Objectives:
1. Review male & female reproductive anatomy
2. Gametogenesis & steroidogenesis
3. Reproductive problems

Male Reproductive anatomy and physiology.

Testes = paired gonads containing seminiferous tubules
Seminiferous tubules = tubules within testes where sperm and testosterone are produced.

- Sperm production
  - Sertoli cells: assist in sperm production by responding to pituitary FSH.
  - Leydig cells: produce testosterone in response to pituitary LH.
  - Spermatogonia: primordial cells that undergo meiosis to produce mature sperm cells (spermatogonia).

Epididymis = structures on top of testes where sperm mature before entering vas deferens.
Scrotum = skin sacs holding testes outside of abdominal cavity. Keeps sperm ~3°C cooler than body temp.
Cremaster muscle = muscle that can lift or lower the testes within scrotum to regulate temperature
Spermatic cord = Connective tissue that wraps around cremaster, testes, & testicular nerve and blood vessels
Inguinal ring = Opening in inguinal ligament through which testes descend (around 7 months gestation).

Sperm Transport Tubes:
1. Vas deferens = first and longest sperm transport tube. Meets with epididymis
2. Ejaculatory duct = sperm transport tube, which goes through prostate.
3. Urethra = common passageway for either urine or semen.

What is a vasectomy?
Surgical cutting and clamping of the vas deferens as a permanent form of birth control.
3 Male Secretory Glands:
1. Seminal vesicles = large, paired glands that meet with vas deferens and contribute secretions to seminal fluid.
   - produce: 
     - alkaline mucus (counteract vaginal acidity)
     - prostaglandin (cause uterine contractions)
     - fructose (energy source)
2. Prostate = gland under bladder which secretes mucus.
3. Bulbourethral gland = Gland that secretes lubricating Fluid, to lubricate head of penis, during sexual arousal.

The Prostate Gland
- Benign prostate hyperplasia (BPH)
  - Prostate grows with age.
  - non-cancerous growth of prostate.
  - Can block urine or semen transport.
- Prostate cancer
  - Malignant
  - Detect with PSA = prostate-specific antigen. High levels in blood indicate possible prostate cancer.
  - Increased risk with mutation in BRCA gene (see later in powerpoint)

Erectile chambers of penis.
- Corpus cavernosa = upper left and right chamber.
  - have arterial blood supply to fill with blood.
  - arteries vasodilate based on nitric oxide (NO) release.

Corpus spongiosum = lower chamber surrounding urethra

How an erection works:
See Clinical App
1. Arousal Causes nitric oxide (NO) release in arteries of corpus cavernosa.
2. NO causes production of a chemical messenger called cGMP.
3. cGMP causes arteries to relax & they open wide (vasodilate) allowing blood into spongy chambers.
4. Fluid pressure of blood causes erection.
5. When stimulation done, or after ejaculation, cGMP is broken down by enzyme phosphodiesterase. Erection ends
How ED Drugs work (Viagra, Cialis, Levitra):
(Click [HERE](Click HERE to see my example writing assignment))

Phosphodiesterase inhibitor = a chemical that inhibits phosphodiesterase.

So ... what would giving a phosphodiesterase inhibitor do to cGMP levels in the corpus cavernosa?

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What would that do to arteries in the penis? Cause it to happen

What would that do w/respect to an erection? _____________

Viagra, Cialis, & Levitra are phosphodiesterase inhibitors.

Priapism = erection longer 3-5 hrs.

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Spermatogenesis:

Spermagonia (2n) = cells that undergo meiosis to make sperm.

Primary spermatocyte (2n) —> Secondary spermatocytes (1n) —> Spermids (1n) —> Spermatozoa = mature sperm cells.

Gametogenesis = production of gametes (eggs & sperm).

> Spermatogenesis = production of sperm within testes.

> Oogenesis = production of eggs within ovaries.

Steroidogenesis = production of sex steroids (estrogen, progesterone, testosterone).

Oogenesis:

Oogonium (2n) —> Primary oocyte (2n) —> Secondary oocyte (1n) —> Ovulated.

Eggs in stasis as primary oocyte (2n) in ovaries from time a fetus to just before puberty.

Oogenesis:

Oogonium (2n) —> Primary oocyte (2n) —> Meiosis 1 —> Meiosis 2 starts at puberty

Oogenesis:

Oogonium (2n) —> Primary oocyte (2n) —> Meiosis 1 —> Spermatogenesis: Gametogenesis and Steroidogenesis in Males and Females

 mittelschmerz = pain with ovulation

1. Primary follicle contains oogonium.

2. Secondary follicle contains primary oocyte.


4. Secondary oocyte ovulated

5. Graafian follicle remains in ovary & becomes corpus luteum (CL) making progesterone.

Progesterone = hormone released from CL that maintains uterus in pregnancy-friendly state. Prevents egg development and ovulation.

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4. Gametogenesis and Steroidogenesis in Males and Females

The Ovaries have follicles that contain a developing egg (oocyte). Once a month one follicle & egg mature. A secondary oocyte is ovulated. The remaining follicle becomes the corpus luteum & produces progesterone.

Meiosis 1
Meiosis 2 starts at puberty

Secondary oocyte (1n) within a “Graafian follicle”

- 2° oocyte is “ovulated” once/month
- graafian follicle becomes corpus luteum
- “CL” produces progesterone ~14 days

Eggs in stasis as primary oocyte (2n) in ovaries from time a fetus to just before puberty.

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Steroidogenesis (Male & Female) =

**review – Hypothalamus endocrine function:**

- Communicates between nervous and endocrine systems
- Secretes "releasing hormone" to stimulate gonads = GnRH
- This stimulates anterior pituitary to secrete LH & FSH
- FSH stimulates sperm or egg maturation
- LH stimulates testosterone production in testes, and estrogen production, ovulation, and corpus luteum formation in ovaries.

**GnRH**

**Hypothalamic neurons** secrete "releasing hormone" GnRH

**Anterior pituitary** responds to GnRH by secreting LH & FSH:

- LH – make testosterone
- FSH – stim. sperm develop.

- LH – make estrogen & ovulate egg
- FSH – stim. egg development.

**QUEST:** How does hormonal birth control work??

Answer = rising blood estrogen & progesterone inhibit hypothalamic GnRH, and pituitary LH & FSH. Egg doesn’t mature nor ovulate.

**Male reproductive anatomy & physiology**
- Male sexual structures
- Physiology of an erection
- Reproductive problems (ED, BPH)

**Gametogenesis**
- Spermatogenesis
- Oogenesis

**Steroidogenesis**
- Hypothalamic-pituitary-gonadal axis
- Negative feedback inhibition of steroidogenesis

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5. Female Reproductive Anatomy & Physiology.

**External genitalia**
- **Vagina** = copulatory & birth canal.
- **Uterus** = muscular sac capable of supporting developing fetus.
- **Fallopian tubes** = paired tubes that can transport fertilized egg from ovaries to uterus.
- **Cervix** = entryway into uterus from vagina.
- **Endometrium** = secretory layer of uterus.
- **Myometrium** = muscular layer of uterus, responds to oxytocin & prostaglandin.
- **Ovaries** = paired gonads making eggs, estrogen & progesterone.

**Vestibule** = tissue surrounding urethral & vaginal openings. Prone to tearing during childbirth!

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**Question:** What is an episiotomy?

- Controlled incision into perineum to allow extra room for baby’s delivery.

**Click the film strips below to see YouTube videos of the following:**
- **Delivery**
- **Epidural**
- **C-sec episiotomy**
The Uterus

Contracts in response to oxytocin

Endometriosis = when endometrial tissue of uterus wanders out of uterus to different locations. Still responds to progesterone by proliferating, and then shedding when progesterone declines each menstrual cycle. *Painful!

Uterine Fibroids = benign (noncancerous) growths of myometrium, which often appear during childbearing years.

Also called leiomyomas (lie-o-my-O-muhs) or myomas.

Are NOT associated with an increased risk of uterine cancer (almost never develop into cancer).

Symptoms:
May have none
Heavy menstrual bleeding
Pelvic pressure / pain
Backache
Frequent/difficult urination

The Fallopian Tubes

Ectopic Pregnancy = pregnancy "out of place" (basically anywhere except within the uterus). Frequency of 2% among females.

Clinical Applications

The majority of hysterectomies (surgical removal of the uterus) are performed because of uterine fibroids (leiomyomas). These are nonmalignant (noncancerous) neoplasms (growths) in the uterus that also include abundant extracellular matrix. Fibroids can be as small as 10 mm or as large as 20 cm, and produce such symptoms as pelvic discomfort and profuse menstrual bleeding. Uterine fibroids have receptor proteins for estradiol and progesterone, which can stimulate their growth. Because most fibroids are located within the uterine wall, they usually can be surgically removed only by a hysterectomy.

Danger of an Out-of-place pregnancy = only uterus & its strong ligaments can support weight of growing fetus. Only endometrium capable of forming a fully functional placenta. All other tissues not compatible for pregnancy.

An ectopic pregnancy is NEVER viable for the embryo AND is life-threatening for the mother

HPV – human papilloma virus. Present in 50% of sexually active adult population. Can cause polyps and warts at site of contact. Can lead to increased risk for cancer.

HPV Vaccine - 2006
- Gardasil marketed by Merck & Cervarix by GlaxoSmithKline
- Both are set of 3 vaccinations given over a 6 month period.
Only Gardasil is:
- Effective against 4 strains HPV – 2 which cause cancer & 2 which cause warts
- Tested & recommended for 9-26 yr old girls AND boys
  (younger is better - before sexual exposure!)
- Can get up to 21-26 yrs but protection goes down w/sexual exposure.

https://www.cdc.gov/hpv/parents/vaccine.html

New slides
Since 2018 ....

https://www.cdc.gov/mmwr/volumes/70/wr/mm7012a2.html#F1_down
**Ovarian cycle**

Days:
1-13 = Follicle phase
Egg development from FSH
Day 14 = Ovulation (LH high)

Days 15-28 = CL makes progesterone

**Menstrual cycle**

Days:
1-5 = menstruation
- progesterone low
5-14 = Estrogen ↑
15-28 = endometrium thickens
progestosterone ↑

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**Clinical Applications**

Because hCG is secreted by the cells of the chorionic membrane of the embryo, and not by the mother’s endocrine glands, all pregnancy tests detect the beta subunit of hCG (one of two different polypeptide chains that comprise the protein), which is unique to hCG and provides the least amount of cross-reaction with related hormones. Pregnancy tests use monoclonal antibodies (produced by lymphocyte clones; see chapter 11), which are specific for the beta subunit of hCG and are produced by animals such as rabbits injected with hCG. Home pregnancy tests, using monoclonal antibodies that react with hCG in urine, are generally accurate in the week following the first missed menstrual period.

**Polycystic Ovarian Syndrome** = follicles in ovary fill with fluid (cysts). Painful condition that decreases fertility.

**Treatment:**
- Hormonal birth control — it inhibits hypothalamic GnRH, which inhibits pituitary LH & FSH. Without FSH, no follicle and egg will mature. Keeps ovaries "quiet".
- Corpus luteum breaks down and stops progesterone secretion @ day 28.
- Without progesterone, endometrium secretes prostaglandin, which cause uterine contractions to expel menstrual tissue.
- Menstrual flow – egg and lining shed

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IF fertilization:
- Embryo makes hCG within 1 week (the hormone pregnancy tests detect)
- hCG “rescues” corpus luteum – it keeps making progesterone ~ 1 month (until placenta forms and takes over progesterone production).
Question: Why do you think having been on birth control lowers risk of ovarian cancer??

The fewer times you ovulated in your life, the fewer times the ovary had to repair itself, with mitosis, then the less the risk of cancer developing.

Ovarian and Breast Cancer and the BRCA Gene:

BRCA Gene = tumor suppressor gene that normally suppresses tumor growth (a good thing!)

Mutation in BRCA Gene – means the gene does not suppress tumors. Mutation in this gene associated with increased risk for ovarian & breast cancer.

Can get blood test for it.

CA-125 test = cancer antigen 125 (a non-genetic test)

Increased levels of this in blood associated with ↑ risk of ovarian cancer (separate from BRCA gene)

Cancer and the BRCA Gene:

Click HERE for a YouTube video I made about my breast cancer story AND the BRCA gene mutation.

Review

Female reproductive anatomy & physiology
- reproductive structures
- ectopic pregnancy & endometriosis
- HPV, warts, cervical cancer, HPV vaccine, ovarian & breast cancer
- review of oogenesis
- menstrual & ovarian cycle
- role of hCG in rescuing corpus luteum in pregnancy
- polycystic ovarian syndrome
- tests for cancer (CA-125 antigen and BRCA gene mutation)