Reproductive System
Organs of Male Reproductive System

- includes:

1. testes (produce & secrete hormones)

2. ducts (transports and stores sperm)

3. accessory sex glands (seminal vesicles, prostate gland & bulbourethral gland)

4. supporting structures including the scrotum & penis
Scrotum

- Supporting structure for the testes
- Left side hangs lower to accommodate a longer spermatic cord
- Sac consisting of loose skin and superficial fascia that hangs from the root of the penis
- raphe - external median ridge that separates the scrotum into lateral portions
- scrotal septum - internally separates the scrotum into two sacs, each containing a single testis
Scrotum (continued)

- Two scrotal layers: outer skin layer and inner smooth muscle layer that contracts when cold and elongates when warm.
- This is due to the fact that the testes need to be cooler than body temp in order to produce viable sperm for reproduction.
Testes

- Paired oval glands that produce sperm and secrete hormones
- Develop near the kidneys and descend into the scrotum around the 7th month of fetal development
- Cryptorchidism - condition when the testes do not descend into the scrotum
  - If untreated, results in sterility due to higher temp. of the pelvic cavity
Spermatogenesis

-production of sperm cells; takes ~ 65-75 days

takes place in the **seminiferous tubules** (coiled tubes inside the testes) via meiosis

-spermatids (gametes) begin their development in the walls of the seminiferous tubules, where they become **spermatozoa** (not fully developed sperm), which continually undergo cell division by meiosis until puberty, becoming **spermatogonia**.
Spermatogenesis (cont)

- Spermatogonia divide mitotically to produce two types of daughter cells

  - Type A cells - remain in the tubule, producing more spermatogonia

  - Type B cells - undergo meiosis to produce four spermatids, which mature into sperm and travel to the epididymis for storage and maturation of the sperm
Maturation of sperm

gametes $\rightarrow$ spermatozoa $\rightarrow$ spermatogonia $\rightarrow$
spermatids $\rightarrow$ sperm
Hormonal Control of Spermatogenesis

- production of gonadotropin hormones secreted by the anterior pituitary gland increases at the onset of puberty

  LH - Luteinizing Hormone - secretes testosterone, which is synthesized from cholesterol in the testes.

  FSH - Follicle Stimulating Hormone - stimulates spermatogenesis
Effect of androgens during puberty

- Development of male sexual characteristics including:
  - development & enlargement of male sex organs
  - muscular & skeletal growth resulting in wider shoulders & narrow hips
  - development of body hair
  - an increase in sebaceous gland secretions
  - enlargement of the larynx (deepening of voice)
Effect of androgens during puberty (cont)

- Development of sexual function
- Stimulation of anabolism (stimulation of protein synthesis...obvious by heavier muscle and bone mass of men compared to women)
- Stimulation of closure of epiphyseal plates
Sperm

- Sperm mature at a rate of 300 million per day
- 150-750 million sperm/ml in ejaculate
- <20 million signifies infertility

Once ejaculated, sperm do not survive more than 48 hours within the female reproductive tract
Parts of sperm cells

1. head - contains DNA
2. acrosome - vesicle that contains enzymes that aid penetration of sperm cell into an oocyte
3. midpiece - contains mitochondria to produce ATP needed for locomotion
4. tail - a typical flagellum to propel the sperm cell
Duct System

- functions in storage and transportation of sperm

1. Epididymis
2. Vas deferens
3. Ejaculatory ducts
4. Urethra
Epididymis

- Lies along posterior border of each testis
- Highly coiled structure (20 feet)
- stores sperm for up to 1 month
- helps propel them by peristaltic contraction of the smooth muscle into the vas deferens
Vas deferens - Tube that carries sperm from the epididymis towards the urethra

Ejaculation - the powerful propulsion of semen from the urethra to the exterior

Ejaculatory ducts - eject sperm and seminal vesicle secretions just before ejaculation

*sperm that are not ejaculated are reabsorbed by the body
Urethra
- in males, the shared terminal duct of the urinary and reproductive systems; subdivided into three parts

1. **Prostatic urethra** - passes thru the prostate gland
2. **Membranous urethra** - middle portion
3. **Spongy urethra** - passes thru the corpus spongiosum of the penis
Semen

- A combination of sperm and secretions of the seminiferous tubules, seminal vesicles, prostate gland and bulbourethral glands.
- Volume in a typical ejaculation is ~ 2.5-5 ml
- Has a pH of 7.2-7.7 to help neutralize the acidic environment of the urethra and the vagina
Semen (cont)

- Provides sperm with a mode of transportation
- Also contains **seminalplasmin**, an antibiotic that can destroy certain bacteria
- Coagulates (clots) within 5 minutes of ejaculation, but will reliquify after ~10-20 minutes due to enzymes from the prostate gland
Accessory Sex Glands

-secrete most of the liquid portion of semen

1. Seminal vesicles - secretions that contain fructose used for ATP production by the sperm.
   - helps to neutralize acid from vaginal secretions
   - seminal fluid makes up 60% of semen
Accessory Sex Glands (cont)

2. prostate gland - secretion that contains citric acid used by sperm for ATP production
   - contributes to sperm motility and viability
   - prostate fluid is about 25% of semen
   - prostate gland increases in size as you age.
   - PSA blood test - the higher the level of prostate specific antigen in your blood...indicative of prostate cancer (#2 cause of death in men)
Accessory Sex Glands (cont)

3. Bulbourethral glands (Cowper’s glands) -

- secretion that protects sperm by neutralizing acids from urine in the urethra

- also secretes mucus to lubricate the end of the penis (pre-ejaculatory fluid)
Penis
-contains urethra and is the passageway for ejaculation of semen and excretion of urine
- composed of body, root and glans penis
Body of penis
- composed of 2 types of erectile tissue filled with blood sinuses

1. corpora cavernosa penis
2. corpus spongiosum penis
Erection

1. Stimulation makes arteries dilate.
2. Sinuses fill with blood (causes an erection)
3. Blood filled tissues cause veins to constrict (blood can’t drain)
4. Urinary bladder is blocked.
5. Muscle contraction causes emission of semen.
6. Erection ends, blood exits the veins.
Root of penis

bulb of the penis - the attached portion; the expanded portion of the base of the corpus spongiosum penis

crus of the penis - the two separated and tapered parts of the corpora cavernosa penis
Glans penis
- the distal end of the corpus spongiosum penis

Corona - the margin of the glans penis

External urethral orifice - terminal slit-like opening of the urethra

Prepuce - foreskin; covers the glans in an uncircumcised penis
Organs of the Female Reproductive System
- consist of

1. ovaries
2. Fallopian tubes
3. Uterus
4. Vagina
5. external organs that constitute the vulva
6. mammary glands
Ovaries

- **Ovaries** - two, almond shaped glands containing approximately 400 mature eggs

- Produce the hormones progesterone, estrogen, inhibin and relaxin

- Homologous (have the same embryonic origin) to the testes
Oogenesis

during fetal development, oogonia (cells in the ovaries) begin meiosis, creating ~ 2 million primary oocytes suspended in prophase I.

By puberty, 75% of the primary oocytes have died, but the remaining ones resume meiosis, splitting into a polar body and a secondary oocyte.
Oogenesis (cont)

- Meiosis continues...the polar body completes the process forming two polar bodies, which disintegrate.

- the secondary oocyte pauses meiosis again, this time at metaphase II and will not complete meiosis until fertilization has been initiated...creating an actual ovum and a polar body that will degenerate.
Maturation of an ovum

Oogonia → primary oocyte → secondary oocyte → ovum
Fallopian Tubes

- Tubes that transport an ovum or a fertilized ovum from the ovaries to the uterus
- **fimbriae** - fingerlike projections at the end of the tubes that help sweep the egg into the tube
- lined with cilia to help propel the egg
Uterus

- commonly called the womb
  - fertilized egg implants in the fundus
  - protects a fetus during pregnancy
  - contracts during labor
- pathway for sperm to reach the uterine tubes
- site of menstruation
Parts of the uterus

Four parts:

1. **fundus** - upper portion
2. **body** - central portion
3. **os** - inferior portion
4. **cervix** - opening of uterus
Layers of the Uterus

1. **perimetrium** - outer; anchors to pelvis
2. **myometrium** - middle; contracts during labor due to oxytocin
3. **endometrium** - inner; highly vascular layer that is shed during menstruation
Problems with the uterus

**endometriosis** - growth of the endometrium outside of the uterus; causes bleeding, pain, scarring and infertility

**hysterectomy** - surgical removal of the uterus
Vagina
- often called the “birth canal”
- passageway for menstrual flow, childbirth and semen from the penis during intercourse
- able to stretch to accommodate a penis during intercourse and a child during birth

hymen - a thin fold of mucous membrane that may partially close the vaginal orifice
Vulva (pudendum)

-refers to the external genitals of the female

- **mons pubis** - an elevation of adipose tissue covered by skin & coarse pubic hair

- **labia majora** - two longitudinal folds of skin (homologous to the scrotum), covered by pubic hair, contain abundant adipose tissue, sebaceous glands and apocrine sudoriferous glands
Vulva (cont)
- labia minora - medial to the labia majora; do not have pubic hair, adipose tissue or sweat glands but do have sebaceous glands (homologous to spongy urethra)
- clitoris - small cylindrical mass of erectile tissue and nerves (homologous to glans penis) covered by prepuce (foreskin)
Vulva (cont)

- **vaginal orifice** - opening of the vagina to the exterior

- **external urethral orifice** - anterior to the vaginal orifice and posterior to the clitoris

- **paraurethral (Skene’s) glands** - on either side of the external urethral orifice, they secrete mucus (homologous to prostate gland)
Vulva (cont)

- greater vestibular (Bartholin’s) glands - open by ducts into a groove between the hymen and labia minora; produce mucus during intercourse for lubrication (homologous to bulbourethral glands)

- bulb of vestibule - two elongated masses of erectile tissue deep to the labia on either side of the vaginal orifice; become engorged with blood & places pressure on the penis during intercourse (homologous to corpus spongiosum penis & bulb of penis)
Mammary Glands
-modified sudoriferous glands that produce milk

nipple - pigmented projection

lactiferous ducts - where milk emerges

areola - pigmented area of skin surrounding the nipple

Cooper’s ligaments - strands of connective tissue that support the breast
Mammary Glands

- internally, consists of 15-20 lobes, separated by adipose tissue

- each lobe contains lobules, composed of grapelike clusters of milk-secreting glands called alveoli

- milk passes from alveoli into secondary tubules into mammary ducts which expand to form lactiferous sinuses near the nipple
Hormone Production by the Ovaries

- **estrogens** - cause the appearance of secondary sex characteristics including:
  - enlargement of organs of reproduction
  - development of breasts
  - appearance of axillary and pubic hair
  - increased fat deposits in hips and breasts
  - widening of pelvis
  - onset of menses (menstrual cycle)

- **progesterone** - produced by corpus luteum as long as LH is present
Female Reproductive Cycle
- includes the ovarian and uterine cycles
- on average, lasts 28 days
- involves MANY hormones

1. **GnRH - Gonadotropin Releasing Hormone**
   secreted by the hypothalamus to stimulate the release of FSH and LH from the anterior pituitary.
2. **FSH** - stimulates the initial secretion of estrogen by growing follicles on the surface of the ovary (pouches holding eggs within the ovary). Usually one follicle outgrows the rest.

3. **LH** - stimulates the rupture of the ovarian follicle, triggering ovulation.
   - Stimulates the secretion of progesterone, relaxin and inhibin after ovulation.
4. **Estrogen** - inhibits GnRH; stimulates development & maintenance of female reproductive system

5. **Progesterone** - prepares the uterus for implantation (with estrogen); inhibits GnRH

6. **Relaxin** - relaxes the uterus

7. **Inhibin** - inhibits the secretion of FSH
Three Phases of Reproductive Cycle

1. Menstrual Phase (days 1-5)
   - ~20 follicles grow in the ovaries
   - estrogen & progesterone levels are low in uterus
   - endometrium is shed (menstruation)
   - menstrual flow - consists of 50-150 ml of blood, fluid, mucus and epithelial cells
Three Phases of Reproductive Cycle (cont)

2. Pre-ovulatory Phase (Proliferative phase)

- days 6-13
- in ovaries, follicles grow and secrete estrogen...one dominant follicle outgrows the others
- in uterus, the endometrium is rebuilt in anticipation of ovulation due to an increase in estrogen
day 14 - **Ovulation** - the follicle ruptures (and becomes the *corpus luteum*), sending a mature egg into the Fallopian tube.

- basal temperature rises 0.5°F
- mucus secretions increase around the cervix
- positive feedback → high estrogen levels cause GnRH to produce more LH (this surge in LH can be detected in urine to predict ovulation)
Three Phases of Reproductive Cycle (cont)

3. Post-ovulatory Phase (Secretory phase)

- day 15 - 28
- time between ovulation and onset of next menses
- if no fertilization occurs, corpus luteum degenerates
- hormones maintain the health of the endometrium
- estrogen, progesterone and inhibin decrease, causing GnRH, FSH and LH to increase, beginning a new ovarian cycle
Fertilization

- if fertilization occurs, corpus luteum does not degenerate due to human chorionic gonadotropin (hCG) which is secreted 8-12 days after fertilization
- normally takes place in the Fallopian tubes
- can occur up to 24 hours after ovulation
- zygote - one cell formed by the union of egg and sperm (46 chromosomes) ...begins to divide and move toward the uterus
Implantation

- takes about 7 days for the zygote to make its way to the uterus and attach to the endometrium of the fundus of the uterus