REBRODUCTIVE BLOCK

Physiology Team

LECTURE 2

Physiology of androgens and control of male sexual functions

DONE BY:
Marwah Zummo
Hessa AlAbdulsalam

REVISED BY:
Yazeed Alhusainy

Believe you can & you're halfway there !
Theodore Roosevelt

OBJECTIVES

Physiology Team

By the end of this lecture, you should be able to:

- Understand the **functions** of the male reproductive organs and glands
- Describe the **synthesis, secretion, metabolism** and effects of **testosterone**
- Explain how the hypothalamus and anterior pituitary gland **regulate** male reproductive function
- Describe the major testicular **abnormalities**
- Discuss the **normal mechanism** of the male sexual act

- Keywords: Leydig cell, Sertoli cell, dihydrotestosterone, cryptorchidism

MIND MAP

Physiology Team

Sperm

1. Maturation in epididymis
2. Storage
3. After ejaculation
4. Physiology

Semen

1. Sperm #
2. Morphology & motility

Hormonal factors stimulate spermatogenesis

1. testosterone
2. LH
3. FSH
4. Estrogen
5. GH

Stages of sexual act

1. Penile erection
2. Lubrication
3. Emission & ejaculation

Testosterone

1. Function in general
2. Function during fetal life
3. On descending of testis
4. On development of 1ry & 2ndry sexual characteristics

Spermatogenesis

- formation of sperm in the seminiferous tubules during active sexual life due to stimulation by AP-Gonadotropic Hormones, begin at age of 13 years (puberty),continue throughout life & decrease in old age.
- (1 spermatogonium will give 4 sperms)

Sertoli cells

large cells with overflowing cytoplasmic envelopes that surround the developing spermatogonia around the central lumen of the seminiferous tubules

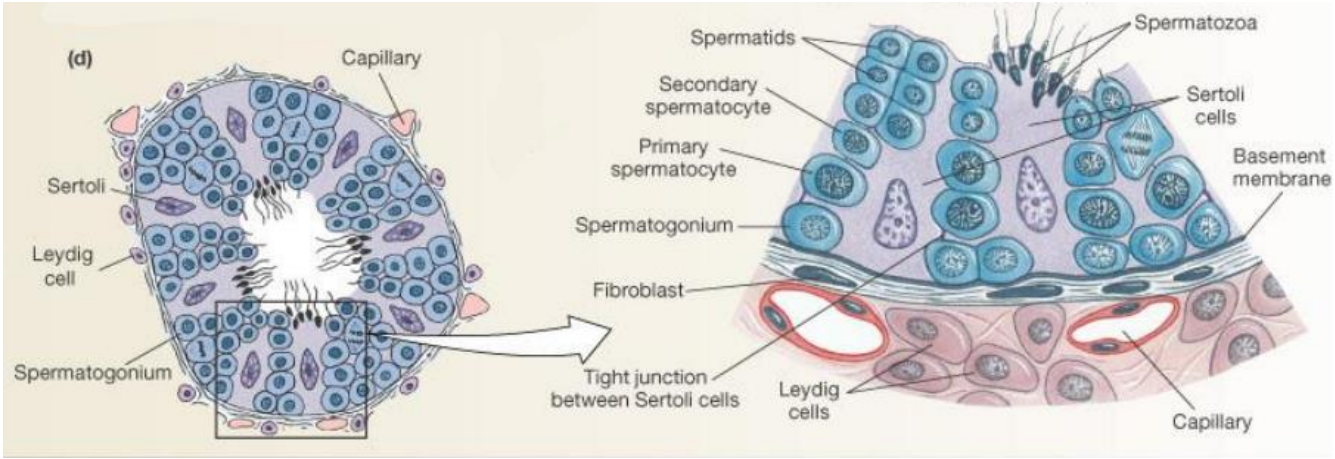
(important for the nourishment of sperms & growth of spermatogonia).

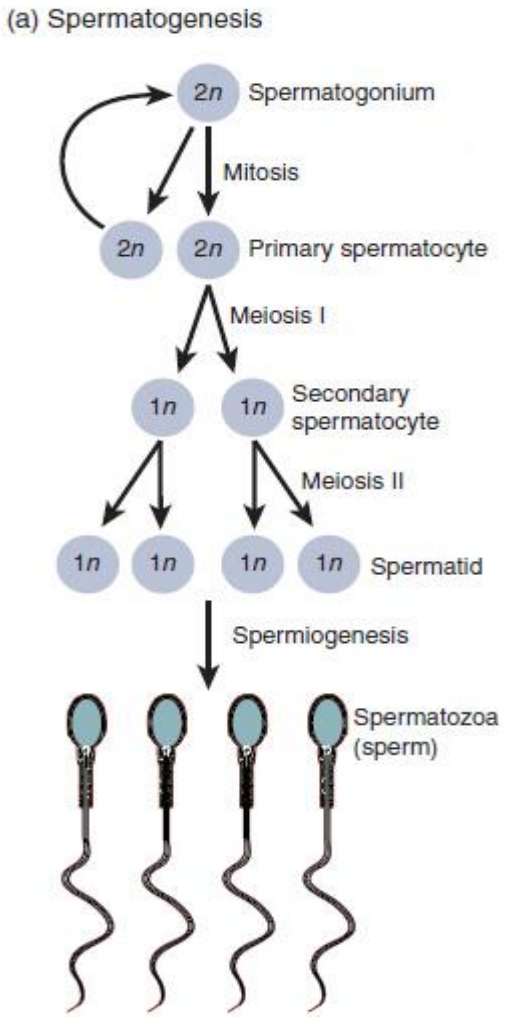
Leydig cell

- lie within the interstitium between the seminiferous tubules (secretes testosterone under the control of LH from anterior pituitary).
  They are non-existent in the testis during childhood when the testis secrete almost no testosterone,
- **numerous** in the newborn male infants for the first few months of life
- **active** at puberty & throughout adult life & secrete testosterone.
- Intra fetal life – few months after birth – disappear at childhood – active at puberty.

Spermatogenesis

- Without testosterone, FSH and LH there will be **no** spermatogenesis.
- Small amounts of estrogen are important for increasing the spermatogenesis.
- Adipocytes can release enzyme aromatase that convert testosterone to estrogen (soft skin, voice and little facial hair in obese men).
- Growth hormone will increase leydig & sertoli cells size and that will cause more spermatogenesis.





Maturation of sperms in the epididymis

- After spermatogenesis in the seminiferous tubules, the sperm require several days to pass through the epididymis (still non-motile & unable to fertilize the ovum).
- After sperms have been in the epididymis for 18 to 24 hour, they develop the capability of motility but still not motile (some inhibitory proteins in the epididymal fluid & from the epithelium of seminiferous tubules & vas deferens prevent final motility (become motile after ejaculation due to less inhibitory substances in female genital duct).

Storage of sperm

Adult testes → **120 million** sperm/day.

- Small amount stored in the epididymis
- The majority stored in the vas deferens, maintaining their fertility for at least a month (no intercourse → loss fertility).

sperms kept inactive by multiple inhibitory substances in the ducts.

After ejaculation

- Sperms become motile & capable of fertilizing the ovum called maturation.
- Sertoli cells & epididymal epithelium secrete nutrient fluid which contains (testosterone & estrogens), enzymes & nutrients essential for sperm maturation (in female genital duct).

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 (female genital duct).
- The life expectancy of ejaculated sperm in the female genital tract is only 1 to 2 days.

Function of the seminal vesicles:

- secrete mucoid material containing fructose, citric acid & nutrient substances & large quantities of prostaglandins & fibrinogen (coagulation of the seminal fluid).
- **Prostaglandins** are important in fertilization by:
  1. Reacting with the female cervical mucus making it more receptive to sperm movement.
  2. Causing backward reverse peristaltic contractions of the uterus & fallopian tubes to move the ejaculated sperm toward the ovaries (fertilization occurs in the ampulla of the fallopian tube).

Function of the prostate gland:

- Secretes thin milky fluid contains Ca2+ ion, citrate ion, phosphate ion, a clotting enzyme & profibrinolysin (counteract the clotting enzyme & fibrinogen from seminal vesicles).
- The alkaline prostatic fluid is important for successful fertilization of the ovum.

Alkaline prostate fluid function:

1. Successful fertilization of the ovum & enhances motility & fertility of sperms.
2. Help to neutralize the slightly acidic fluid of the vas deferens & seminal vesicles (due to the presence of citric acid and metabolic products of the sperm which inhibits sperm fertility).
3. Helps to neutralize the acidity of other seminal fluids during ejaculation.

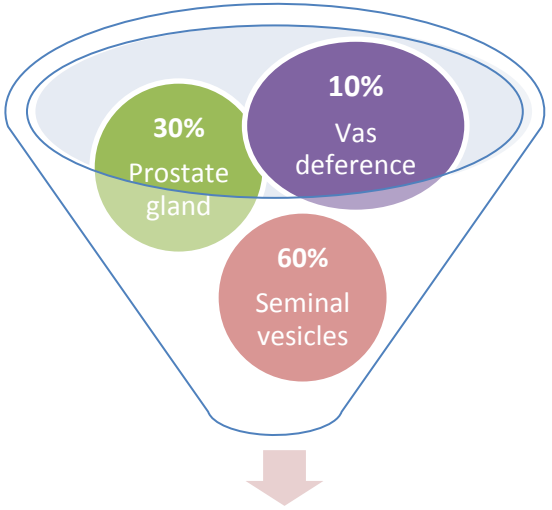
Semen

Ejaculated semen is composed of:

1)sperms from vas deferens.

2)fluid from vas deferens (10%), prostate gland (30%), seminal vesicles (60%), small amounts of mucous glands the bulbourethral glands.

- pH is about 7.5, the alkaline prostatic fluid help to neutralize the mild acidity of other portions of the semen & gives the semen a milky appearance.
- fluid from the seminal vesicles & mucous glands give the semen mucoid consistency.



Sperms abnormalities

Effect of sperm count on fertility	Effect of sperm morphology and motility on fertility
• The quantity of ejaculated semen during coitus about 3-5 ml, each milliter contains about 120 million sperm (normal male count vary between 35 million to 200 million sperm). • Sperm count below 20 million leads to infertility.	• Sometimes sperm count is normal but still infertile when about one half of the sperm having abnormal shape (head, body & tail). • Sometimes the shape of the sperm is normal but they either relatively non-motile or entirely non-motile which causes infertility.

Capacitation of the spermatozoa

Important

Physiology Team

Capacitation of the spermatozoa: Making it possible for them to penetrate the ovum.

- Sperms get activated in female genital tract for fertilization. These activation changes are called capacitation of the spermatozoa (require 1 to 10 hrs).
- Uterine & fallopian fluids wash away the inhibitory factors which was suppress the sperm activity in the male genital ducts.

- While spermatozoa in the male genital ducts, they exposed to many floating vesicles containing large amount of cholesterol which is added to the cellular membrane covering the acrosome making it more rough & prevent the release of its enzyme. After ejaculation the sperm removed from the cholesterol vesicles (in seminiferous tubules) & makes the membrane of the sperm & head becomes weaker & more permeable to Ca2+ ion which increase their movements & help in releasing the proteolytic enzymes from acrosome which penetrate the ovum.

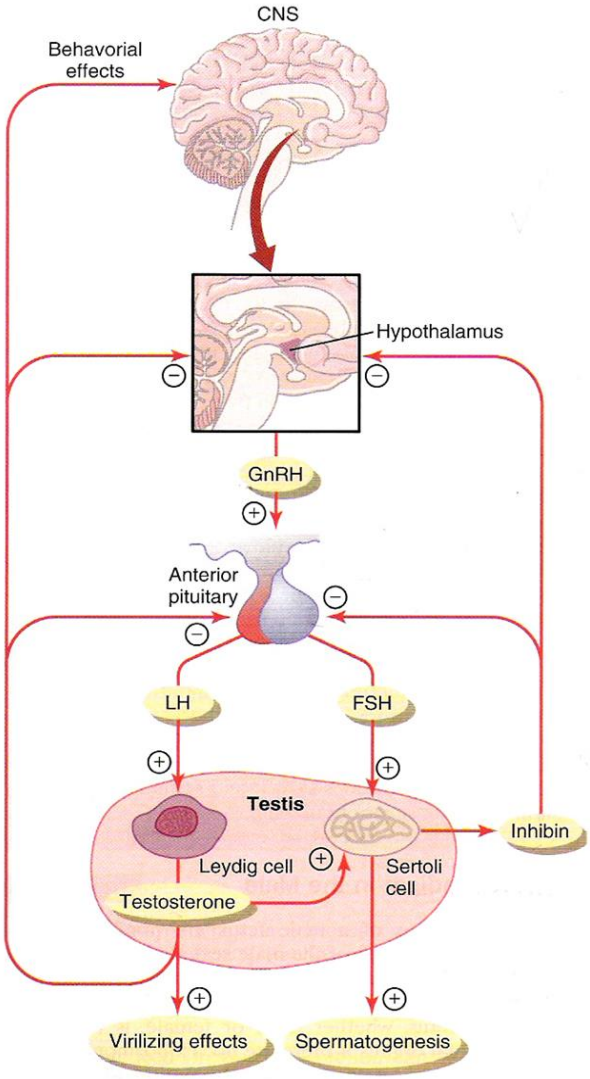
Acrosome enzymes, the "Acrosome Reaction" and penetration of the ovum:

- The acrosome of the sperm stored large quantities of hyaluronidase and proteolytic enzymes. Hyaluronidase depolarizes hyaluronic acid polymers in the intracellular cement that hold the ovarian granulose cells together. Also the proteolytic enzymes digest the proteins.

Hormonal factors stimulate spermatogenesis

Physiology Team

1. Testosterone	• secreted by →leydig cells located in the interstitium of the testis. • Is essential for the growth and division of the testicular germinal cells.
2. (LH)	• secreted by→anterior pituitary gland • stimulates the leydig cells to secrete testosterone.
3. (FSH)	• secreted by →anterior pituitary gland. • stimulates sertoli cells, stimulate the conversion of spermatids to sperm (also important for spermatogenesis).
4. Estrogen	• from testosterone by the sertoli cell under FSH stimulation • essential for spermatogenesis.
5. (GH)	• controlling the metabolic functions of the testis, promotes early division of spermatogonias. • In pituitary dwarfs (abcent of GH) spermatogenesis is deficient or absent →infertility



Male sexual act; Stages of male sexual act:

Physiology Team

Important

1-Penile erection.	2-Lubrication	3-Emission and ejaculation.
Erection is caused by **parasympathetic** impulses that pass from the sacral portion of the spinal cord through the pelvic nerves to the penis.	Parasympathetic impulses cause the **urethral glands*** & **bulbourethral glands** to secrete mucous.	• Function of the **sympathetic** nerves. Emission begins by 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 urethral or periurethral glands (also Littre glands after Alexis Littré) are glands that branch off the wall of the urethra of male mammals.		

Testosterone

Physiology Team

Testosterone and other male sex chromosomes: secretion, metabolism and chemistry of the male sex hormone:

- Secretion of testosterone by the interstitial cell of leydig in the testis. The testis secrete several male sex hormone called **androgens** including testosterone, dihydrotestosterone and androstenedione.
- (Testosterone is the most abundant form while dihydrotestosterone is most active and testosterone converted into dihydrotestosterone in the target cells.)

Secretion & chemistry of androgens in the body:

- From the adrenal glands & synthesized either from cholesterol or directly from acetylcoenzyme A.

Metabolism of testosterone:

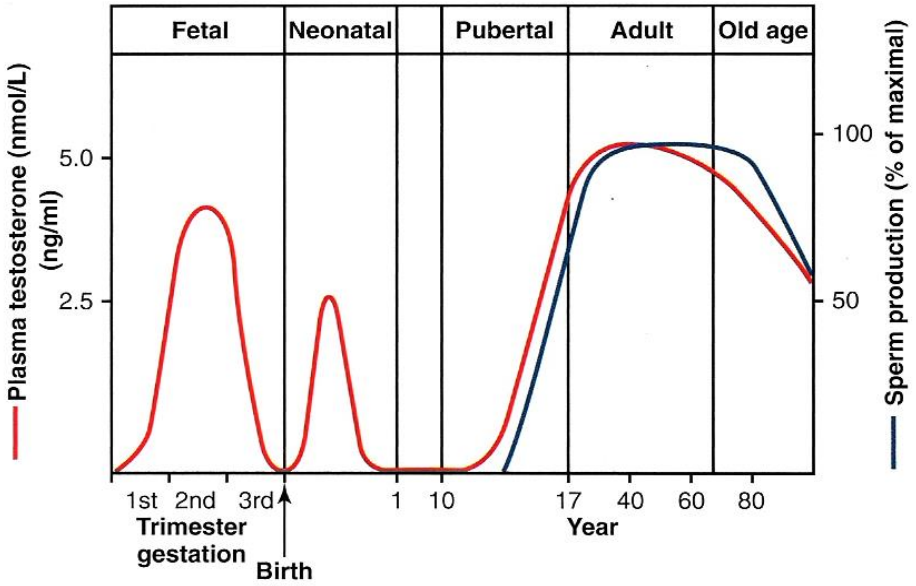
- Testosterone bound with beta globulin and circulate in the blood for 30 minutes to several hours and converted to estrogen in the liver and excreted either into the gut through liver bile or into the urine through the kidneys.

Testosterone, cont.

Physiology Team

Functions of testosterone:

It is responsible for the characteristic masculine body. During fetal life the testis are stimulated by placenta chorionic gonodotropin to produce testosterone throughout fetal life & the 10 weeks after birth then no more testosterone production during childhood & at puberty under the anterior pituitary gonadotropic hormones stimulation throughout life & then decline beyond 80 years to 50%.



Function of testosterone during fetal development:

- Testosterone secreted by the genital widges & later by the fetal testis is responsible for development of the male body characteristics including the formation of penis & scrotum. & prostate gland, seminal vesicles & male genital ducts & suppressing the formation of female genital organs.

- **Effect of testosterone to cause descent of the testis:**
- The testis descend into the scrotum during the last 2 to 3 months of gestation when the testis begin secreting reasonable quantities of testosterone.

Testosterone, cont.

Important

Physiology Team

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:

a. over the pubis
b. upward along the linea alba of the abdomen to the umbilicus
c. on the face
d. on the chest
e. less often on other regions such as the back.

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)

- Mood changes

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

Testosterone increases the thickness of skin over the body & subcutaneous tissues. Also it increases the secretion of the sebaceous glands & sebaceous glands of the face causing acne.

6-Testosterone increased protein formation and muscle development:

Increase muscular development after puberty by 50% in muscle mass over that in female. Also increase in protein in non-muscle parts of the body. These effect due to the anabolic effect of testosterone.

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). Testosterone has specific effect on the pelvis 1) narrow the pelvic outlet; 2) lengthen it; 3) cause the funnel-like shape instead of the broad ovoid shape of the female pelvis. It causes the epiphyses of the long bones to unite with the shafts of the bones & early closure of the epiphyses.

9-Effect on red blood cells:

It increases red blood cells/ml (due to increase metabolic rate).

10-Effect on electrolyte and water balance:

It increase the reabosorption of Na+ in the distal tubules of the kidneys. But not as strong as mineralocorticoid

8-Testosterone increases basal metabolism:

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

The basic intracellular mechanism of action of testosterone:

It increases the rate of protein synthesis in target cells. Testosterone converted by the intracellular enzyme 5-α reductase to dihydrotestosterone, then it binds with cytoplasmic "receptor protein". This combination moves to the nucleus where it binds a nuclear protein and induces protein formation.

Abnormalities of male sexual function:

Physiology Team

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 testis are non-functional, none of the male sexual characteristics develop in the fetus. Instead female organs are formed.
- If the boy loses his testis **before puberty**, a state eunuchism (he have infantile sex organs & infantile sexual characteristics) & the height of an adult eunuch is slightly greater than normal because of slow union of the epiphyses.
- If a man is castrated after puberty, sexual organ regress in size and voice regress - loss of the thick musculine bones- loss of masculine hair production -loss of musculature of the virile male.
- (Soft skin, no hair in the face & very tall)

Adiposogenitial syndrome, Frohlich's 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 result in obesity (feminine obesity) with eunuchism.

Abnormalities of male sexual function cont.:

Physiology Team

Cryptorchidism (Common in pediatric surgeries)

- Failure of the testes to descend in the scrotum which normally occur during fetal life.
- 10% of newborn males and it falls to 2% at age 1 year
- 0.3% after puberty
- They should be treated before puberty because of higher incidence of malignant tumors.

Testicular tumors and hypergonadism in male:

- Interstitial leydig cell tumors (rare), over production 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. (Early puberty)

- Tumor of the germinal epithelium (more common).

Spermatogenesis: formation of sperm in the seminiferous tubules.

Sertoli cells: large cells with overflowing cytoplasmic envelopes that surround the developing spermatogonia around the central lumen of the seminiferous tubules (important for the nourishment of sperms & growth of spermatogonia).

Leydig cell: lie within the interstitium between the seminiferous tubules (secretes testosterone under the control of LH from anterior pituitary).

Maturation of sperms in the epididymis:

- After spermatogenesis in the seminiferous tubules, the sperm require several days to pass through the epididymis
- After sperms have been in the epididymis for 18 to 24 hour, they develop the capability of motility but still not motile (some inhibitory proteins in the epididymal fluid & from the epithelium of seminiferous tubules & vas deferens prevent final motility (become motile after ejaculation due to less inhibitory substances in female genital duct).

Storage of sperm: Adult testes → 120 million sperm/day.

After ejaculation: Sperms become motile & capable of fertilizing the ovum called maturation.

Mature sperm are motile & capable of fertilizing the ovum.

Function of the seminal vesicles: secrete mucoid material containing fructose, citric acid & nutrient substances & large quantities of prostaglandins & fibrinogen

Function of the prostate gland:

- Secretes thin milky fluid contains Ca2+ ion, citrate ion, phosphate ion, a clotting enzyme & profibrinolysin (counteract the clotting enzyme & fibrinogen from seminal vesicles).
- The alkaline prostatic fluid is important for successful fertilization of the ovum.

SEMEN:

- **Ejaculated semen is composed of:**
  1. sperms from vas deferens.
  2. fluid from vas deferens (10%), prostate gland (30%), seminal vesicles (60%), small amounts of mucous glands the bulbourethral glands.

Sperms abnormalities:

1-Effect of sperm count on fertility: Sperm count below 20 million leads to infertility.

2-Effect of sperm morphology and motility on fertility

Capacitation of the spermatozoa: Go back to slide 11 (Very Imp Slide)

Stages of male sexual act:

- ✓ 1-Penile erection. + 2-Lubrication = under Parasympathetic effect
- ✓ 3-Emission and ejaculation. = under sympathatic effect

- Testosterone is the most abundant form while dihydrotestosterone is most active and testosterone converted into dihydrotestosterone in the target cells.

Functions of testosterone:

- It is responsible for the characteristic masculine body.

1. During fetal life the testis are stimulated to produce testosterone throughout fetal life & the 10 weeks after birth
2. Then no more testosterone production during childhood
3. at puberty under the anterior pituitary gonadotropic hormones stimulation throughout life & then decline beyond 80 years to 50%.

Function of testosterone during fetal development: Go back to slide 15 , Very Imp Slide

- responsible for development of the male body characteristics including the formation of penis & scrotum. & prostate gland, seminal vesicles & male genital ducts & suppressing the formation of female genital organs.
- Descending of testes into the scrotum during the last 2 to 3 months

Abnormalities of male sexual function:

1. **Prostate gland and its abnormalities**
   - ✓ Benign prostatic fibroadenoma in older age due to overgrowth of prostate tissue
   - ✓ Cancer of the prostate gland caused by stimulation of cancerous cells by testosterone.
2. **Hypogonadism in male**: (Soft skin, no hair in the face & very tall)
3. **Cryptorchidism** (Common in pediatric surgeries)
4. **Testicular tumors and hypergonadism in male:** (Early puberty)
5. **Tumor** of the germinal epithelium (more common).

QUESTIONS

Physiology Team

1. **Maturation of sperms occur ……. & become motile after ……..:**

A) In testis, lubrication
B) In epididymis, ejaculation
C) In vas deferens, erection
D) In prostate, emission

2. **Neutralization of the acidic fluids done by:**

A) Prostate gland
B) Vas deferens
C) Seminal vesicles
D) Bulbourethral gland

3. **Infertility in men occurs when sperms count fall under:**

A) 200 million
B) 150 million
C) 35 million
D) 20 million

4. **Penile erection & Lubrication is under… :**

A) Parasympathetic effect
B) Sympathetic effect
C) Parasympathetic effect + sympathetic effect
D)None

5. **Emission and ejaculation is under… :**

A) Parasympathetic effect
B) Sympathetic effect
C) Parasympathetic effect + sympathetic effect
D)None

1	B
2	A
3	D
4	A
5	B

THE END

Physiology Team

If there are any Problems or Suggestions,
Feel free to contact us:

Physiology Team Leaders
Mohammed Jameel & Shaimaa Al-Refaie

432Physiology@gmail.com

THANK YOU

IF YOU WANT TO SHARE ANY INFORMATION REGARDING PHYSIOLOGY OR ANY OTHER SUBJECT .. YOU CAN MENTION THIS ACCOUNT
@MED432