might be damaged
  - 70% survival for many years
  - Reduces need for uncomfortable oocyte collection procedures later
- Other ethical issues (male might no longer want children years later)

Sperm Banks
- Sperm are cryopreserved and can be organized by donor traits
- Allows long-time storage for a man who might lose fertility
- Sperm source for women with infertile partners, same-sex partners, or who want to have a child alone

Other infertility issues
- Women:
  - Ovulation disorders (hormones to treat)
  - Endometriosis (endometrium blocks other organs—may need surgery)
  - Blockages in fallopian tubes (IVF/surgery)
  - Antibodies to sperm (IVF)
- Men:
  - Abnormal sperm (IVF and ICSI)
  - Low sperm count (surgery if blockage/IVF)

Questions?