

Reproductive and Hormonal Functions of the Male-I

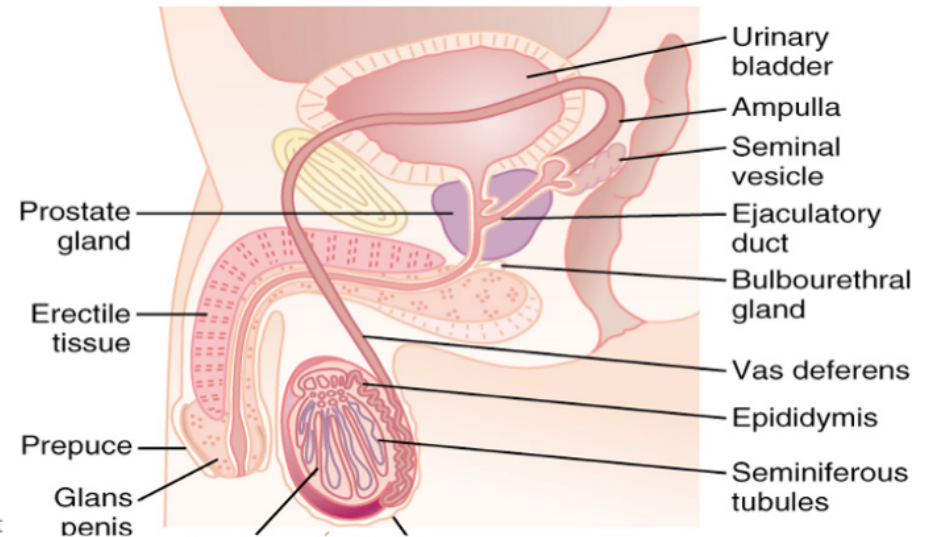
Unit XIV

Chapter 81

Dr Iman Aolymat

Male Reproductive System

Primary Sex Organs	Accessory Sex Organs
➤ Testes	➤ Seminal vesicles ➤ Prostate gland ➤ Urethra ➤ Penis



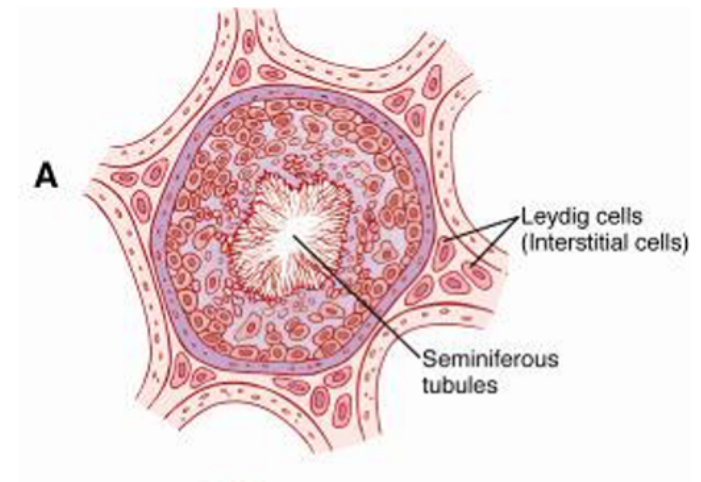
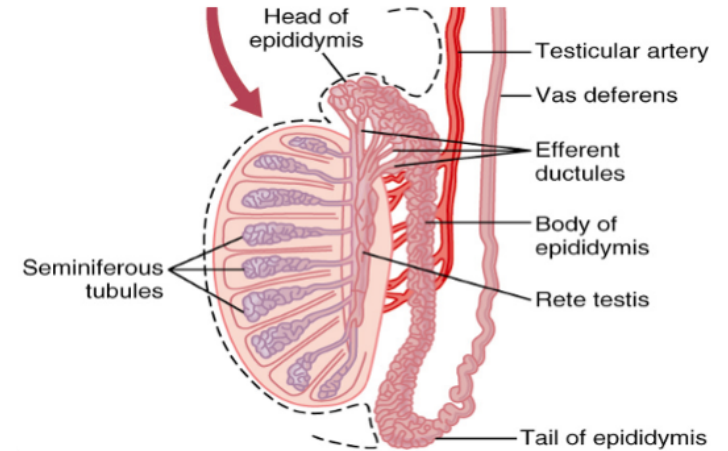
Dr Iman Aolymat

Functions of the male reproductive system

Testes	Produce sperm and male sex hormone testosterone.
Ducts	Transport, store, and assist in maturation of sperm
Accessory sex glands	Secrete most of the liquid portion of semen.
Penis	Contains the urethra, a passageway for ejaculation of semen and excretion of urine

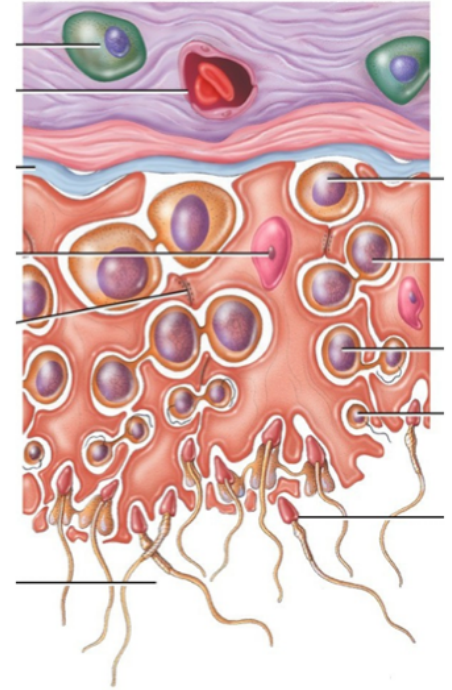
Spermatogenesis

- Occurs in the seminiferous tubules of the testes
- Start at Puberty
- 74 days
- Germ cell line, Sertoli cells & Lyedig Cells (Testosterone)
- → Blood Testes Barrier

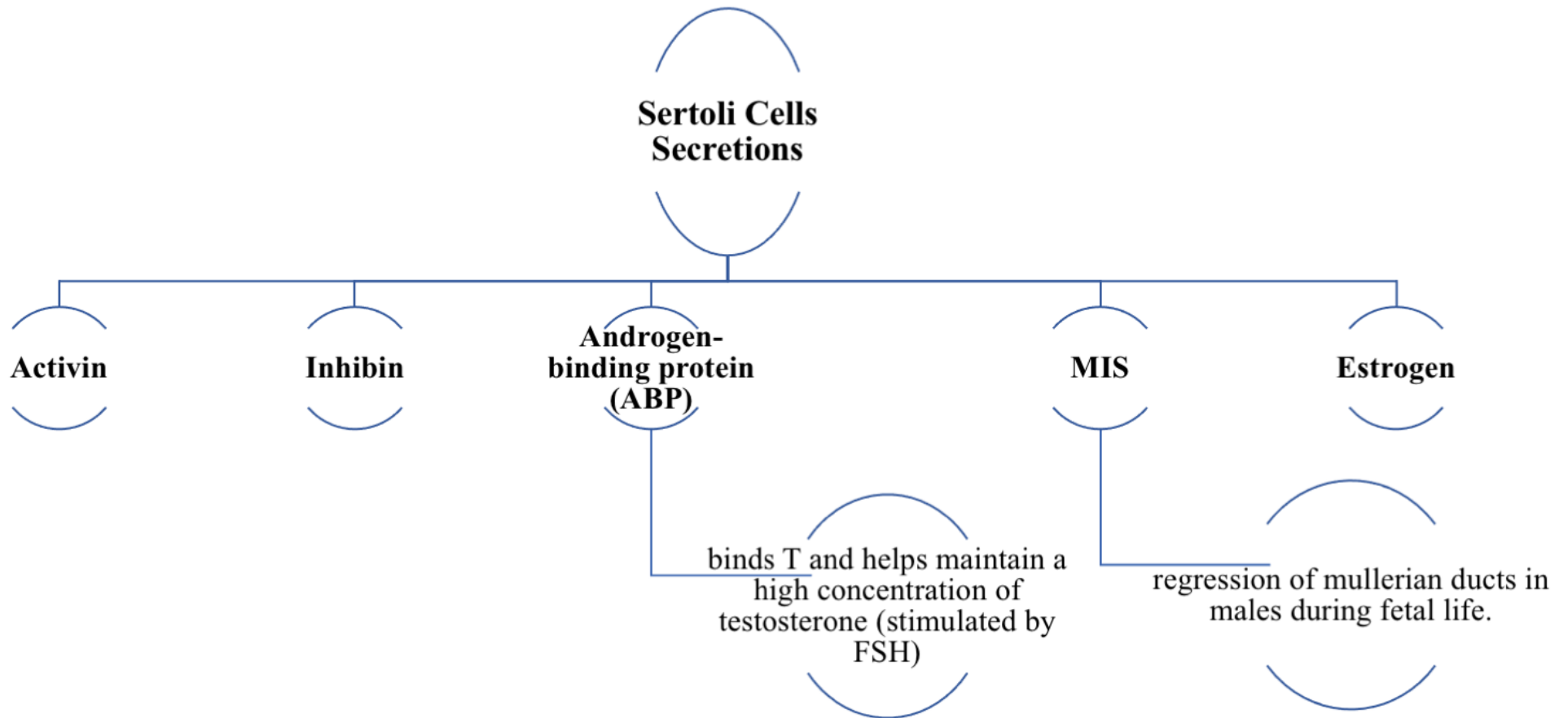


Sertoli Cells & Spermatogenesis

- Supporting and nourishing the germ cells + Phagocytosis
- Secretory function
- Blood Testes Barrier → The germ cell line is completely invested by cytoplasm of surrounding Sertoli cells
- Releasing sperms into the lumen of seminiferous tubules (**spermination**) → sperm are released from their connections to sustentacular cells.



Secretory Functions of Sertoli Cells

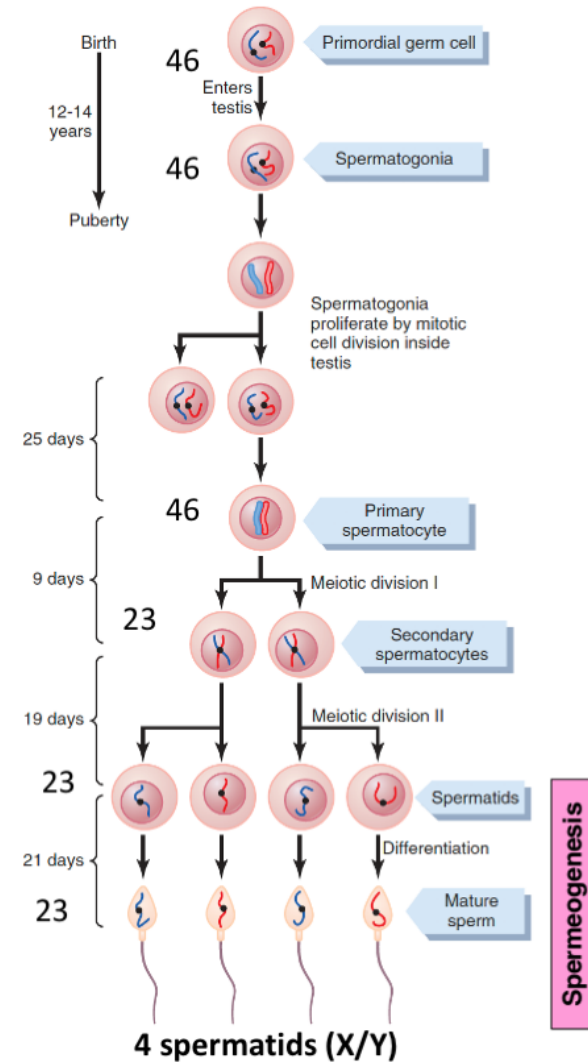


Spermatogenesis

Spermeogenesis: spermatids become matured spermatozoa.

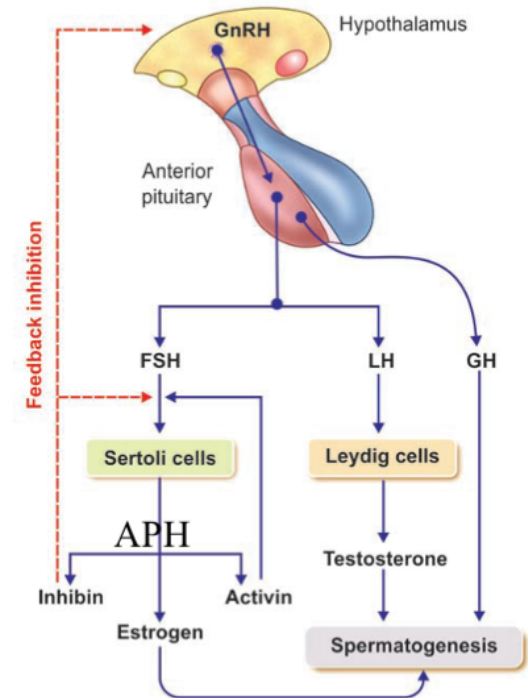
Changes e during spermeogenesis:

- Condensation of nuclear material
- Formation of acrosome, mitochondrial spiral filament and tail structures
- Removal of extra volume of nonessential cytoplasm.



Hormonal Factors Stimulates Spermatogenesis

- GnRH → stimulates anterior pituitary gland to produce luteinizing hormone (LH) and follicle stimulating hormone (FSH)
- LH → stimulates the Leydig cells to secrete **testosterone** → growth and division of the testicular germinal cells
- FSH → stimulates Sertoli cells
- Estrogens → formed from **testosterone** by the Sertoli cells
- Growth hormone → controlling metabolic functions of the testes & promotes division of the spermatogonia
- Dwarfs → spermatogenesis is severely deficient or absent, thus causing infertility.



Structure of the Human Spermatozoon

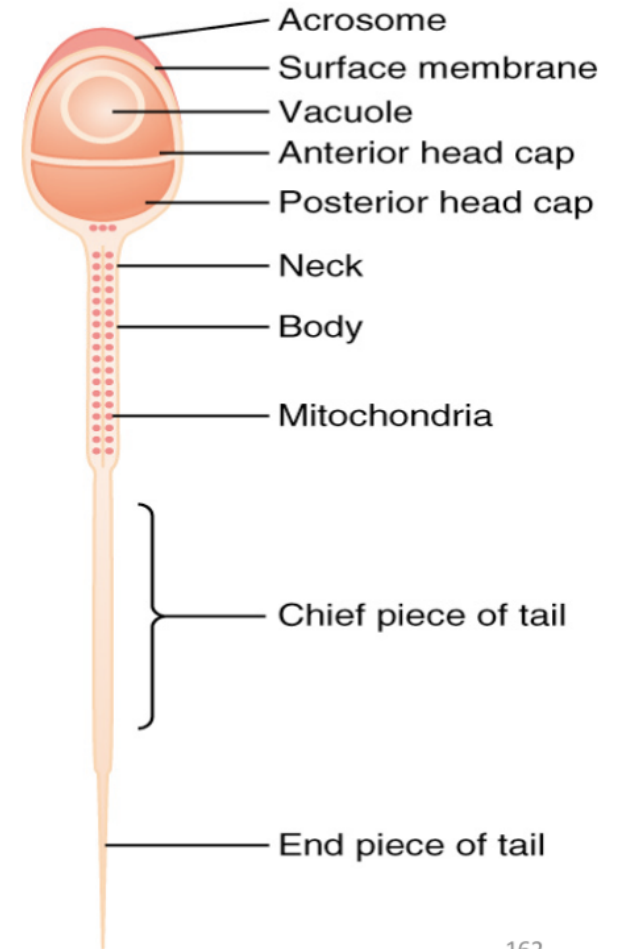
Sperm shape designed to reach and penetrate the secondary oocyte in order to achieve **fertilization** and create a zygote.

Head → contains condensed nucleus with 23 chromosomes+ thin cytoplasm.

Acrosome → covers the head and contains enzymes (hyaluronidases & proteolytic enzymes) to help with penetration.

Tail= flagellum

Microtubules & Mitochondria → ATP for locomotion



Maturation of Sperms

- Seminiferous tubules → tubule of the epididymis
- Sperms at early portions of epididymis → **nonmotile & cannot fertilize an ovum.**
- **After 18- 24 hours** presence in epididymis → sperms develop **capability of motility**, even though **several inhibitory proteins** in the epididymal fluid still prevent final motility until after ejaculation.

The Sertoli cells and the epithelium of the epididymis → secrete a special **fluid** that is ejaculated along with the sperm.

fluid contains:

Hormones (testosterone and estrogens)

Enzymes

Nutrients

Stored at epididymis (mainly) & vas deferens for 1 month in depressed state

Frequent ejaculation → few days storage

After ejaculation → maturation of sperm → *become motile* and capable of fertilizing the ovum

Maturation of Sperms

Capacitation: A process to render the sperms **competent to fertilize** the ovum/hypermotile.

- Occurs when sperm is expelled coming in contact with **the fluids of the female genital tract**
- Normally requires from 1 to 10 hours.

Changes leading Capacitation of Spermatozoa

- various inhibitory factors that suppress sperm activity → washed by uterine and fallopian tube fluids
- Loss of cholesterol vesicles (tough & prevent enzymatic release) at acrosome of sperm
- Increase permeability of flagella to *Ca ions cause increase in motility*
- Ca ions enhances the release of enzymes by the acrosome enhancing the penetration of ovum

Seminal Vesicles

- Secretes 60% of total semen.
- **Functions of seminal fluid-**
- Nutrition to sperms → Fructose
- Other substances: citric acid, PG
- Secretes fibrinogen.
- Fertilization

Prostaglandin → enhances fertilization of ovum by:

1. Increasing the **receptive capacity** of cervical mucosa for sperms
2. Initiating **peristaltic movement** of uterus and fallopian tubes → increasing rate of semen transport (**oxytocin is also responsible for this process**).

Prostate Gland

- Secretes 30% of total semen.

Functions of prostatic fluid-Ca, citrate, phosphate→Maintenance of sperm motility

pH<6 →NON-MOTILE SPERM

Vas deference & female genital tract are acidic.

Prostatic fluid provides optimum pH for the motility of sperms.

Clotting of semen

Clotting enzymes present in prostatic fluid→ convert fibrinogen (from seminal vesicles) into fibrin→ **coagulum**→ holding the sperms in uterine cervix.

Lysis of coagulum

The coagulum is dissolved by **fibrinolysin** of prostatic fluid (15-30 min after ejaculation), so that the sperms **become motile**.

Prostate-specific antigen (PSA)→ hydrolyse sperm motility inhibitors.

Bulbourethral (Cowper's) glands

Secrete an alkaline fluid during sexual arousal that neutralizes acids from urine and mucus for lubrication

Semen:

Milky fluid from seminal vesicles, prostate, vas deference and mucus glands, such as bulbourethral gland

Fructose, vit B, C, E, electrolytes & proteins

pH = 7.5 final

Each ejaculation contains approximately 2-6 ml,
35-200 sperm, avg 120 m/ml, Avg 400 million/ejaculation

Reach fallopian tube 30-60 min

Factors affecting sperm activity

Factors affecting activity of sperm:

1-pH

Neutral and slightly alkaline medium → increase activity

Mildly acidic medium → depressed

Strong acidic medium → death

2- Temperature → activity increases with increasing T

Optimum 2°C below the internal temperature.

On cold days → scrotal reflexes → pulling the testes close to the body

Warm days → scrotum descend

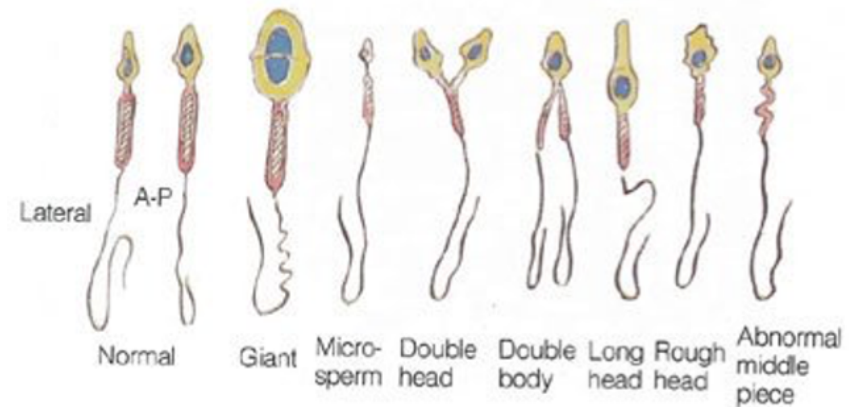
Excessive temperature → degeneration of cells of seminiferous tubules

3-Rate of metabolism → Proportional

the life expectancy of ejaculated sperm in the female genital tract is only **1 to 2 days.**

Qualities of semen required for fertility

	Minimum required
Volume	2 mL
Sperm count	20 million/mL
Number of sperms /ejaculation	40 million
Alive sperms	75%
Motile sperms	50%
normal shape and structure	30%



Male sexual response

1-Sensation: somatic

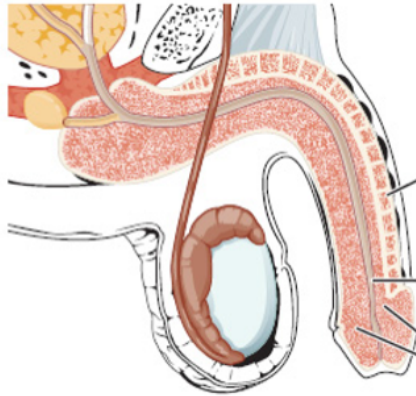
Genitalia & perineum → pudendal nerve → S2-S4

2-Erection:

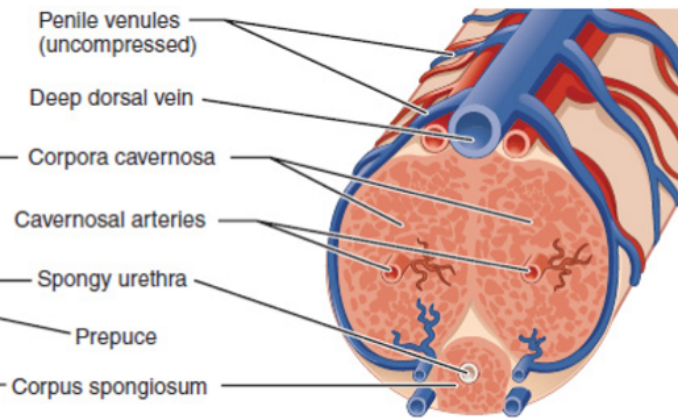
Controlled by **parasympathetic** nervous system

S2-S4 → **Pelvic splanchnic nerve** → pre-ortic & prostatic plexuses → penis (deep penile arterioles) → NO → **vasodilation** of penile arterioles & engorgement of erectile tissue & **compression of** veins *causing reduction in venous return*

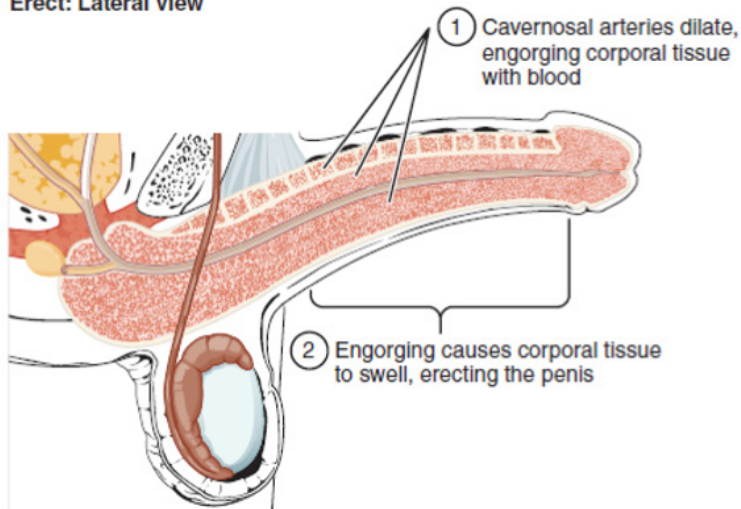
Flaccid: Lateral view



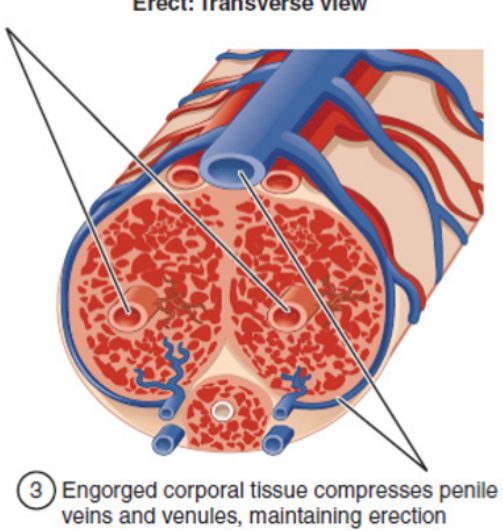
Flaccid: Transverse view

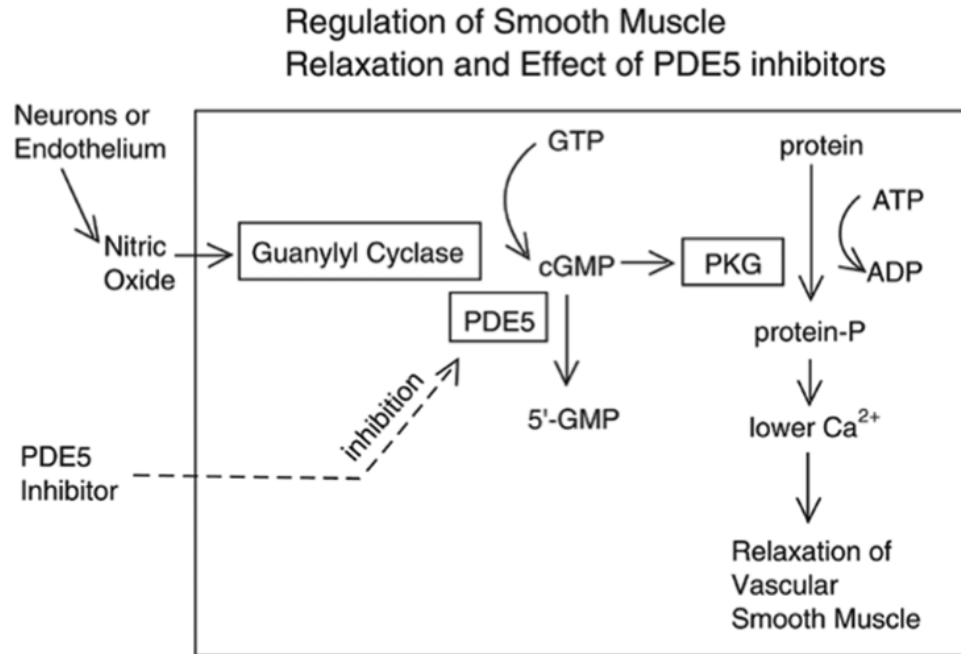


Erect: Lateral view



Erect: Transverse view





-- NO → protein kinase G (PKG) → dec Ca⁺⁺ → relaxation

Erectile dysfunction: phosphodiesterase-5 inhibitors: sildenafil citrate, vardenafil, tadalafil

Male sexual response

3-Emission:

movement of ejaculate into proximal part of urethra

under sympathetic control (T10-L2, Lumbar & sacral splanchnic nerve) →
sequential peristaltic contraction of smooth muscle of vas deferens
closing of internal urethral sphincter

Male sexual response

4-Ejaculation:

Spinal reflex → triggered by entry of semen into urethra → causes motor nerve impulses by **pudendal nerve (S2-S4)** to activate perineal muscles → forcibly expel semen from urethra

Orgasm: culmination of sexual excitation

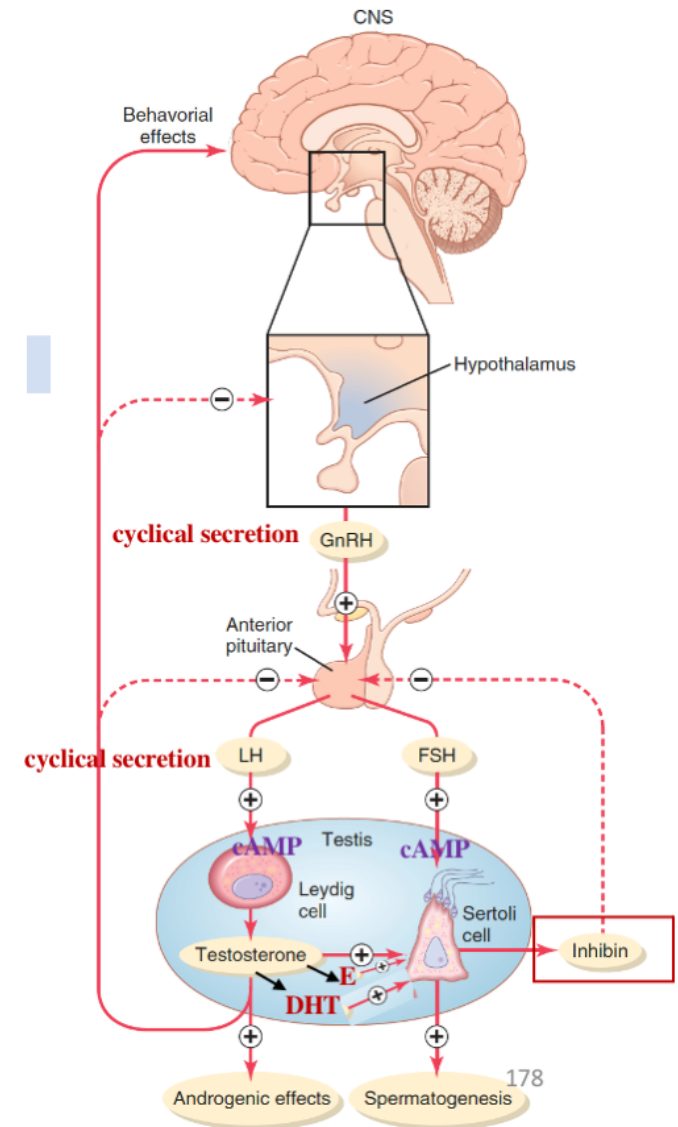
Detumescence: (flaccidity) NE from **sympathetics**, endothelin = contraction of smooth muscle and inc venous outflow

Hormonal control of male sexual functions

Placental **chorionic gonadotropins (hCG)** → fetal and **neonatal** testosterone secretion

Gonadotropins → Puberty & adulthood

- Gonadotropin releasing hormone (GnRH) → LH & FSH.
- LH stimulates cells in the testes to produce testosterone → spermatogenesis.
- FSH stimulates spermatogenesis.



Testosterone and other male sex hormones

- Androgens → masculinizing effects
- Androgen secretion sites
 - 1-Testes → Interstitial **cells of Leydig** in the testes → secrete androgens (testosterone, DHT & androstenedione)
 - 2-Adrenals (<5% of total androgens in male)
- Testosterone is **the most abundant** male testicular androgen
- DHT is the active form of T

Testosterone and other male sex hormones

- **T is secreted in:**

- 1- Newborn male infant (Only for the first few months of life)
- 2- Adult male after puberty

- Germinal epithelium of the testes is more sensitive for radiation or excessive heat than Leydig cells → impaired spermatogenesis but normal testosterone production.

Testosterone and other male sex hormones

Production of Estrogen in the Male.

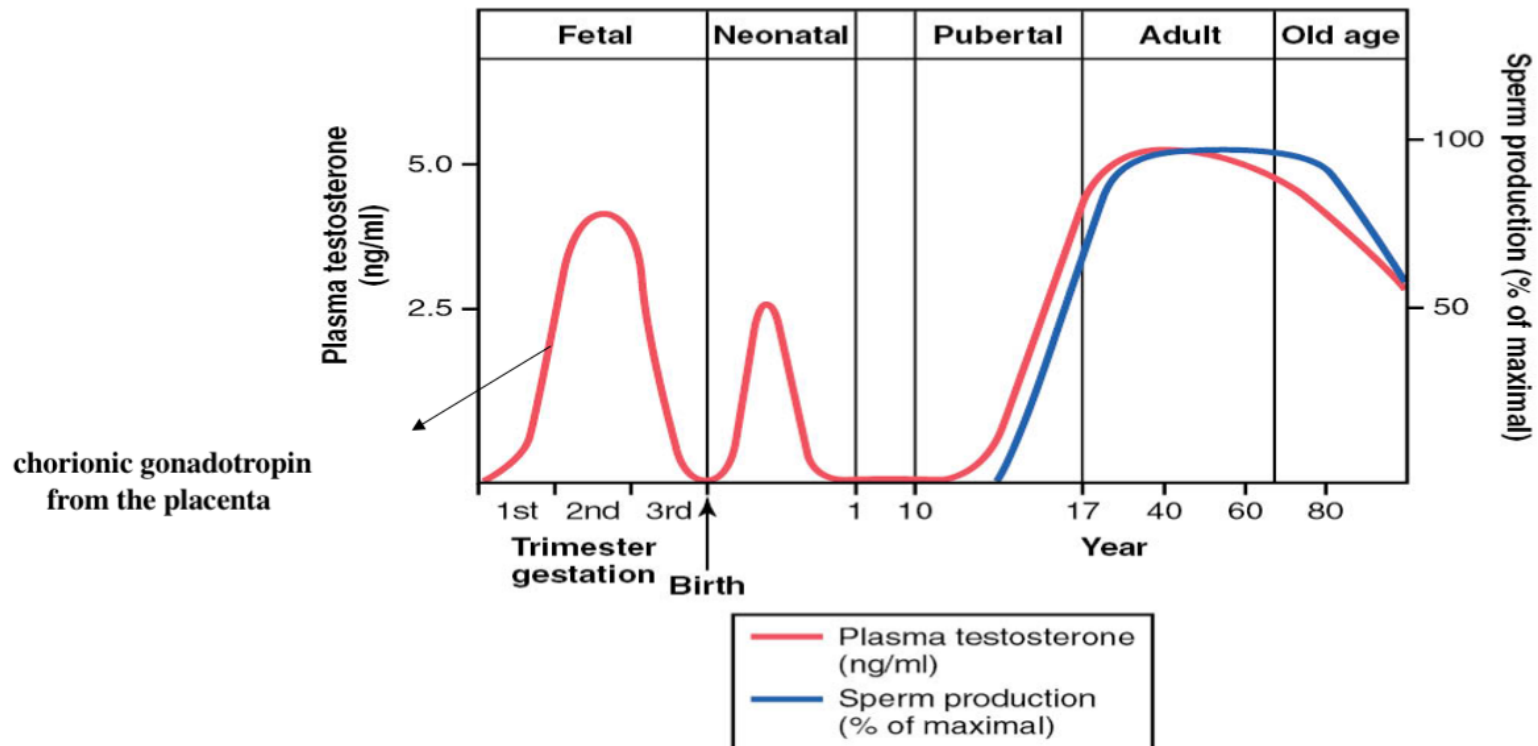
- Small amounts of estrogens are formed in the male by **Sertoli cells**.

Testosterone → estradiol

- important role in spermiogenesis

Much larger amounts (80%) of estrogens are formed from T and androstenediol in other tissues of the body, especially the **liver**.

The different stages of male sexual function as reflected by average plasma testosterone concentrations (*red line*) and sperm production (*blue line*) at different ages.



(Modified from Griffin JF, Wilson JD: The testis. In: Bondy PK, Rosenberg LE [eds]: Metabolic Control and Disease, 8th ed. Philadelphia: WB Saunders, 1980.)

Functions of Testosterone During Fetal Development

- 7th week of embryonic life → Testosterone secreted first by the **genital ridges**
- Later by the fetal **testes**

- **Functions:**

1-Development of the male body characteristics:

Formation of penis, scrotum, prostate gland, seminal vesicles, & male genital ducts

at the same time suppressing the formation of female genital organs

NO TESTESTERONE → NO MALE GENITALIA

2-Descends testis to scrotum

Functions of testosterone-Puberty

- Pubertal growth of penis, scrotum, and testes to 8X
- Development of secondary sexual characteristics of the male & spermeiogenesis

Functions of testosterone

secondary characteristics:

1) body hair distribution

(pubis, face, chest, back, linea alba, etc)

Male Pattern Baldness → T↓ growth of hair on the top of the head (androgen & genetic factors)

2) voice

hypertrophy of laryngeal mucosa and larynx → masculine voice

Functions of testosterone

secondary characteristics:

3) skin

- ↑ thickens skin
- ↑ ruggedness of subcutaneous tissues
- ↑ sebaceous glands secretion and oil production → acne

4) Protein & muscle development

↑ **muscle mass** ↑ **protein**

Synthetic androgens

Functions of testosterone

5) Bone

Increases Bone Matrix → due to protein anabolic function & calcium Retention

Earlier closure of epiphyses

Used in female to treat osteoporosis

Effects of pelvis

narrow the pelvic outlet

lengthen pelvis

cause a funnel-like shape

increase the strength of the entire pelvis for load bearing.

Functions of testosterone

6) Increase metabolic rate

7) Increase RBC number

may be due to increase metabolic demands

8) Increase the reabsorption of Na in the distal tubules of the kidneys.

9) acute vasodilation

Testosterone in aging:

decrease slowly after age 40
decreased bone formation, muscle mass,
decreased growth of facial hair, appetite,
decreased libido

LH not changed; FSH increased with aging in men

Dihydrotestosterone (DHT) function

- **Fetal** development of penis, penile urethra, scrotum, prostate
- **Pubertal** growth of scrotum, prostate, pubic hair, sebaceous glands

Prostatic secretion

Puberty:

- During childhood → no secretion of GnRH
- At puberty, the secretion of hypothalamic GnRH breaks through the childhood inhibition and adult sexual life begins.