The Basics of Reproductive Anatomy & Physiology

1. Basic male & female anatomy
2. Production of reproductive hormones
3. Production of sperm or eggs
4. Common reproductive disorders

Reading Assignments:
1. The Reproductive System
2. Male Andropause, parts 1
3. Male Andropause, part 2
4. Cervical Cancer Vaccine
5. Genital Mutilation
6. Hormone Replacement Therapy (WHI study)
Male Anatomy & Physiology

The Reproductive System Pgs 2 - 7

Spermatogonia
Sertoli cells
Leydig cells

Testis

Sertoli cells
Leydig cells

Cells that undergo meiosis

Spermatogonia
**Male Anatomy & Physiology**

**Testes** = paired gonads that produce sperm and testosterone

**Seminiferous tubes** = coiled tubes within testes where sperm produced.

**3 cell types in seminiferous tubules:**

1. **Sertoli cells** respond to FSH by helping in sperm production.
2. **Leydig cells** respond to LH by producing testosterone.
3. **Spermatogonia** = go through meiosis to become sperm.

**Epididymis** = sperm warehouse where sperm stored & mature before ejaculation.

**Scrotum** = contain testes outside of abdomen ~3° lower than body temp of 98.6. For proper sperm production.

**Cremaster muscle** = muscle that lifts/lowers testes for temperature regulation.

**Inguinal ring** = opening in abdominal cavity where testes descend into scrotal sac of male fetus by 7 months gestation.

**Cryptorchidism** = when one or both testes are retained within the abdomen. Abnormal! Must be removed or risk testicular cancer.
3 Sperm Transport Tubes:
1. **Vas deferens** = transport sperm from epididymis to seminal vesicles.

   QUESTION: What is a **vasectomy**? = by cutting vas deferens.

2. **Ejaculatory duct** = found in prostate gland.

3. **Urethra** = passageway for urine or semen, but not at the same time!

3 Male Secretory Glands:
1. **Seminal vesicles** = Largest glands contributing to semen. produce:
   - alkaline mucus (counteract vaginal acidity)
   - prostaglandin (cause uterine contractions)
   - fructose (energy source) Sugar For energy For sperm.

2. **Prostate** – produce alkaline mucus.

3. **Bulbourethral gland** (Cowper's gland) produces lubricant 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.

**The Penis**

- **Corpus cavernosum** = upper left and right chamber
  - Have arterial blood supply to fill with blood.
  - Arteries open up (vasodilate) based on nitric oxide (NO) & cGMP.

- **Corpus spongiosum** = lower chamber surrounding urethra

- **Foreskin (prepuce)** = loose flap of skin covering the head (glans) penis.

- **Circumcision** = surgical removal of the foreskin.
Circumcision?
To do, or not?
Click HERE for further reading.

How an erection works:

1. **Stimulation** Causes **nitric oxide** release in arteries of corpus cavernosa.

2. **NO** causes production of a chemical messenger called **cGMP** in **corpus cavernosa**.

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.
**Erectile Dysfunction (ED)** = inability to achieve or maintain an erection.

**Many possible causes:**

**Treatments:**

1. Counseling if psychological
2. Pharmacological (drugs)
   - A) Testosterone supplement
   - B) ED drugs (ex. Viagra, Cialis, Levitra)

3. Surgical options:
   - A) Semi-rigid malleable rod = implanted into penis. Can manually straighten rod for erection.
   - B) inflatable implant = implant fluid reservoir into abdomen, pump into scrotum, and tubes into penis. Squeeze the pump to push fluid into tubes for erection. Hit a release valve to return fluid to reservoir to end erection.

**How ED Drugs work (Viagra, Cialis, Levitra):**

- **Phosphodiesterase inhibitor** = a chemical enzyme that inhibits phosphodiesterase.

  So ..., what would giving one of these drugs do to cGMP levels in the corpus cavernosa?

  - stops cGMP breakdown, \( \uparrow \) cGMP in penis

  What would that do to arteries in the penis? **vasodilation** (open penile arteries)

  What would that do w/respect to an erection? **causes one**

  **Viagra, Cialis, & Levitra work this way:**
  - side effects = drop in blood pressure rest of body.
  - priapism = erection lasts longer than body.
Steroidogenesis in males & females:

Steroidogenesis = production of sex steroids in males & females.

**The BRAIN controls steroidogenesis!**

- **Hypothalamus** = brain structure that controls it.

- Hypothalamus secretes **GnRH** = gonadotropin-releasing hormone.

- GnRH tells anterior pituitary (in brain) to secrete **LH & FSH** (see next slide!)

- **LH** tells testes to make testosterone & ovaries to make estrogen.

- **FSH** tells testes to mature sperm & ovaries to mature eggs.
LH (luteinizing hormone) > stimulates testes ( Leydig cells) to make **Testosterone**.

> Stimulates ovaries to make **Estrogen & to ovulate an egg**.

When levels of testosterone, estrogen, or progesterone are high it inhibits pituitary release of LH & FSH as part of negative feedback to control hormone levels.

**FSH (follicle-stimulating hormone)** - stimulates sperm or egg maturation.

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**Steroidogenesis in males & females:**

<table>
<thead>
<tr>
<th>Pituitary</th>
<th><strong>LH (luteinizing hormone)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; stimulates testes ( Leydig cells) to make <strong>Testosterone</strong></td>
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**Steroid regulation in males & females:**

**Hypothalamus**

- **GnRH**

<table>
<thead>
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<tbody>
<tr>
<td><strong>GnRH</strong></td>
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</table>

- **Anterior pituitary**

<table>
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<th>Sex steroids</th>
</tr>
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<td><strong>Testes</strong></td>
</tr>
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<td>LH – make testosterone</td>
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<td>FSH – stim. Sperm develop</td>
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</tr>
<tr>
<td>LH – make estrogen</td>
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<tr>
<td>FSH – stim. Egg development</td>
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</table>

**High blood levels of testosterone, estrogen, and progesterone inhibit:**

- hypothalamic GnRH & pituitary LH & FSH.
- & cause ovulation.
**Making sperm**

Gametes (Eggs/Sperm) → Gametogenesis = production of eggs or sperm.

> Spermatogenesis = production of sperm in seminiferous tubules of testes. Is driven by testosterone (controlled by brain).

- Hypothalamus (brain)
  - GnRH (Gonadotropin-releasing hormone)
  - Pituitary gland
    - LH (Luteinizing hormone)
    - FSH (Follicle-stimulating hormone)
  - Testes = testosterone
    - Male sperm

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**Spermatogenesis** = production of sperm in seminiferous tubules of testes. **DO NOT MEMORIZE**

- **Spermatogonia (2n)** = primitive sperm cells that become primary spermatocytes.

  - **Primary spermatocyte (2n)**
    - = cells that undergo meiosis 1
  - **Secondary spermatocytes (1n)**
    - = cells that undergo meiosis 2
  - **Spermatids (1n)** = immature sperm cells.
  - **Spermatozoa (1n)** = mature sperm cells.

Click [HERE](#) for YouTube video on spermatogenesis.
Male Fertility – need ~ 20 million sperm / ml of semen. Of these sperm, 40% must have normal movement (good swimmers!) and 60% must have normal shape (morphology)

CAUSES OF MALE INFERTILITY?

- Smoking
- High alcohol consumption
- Stress
- Excess testosterone
- Low testosterone
  - Need to
  - Testes too warm (switch from briefs to boxes)
- BPH
- Chemotherapy

Any questions?
Any topics not covered that you want to know about male reproductive system?
Review

- Male reproductive anatomy & physiology
  - reproductive structures
- How an erection works
- BPH, prostate cancer, ED, ED drugs
- Spermatogenesis
- Male fertility and infertility
**The Basics of Female Reproductive A & P**

- **Ovaries** = paired gonads making eggs, estrogen, & progesterone.
- **Vagina** = muscular copulatory & birth canal.

**External genitalia:**
- **Vulva** = labia major & minor
  - Larger outer fold
  - Smaller inner fold
- **Clitoris** = erectile tissue with sensory nerves (similar to head of penis)
- **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. Where embryo implants
  - **Myometrium** = muscular layer of uterus, responds to oxytocin & prostaglandin.

The Reproductive System Pgs 8 - 11

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**External Genitalia**

- **Clitoris** = equivalent of glans penis. Same sensory nerves & erectile tissue
- **Labia minor** = smaller inner labia
- **Labia major** = larger outer labia
- **Vestibule** = tissue surrounding urethral & vaginal openings. Prone to tearing during childbirth!

**Question:**

What is an **episiotomy**?

- Controlled cut in vestibule to prevent uncontrolled tearing during birth.

Added 2/9/23  Click HERE for YouTube video
Clitorectomy = surgical removal of clitoris (C in photo)

Infibulation = removal of labia minor and suturing (stitching) of labia major partially closed (narrow opening left for menstrual flow). A & B in photo. Can often include clitorectomy.

See reading assign.: “Genital Mutilation”

Click HERE for YouTube video of Survivor’s account. (Warning: video includes some graphic descriptions.)
Figure 27.7. Uterus

http://commons.wikimedia.org/wiki/File:Illu_cervix.jpg
Human uterus: normal Vs menstrual

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!

Treatment = hormonal birth control (synthetic estrogen & progesterone) has steady levels of hormone so that endometrial growth minimized.
**The Fallopian Tubes**


_Danger of an ectopic pregnancy_ = only the 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. Embryo CANNOT survive, and mother could die (bleed out).

An ectopic pregnancy is NEVER viable for the embryo AND is life-threatening for the mother.
The Cervix
= entryway to uterus.

> normally ~ 2.5 cm in diameter.
> Can dilate during childbirth over 10 cm!

Let's look at an analogy, shall we??

Question: What is a PAP smear?

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.

Cervical cancer stages

Penile warts

Cervical warts

Labial warts

Throat cancer?
**HPV Vaccine - 2006**

- Gardasil marketed by Merck & Cervarix by GlaxoSmithKline
- Both are set of 3 vaccinations.

**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.

See reading assign.: Cervical cancer vaccine

Source: www.cdc.gov/hpv/vaccine

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**Since 2018 ....**

![HPV infections targeted by vaccine have decreased since vaccination was introduced](https://www.cdc.gov/mmwr/volumes/70/wr/mm7012a2.htm#F1_down)
Uterus and Child Birth

Maturation of eggs

**Oogenesis** = production of eggs in ovaries. All the eggs a woman will ever have were in her fetal ovaries (before she was ever born!).

**Eggs** called **oocytes**, cell

- **Primary Follicle**
  - **Secondary Follicle**
    - **Graffian Follicle**

**Egg**

- **Oogonia**
  - **Primary Oocyte**
  - **Secondary Oocytes (Ovulated)**
Oogenesis:

- **Oogonium** (2n)
- **Primary oocyte** (2n) → **Secondary oocyte** (1n) = egg that gets ovulated from the “graafian follicle”
- Graafian follicle becomes corpus luteum (CL) “which produces progesterone ~14 days of pregnancy” hormone released from CL that maintains uterus in pregnancy-friendly state. Prevents egg development and ovulation.

After puberty: once/month

**Secondary oocyte** (1n) = egg that gets ovulated from the “graafian follicle”

- Graafian follicle remains in ovary & becomes corpus luteum (CL) making progesterone.
- If fertilized
- If no fertilization CL disintegrates.

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. Click **HERE** for YouTube video.

Puberty

1. Primary follicle contains oogonium.
2. Secondary follicle contains primary oocyte.
4. Secondary oocyte ovulated
6. If no fertilization CL disintegrates.
5. Graafian follicle remains in ovary & becomes corpus luteum (CL) making progesterone.

Mittelschmertz = pain with ovulation
**Ovarian cycle**

- Days: 1-13 = Egg development from FSH
- **Day 14 = ovulation (LH high)**
- Days 15-28 = CL makes progesterone

**Menstrual cycle**

- Days: 1-5 = menstruation
- 15-28 = endometrium thickens Because of progesterone

After day 28, if no fertilized egg, CL disintegrates

IF no fertilization:
- Corpus luteum breaks down and stops progesterone secretion @day 28.
- Without progesterone, uterine lining breaks down.
- Menstrual flow – egg and lining shed
- Endometrium secretes Prostaglandin, which causes uterine cramping to expel blood and tissue.

IF fertilization:
- Embryo makes hCG within 1 week (the hormone pregnancy tests detect this in the urine)
- This hormone “rescues” corpus luteum – it keeps making progesterone ~ 1 month (until placenta forms and takes over progesterone production).
**Polycystic Ovarian Syndrome (PCOS)**

- Condition in which follicles in ovary fill with fluid (cysts). Painful condition that decreases fertility.

**Treatment:**

- Hormonal Birth Control to prevent these problems.

**Ovarian Cancer**

- > 5th deadliest cancers for women
- Occurs in about 1 / 75 women
- Occurs more in women after 50 yrs (aftermenopause)
- Often no symptoms

**Detection**

- CA-125 = **blood test for cancer antigen 125**. If higher than normal, associated with increased risk of cancer.
- BRCA test = **blood test for genetic abnormality**. Is inherited. Increases risk of ovarian cancer (and breast cancer).

**Ultrasound** – to visualize the ovaries.

Click [HERE](#) for more info on ovarian cancer from CDC.
Ovarian cancer

↑ risk factors include:
> Genetics (close female relative had it)
> Have had more ovulations in life
(never been on hormonal birth control or been pregnant)
> Have mutation in the BRCA gene
> Polycystic ovarian syndrome
> Hormonal problems

↓ risk factors include:
> Not have genetics
> No mutation in BRCA gene
> Fewer ovulations in life
  (never have been on birth control, never have been pregnant)

Question: Why do you think having been on birth control lowers risk of ovarian cancer??

Every time you ovulate, hole in ovary is repaired by mitosis. More you ovulate, more mitosis happens.

↑ Mitosis goes wrong (cell division out of control) →
↓ Cancer

Question: Why do you think having been on birth control lowers, or having been pregnant, decreases the risk of ovarian cancer??
Ovarian and Breast Cancer and genetic predisposition:

\[ \text{BRCA Gene} \] = tumor suppressor gene that normally suppresses tumor growth (a good thing!)

**Mutation in this 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.

\[ \text{CA-125} \] = cancer antigen 125

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

### Risk of Cancer in Individuals Wth a BRCA1 or BRCA2 Mutation

<table>
<thead>
<tr>
<th>Cancer Type</th>
<th>General Population (No Mutation)</th>
<th>Individuals With Mutation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>BRCA1</td>
</tr>
<tr>
<td>Breast</td>
<td>12%</td>
<td>50-80%</td>
</tr>
<tr>
<td>Ovarian</td>
<td>1-2%</td>
<td>24-40%</td>
</tr>
<tr>
<td>Male Breast</td>
<td>0.10%</td>
<td>1-2%</td>
</tr>
<tr>
<td>Prostate</td>
<td>15% (N. Europe Origin)</td>
<td>up to 30%</td>
</tr>
<tr>
<td></td>
<td>18% (African American)</td>
<td>1-3%</td>
</tr>
</tbody>
</table>
**Uterine Cancer**

> ~ 65,000 women / year in US diagnosed with uterine cancer.
> 4\(^{th}\) most common cancer in women.
> Tends to start in endometrium (90\% cases)
> increased risk = 50 yrs and older, taking supplemental estrogen, have family members who had ovarian and/or uterine cancer.

**Symptoms:**
> Abnormal vaginal bleeding - 66\% of uterine cancers diagnosed early due to abnormal vaginal bleeding.
> Pelvic pain
> Abnormal PAP smear.

**Treatment:**
> Hysterectomy = surgical removal of uterus.
> Chemotherapy
> many other treatments available


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**Menopause** = end of woman’s reproductive cycle. Ovaries suddenly stop producing eggs, estrogen, & progesterone (age 50 or so).

Symptoms:  
> moodiness  
> hot flashes  
> vaginal dryness  
> osteoporosis (thinning of bones)  
> ↑ libido (due to testosterone from adrenal glands)  
> ↑ facial hair growth in some women (hirsutism)

**Andropause** = gradual decline in man’s reproductive function. Testosterone and sperm production slowly decline from age 40 & on.

Source: [https://www.webmd.com/men/guide/male-menopause](https://www.webmd.com/men/guide/male-menopause)

CAUSES OF FEMALE INFERTILITY:

- Smoking
- Alcohol
- Obesity (↑ WHR)
- High estrogen
- Low estrogen
- PCOS
- Endometriosis
- Age

Any questions?
Any topics not covered that you want to know about female reproductive system?
Review

- Female reproductive anatomy & physiology
  - reproductive structures
- Ectopic pregnancy, endometriosis, polycystic ovarian syndrome, episiotomy.
- HPV, warts, cervical cancer, HPV vaccine, breast & ovarian cancer, mutations in the BRCA gene, CA125 test.
- Genital mutilation
- Oogeneis
- Menstrual cycle (follicle & uterine cycles)
- Role of hCG in rescuing corpus luteum in pregnancy
- **Ovarian and Uterine cancer (added)**
- Menopause & Andropause
- Fertility and infertility in women