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—mobility 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
- Bulbourethral 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 →

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
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
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 5α-reductase deficiency (failure to convert testosterone to DHT)
- Gynecomastia (breast enlargement)