Male Reproductive Physiology
Chapter 17 Lecture 21

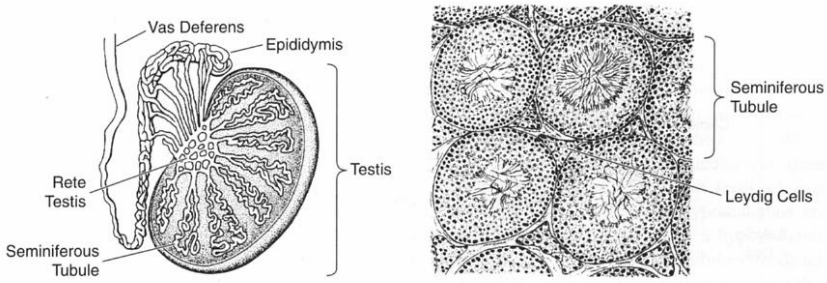


Figure 17.1 Gross and microscopic anatomy of the human testis.

Major Organs Involved in Sperm Production, Maturation, and Transport

Testes: Sperm production: mitosis, meiosis, and differentiation

Epididymis: Sperm transport and maturation—motility and fertility

Vas deferens: Sperm storage

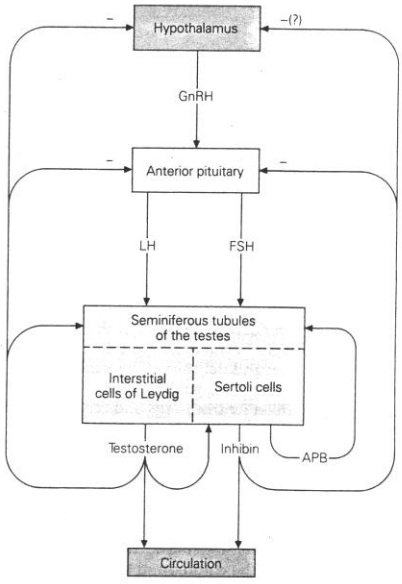
Seminal vesicles: Production of seminal fluid containing nutrients, fructose, and prostaglandins

Prostate: Production of prostatic fluid that is alkaline and contains calcium and citric acid

Bulbo-urethral gland: Production of "pre-ejaculatory" fluid

Penis: Erection and ejaculation

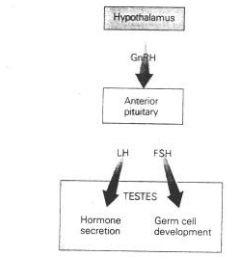
Hormonal feedback loops within the hypothalamic-pituitary-gonadal system. The minus sign indicates inhibition.



NEUROENDOCRINE CONTROL OF MALE REPRODUCTION

Pituitary gland →relay station
receiving neural & hormonal input from brain
relay information as hormonal messages to other organs

I. Spermatogenesis: LH & FSH required for spermatogenesis
A. hypothalamus →gonadotropin releasing hormone (GnRH) →
hypothalamic-pituitary portal vessels→
B. anterior pituitary gland →two gonadotropins
1) luteinizing hormone (LH) secreted into blood & transported to testes →
stimulates Leydig cells to synthesize/secrete testosterone
2) follicle-stimulating hormone (FSH) secreted into blood & to testes →
a) binds to specific receptors on plasma membranes of Sertoli cells →



Relationship among the hypothalamus, pituitary gland, and testes.

C. T & anterior pituitary
T inhibit release of LH in response to ~ titers of GnRH from hypothalamus

D. inhibin & anterior pituitary
secreted by Sertoli cells (seminiferous tubules) inhibits FSH release
inhibin—peptide hormone

?? maturing sperm ↓FSH

?? inhibit release of GnRH from hypothalamus

↑LH stimulates Leydig cells → ↑ synthesis/release T

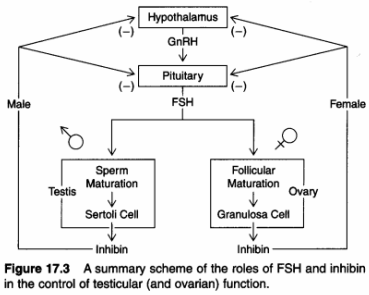
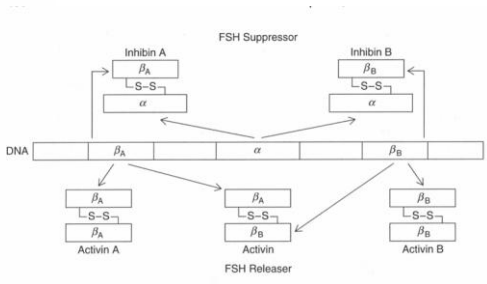


Figure 17.3 A summary scheme of the roles of FSH and inhibin in the control of testicular (and ovarian) function.



II. Feedback loop

daily GnRH, LH, FSH secretions fairly **constant**

continuous inhibitory feedback loop hypothalamus, pituitary gland & testes

A. testosterone (T) & hypothalamus

hypothalamus:

1) sensitive to changes in circulating titers of sex hormones
2) monitors sex hormones in blood to alter production of GnRH
3) ↑ T inhibits further production of GnRH in hypothalamus
4) ↓GnRH results in ↓ LH & FSH
5) ↓ LH: ↓ T synthesis/secretion by Leydig cells →↓ blood T titers
6) hypothalamus: ↑synthesis/release of GnRH
7) GnRH → anterior pituitary↑ secretion of LH

B. T produced in testes (**Leydig cells**)

1. Leydig cells not store T but store cholesterol precursors

2. T →extracellular fluid surrounding seminiferous tubules → sperm production

3. T transported into blood from extracellular fluid

a) binds to plasma proteins
   1. albumin
   2. **sex steroid-binding globulin** (SSBG)
      testosterone-estradiol binding globulin (TeBG)

b) protects T from metabolic processes: unbound T quickly metabolized

c) binding to proteins → form of storage

4. free T acts on target tissues

a) muscle
b) kidney
c) bone

5. T transformed into another steroid by target tissues

a) dihydrotestosterone (DHT)
   1. seminal vesicles
   2. prostate

b) estrogen
   brain

6. Puberty
   a) before puberty: hypothalamic-gonadal system relatively dormant
   b) initiation of puberty: increase secretion of GnRH
   c) ↑ LH & FSH from pituitary
   d) FSH stimulates enlargement of testes
   e) LH stimulates ↑ T secretion from Leydig cells
   f) enlargement of external genitalia
   g) development of male secondary sex characteristics
      1) muscular development
      2) bone growth
      3) thickening of skin
      4) growth of facial/body hair
      5) growth/thickening of vocal cords
      6) enlargement of larynx: lowering of voice

7. Spermatogenesis
   a) high amounts of T required
   b) stimulates formation of spermatogonia & second meiotic division of spermatid formation in seminiferous tubules
   c) interdependence between T & Sertoli cells
      1) T stimulates protein synthesis & fluid secretion from Sertoli cells
      2) Sertoli cells secrete **androgen-binding protein** (ABP) which bind T & keep T titers high in seminiferous tubules

Androgen-binding protein (ABP)

1. glycoprotein (beta-globulin)
   a. same 403 amino acid sequence as sex hormone-binding globulin (SHBG)
   b.difference is the site of production & addition of different sugar moieties
   c. 403 amino acids: MW 44,533
   d. gene: chromosome 17

2. source: Sertoli cells (seminiferous tubules)
   a. regulated by FSH
   b. enhanced by insulin, retinol & T
   c. salivary glands in mice

3. binds specifically to:
   a. T& DHT
      1)↓ lipophilic: ↑ titers *luminal fluid* of seminal vesicles
      2) spermatogenesis seminiferous tubules
      3) sperm maturation in epididymis

   b. 17-beta-estradiol

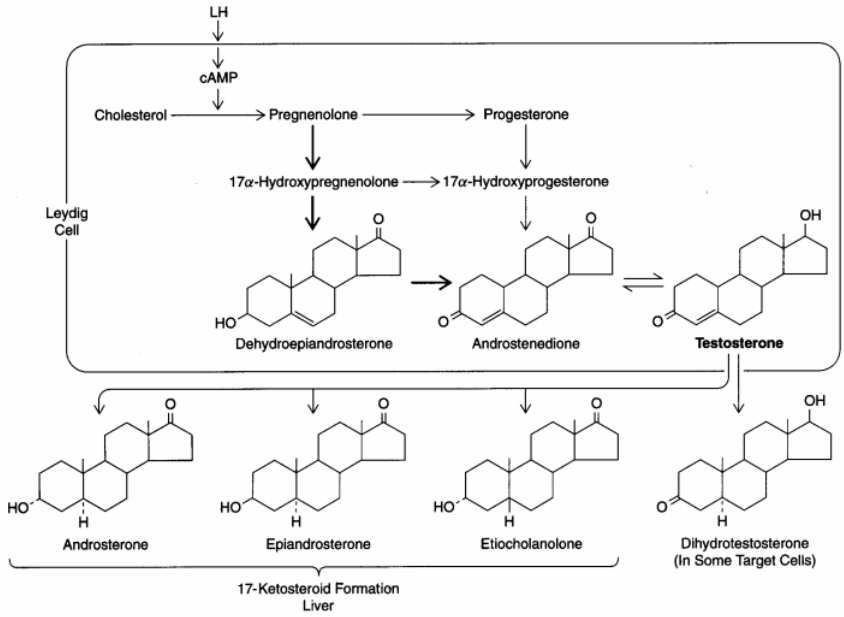


Figure 17.2 Testicular biosynthesis and hepatic metabolism of testosterone.

Pathophysiology

Hypogonadism
- Primary
  - Leydig cell deficiency (Leydig cell agenesis)
  - Adult Leydig cell failure (male climacteric phase)
  - Germinal cell aplasia (Sertoli-cell-only syndrome)
- Secondary
  - Gonadotropin deficiency (hypogonadotropic hypogonadism)
  - Hypothalamic hypogonadism (defect in GnRH secretion)

Hypergonadism
- Primary (steroid-secreting testicular tumors)
  - Virilizing (androgen-secreting) Leydig (interstitial) cell tumors (macrogenitosomia in the prepubertal male)
  - Feminizing (estrogen-secreting) Leydig (interstitial) cell tumors
- Secondary
  - Hypothalamic origin (enhanced GnRH secretion)
  - Pituitary origin (hypergonadotropic hypergonadism)

Syndromes of androgen resistance
- Testicular feminizing syndrome (absence of target tissue androgen receptors)
- Syndrome of 5 α-reductase deficiency (failure to convert testosterone to DHT)

Gynecomastia (breast enlargement)