
MALE REPRODUCTIVE PHYSIOLOGY PART II

GUYTON & HALL, CHAPTER 81

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OBJECTIVES

- Describe the synthesis, secretion, metabolism, signaling and the effects of testosterone
- Describe peaks of Testosterone during different stages and role of Testosterone in Fetal life
- Puberty onset in male and GnRH influence
- Define *male climacteric*
- Touch base on some abnormalities of male reproductive function

TESTOSTERONE AND OTHER MALE SEX HORMONES

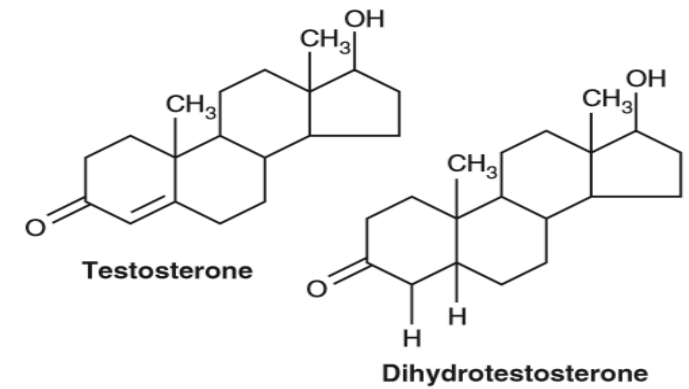


Figure 81-8. Testosterone and dihydrotestosterone.

The testis secretes several male sex hormones called **androgens**; testosterone, dihydrotestosterone and androstenedione.

Testosterone is the more abundant form (primary testicular hormone) while dihydrotestosterone is the more active form (most Test. is converted to DHEA in target responsible for some Test. effects).

The term “androgen” means any steroid hormone with masculinizing effects.

From the testes and adrenal glands.

Synthesized either from cholesterol or directly from acetylcoenzyme A.

97 percent of the testosterone becomes either loosely bound with plasma albumin or more tightly bound with a beta globulin called *sex hormone–binding globulin*

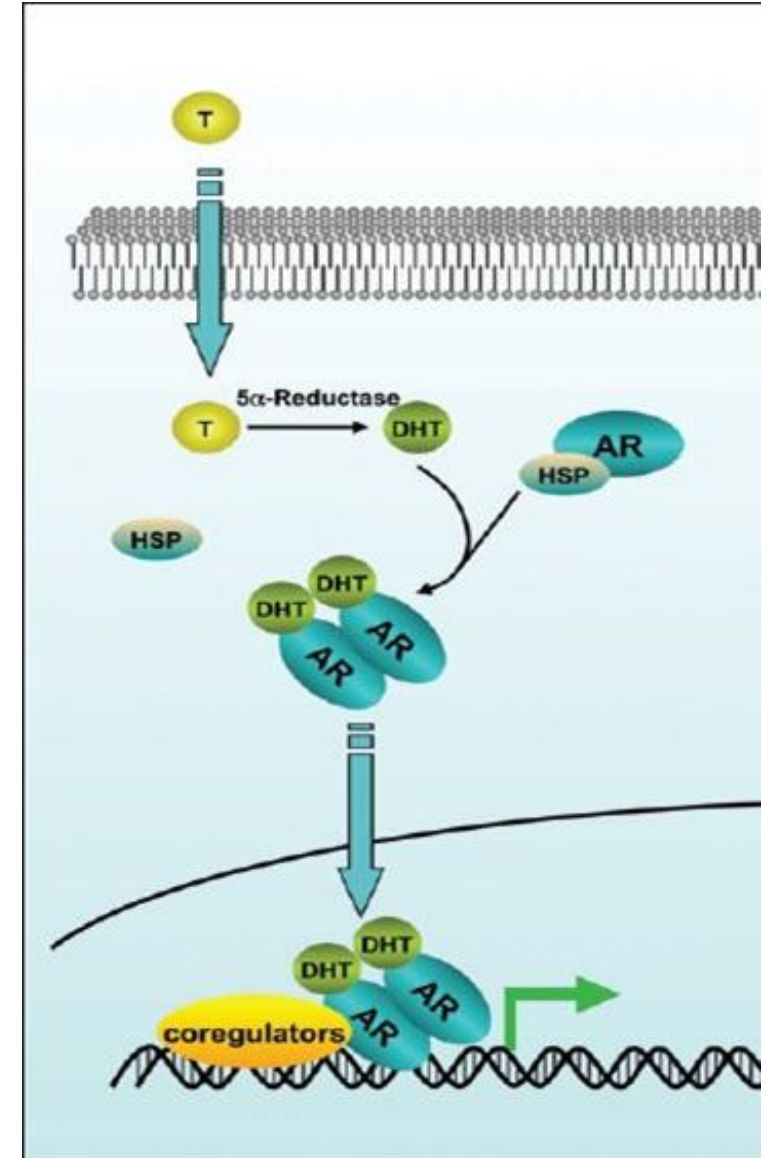
Testosterone is either transferred to the tissues or degraded into inactive products that are subsequently excreted.

By the liver, into *androsterone* and *dehydroepiandrosterone* and simultaneously conjugated as either glucuronides or sulfates (glucuronides, particularly). Exc: Gut and Urinary

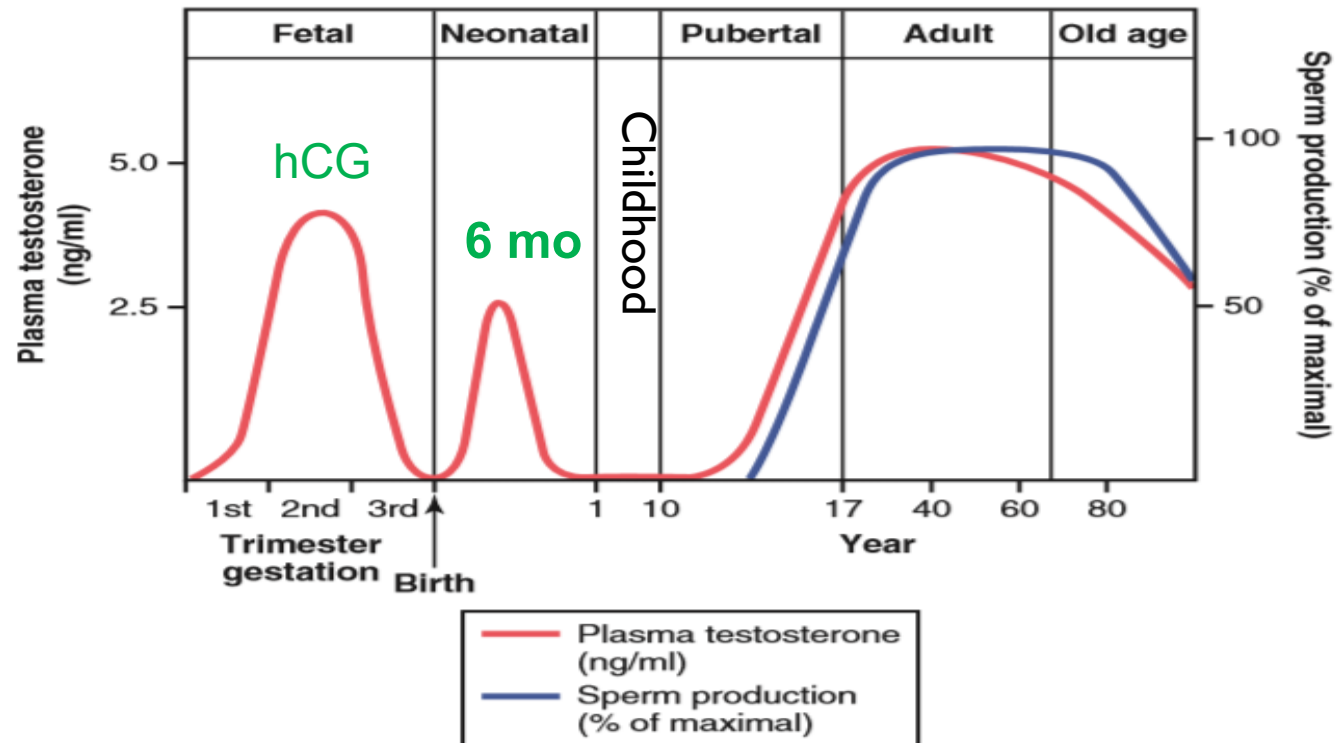
The Intracellular mechanism of action of testosterone

- Testosterone enters the prostatic cells as an example within a few minutes after secretion.
- Most often converted, by the intracellular enzyme 5α -reductase, to *dihydrotestosterone*, which binds with a cytoplasmic “receptor protein.”
- Translocates to the cell nucleus, where it binds with a nuclear protein and induces DNA-RNA transcription.
- Within 30 minutes, RNA polymerase has become activated and the concentration of RNA begins to increase in the prostatic cells, which is followed by a progressive increase in cellular protein.
- After several days, the quantity of DNA in the prostate gland has also increased, and a simultaneous increase in the number of prostatic cells has occurred

It increases the rate of protein synthesis in target cells.



Functions of testosterone



HUMAN CHORIONIC GONADOTROPIN SECRETED BY THE PLACENTA DURING PREGNANCY STIMULATES TESTOSTERONE SECRETION BY THE FETAL TESTES

- During pregnancy the hormone *human chorionic gonadotropin* (hCG) is secreted by the placenta and circulates both in the mother and in the fetus.
- This hormone has almost the same effects on the sexual organs as LH.
- During pregnancy, if the fetus is a male, hCG from the placenta causes the testes of the fetus to secrete testosterone.
- It is critical for promoting formation of the male reproductive organs

FUNCTIONS OF TESTOSTERONE DURING FETAL DEVELOPMENT

- Testosterone begins to be elaborated by the male fetal testes at about the seventh week of embryonic life.
- One of the major functional differences between the female and the male sex chromosome is that the male chromosome has the *sex-determining region Y (SRY) gene* that encodes a protein called the *testis determining factor* (also called the *SRY protein*).
- The SRY protein initiates a cascade of gene activations that cause the genital ridge cells to differentiate into cells that secrete testosterone and eventually become the testes, whereas the female chromosome causes this ridge to differentiate into cells that secrete estrogens.
- Injection of large quantities of male sex hormone into pregnant animals causes development of male sexual organs, even though the fetus is female.
- Also, early removal of the testes in the male fetus causes development of female sexual organs.

FUNCTIONS OF TESTOSTERONE DURING FETAL DEVELOPMENT


- Testosterone secreted by the genital ridges & later by the fetal testes is responsible for development of the male body characteristics including the formation of penis & scrotum & suppression of the formation of female genital organs.

Effect of testosterone on descending the testis:

The testes usually descend into the scrotum during the last 2 to 3 months of gestation when the testes begin secreting reasonable quantities of testosterone.

EFFECT OF TESTOSTERONE ON SPERMATOGENESIS WITH FSH

- FSH binds with specific FSH receptors attached to the Sertoli cells in the seminiferous tubules, which causes the Sertoli cells to grow and secrete various spermatogenic substances.
- Simultaneously, testosterone (and dihydrotestosterone) diffusing into the seminiferous tubules from the Leydig cells in the interstitial spaces also has a strong tropic effect on spermatogenesis.
- Thus, both FSH and testosterone are necessary to initiate spermatogenesis.



Effect of Testosterone on
Development of Adult Primary
and Secondary Sexual
Characteristics

1- After puberty, the increasing amounts of testosterone cause enlargement of the penis, scrotum & testis & secondary sexual characteristics.

2- Effect on the distribution of body hair:

Testosterone causes growth of hair over the pubis and on the face

3- Baldness:

Testosterone decreases the growth of hair on the top of the head (two factors

1) genetic background; 2) large quantities of androgenic hormones.

4- Effect on voice:

It causes hypertrophy of the laryngeal mucosa, enlargement of the larynx (typical adult masculine voice)

5- Testosterone increases thickness of the skin and can contribute to development of acne

6- Testosterone increases protein formation and muscle development It is responsible for the characteristic masculine body of a male.

7- Testosterone increases bone matrix and causes Ca²⁺ retention:

Bones grown thicker & deposit additional Ca²⁺. Thus it increases the total quantity of bone matrix & causes Ca²⁺ retention (anabolic effect).

8- Testosterone increases basal metabolism:

It increases the basal metabolic rate by about 15% (indirectly as a result of the anabolic effect).

9- Effect on red blood cells:

It increases red blood cells 15-20% (due to increased metabolic rate).

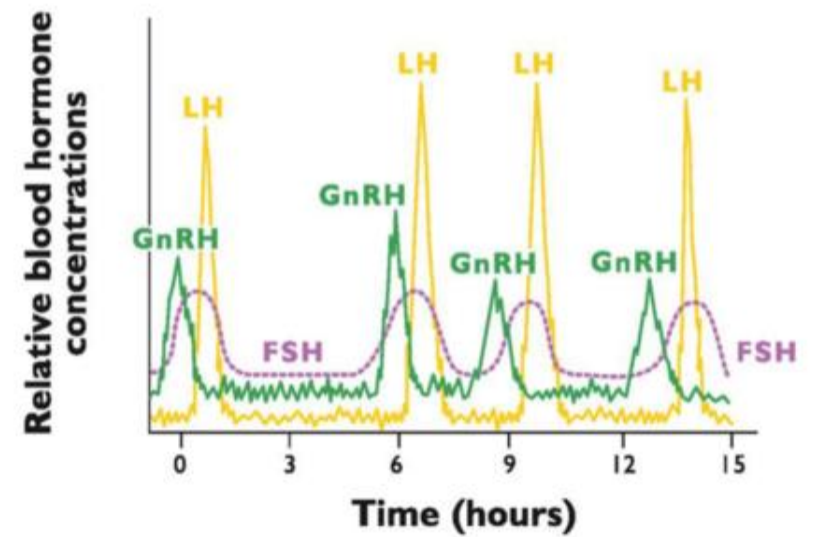
10- Effect on electrolyte and water balance:

It slightly increases the reabsorption of Na⁺ in the distal tubules of the kidneys. ECFV of the male after puberty increase as much as 5-10 %.

PUBERTY AND REGULATION OF ITS ONSET

- *During childhood no significant amounts of GnRH released.*
- Probably, during childhood, the slightest secretion of any sex steroid hormones exerts a strong inhibitory effect on hypothalamic secretion of GnRH.
- At the time of puberty, the secretion of hypothalamic GnRH breaks through the inhibition and adult reproductive system function starts.

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- In the absence of GnRH, almost no LH or FSH.
 - GnRH is secreted intermittently a few minutes

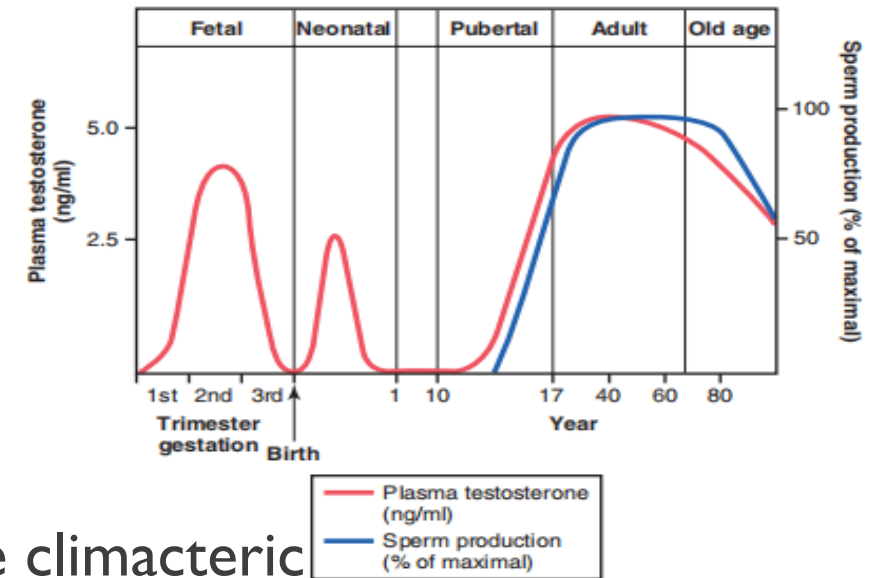
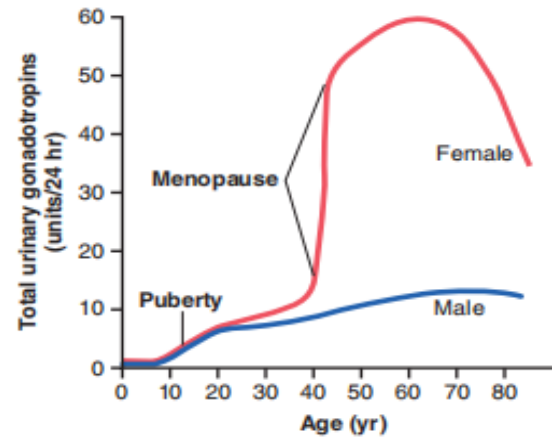


at a time once every 1 to 3 hours. The intensity of this hormone's stimulus is determined in two ways:

- (1) by the frequency of these cycles of secretion
- (2) by the quantity of GnRH released with each cycle.

- The secretion of LH by the anterior pituitary gland is also cyclical, with LH following fairly faithfully the pulsatile release of GnRH.
- Conversely, FSH secretion increases and decreases only slightly with each fluctuation of GnRH secretion, it changes more slowly over a period of many hours in response to longer-term changes in GnRH.
- GnRH is also widely known as *LH-releasing hormone*.

MALE CLIMACTERIC



- The decrease in male sexual function is called the Male climacteric
- After puberty, gonadotropic hormones are produced by the male pituitary gland for the remainder of life, and at least some spermatogenesis usually continues until death.
- Most men, however, begin to exhibit slowly decreasing sexual functions in their late 50s or 60s.
- Variable decline, with some men continuing to be virile (fertile) until their 80s and 90s.
- The gradual decline in sexual function is related, in part, to a decrease in testosterone secretion



Abnormalities of spermatogenesis and male sexual function

Effect of sperm count on fertility:

- The quantity of ejaculated semen during coitus is about 3-5 ml
- 1ml >>>120 million sperm (normal sperm count 35 - 200 million sperm/ml).

Effect of sperm morphology and motility on fertility:

- Sperm count is normal but infertile? abnormal shape.
- Shape of the sperm is normal but relatively non-motile or entirely non-motile which causes infertility.

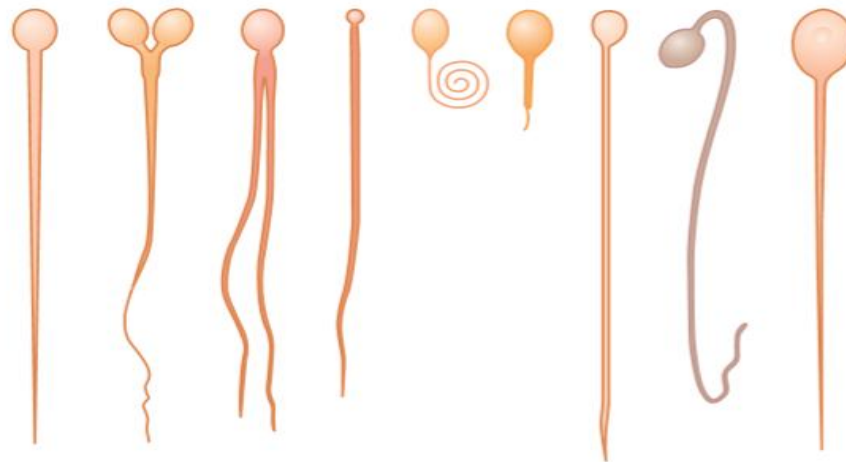


Figure 81-5. Abnormal infertile sperm, compared with a normal sperm on the right.

Prostate gland and its abnormalities

- Benign prostatic fibroadenoma in older age due to overgrowth of prostate tissue (**not caused by testosterone**).
- Cancer of the prostate gland caused by stimulation of cancerous cells by **testosterone**.

Hypogonadism in male:

- During fetal life when the testes are nonfunctional, **none of the male sexual characteristics develop in the fetus**. Instead female organs are formed.
- If the boy loses his testes before puberty → **eunuchism** (infantile sex organs & infantile sexual characteristics) is developed
- If a man is castrated after puberty, sexual organ regress in size and voice regress

Adiposogenital syndrome, Fröhlich syndrome, or hypothalamic eunuchism:

- Hypogonadism due to genetic inability of the hypothalamus to secrete normal amount of GnRH & abnormality of the feeding center of the hypothalamus resulting in obesity with eunuchism.

Cryptorchidism:

Failure of the testes to descend in the scrotum which normally occurs during fetal life.

Testicular tumors and hypergonadism in male:

Interstitial leydig cell tumors (rare), **overproduction of testosterone**. In children, causes rapid growth of the musculature and bones and early uniting of the epiphyses and causes excessive development of male sexual organs.



SELF STUDY

MALE SEXUAL ACT



Stages of male sexual act:

1- Penile erection. by parasympathetic impulses.

2- Lubrication, Parasympathetic impulses cause the urethral glands & bulbourethral glands to secrete mucous.

3- Emission and ejaculation. Function of the sympathetic nerves. Contraction of the vas deferens & ampulla to cause expulsion of the sperm in the internal urethra. Contraction of the prostate & seminal vesicles to expel their fluid in the urethra. All these fluid mix in the internal urethra with the mucous secreted by the bulbourethral glands to form the semen. This process at this point is called **emission**

- **Filling of the internal urethra** with semen causes sensory impulses through pudendal nerves to the sacral region of the cord. Fullness of the internal urethra causes rhythmical contractions of the internal genital organs which increases their pressure to ejaculate the semen to the outside called **ejaculation**
- The male sexual act results from inherent reflex mechanisms integrated in the sacral and lumbar spinal cord, and these mechanisms can be initiated by either psychic stimulation from the brain or actual stimulation from the sex organs, but usually it is a combination of both. Can be intact even after spinal cut above lumbar.

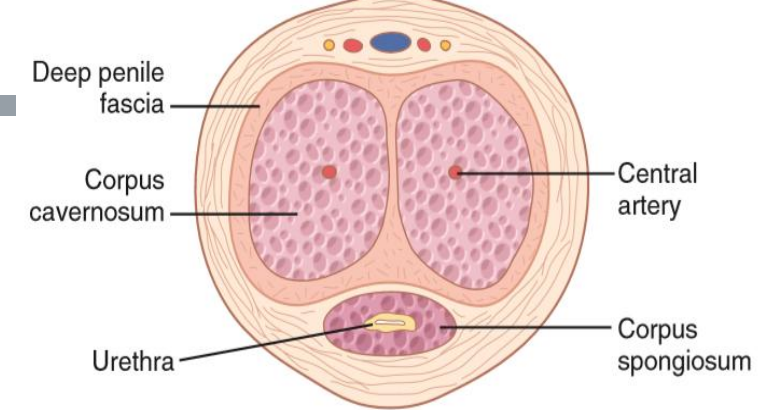


Figure 81-6. Erectile tissue of the penis.