NOTES
MALE REPRODUCTIVE SYSTEM

ANATOMY & PHYSIOLOGY OF THE MALE REPRODUCTIVE SYSTEM

osms.it/anatomy-physiology-male-reproductive-system

EXTERNAL ORGANS

- Penis, scrotum
- Two testes (male gonads) in scrotum

Penis

- Smooth muscle cells
- Enlarged tip (glans penis), surrounded by loose skin (foreskin)
- Opens as external urethral orifice
- Three cylindrical bodies of erectile tissue (vascular spaces, surrounded by smooth muscle)
  - Corpus spongiosum, two corpora cavernosa
- Arousal → smooth muscle cells relax, blood flows into vascular spaces, corpora cavernosa distend → veins compress, blood doesn't drain → local engorgement → erection

Testes

- *Functions:* produce sperm (in seminiferous tubules), testosterone (by Leydig cells)
  - Descend into scrotum from abdominal cavity (seventh month of gestation)
  - Scrotum provides cooler environment needed for spermatogenesis
- Contains epithelial, Sertoli, Leydig, sperm cells
- Separated by scrotal raphe
- Covered by tunica albuginea
  - Septa project towards center → 250 lobules (1–4 seminiferous tubules)
- Seminiferous tubules
  - Surrounded by epithelial lining,

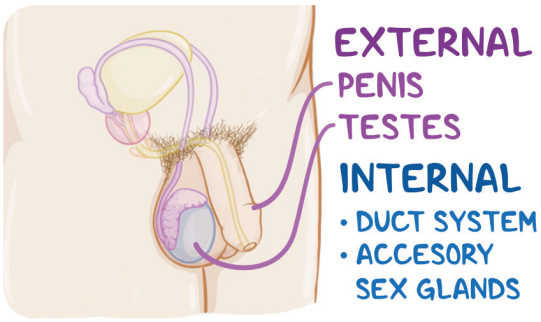

Figure 65.1 External and internal male reproductive system anatomy.

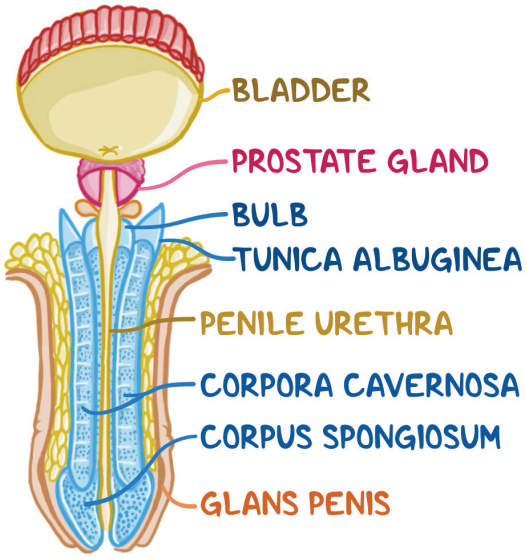

Figure 65.2 Penis anatomy.

capillaries, Leydig cells
  - Spermatogonia (primordial sperm cells) → spermatocytes (towards lumen) → spermatids → sperm (most central); Sertoli cells (extend from margin to lumen; provide nutrients; establish blood-testis barrier)
  - Tubules combine → rete testis (in mediastinum testis) → efferent ducts → epididymis

INTERNAL ORGANS

- Ducts for sperm, accessory glands (seminal vesicles, prostate gland, bulbourethral glands)

Sperm

- *Acrosome:* enzymes to penetrate oocyte (female gamete)
- *Neck (midpiece):* mitochondria for energy
- *Tail:* helps sperm swim
- Mature, swim in epididymis head; move through seminiferous tubules, rete testis by peristalsis

Spermatogenesis

- Begins at puberty
- Hypothalamus secretes gonadotropin-releasing hormone (GnRH) → pituitary secretes luteinizing hormone (LH), follicle-stimulating hormone (FSH)
  - LH binds to Leydig cells → stimulates testosterone production
  - FSH binds to Sertoli cells → produces androgen binding protein (ADP) → more testosterone crosses blood-testis barrier

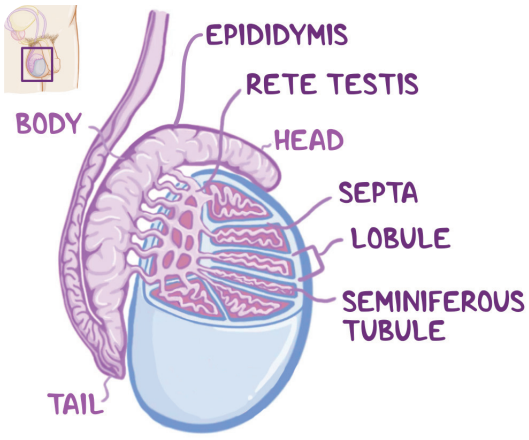

Figure 65.3 Testes anatomy.

- Spermatogonium (diploid cell) undergoes mitosis → two daughter cells (spermatogonia)
  - One spermatogonia cycled back to serve as spermatogonium
  - Second spermatogonia continues on to produce sperm
- Spermatogonia (diploid cell) undergoes mitosis → primary spermatocyte
- Primary spermatocyte undergoes meiosis I → secondary spermatocytes (haploid cells) emerge
- Secondary spermatocytes undergo meiosis II → spermatids (haploid)
- Spermatids enter lumen → cellular

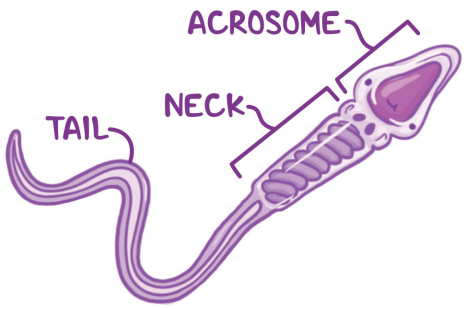

Figure 65.4 Sperm anatomy.

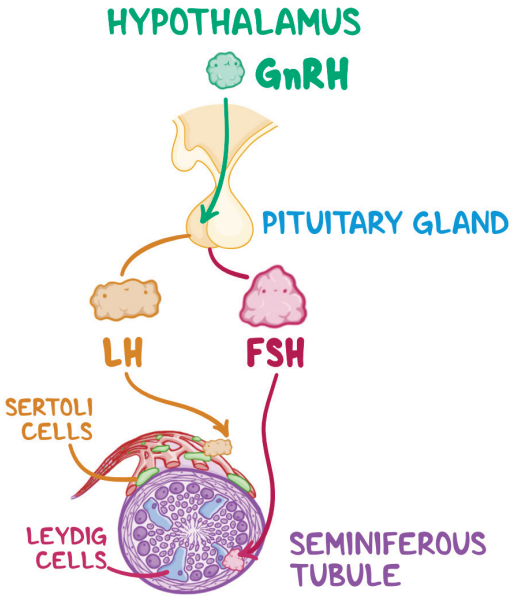

Figure 65.5 Hypothalamus secretes GnRH, stimulates pituitary release of FSH, LH (important to testosterone production).

differentiation → acquire tail → mature sperm

- Regulation via feedback loops
  - Sertoli cells secrete inhibin → negative feedback to pituitary → ↓ FSH
  - Leydig cells secrete testosterone → negative feedback to pituitary → ↓ LH

Ejaculation

- Mature sperm exit through tail of epididymis → vas deferens → secretions from seminal vesicle at ampulla → ejaculatory ducts → secretions from prostate gland → secretions from bulbourethral glands → empty into urethra
- Accessory glands secrete fluids into urethra
  - *Seminal:* seminal fluid (contains fructose for energy, prostaglandins for transport)
  - *Prostate:* prostatic fluid (alkaline → neutralizes acidic vaginal secretions)
  - *Bulbourethral:* lubricant
- *Semen (seminal fluid):* final mixture of all fluids with spermatozoa
- During ejaculation, bladder sphincter contracts (prevents urine from mixing with semen)

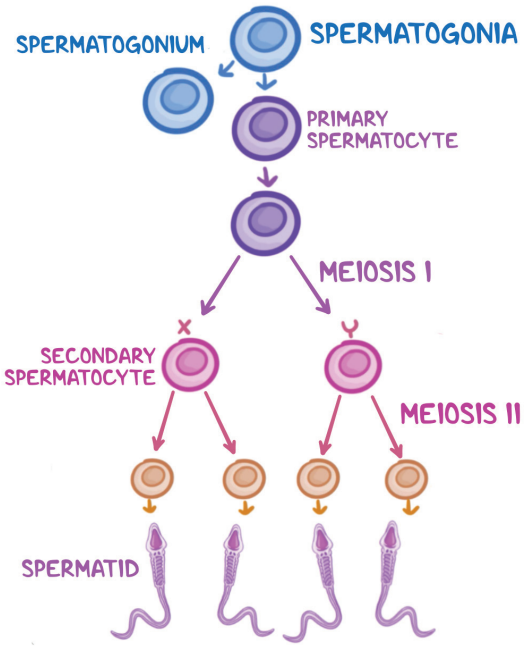

Figure 8.6 Spermatogenesis.

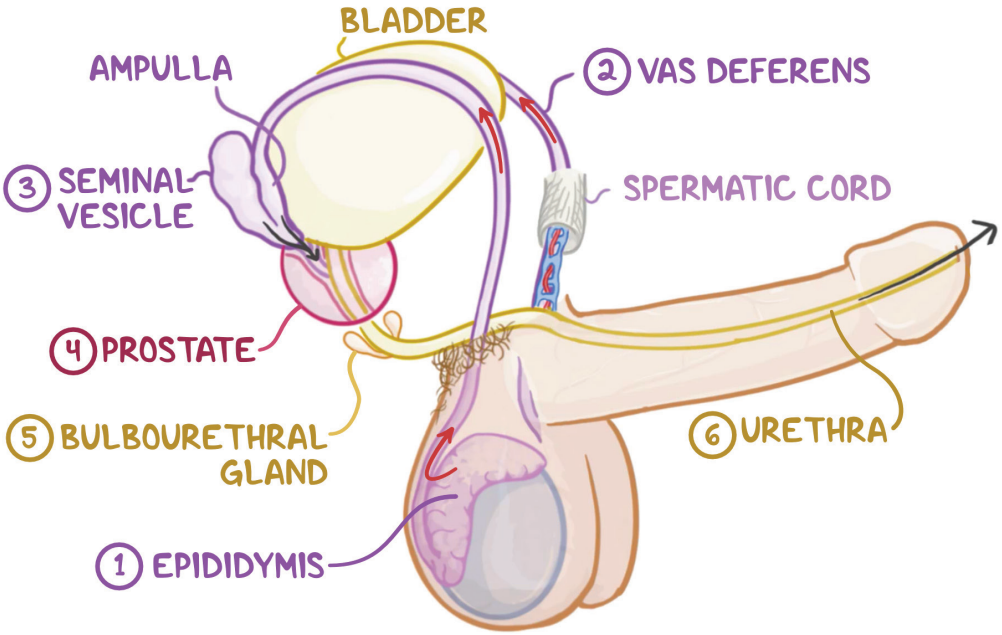

Figure 65.7 Once produced, the mature sperm exit the tail of the epididymis (1) and travel through the vas deferens (2) where they are combined with secretions of the seminal vesicles (3) at the ampulla. The mature sperm then pass through the ejaculatory ducts and secretions of the prostate gland (4). Finally, the bulbourethral gland (5) secretions are added and the semen is ejaculated through the urethra.

TESTOSTERONE

osms.it/testosterone

WHAT IS TESTOSTERONE?

- Main androgenic hormone
- Produced, released by Leydig cells of testes
- Synthesized from cholesterol in series of steps involving multiple enzymes
- Inactivated in liver → eliminated in urine, bile
- Active locally on Sertoli cells (paracrine action)
  - Sertoli cells produce androgen-binding protein (ABP) → keep testosterone levels high
  - Testosterone reinforces follicle-stimulating hormone (FSH) spermatogenesis stimulation
- Active in rest of body (endocrine action)

Circulation in bloodstream

- Approx. 98% bound to proteins (albumin, sex-hormone binding globulin)
  - Not biologically active when bound to protein
  - Functions as reservoir of free testosterone
  - Production regulated by androgens, estrogens
- Approximately 2% free, biologically active

PRODUCTION

Regulated by hypothalamic-pituitary axis

- Low testosterone → hypothalamic arcuate nuclei secrete GnRH into hypothalamic-hypophyseal portal blood → GnRH arrives to anterior lobe of pituitary gland → pituitary gland secretes FSH, LH (AKA gonadotropins)
  - LH → Leydig cells produce testosterone by increasing cholesterol conversion into pregnenolone (first step of testosterone production)
  - FSH → spermatogenesis, Sertoli cell function

NEGATIVE FEEDBACK REGULATION

- High testosterone levels → inhibits hypothalamus from secreting GnRH, pituitary gland from secreting LH
- Sertoli cells in testes secrete glycoprotein called inhibin → inhibits pituitary gland secreting FSH

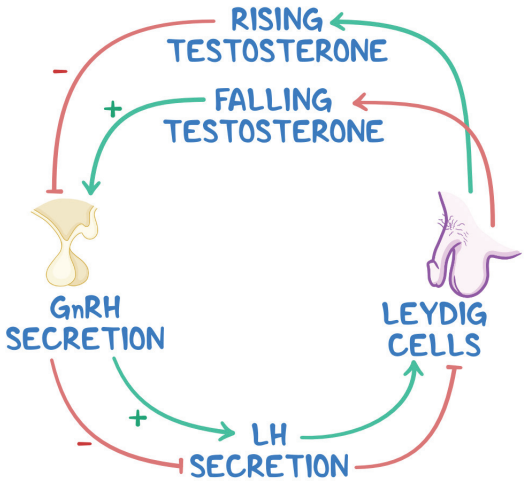

Figure 65.8 Testosterone production is regulated through a negative feedback loop by the hormones released by the hypothalamus and the Leydig cells.

MECHANISM OF ACTION

- Binding on androgen receptor in cell of target tissue → androgen-receptor complex moves into nucleus → gene transcription → generation of new proteins → physiological effects

EFFECTS OF ANDROGENIC HORMONES TESTOSTERONE & DIHYDROTESTOSTERONE

Testosterone

- Masculinizes internal genital tract in male fetus; promotes descent of testes before birth

- *Puberty:* muscle mass increases; epiphyseal plates close; penis, seminal vesicles grow; spermatogenesis; rise of libido; secondary sexual characteristics (thickens vocal cords, deepening voice, male pattern of hair growth)
- *Adulthood:* maintains reproductive tract; anabolic effect on proteins

Dihydrotestosterone (DHT)

- Produced from testosterone by 5 alpha-reductase in target tissues
- Determines
  - Fetal maturation of external male genitalia (penis, scrotum, prostate)
  - Hair distribution (baldness)
  - Sebaceous gland activity
- 5 alpha-reductase inhibitors block testosterone conversion in dihydrotestosterone → treats male pattern baldness, benign prostatic hypertrophy
  - Propecia (finasteride)