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

The Basics of Reproductive Anatomy & Physiology

Reading Assignments:
1. The Reproductive System
2. Male Menopause or “ADAM”
3. Human Papilloma Virus (HPV) Vaccine
4. Genital Mutilation
5. Hormone Replacement Therapy (WHI study)
Testes = paired gonads that produce sperm and testosterone

Seminiferous tubules = 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 = where sperm stored & mature before ejaculation. (Sperm warehouse)

Scrotum = contain testes outside of abdomen ~3° lower than body temp of 98.6.

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

QUESTION: Why is lifting & lowering the testes important in male reproductive function?

Control temp. of testes for sperm production. Muscle contracts - lift testes; relaxes - lowers testes.

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

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

**QUESTION:** What is a vasectomy?

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

3. **Urethra** = passageway for urine or semen, but not at 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)

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

3. **Bulbourethral gland** - produces lubricant during sexual arousal.
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)
The Penis

**Corpus cavernosa** = 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?

**Circumcision** = surgical removal of the foreskin (penile prepuce).

**Reading assignment:**
Circumcision – Pros and Cons
**How an erection works:**

1. **Stimulation** 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.

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

**Many possible causes:**

**Treatments:**

1. Counseling if psychological
2. Pharmacological (drugs)
   - A) testosterone supplements if low T.
   - B) ED drugs (ex. Viagra, Cialis, Levitra)
     These drugs work by phosphodiesterase inhibitor (block enzyme that breaks down cGMP in corpus cavernosa, ↑ blood flow)
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):

Question: What is phosphodiesterase?

ED drugs work as
Phosphodiesterase inhibitor = a chemical that inhibits phosphodiesterase.

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

↑ cGMP in penis

What would that do to arteries in the penis?

Increased blood flow to penis causes erection

Viagra, Cialis, & Levitra are phosphodiesterase inhibitors.

Inflatable Penile Implant

Click image for webpage with a YouTube video embedded
Steroidogenesis in males & females:

Steroidogenesis = production of sex steroids in males & females.

The BRAIN controls steroidogenesis!

- **Hypothalamus** = brain structure that controls it.
  - General
  - 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.
- stim. ovaries to make estrogen & progesterone

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)** > stim. sperm or egg development
Steroidogenesis in males & females:

- High blood levels of testosterone, estrogen, and progesterone inhibit pituitary LH & FSH.

Gametogenesis in males:

- **Gametogenesis** = production of eggs or sperm.
  - "gametes" = production of sperm in seminiferous tubules of testes. Driven by testosterone (controlled by brain).
  - Relies on FSH
  - Spermatogenesis = production of sperm in seminiferous tubules of testes. Driven by testosterone (controlled by brain).
**Spermatogenesis** = production of sperm in seminiferous tubules of testes.

- **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.

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**Spermatogenesis** diagram:
- **diploid** = 23 pairs chromosome
- **Meiosis**
  - First meiotic division
  - Second meiotic division
- **Spermiogenesis**
  - **Spermatogonia**
  - **Primary spermatocyte**
  - **Secondary spermatocytes**
  - **Spermatids**
  - **Spermatozoa**
**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:**

- Poor sperm count, or abnormal movement or morphology.
- Testes too warm (try boxers not briefs!).
- Testicular injury or cancer.
- Health issues (heart, diabetes, etc...)
- Obesity
- Prostate problems (BPH or cancer)
- Long term use of anabolic steroids
- Deletions from the Y chromosome (deletions from the AZF region)

See Reading Assignment: “Why the Y?” Pg 61
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** = copulatory & birth canal.

**External genitalia:**

> **Vulva** = labia major & minor

> **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.

> **Myometrium** = muscular layer of uterus, responds to oxytocin & prostaglandin.

Prostaglandin produced by endometrium when progesterone stops cause contractions.
Female reproductive anatomy Fig. 27.7
**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!

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**Question:**

What is an **episiotomy**?

= Controlled incision to widen vaginal opening to prevent uncontrolled tearing during childbirth

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Episiotomy

- Vagina
- Rectum

Median incision  Mediolateral incision
**Clitorectomy** (see reading assignment online)

= 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”*
Human uterus: normal Vs menstrual

I wanted to share this image with you. In my hand are life-sized replicas of a non-menstruating uterus and a menstruating uterus.
**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!

Treat with:
- pain meds
- hormonal birth control
- lower level of estrogen & progesterone
- less thickening of endometrium

**The Fallopian Tubes**

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

**The Fallopian Tubes**


**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.

**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.

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.

Reading assignment:
Human Papilloma Virus (HPV) Vaccine

Source: www.cdc.gov/hpv/vaccine
The Ovaries have follicles that contain a developing egg. Once a month one follicle & egg mature. A secondary oocyte is ovulated. The remaining follicle becomes the corpus luteum & produces progesterone.

"Mittelshmerz" = pain with ovulation.

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

Treatment: hormonal birth control.

Ovarian cancer
↑ risk factors include:
> Genetics (close female relative had it)
> mutation in BRCA gene!!!!
> More menstrual cycles in life
  (never on birth control, never pregnant)
> hormonal problems
> Polycystic ovarian syndrome

↓ risk factors include:
> not have genetics
> no mutation in BRCA gene
> fewer menstrual cycles
(have taken BC, or pregnant)
**Polycystic Ovarian Syndrome** = follicles in ovary fill with fluid (cysts). Painful condition that decreases fertility.

**Treatment:**

**Ovarian cancer**

↑ risk factors include:
> Genetics (close female relative had it)
> mutation in BRCA gene!!!!
> More menstrual cycles in life
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> Polycystic ovarian syndrome

↓ risk factors include:
> not have genetics
> no mutation in BRCA gene
> fewer menstrual cycles
  (have taken BC, or pregnant)

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

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**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

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

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### Gametogenesis in females:

**Oogenesis** = production of eggs in ovaries. Is driven by estrogen (controlled by brain).
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

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

**After puberty:**

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

- graafian follicle becomes **corpus luteum (CL)** “which produces progesterone ~14 days

**Puberty**

**Monthly, from puberty to menopause:**

- **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

**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).
**Ovarian cycle**

Days:
- **1-13** = Follicle phase
  - Egg development with FSH
- **Day 14** = ovulation
  - with high LH
- **Days 15-28** = CL makes high progesterone

**Menstrual cycle**

Days:
- **1-5** = menstruation
  - progesterone low
- **5-14** = high Estrogen
- **15-28** =
  - endometrium thickens
  - High progesterone
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)

Male Menopause (ADAM) = gradual decline in man’s reproductive function. Testosterone and sperm production slowly decline from age 40 & on.

Reading assignment:
Male Menopause or “ADAM

**CAUSES OF FEMALE INFERTILITY:**

- Poor health
- Low body fat (7 – 10 %) found in extreme athletes, malnourishment, anorexia.
- Polycystic ovarian syndrome
- Pelvic inflammatory disease
- Obesity
- Sexually transmitted disease (STDs) – can scar uterus & fallopian tubes
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
- Oogenesis
- Menstrual cycle (follicle & uterine cycles)
- Role of hCG in rescuing corpus luteum in pregnancy
- Menopause & Andropause
- Fertility and infertility in women

Exam 1 Review

Evolution of Sex, Part 2: 29 questions
- Vocabulary! (gametes, diploid, haploid, zygote, isogamy, heterogamy, gonochoristic, hermaphrodite (simultaneous & sequential, and examples).
- Know number of chromosomes (autosomes & sex) in human somatic cells (non-egg, non-sperm) versus number of chromosomes in egg and sperm).
- Advantages and disadvantages of asexual reproduction
- Know examples of asexual reproduction – “cloning” (fission in bacteria, parthenogenesis in whiptail lizards, artificial cloning, monozygotic twins, budding, viral replication, fragmentation).
- Advantages and disadvantages of sexual reproduction
- Who came up with Tangled Bank, Red Queen, and DNA repair hypotheses

Biology of Beauty: 15 questions
- Know researcher who studied symmetry in scorpionflies
- Know researcher who studied women’s choice of facial attractiveness & sperm quality
- Know who studied waist to hip ratio (and what the ratios should be for men & women)
- Visual secondary sexual characteristics in men and women, that are caused by testosterone and estrogen.
- “The Biology of Beauty: Face Values” – bad effects of testosterone
- “Biology of Beauty by Geoffrey Cowley – women’s fertility changes with WHR
- Reproductive roles of men and women, from evolutionary standpoint
- MHC t-shirt match and sniff test
- 5 universal ideals that men and women tend to seek in the opposite sex
“Beards: Too Hip for Their Own Good” – frequency dependent selection