

# MALE REPRODUCTIVE PHYSIOLOGY

*GUYTON & HALL,  
CHAPTER 81*

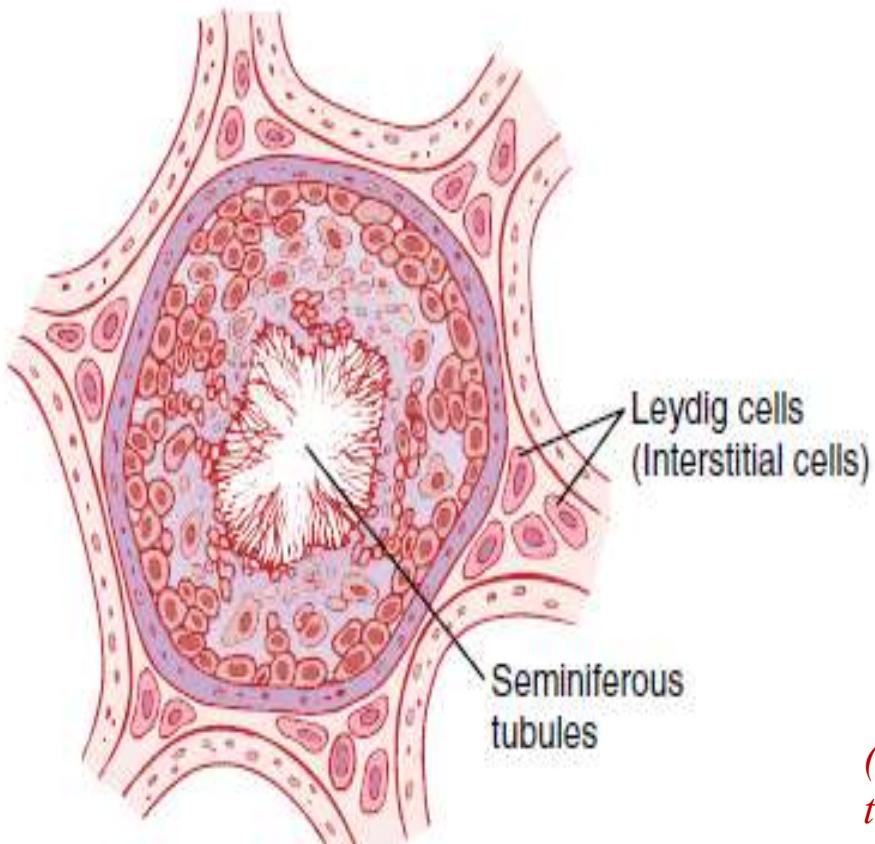
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# MALE REPRODUCTIVE SYSTEM

## OBJECTIVES:

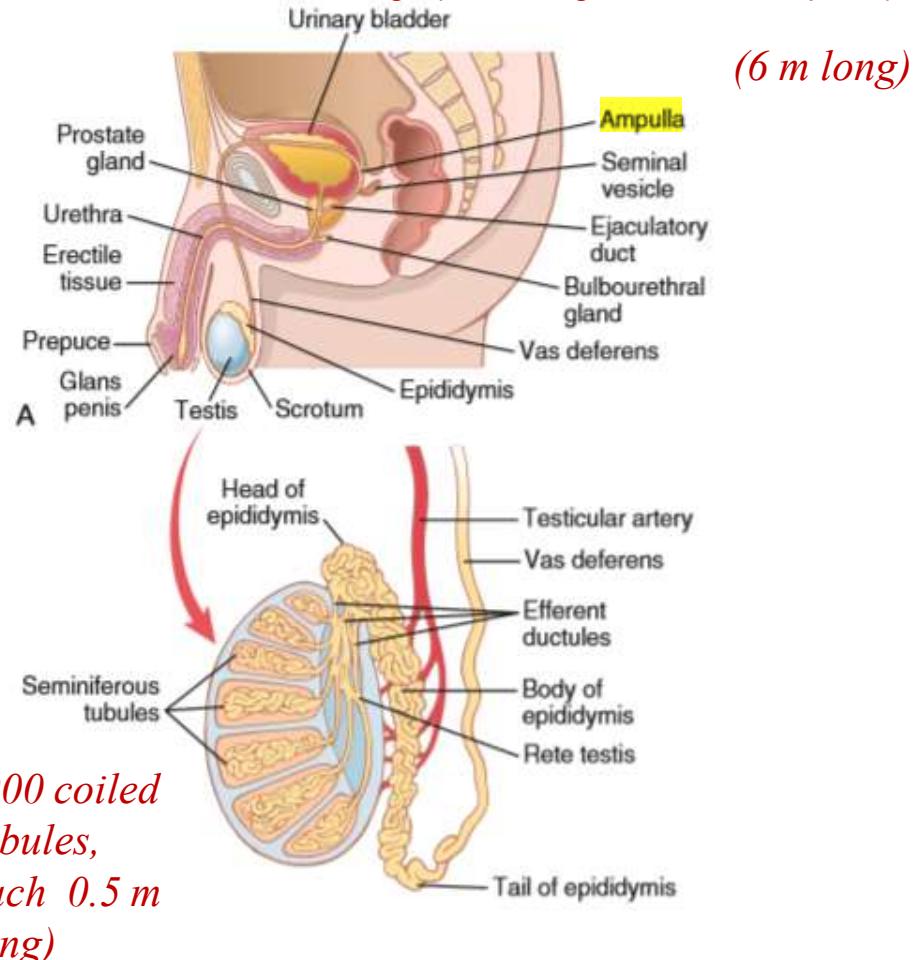
- Explain how the hypothalamus and anterior pituitary gland regulate the male reproductive function
- Explain the *spermatogenesis* and the functions of the male reproductive organs and glands
- Describe the synthesis, secretion, metabolism and the effects of testosterone
- Describe the abnormalities of male sexual function

# Male Reproductive Organs

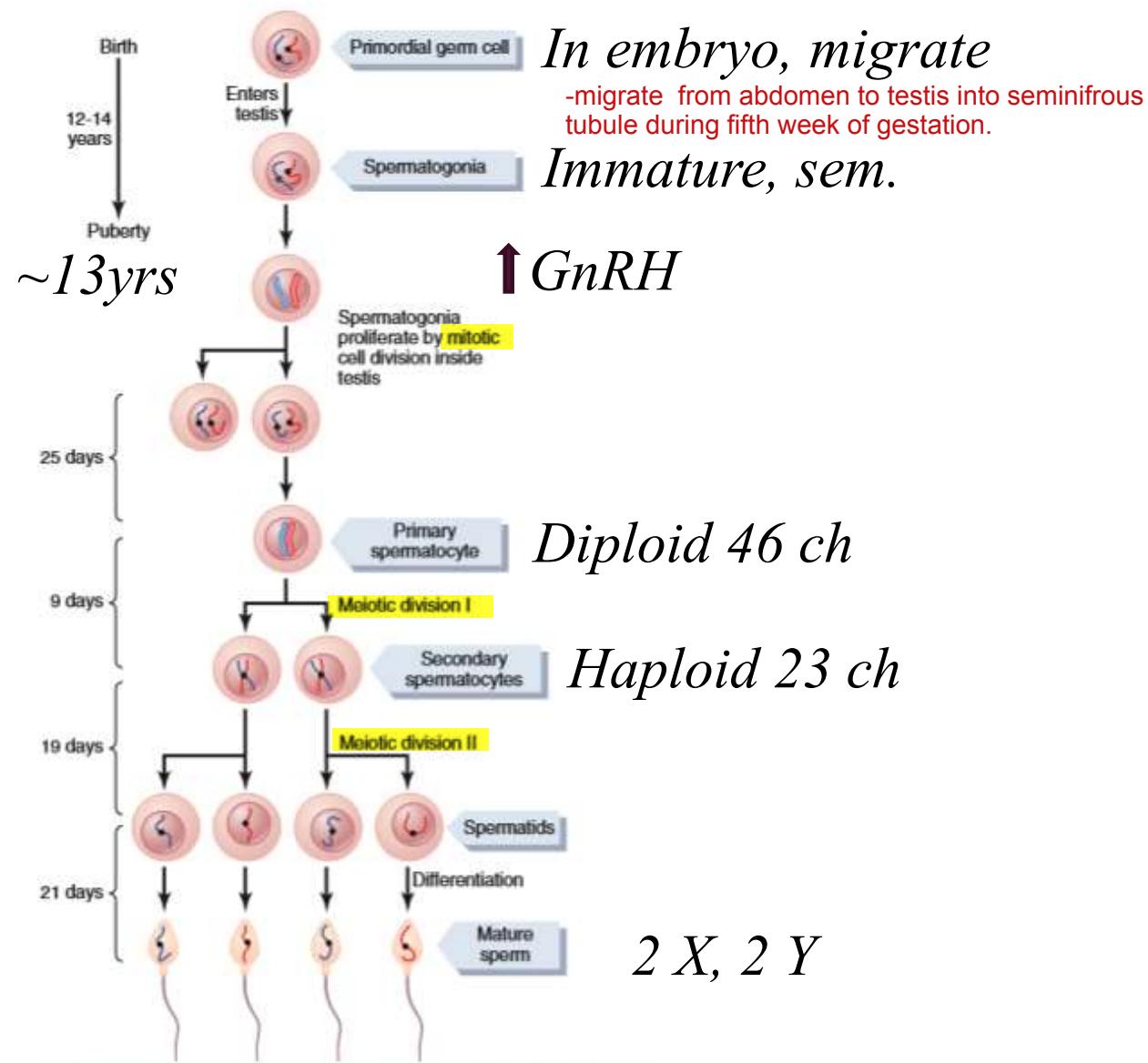


Spermatogonia as you see in cross section  
lie at inner lining of seminiferous tubule

vas deference continue and will enlarge (this enlargement called **ampulla**)

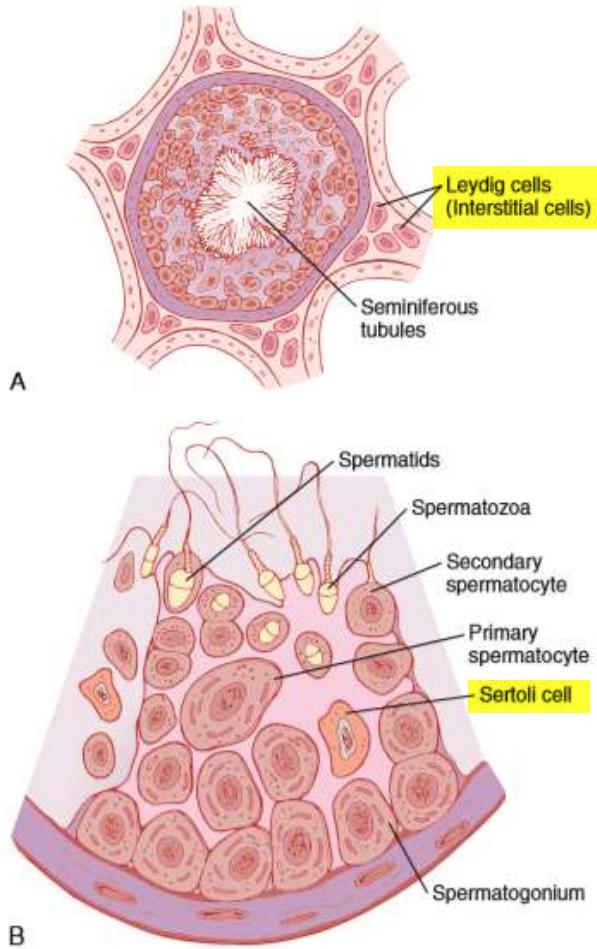


The production of sperms begins at puberty and may decrease in older age which is called Climacteric. However, spermatogonia cells are present at birth



one primary spermatocyte will give rise 4 mature sperms –two of them have X chromosome and other two have Y chromosome ). The whole process takes around 74 days .

# SPERMATOGENESIS



- Formation of sperm from spermatogonia.
- Occurs in seminiferous tubules influenced by GnRH.
- Starts 10-13 years old > ↓ older people, climacteric
- Sertoli cells: large with overflowing cytoplasmic envelopes that surround the developing spermatogonia around the central lumen of the seminiferous tubules. (nourish and support) (FSH) / working under the influence of FSH
- Leydig cells: lie with interstitium between the seminiferous tubules. (LH → testosterone) / stimulated by LH + they function to secrete testosterone
- - numerous in the newborn male infants ONLY for the first few months of life / after that they will disappear until age of puberty
- - active at puberty & throughout adult life & secrete testosterone.

# Hormonal factors that stimulate spermatogenesis

**1-Testosterone,**

by the Leydig cells for growth and division of the testicular germinal cells.

**2-Luteinizing hormone, LH**

stimulates the Leydig cells to secrete testosterone.

**3-Follicle-stimulating hormone, FSH** / is secreted under the effect of gonadotropin releasing hormone  
stimulates the Sertoli cells; without this, no spermatogenesis

**4-Estrogens**

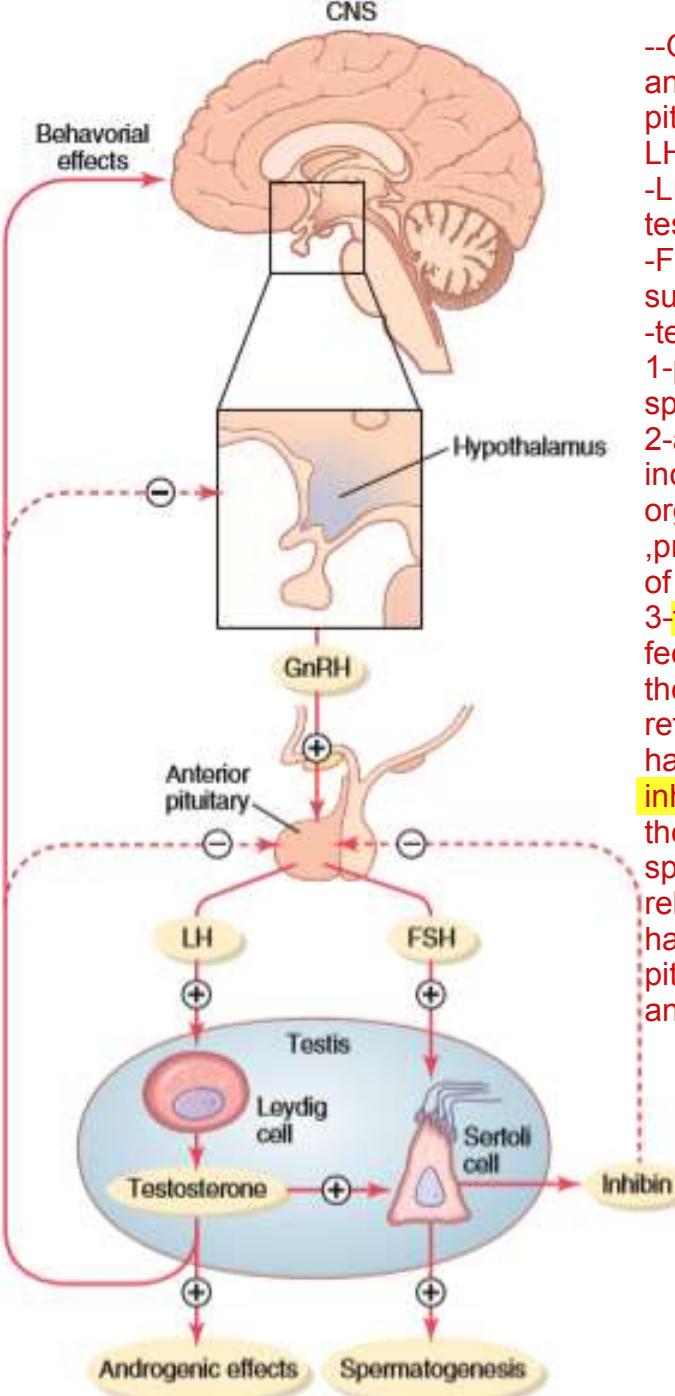
formed from testosterone by the Sertoli cells when they are stimulated by FSH  
hormone, are probably also essential. / this essential for spermatogenesis process

**5-Growth hormone,**

metabolic function in testes and promotes early division of the spermatogonia  
themselves; in pituitary dwarfs ? spermatogenesis?

/ if there is deficiency or no secretion of growth hormone there will be malformation with spermatogenesis and pituitary dwarfs.

## Hypothalamic-anterior pituitary-gonad's axis



--GNRH is secreted by hypothalamus and has stimulatory effect on anterior pituitary gland to secrete both FSH and LH  
-LH will stimulate lydig cells to produce testosterone  
-FSH will stimulate sertoli cells to support and induce spermatogenesis .  
-testosterone :  
1-play role with FSH to induce spermatogenesis.  
2-also it has another androgenic effects including :male reproductive growth organ ,primary and secondary characteristics of males .  
3-testosterone also has negative feedback on :anterior pituitary when there is increased testosterone secretion reflect negative effect on FSH ,LH + it has negative feedback on GtRH // other inhibitory factors from sertoli cells ;when there is increase of induction of spermatogenesis -inhibin will be released from sertoli cells accordingly have negative feedback on anterior pituitary gland and its secretion of LH and FSH .

# PHYSIOLOGY OF MATURE SPERM:

- Mature sperm are motile & capable of fertilizing the ovum & their activity is enhanced in a neutral & slightly alkaline medium & depressed in mildly acidic medium. / highly acidic medium can cause death of sperms or shorten their life span .
- ejaculated sperm live in the female genital tract for **only 1 to 2 days**
- The acrosome** stores large quantities of **hyaluronidase** (to digest proteoglycans) and **proteolytic enzymes** (to digest proteins).

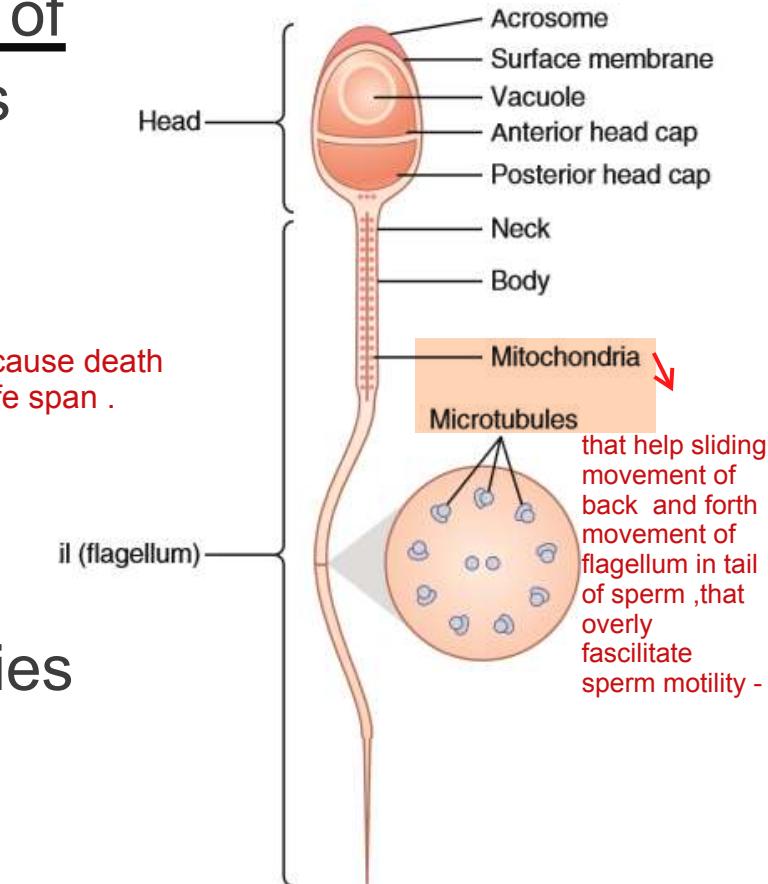


Figure 81-4. Structure of the human spermatozoon.  
/ Both are important to digest cells surrounding ovum to facilitate fertilization process .

# MATURATION OF SPERM IN THE EPIDIDYMIS

- After their formation in the seminiferous tubules, sperms require several days to pass through the epididymis (non-motile).
- After 18 to 24 hrs → they develop the capability of motility in epididymis
- (some inhibitory proteins in the epididymal fluid prevent final motility until after ejaculation).

/ develop capability of motility in epididymis but still it isn't motile till this point despite having the capability because epididymal fluid has inhibitory proteins that prevent its motility along the duration when they are in epididymis, but once it is ejaculated, the inhibitory proteins washed away and removed so now the sperms restore its motility after ejaculation

# STORAGE OF SPERMS

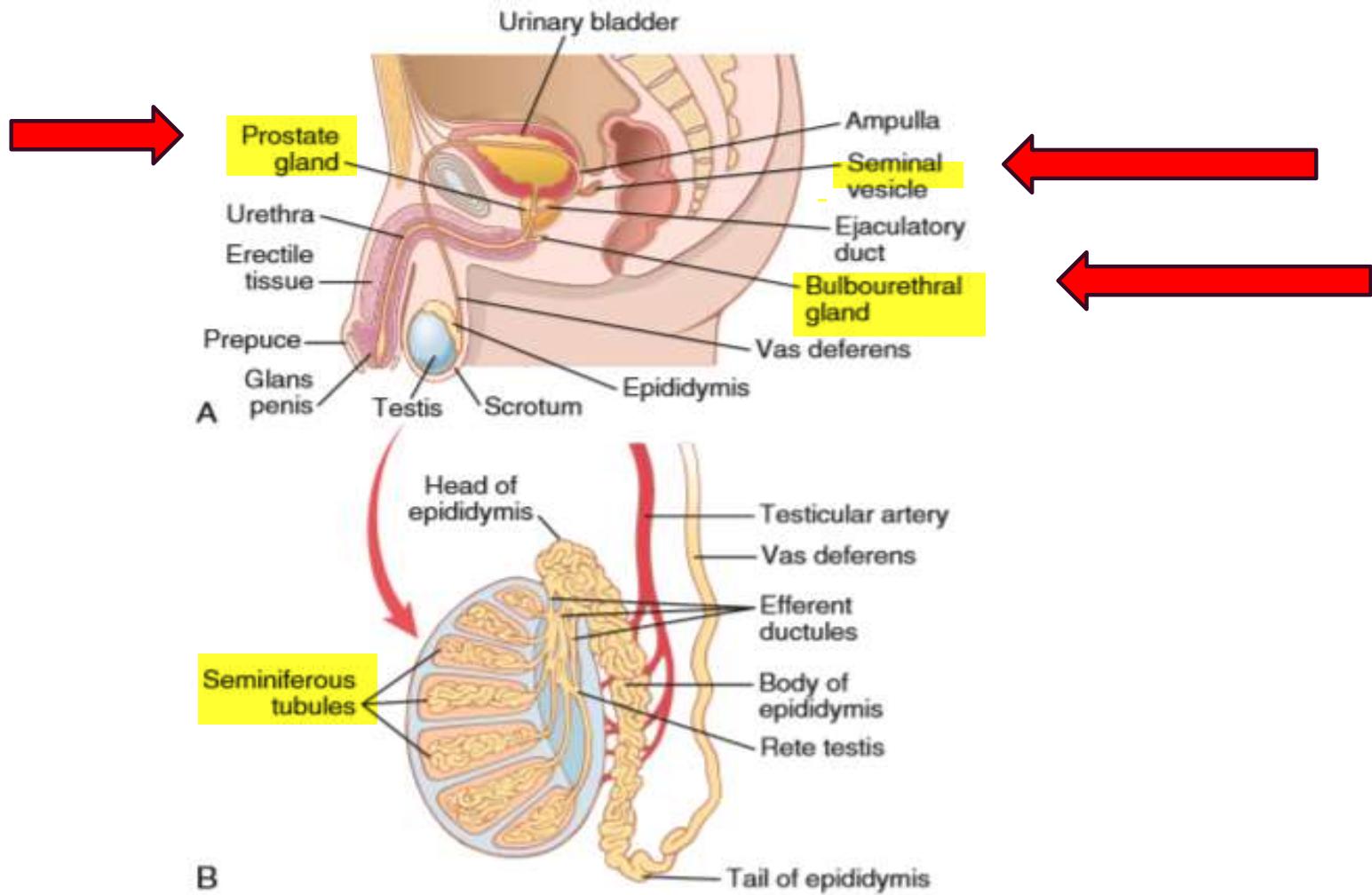
The 2 testes of adult human form up to **120 million sperms** each day.

- Small amount are stored in the epididymis
- The majority are stored in the vas deferens(**month**).  
*/(the life expectancy of the mature sperms only one month).*

After ejaculation, the sperm becomes motile & capable of fertilizing the ovum “maturation”

- The sertoli cells and epithelium of the epididymis secrete nutrient fluid which contains (testosterone & estrogens), enzymes & nutrients essential for sperm maturation.

# SECRETION OF MALE GLANDS



# Seminal Vesicles Function

– mucoid material containing fructose, citric acid & nutrient substances & large quantities of prostaglandins & fibrinogen. (it is important for **coagulation** and aids in movement of sperms and semen in female genitalia)

**NOTE:**

although there is citric acid, but the pH is from (6.7 - 8). So tend to be more basic (alkaline secretions)

The prostaglandins help in fertilization in two ways:

3-it has been suggested to reduce immune response in female reproductive system toward foreign sperms.

1- by reacting with the female cervical mucus making it more receptive to sperm movement.

2- by causing backward reverse peristaltic contractions of the uterus & fallopian tubes to move the ejaculated sperm toward the ovaries.

# Prostate Gland Function

The prostate gland secretes **thin milky fluid** containing; **Ca<sup>2+</sup>**, **citrate ion**, **phosphate ion**, **a clotting enzyme & profibrinolysin**. The **alkaline prostatic fluid** is important for successful fertilization of the ovum.

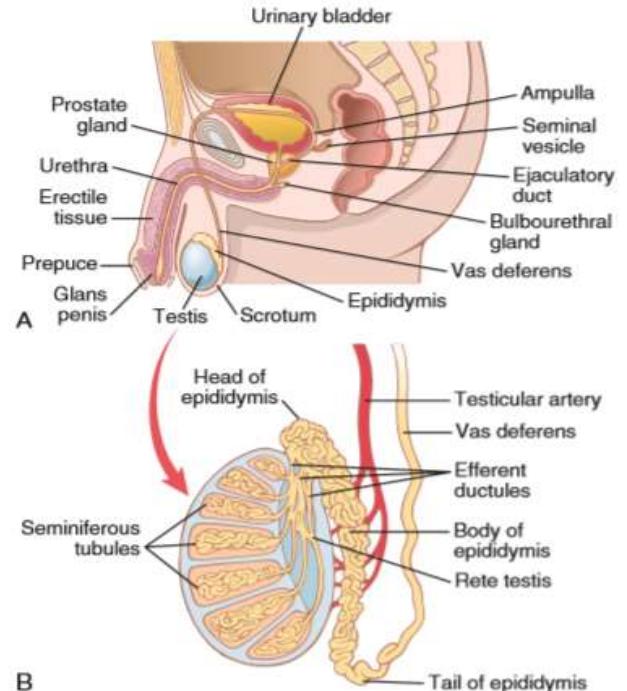
## **Alkaline prostate fluid function:**

- 1- helps to **neutralize the slightly acidic fluid of the vas deferens** (due to the presence of citric acid and metabolic product of the sperm which inhibits its fertility).
- 2- helps to **neutralize the acidic vaginal secretions (pH 3.5-4.0)** to **optimize it for better sperm motility (pH 6.0-6.5)**  
*/ so this alkaline secretion is important to maintain viability of sperms .*

# SEmen

Ejaculated semen during sexual act  
is composed of :

- the fluid & sperm from the **vas deferens** ( $\approx 10\%$ )
- fluid from the **seminal vesicles** ( $\approx 60\%$ )
- fluid from the **prostate gland** ( $\approx 30\%$ )
- small amounts from the mucous glands the **bulbourethral glands**. / that lubricate and facilitate movement of secreted fluid .



# Capacitation of the Spermatozoa

- Freshly ejaculated semen undergoes “**capacitation**”

within 1-10 hours. / In female genital tract

I. inhibitory factors are washed out by uterine and fallopian fluids

2. the sperm swims away from cholesterol vesicles(acrosome gets thinner)

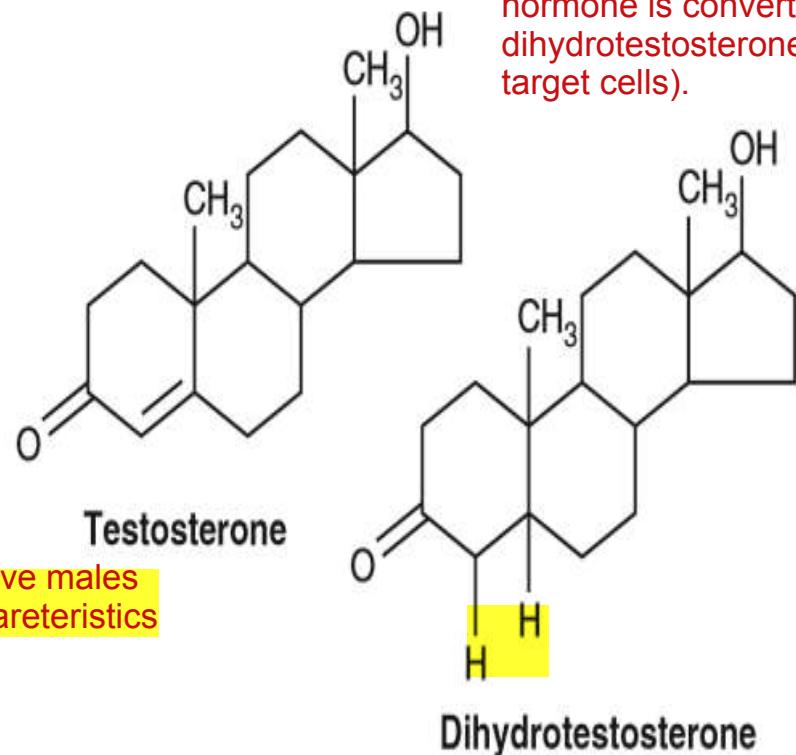
 they get out of acrosome  
at head of sperm

3. the membrane of the sperms becomes more permeable to  $\text{Ca}^{++}$  / which is necessary for fertilization of ovum process .

- The testis secretes several male sex hormones called **androgens**; testosterone, dihydrotestosterone and androstenedione.
- Testosterone is the more abundant form while dihydrotestosterone is the more active form. / & the least abundant
- The term “androgen” means any steroid hormone that has **masculinizing effects**. which responsible to give males secondary physical characteristics
- From the testes and adrenal glands. Synthesized either from cholesterol or directly from acetylcoenzyme A.

## TESTOSTERONE AND OTHER MALE SEX

(Most of testosterone hormone is converted to dihydrotestosterone in target cells).



**Figure 81-8.** Testosterone and dihydrotestosterone.

--Testosterone is secreted by testis and androgens are secreted from both testis and adrenal glands .

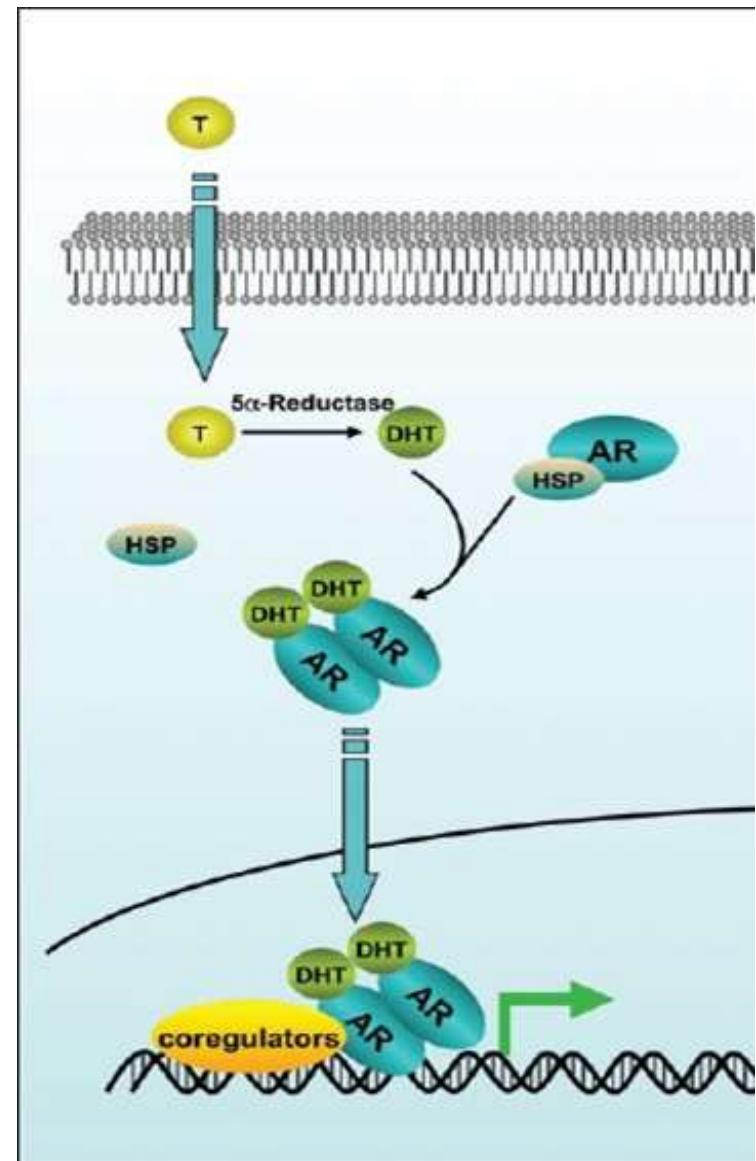
- testosterone is a steroid hormone so it is capable of entering /diffusing into target cells then it will converted by 5-alpha-reductase into dihydrotestosterone

-DHT compind to hydrocytosolic androgen receptors, then the complex will be translocated into dimers (hormone transport element ) to induce gene expression that will end up with increase protein synthesis in target cells .(it is considered anabolic hormone)

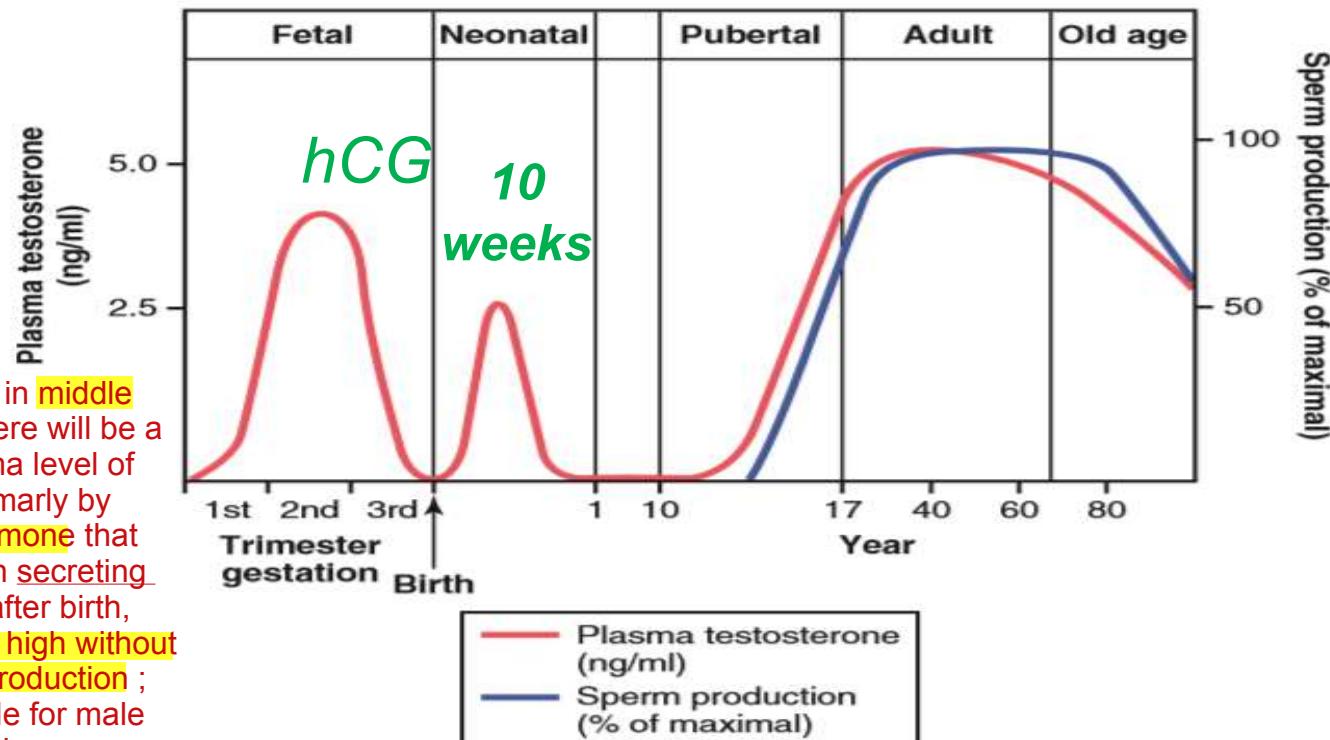
## The Intracellular mechanism of action of testosterone

*It increases the rate of protein synthesis*

*in target cells.*



# Functions of testosterone



- It is responsible for the characteristic masculine body of a male.

# FUNCTIONS OF TESTOSTERONE DURING FETAL DEVELOPMENT

in the first 7 weeks of gestation

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.

/ but if this process failed due to suppression of testosterone should be treated nonsurgically by injecting testosterone to help testis to descend into scrotum .

TESTOSTERONE

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:** الصلع

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** / increases sebaceous gland secretions

**6- Testosterone increases protein formation and muscle development**  
/ anabolic effect

**7- Testosterone increases bone matrix and causes Ca<sup>2+</sup> retention:**

Bones grow thicker & deposit additional Ca<sup>2+</sup>. Thus it increases the total quantity of bone matrix & causes Ca<sup>2+</sup> 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 increases the reabsorption of Na<sup>+</sup> in the distal tubules of the kidneys.

# MALE REPRODUCTIVE SYSTEM

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: can take place in different stages of male development

- 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.

- but if it took place in adult it might be hard to recognize /see the effect of high testosterone secretion .



# 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.

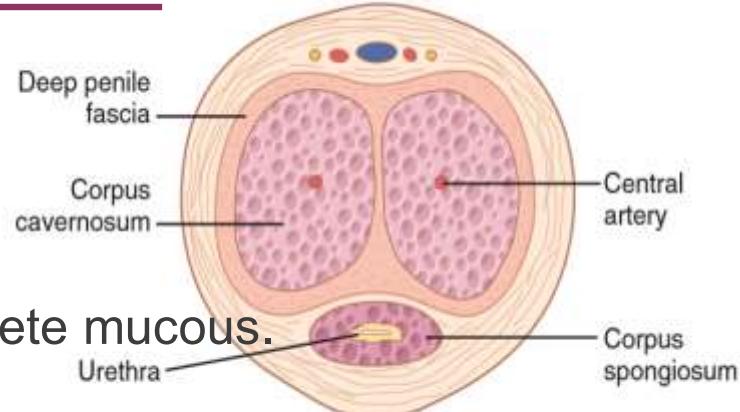


Figure 81-6. Erectile tissue of the penis.

**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 rhythrical contractions of the internal genital organs which increases their pressure to ejaculate the semen to the outside called **ejaculation**