

Male Reproductive Physiology

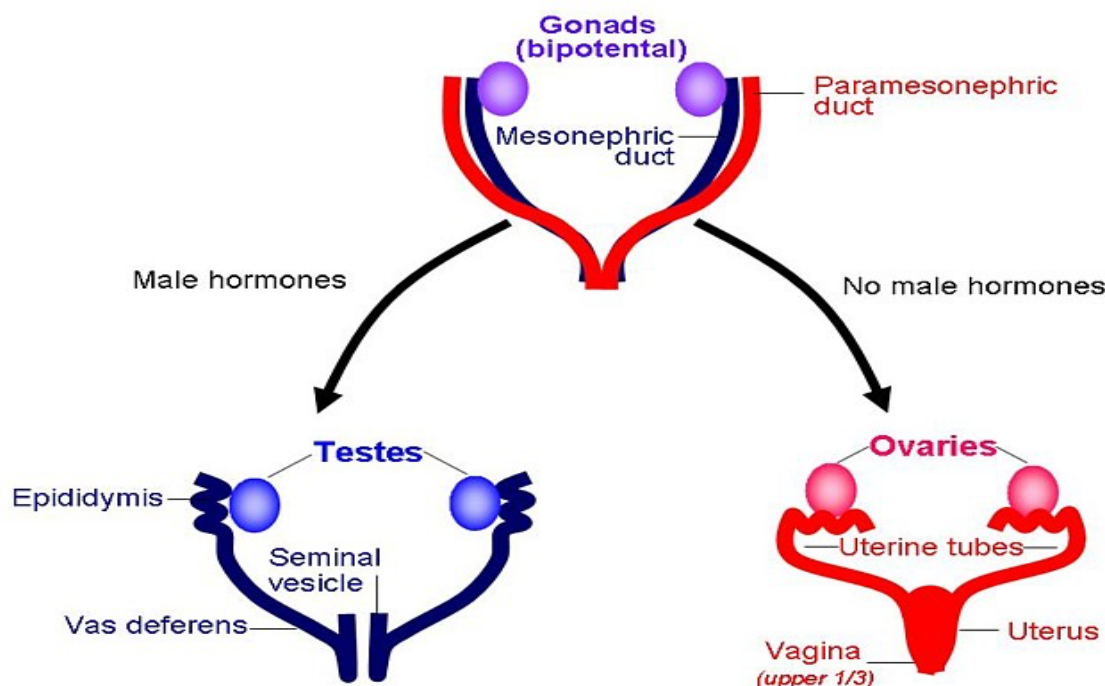
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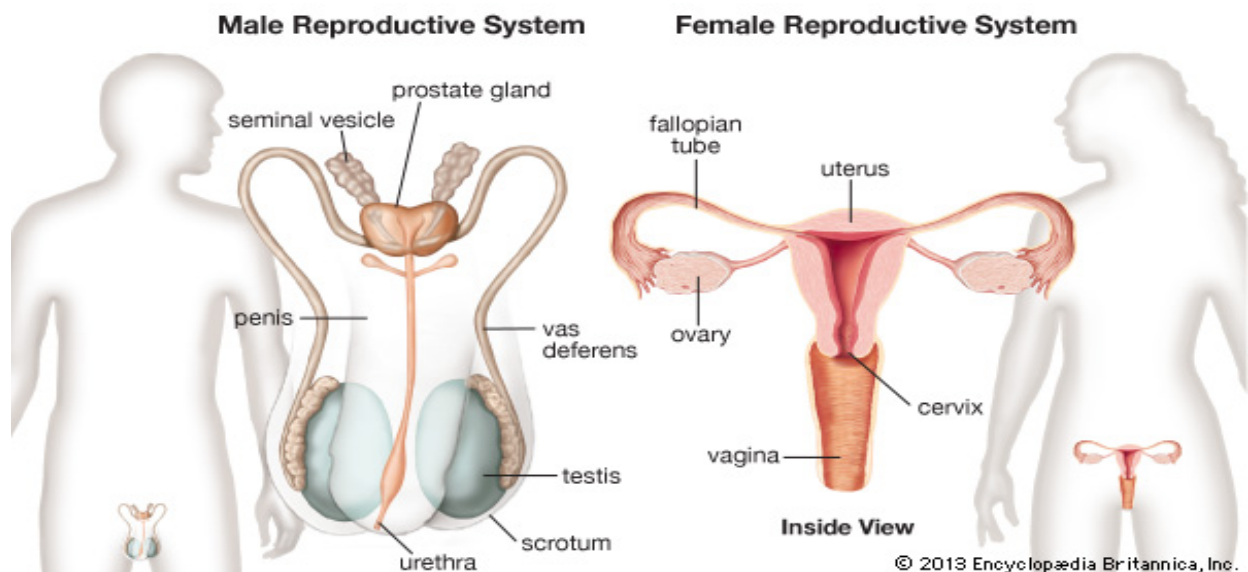
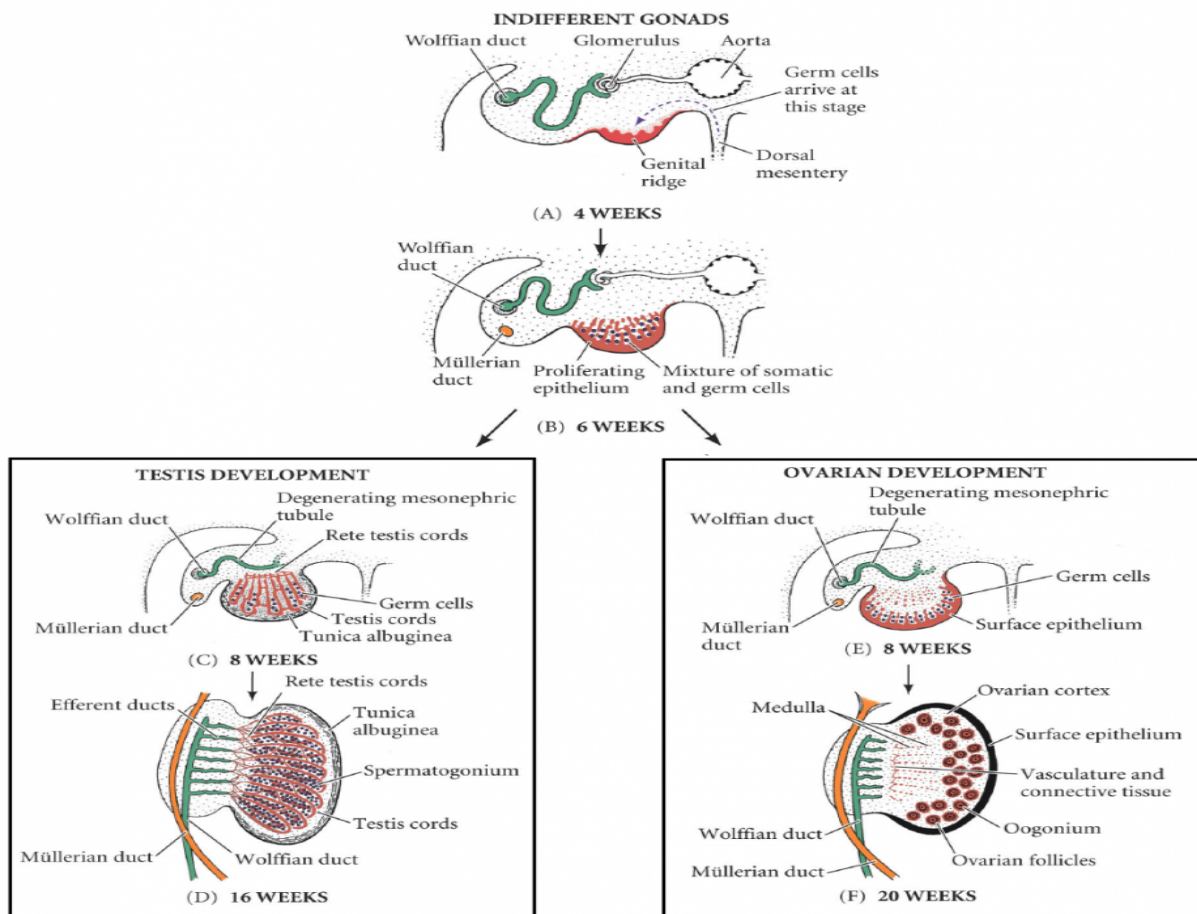
Reproductive System Basics

- **Primary sex organs** (gonads) – testes in males, ovaries in females
- Gonads produce sex cells called gametes (gametes means spouses) and secrete sex hormones
- **Accessory reproductive organs** – ducts, glands, and external genitalia
- **Sex hormones** – androgens (males), and estrogens and progesterone (females)
- Sex hormones play roles in:
 - The development and function of the reproductive organs
 - Sexual behavior and drives
 - The growth and development of many other organs and tissues

Reproductive Homologies

- Our anatomy was exactly the same for the first 5-6 weeks - male and female anatomy is *indistinguishable*.
- Once the genes determining sex are activated, the appropriate structures will remain and mature while the others degenerate.
- Gonads then develop into a female or male system.
- At the same time of undifferentiated structures in the internal system, the external genitalia is also undifferentiated.
- No matter our sex, we all start out with the same external anatomy:
 - Genital tubercle >>> glans penis or clitoris
 - Urogenital fold >>> male urethra or labia minora
 - Labioscrotal area >>> scrotum or labia majora
 - Urogenital membrane will separate the urinary system from the reproductive system
- In the next couple of weeks *in utero*, the undifferentiated anatomy will slowly develop characteristics to match the embryo's sex with testes and ovaries
- The penis and clitoris are different in shape and most functions, what they have in common is nerves.
- There are higher concentrations of nerve endings in the clitoris (8,000+) and the head of the penis (4,000+) than anywhere else in the female and male bodies.





Male Reproductive Organs

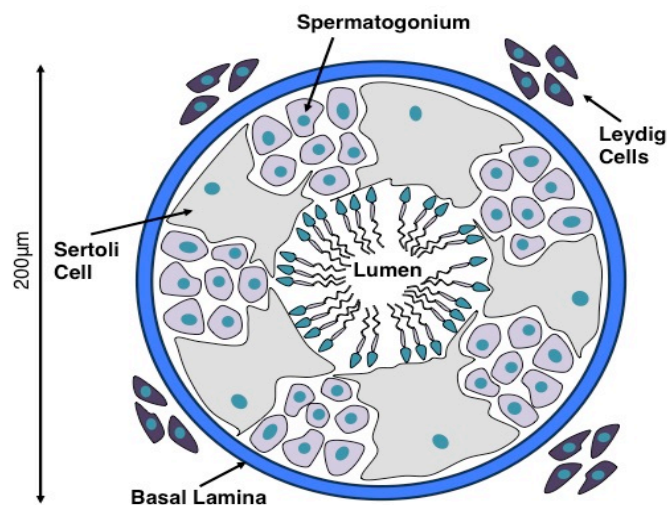
- **Essential organs**
 - For production of gametes
 - Gonads of male – testes
- **Accessory organs**
 - Support the reproductive process
 - Genital ducts convey sperm outside the body
 - pair of epididymides
 - paired vasa deferentia,
 - pair of ejaculatory ducts, and the
 - urethra
- **Accessory Glands**
 - Produce secretions that nourish, transport, and mature sperm
 - Two seminal vesicles, the prostate, and two bulbourethral glands
- **Supporting Structures**
 - Scrotum
 - Penis
 - Pair of spermatic cords

The Scrotum

- Superficial fascia that hangs outside the abdominopelvic cavity at the root of the penis
- Contains testis, epididymis, and lower part of a spermatic cord on each side
- Dartos and cremaster muscles elevate the scrotal pouch
- Its external positioning keeps the testes 3°C lower than core body temperature (needed for sperm production)

The Testes

- Each testis is surrounded by two tunics or layers
 - Tunica vaginalis – outer layer that is an out pocket of the peritoneum
 - Tunica albuginea – “white coat” is deep serous layer
- Has 250-300 lobules, each containing 1-4 seminiferous tubules
 - Produce and carry the sperm
 - Seminiferous tubules convey sperm to the rete testis which goes to epididymis
- **FSH**
 - From anterior pituitary causes tubules to produce sperm & Sertoli cells
 - Sertoli Cells supply nutrients and maintains hormonal levels of developing sperm
 - Sertoli cells form a blood testis barrier
- **LH**
 - From anterior pituitary acts on the interstitial cells to produce testosterone



Brain Testicular Axis

- Hormonal regulation of spermatogenesis and testicular production
 - Involves hypothalamus, ant pituitary and testis
- Maturation of the brain-testicular axis takes about 3 years and then stays fairly constant throughout life
- Involves three hormones
 - **GnRH** – gonadotrophic releasing hormones stimulates testes
 - **FSH** – causes tubules to produce sperm. Produces sertoli cells which supply nutrients and maintains hormone levels for developing sperm
 - **LH** – acts on interstitial cells to produce testosterone

Functions of Testes

- Spermatogenesis
 - Formation of spermatozoa by seminiferous tubules
 - Stimulated by FSH from the anterior pituitary
- Secretion of hormones by interstitial cells
 - Testosterone
 - Inhibin
 - Estrogen

Testicular androgenic hormones

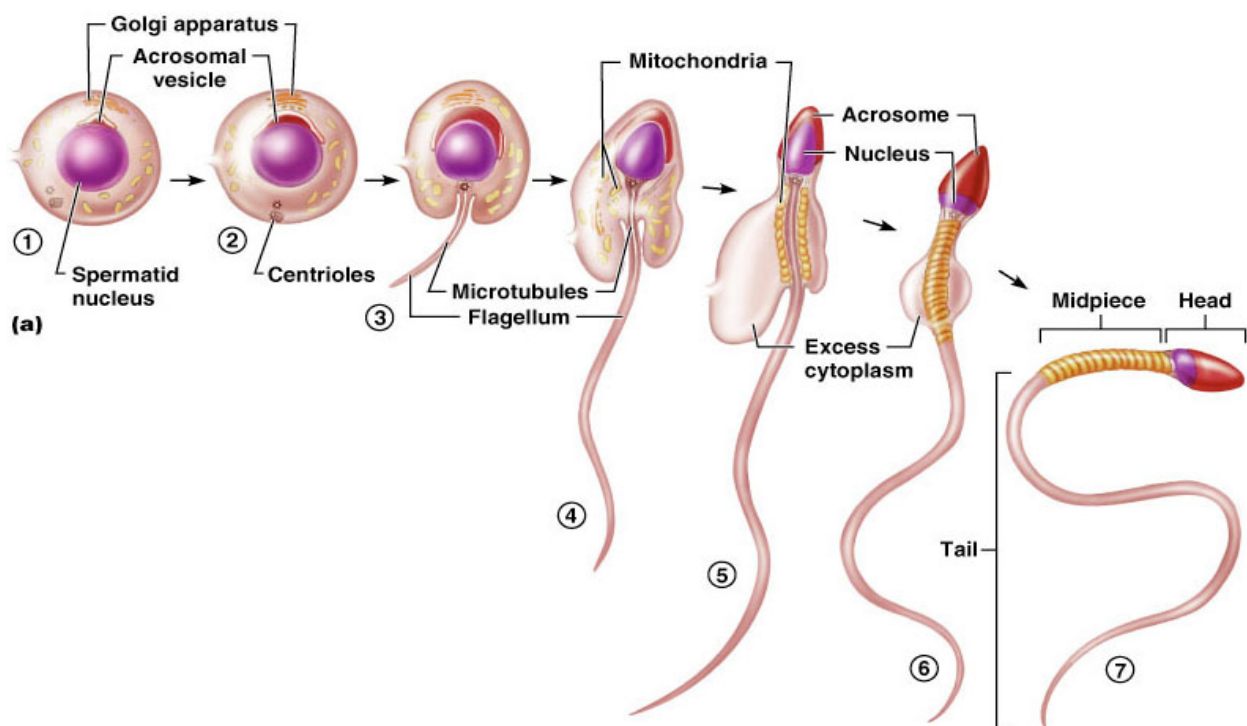
- **Testosterone**
 - Type of androgen: maleness hormone
 - Secondary male sexual characteristics
 - Regulated by LH from anterior pituitary
- **Inhibin**
 - Inhibits release of FSH by anterior pituitary
 - Allows the testis some control over spermatogenesis
- **Estrogen**
 - Small amounts secreted by interstitial cells, liver, and other organs
 - Role in males uncertain but may influence spermatogenesis and other functions

Male Secondary Sex Characteristics

- Male hormones make their appearance at puberty and induce changes in non-reproductive organs, including
 - Appearance of pubic, axillary, and facial hair
 - Enhanced growth of the chest and deepening of the voice
 - Skin thickens and becomes oily
 - Bones grow and increase in density
 - Skeletal muscles increase in size and mass
- Testosterone is the basis of libido in both males and females

Spermatogenesis

- The sequence of events that produces sperm in the seminiferous tubules of the testes - takes 64 to 72 Days
- The spermatozoa goes through three stages that takes about 7 weeks to develop.
- It will take them another month to make it to the rete testis.
- Spermatogenesis begins at puberty and continues throughout life
- Healthy adult male produces 400 million sperm per day
- Sperm have three major regions
 - Head – contains DNA and has a helmetlike acrosome containing hydrolytic enzymes that allow the sperm to penetrate and enter the egg
 - Midpiece – contains mitochondria spiraled around the tail filaments
 - Tail – a typical flagellum produced by a centriole
- Tight junctions between cells
 - Blood testis barrier - protects developing sperm from the immune system



Journey of Happy Swimmers

- At the end of spermatogenesis , spermatozoa are propelled by cilia in the rete testis to the epididymis (The tails of these sperm are not movable at this point).
- Inside the epididymis, enzyme reactions occur that allow spermatozoa to be fully matured and functional.
- If no ejaculation occurs during the 3 day storage time in the epididymis, phagocytes will destroy millions of older sperm in storage.
- During ejaculation, peristalsis in the epididymis and vas deferens propel the millions of sperm.
- After several minutes in the vagina, about ½ of the sperm is destroyed by the acidic vagina. Vagina pH is 3.8-4.5
- For the other ½ of sperm, the tail becomes functional, and they swim through the cervix and into the uterus.
- ½ will swim into the left uterine tube, and the other ½ will swim into the right uterine tube.
- Sperm continue swimming toward the deeper end of uterine tube, against the expulsion force of the cilia lining the inner wall of uterine tube .
- During this movement in the uterine tube, the acrosome is slowly activated to prepare for the release of acrosin enzyme.
- Only about 50 sperm reach the egg and only a few are strong enough to try to fertilize the egg.
- It takes the sperm about 2-12 hours to reach the egg.
- Many sperm can survive somewhere in the female reproductive tract for up to 2-3 days .
- One of the sperm will eventually penetrate through zone pellucida.
- This causes a rapid electrical depolarization at the cell membrane of ovum, preventing other sperm entering the ovum.

The Penis

- Composed of three cylindrical masses of erectile tissue, one of which contains urethra
- Functions
 - Contains the urethra, the terminal duct for both urinary and reproductive tracts
 - Penetrating copulatory organ during sexual intercourse
- Consists of an attached root and a free body that ends in the glans penis or head
- Prepuce, or foreskin – cuff of skin covering the distal end of the penis
- Internal penis – the urethra and three cylindrical bodies of erectile tissue
- Erectile tissue – spongy network of connective tissue and smooth muscle riddled with vascular spaces
- Corpus spongiosum – surrounds the urethra and expands to form the glans and bulb of the penis

Mechanism of penile erection

- Sexual stimulation
- Parasympathetic neurons release nitric oxide (NO), causing dilation of small arterioles of penis
- This also compresses the veins reducing blood flow away from penis
- Blood accumulates within the vascular spaces (corpora cavernosa) in erectile tissue of penis
- Viagra is essentially nitric oxide
- NPT – Nocturnal Penile Tumescence
 - Morning erections / night time erections
 - Not related to having a full bladder
 - Related to REM sleep cycle
 - Average male will have 3-5 erections in a full night's sleep each lasting 25-35 minutes

Mechanism of emission & ejaculation

- Intense sexual stimulation
- Sympathetic impulses contract smooth muscles causing:
 - Peristaltic contractions in testicular ducts, Epididymis, vas deference and ejaculatory ducts .
 - Rhythmic contraction in bulbourethral, prostate, and seminal vesicles
 - Rhythmic contractions in erectile columns of penis.
- Emission -semen moves into urethra
- Ejaculation - semen is forcefully expelled from urethra.
- What is the average ejaculation?
 - 2-6 ml. (5 ml. = 1 teaspoon)
 - Average amount of spermatozoa per ejaculation
 - 50-130 million per ejaculate - Can be up to 200 million
 - Definition of male sterility - Less than 20 million per ejaculate

Accessory Glands

- **Seminal Vesicles**
 - Secrete 60% of the volume of semen
 - Join the vas deferens to form the ejaculatory duct
 - Sperm and seminal fluid mix in the ejaculatory duct and enter the prostatic urethra during ejaculation
- **Prostate Gland**
 - Encircles part of the urethra inferior to the bladder
 - Doughnut shaped
 - Plays a role in the activation of sperm
 - Function: adds slightly acidic, watery, milky-looking secretion to seminal fluid (30% of semen volume)
- **Bulbourethral Glands (Cowper's Glands)**
 - Structure and location
 - Small, pea-shaped structures with approximately 2.5-cm long (1 inch) ducts leading into urethra
 - Lie below prostate gland
 - Function: secrete alkaline fluid that is part of semen (5% of semen volume)
 - Produce thick, clear mucus prior to ejaculation that neutralizes traces of acidic urine in the urethra

Functions of Semen

- Provides transport medium and nutrients
- Moves the sperm
- Protects and activates the sperm
- Prostaglandins in the semen
 - Decreases the viscosity of the mucus plug
 - Moves the spermatozoa
 - Causes reverse peristalsis in the uterus
 - Alkalinity of the semen neutralizes the acidity of urethra & vagina

Composition and Course of Seminal Fluid

- Consists of secretions from testes, epididymides, seminal vesicles, prostate, and bulbourethral glands
- Each milliliter contains millions of sperm
- Passes from testes through epididymis, vas deferens, ejaculatory duct, and urethra

Cycle of Life: Male Reproductive

- Reproductive functions begin at time of puberty
- Development of organs begins before birth; immature testes descend into scrotum before or shortly after birth
- Puberty: high levels of hormones stimulate final stages of development
- System operates to permit reproduction until advanced old age
- Late adulthood: gradual decline in hormone production may decrease sexual appetite and fertility