

Male Reproductive System

Dr.Dulani Kottahachchi
Department of Physiology



Overview

- Structure of the male reproductive system
- Blood testis barrier
- Spermatogenesis
- Sperm
- Semen

Introduction

- Function of Male gonads
 - Production of germ cells (Gametogenesis)
 - Secretion of sex hormone
- Androgens – Testosterone and estrogen

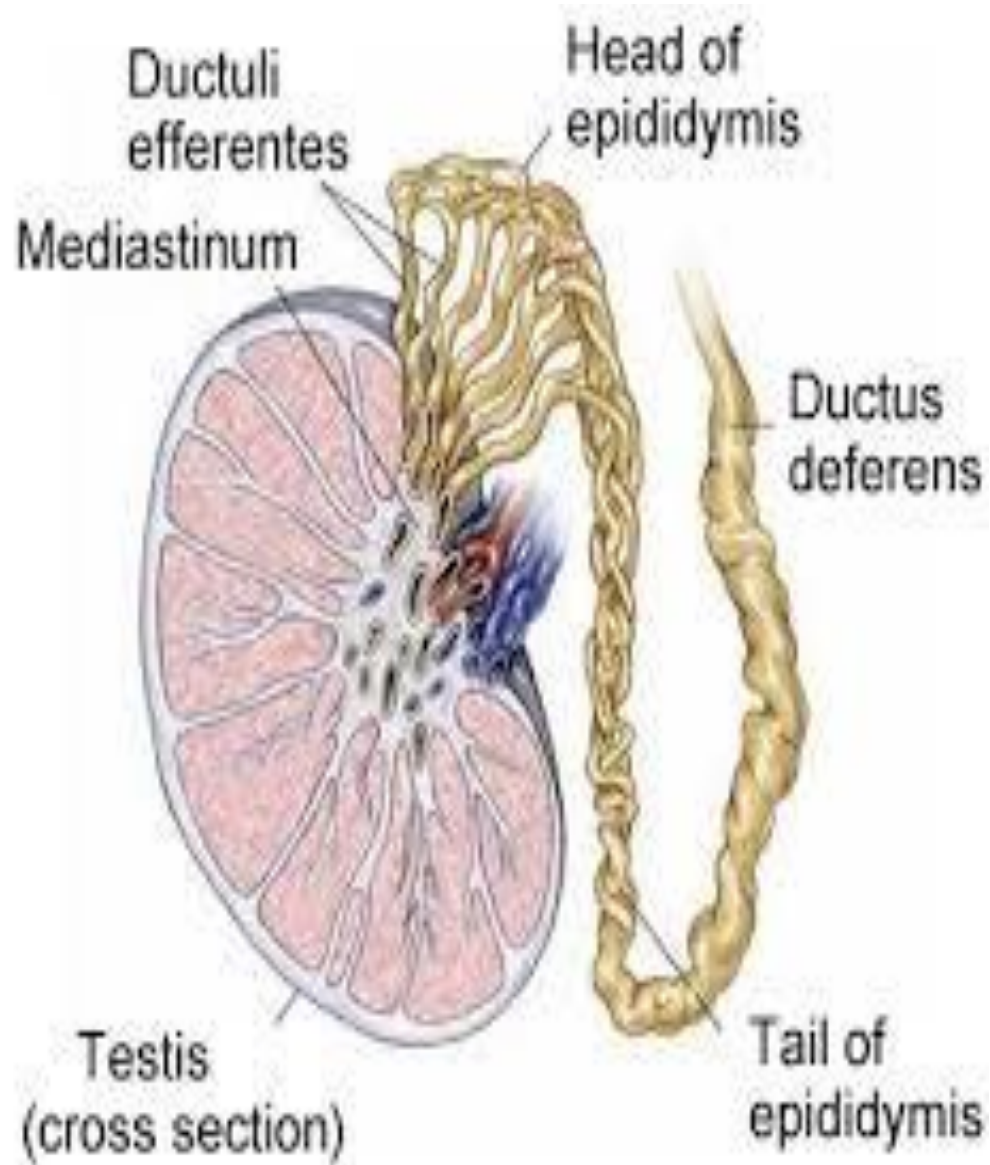
Structure

- Testes made up of loops of seminiferous tubules ,where spermatozoa are formed
- Both ends of each loop drain to head of epididymis

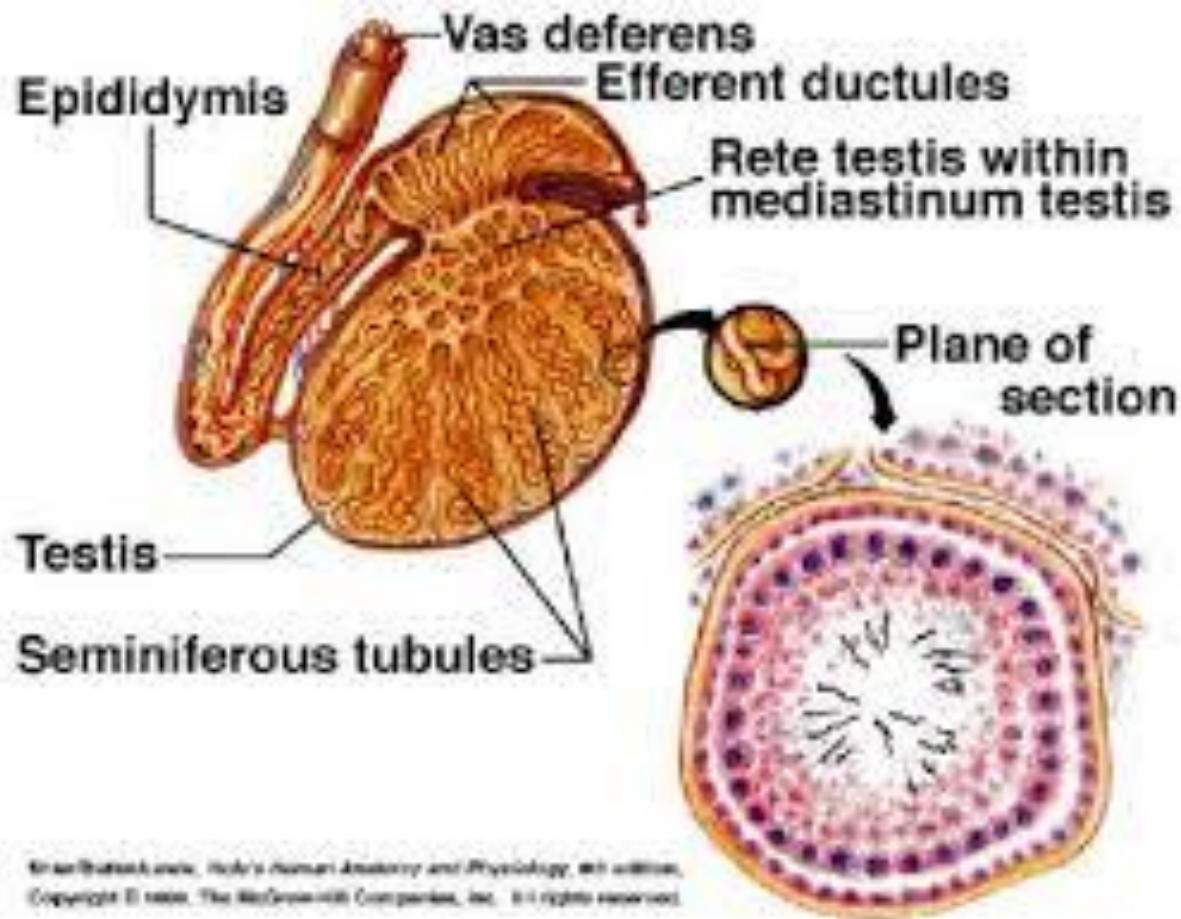
Structure

- Then spermatozoa pass through the tail of the epididymis into vas deferens
- Enter through the ejaculatory ducts in to the urethra in the body of the prostate

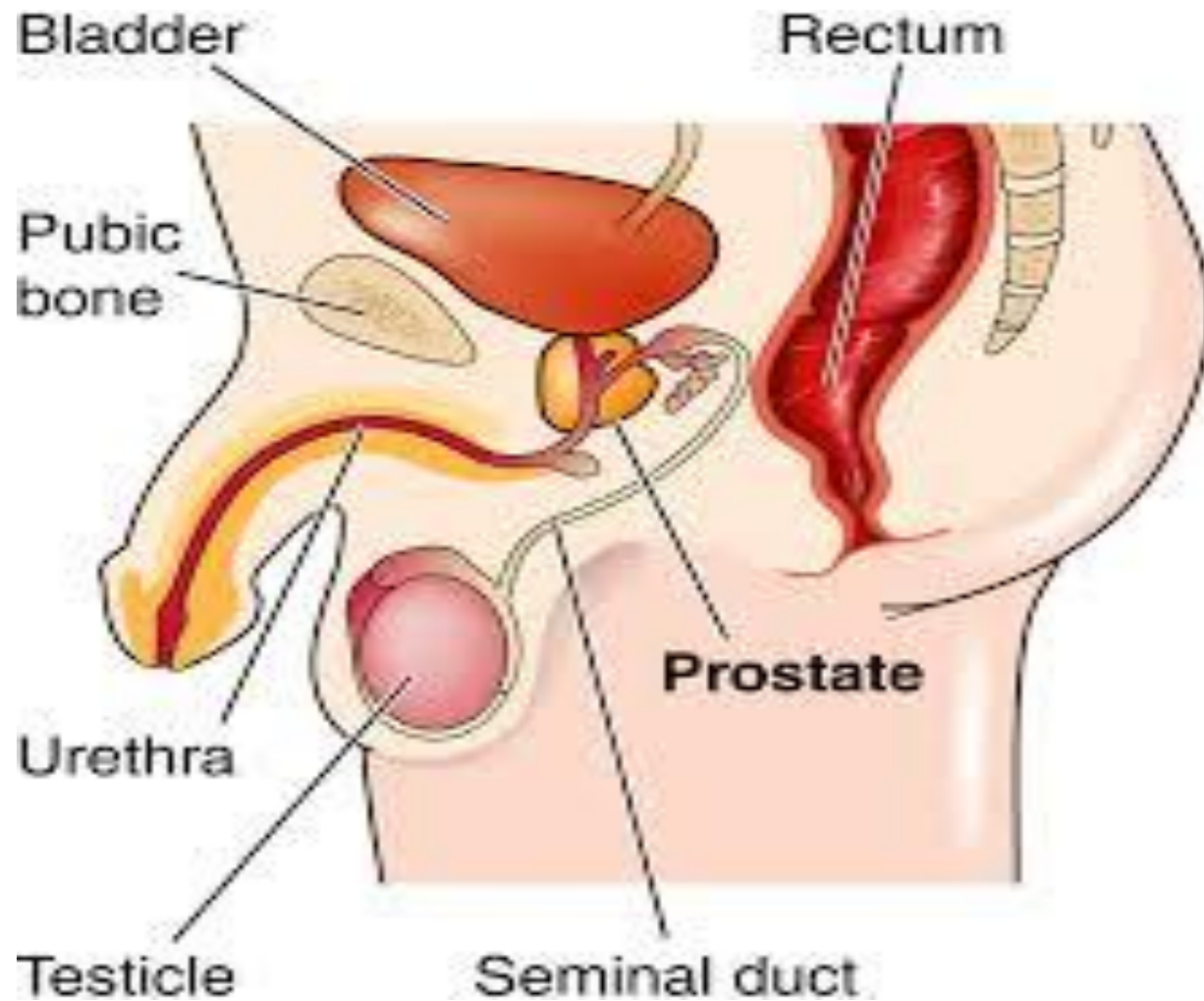
Structure



Structure

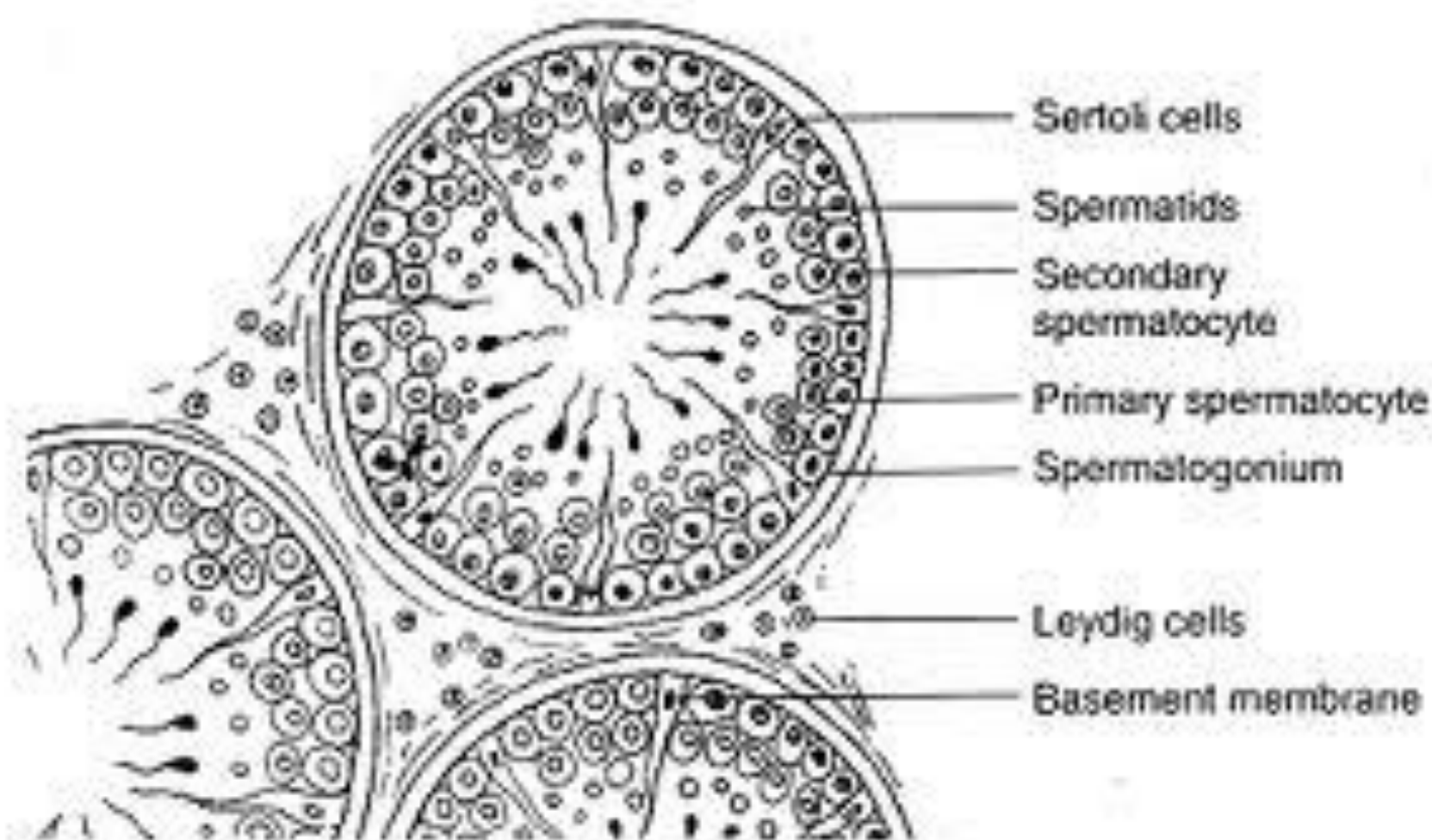


Structure



Structure

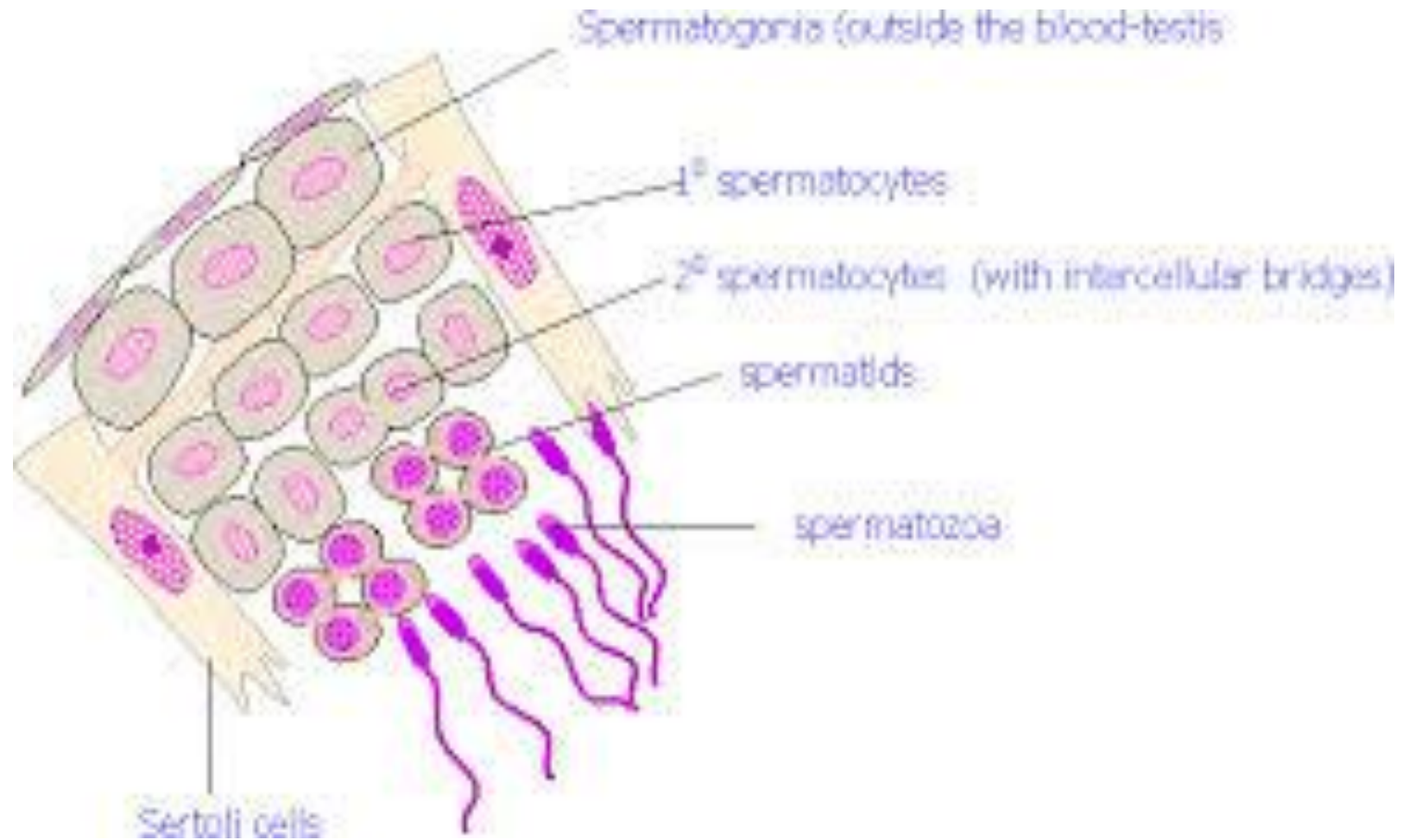
- Between seminiferous tubules are interstitial cells of Leydig.
- They secrete Testosterone to the blood stream



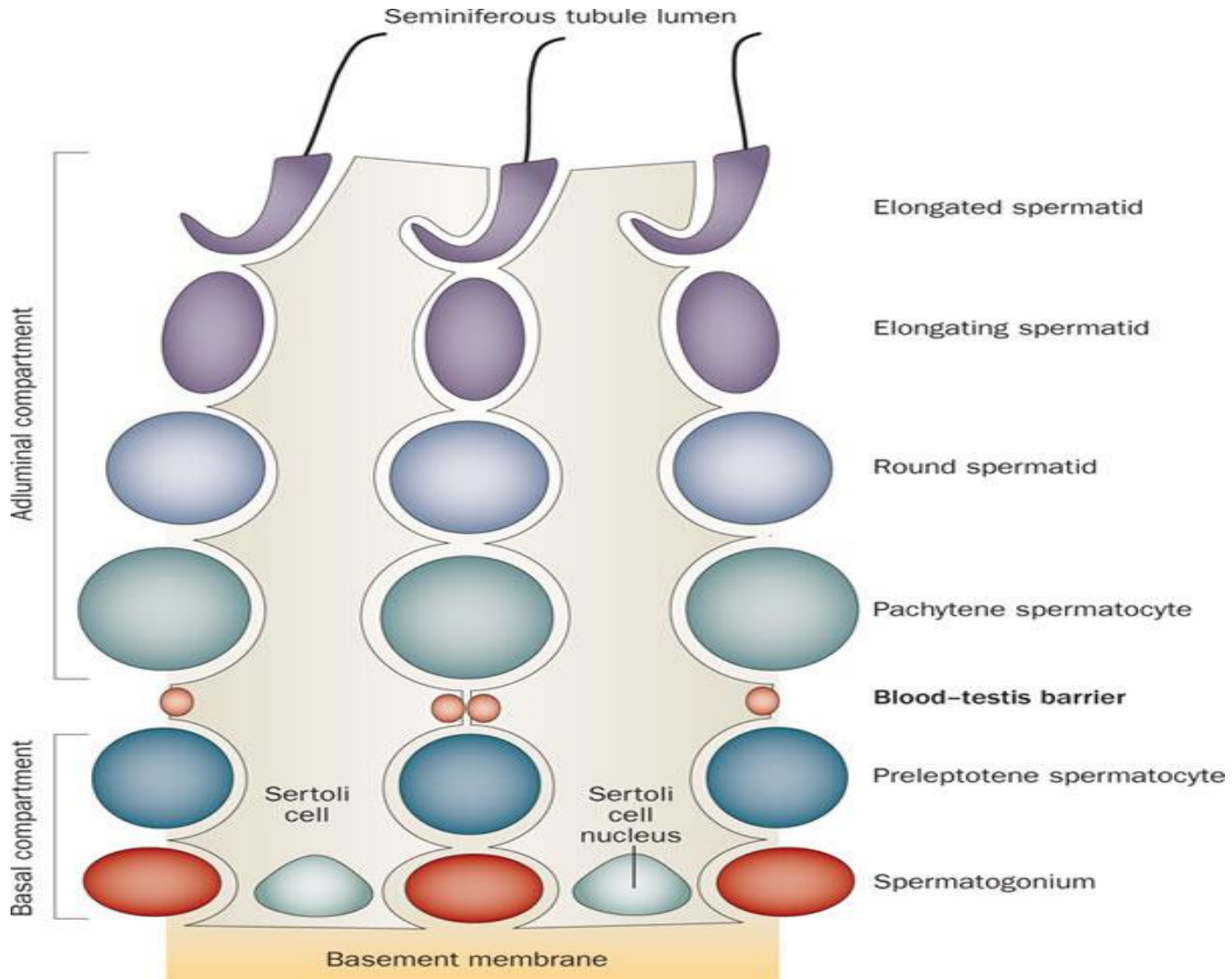
Blood testis barrier

- Walls of seminiferous tubules are lined by Sertoli cells and primitive germ cells.
- Sertoli cells are large cells which stretch from the basal lamina of the tubule to lumen
- Tight junctions between adjacent sertoli cells near the basal lamina form the **BLOOD-TESTIS BARRIER**

Blood testis barrier



Blood testis barrier



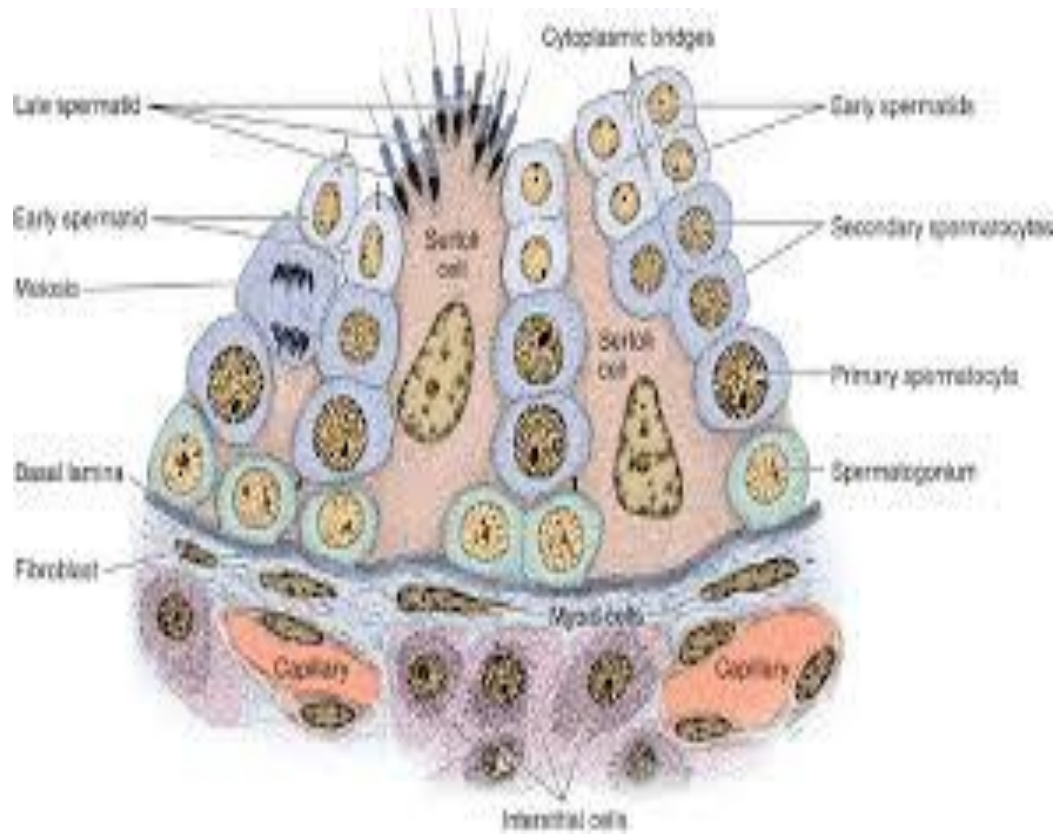
Blood testis barrier

- It prevents many large molecules from passing interstitial tissue to lumen
- Maintain fluid composition of the lumen
- Very little protein and glucose
- High levels of
 - androgens
 - estrogens
 - K^+
 - Inositol
 - Aspartic acid

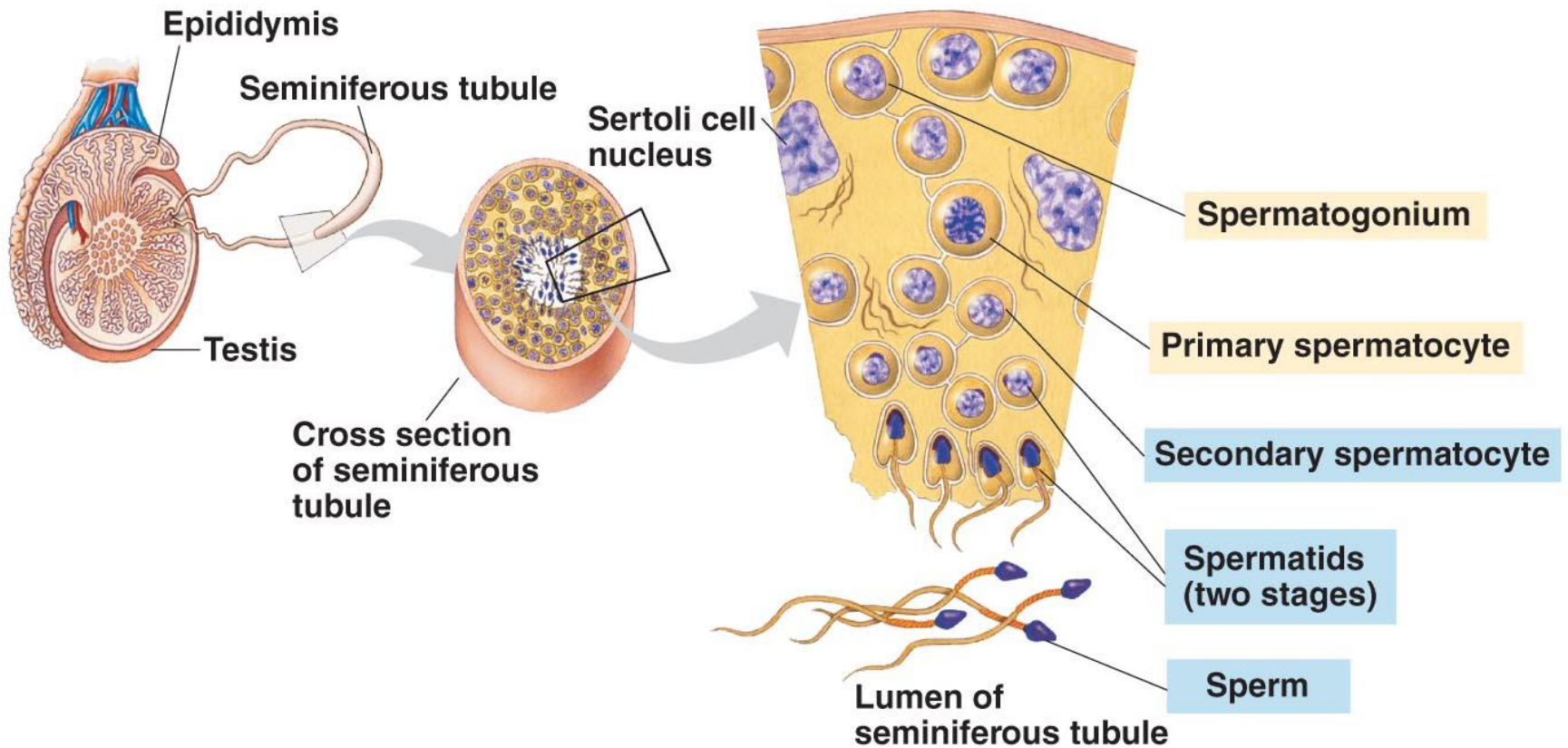
Blood -testis barrier

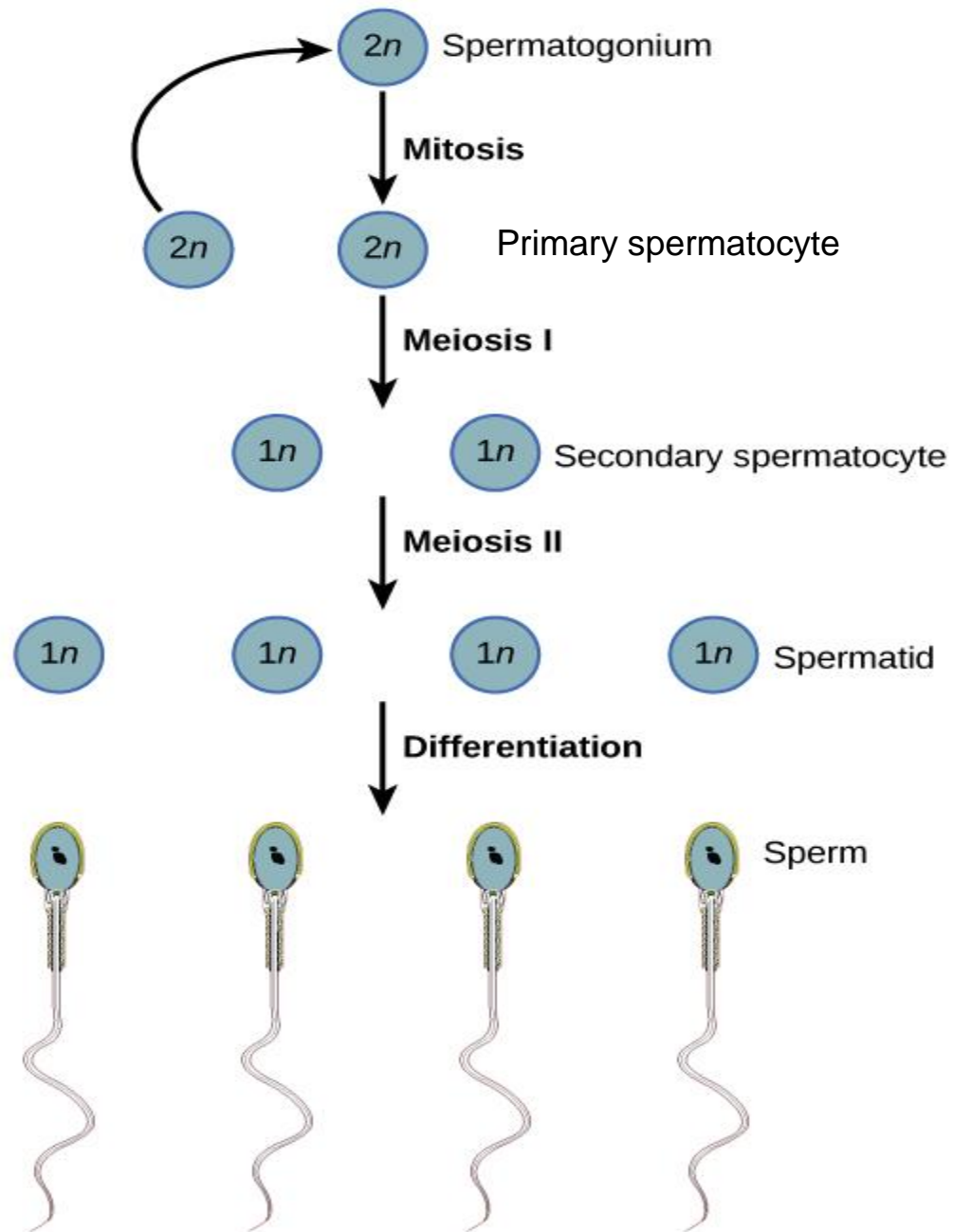
- Protects testis from noxious agents, antigenic products
- Establish the osmotic gradient needed for fluid movement in to the lumen

Spermatogenesis



Spermatogenesis

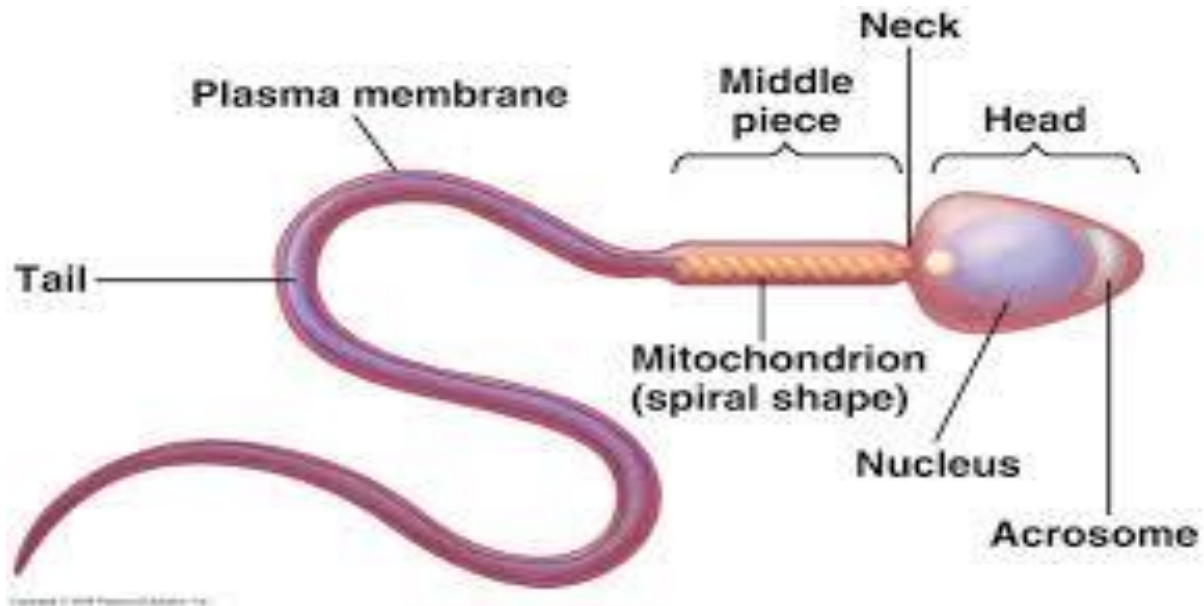




Spermatogenesis

- Number of spermatids formed from one spermatogonia is 512
- Approximately 74 days taken from primitive germ cell to form mature sperms

Sperm



Sperm

- Motile cell
- Rich in DNA
- Contains Head ,Middle piece, Principal piece and End piece
- Acrosome - Cover the head
 - Lysosome like organelle, which helps sperm penetration of the ovum

Sperm

- Membranes of late spermatids and spermatozoa contain a special form of Angiotensin Converting Enzyme (ACE)
- It's called germinal ACE (g ACE)
- It displays tissue specificity
- Full function not known.

Sertoli cells

- Spermatids mature in to spermatozoa in the cytoplasm of sertoli cells.
- Secrete
 - Androgen binding proteins-maintain high stable supply of androgens in tubular fluid
 - Inhibin-Inhibits FSH secretion
 - MIS
 - Contain Aromatase (CYP19) ,enzyme responsible for conversion of androgens to estrogens

Role of FSH

- Along with androgens maintain gametogenesis
- Stages from spermatogonia to spermatids are androgen independent
- Maturation from spermatid to spermatozoa is androgen dependent
- FSH acts on the sertoli cells to facilitate the later stages of spermatid maturation
- Promote production of ABP

Further development of Spermatozoa

- Sperms acquire the full motility when they pass through the epididymis
- Progressive motility acquired in the epididymis involve activation of proteins from **CatSper family** in the principal piece of tail
- Form an alkaline sensitive Ca^{2+} channel

Further development of Spermatozoa

- Once ejaculated in to the female spermatozoa move up the uterus
- At the isthmus of uterine tubes they under go **capacitation**
- This leads to increase motility and prepare for the acrosome reaction

Effect of temperature

- Spermatogenesis require lower temperature than interior of the body.
- Testes are maintained at 32⁰C
- This temperature is maintained by
 - air circulating around the scrotum
 - Heat exchange in countercurrent fashion between spermatic arteries and veins
- Hot baths ,insulated atheletic supporters can reduce sperm count.

Semen

- It's the fluid ejaculated at the time of orgasm
- Contains the sperm, secretions of the seminal vesicles, prostate, cowper's glands
- Average volume per ejaculate is 2.5-3.5 ml

Composition of the semen

Colour	White , opalescent
pH	7.35-7.5
Sperm count	100 million/ml
Fructose Phophorylcoline Ascobic acid Prostaglandina	Seminal vesicles (65%)
Spermine Citric acid Chloesterol	Prostate (20%)
Phosphate Bicarbonate Hyaluronidase	Buffers

Semen

- Reduction of sperm count leads to infertility.
- Sperm count <20 million/ml are infertile
-
- Sperm count between 20 -40 million /ml -50% are infertile
- Many morphologically abnormal or immotile sperms , will cause infertility

Summary

- Male gonads maintain gametogenesis and secrete mainly testosterone
- Seminiferous tubules are responsible for the spermatogenesis
- Tight junctions between adjacent sertoli cells near the basal lamina form the blood testes barrier
- Leydig cells secrete testosterone to the blood
- Semen contain 100 million sperms/ml

Oldest man to father a child



Male Reproductive System II

Dr.Dulani Kottahachchi
Department of Physiology



Overview

- Erection
- Ejaculation
- Endocrine functions of the testes
- Testosterone
- Abnormalities of the male reproductive system

Erection

- Initiated by the dilatation of the arterioles of the penis
- When the erectile tissue of the penis fills with blood then veins are compressed
- This blocks the outflow which adds to the turgor of the organ

Erection

Erotic psychologic stimuli



Impulses from in afferents of genitalia



Activates integrating centers in the lumbar segments of the of the spinal cord



Efferent parasympathetic fibres in the pelvic splanchnic nerves



Release acetylcholine and VIP



VASODILATATION

Erection

- Nonadrenergic noncholinergic fibres also present in splanchnic nerves
- They release Nitric Oxide Synthase (NOS) which catalyzes the formation of Nitric oxide
- NO increase the cGMP levels ,which is a vasodilator
- Sildenafil is a drug which inhibit the breakdown of cGMP by phosphodiesterase inhibitors ,used for the erectile dysfunction

Ejaculation

- Involves emission and ejaculation proper
- Emission is movement of semen to the urethra
- Ejaculation proper is the propulsion of the semen out of the urethra by the contraction of bulbocavernosus muscle
- Emission is a sympathetic response.(upper lumbar segments)
- Afferent pathways are mostly fibres from the touch receptors in the glans penis.

Prostate specific antigen

- Produced by the prostate and secreted to the semen
- It's a serine protease.
- PSA hydrolyzes the sperm motility inhibitor seminogelin in semen
- Elevated levels seen in prostate cancer and benign prostatic hyperplasia

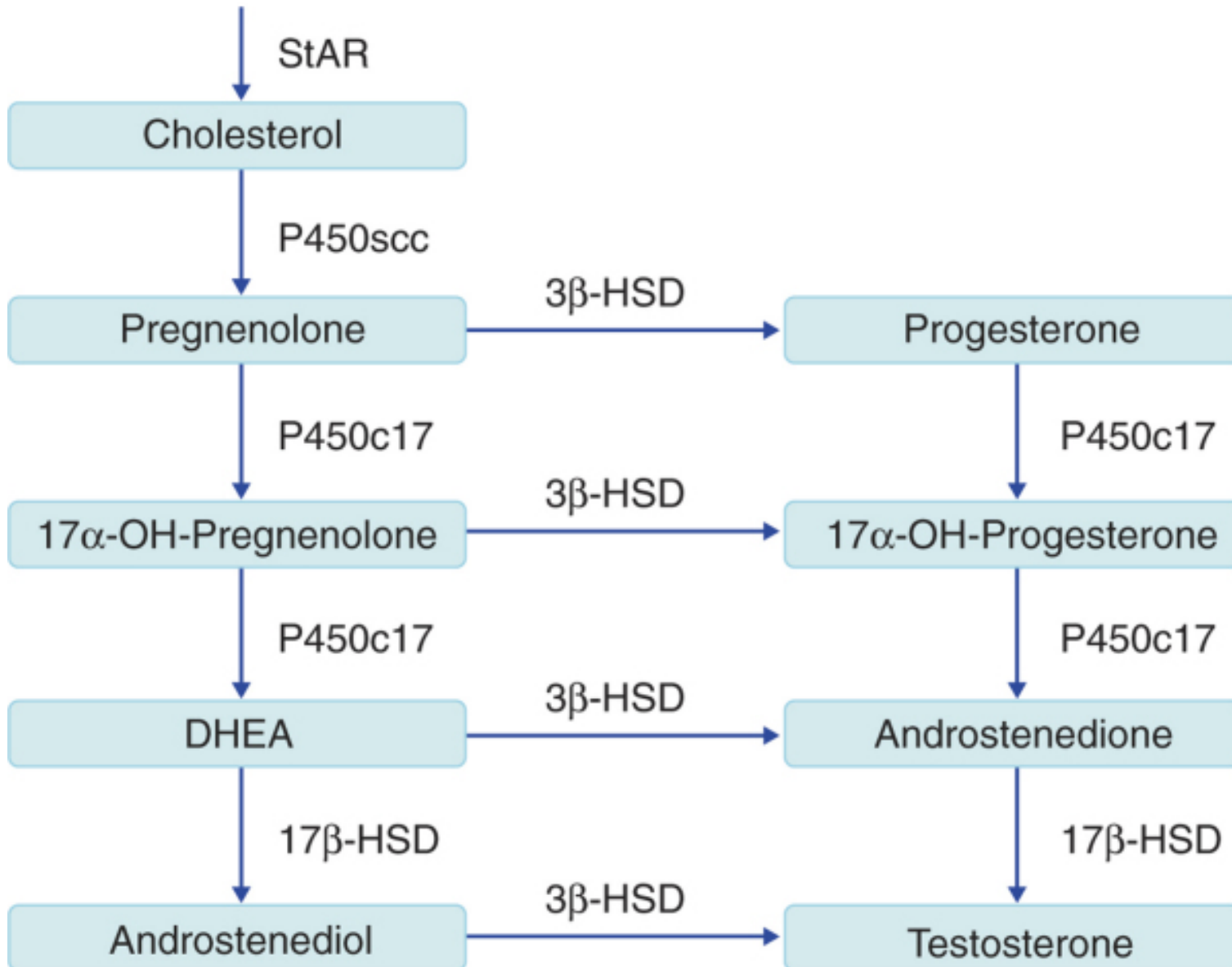
Endocrine functions of the testes

- Production of testosterone is the main endocrine function
- Estrogen is also produced

Testosterone

- Steroid with a hydroxyl group
 - Men -300 -1000 ng/dL
 - Female 30 -70 ng/dL
- Synthesized from the
 - cholesterol in the leydig cells
 - Androstenedione secreted by the adrenal cortex
- Secretion is under LH ,which increase c AMP via G protein coupled LH receptor
- Activation is via protein kinase A

Testosterone Synthesis in the Testis



Secretion of testosterone

- Rate 4-9 mg/d
- Small amounts are secreted in females by the ovary and adrenal

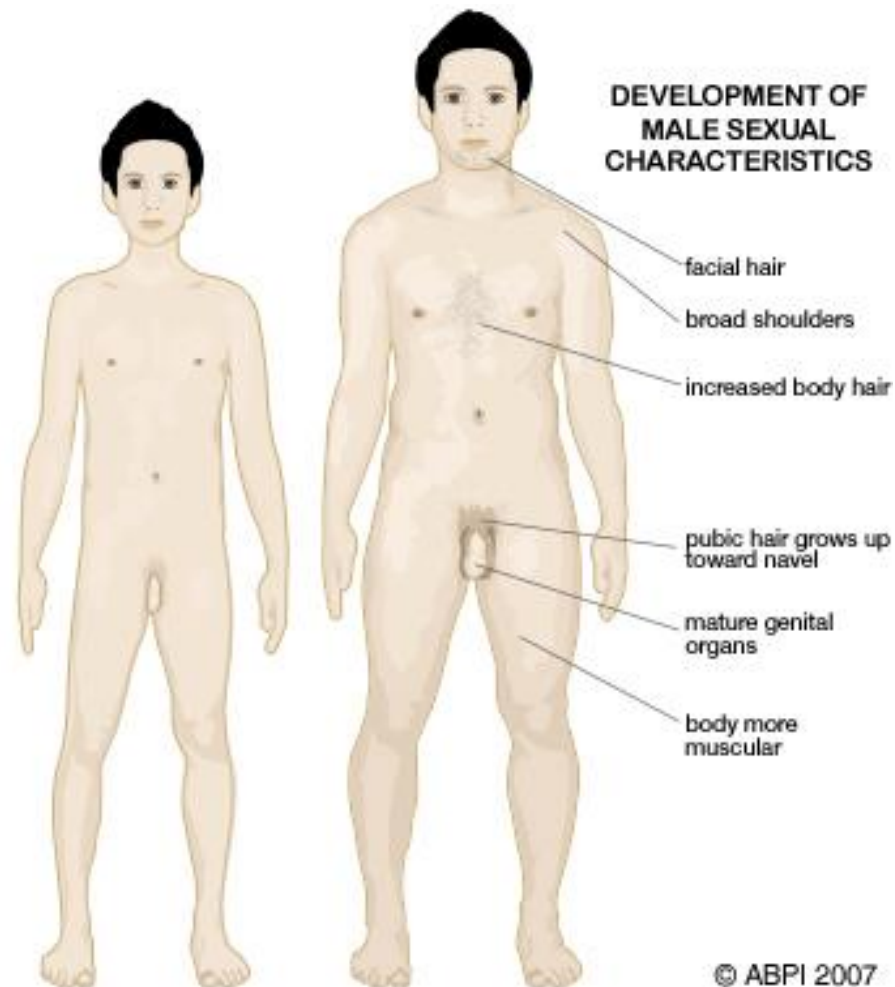
Transport

- 98% -plasma bound to protein
 - 65% Gonadal steroid binding Protein/sex steroid binding globulin
 - 33% -albumin
- Converted to 17-Ketosteroids and excreted in the kidneys(1/3 of excreted 17 ketosteroids)

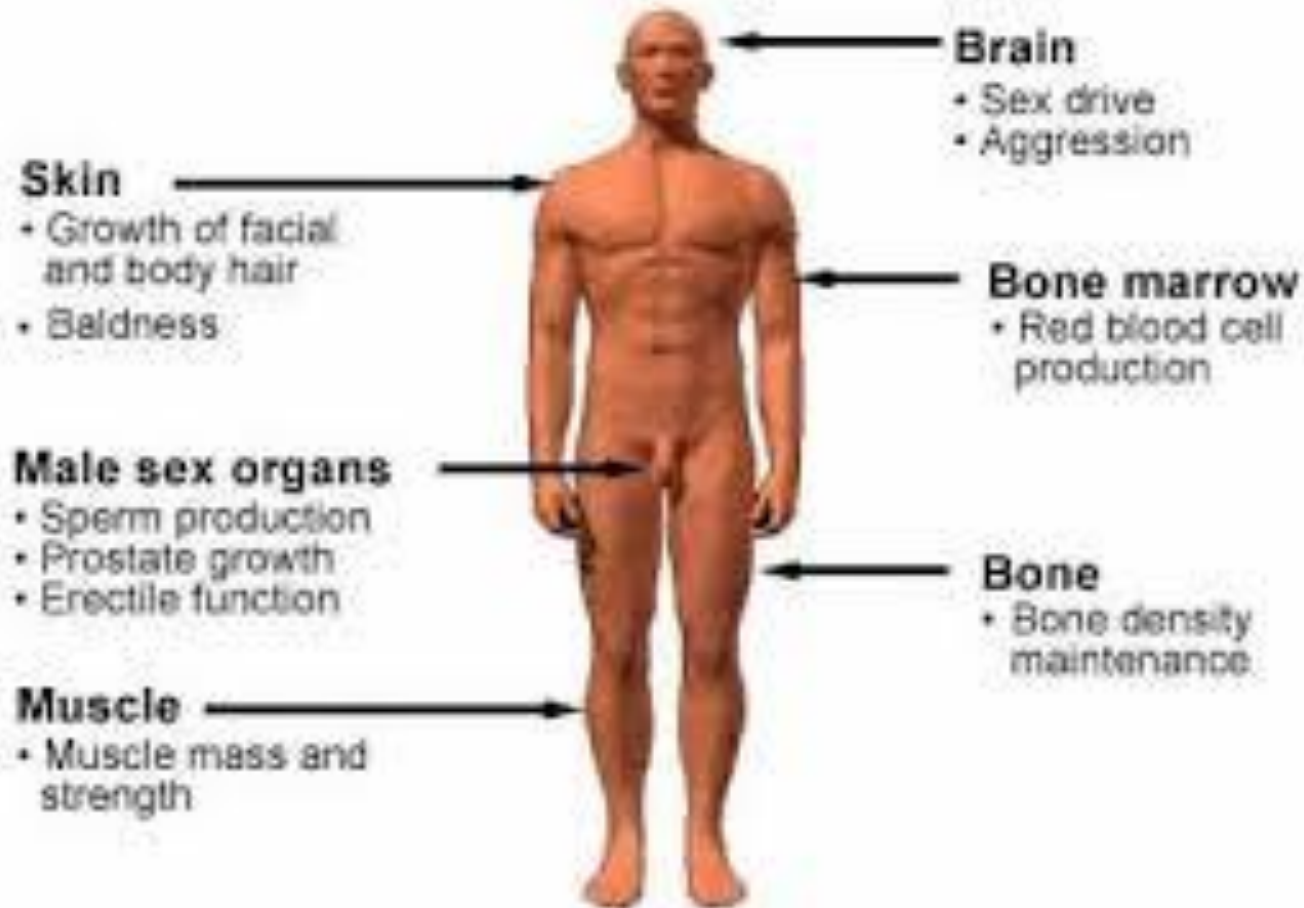
Actions

- Develop and maintain male secondary sexual characteristics
- Promote protein anabolic, growth promoting effect
- Maintain spermatogenesis along with FSH

Secondary sexual characteristics



Secondary sexual characteristics



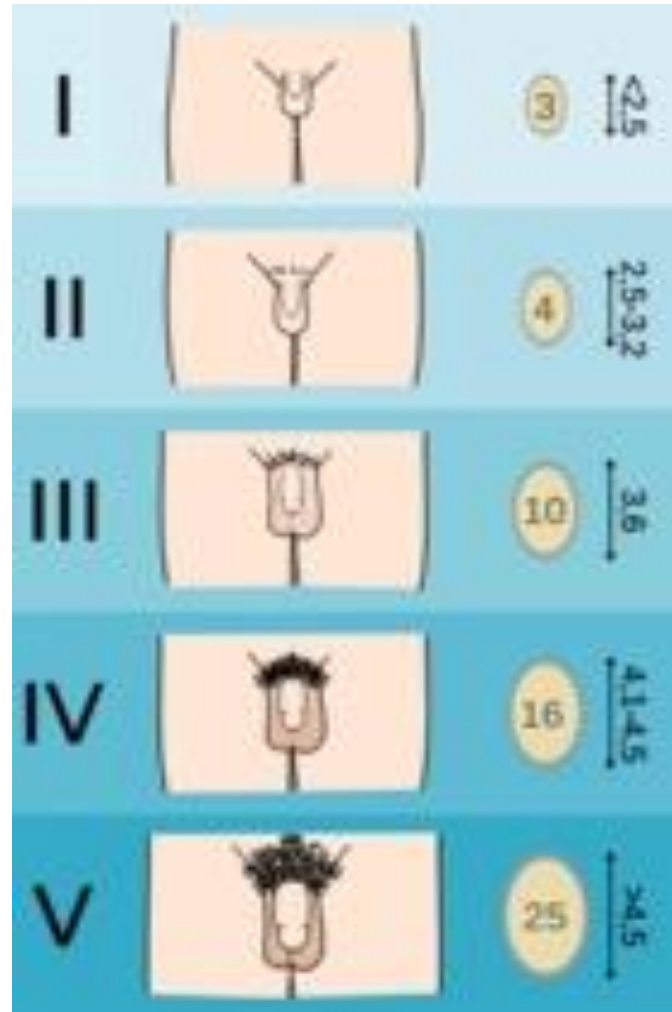
Secondary sexual characteristics

- External genitalia –penis increase in length and width
- Scrotum become pigmented and rugose
- Internal genitalia –seminal vesicles enlarge and secrete fructose
- Prostate and bulbourethral glands enlarge and secrete

Secondary sexual characteristics

- Voice –larynx enlarge
- Vocal cords enlarge in length and thickness and voice becomes deeper
- Hair growth –beard appears
- Hairline on scalp recedes anterolaterally
- Pubic hair male pattern (apex up in the triangle)
- Mental- more aggressive, active
- Shoulders broaden, muscles enlarge
- Sebaceous gland secretion thickens

Pubic hair male pattern (apex up in the triangle)



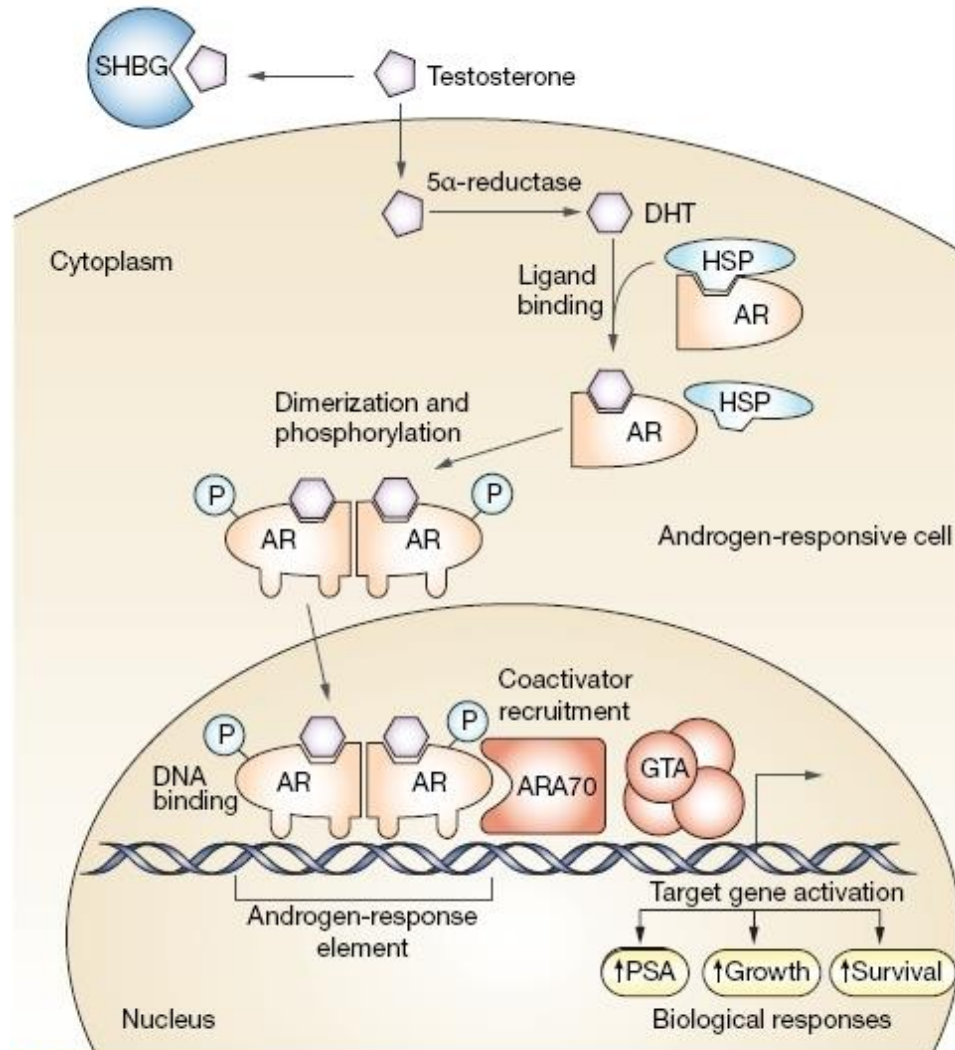
Anabolic effects

- Increase the synthesis and decrease the breakdown of protein leading to increase growth
- Moderate Na^+ , K^+ , H_2O , Ca^{2+} , SO_4 and PO_4 retention

Mechanism of action

- Testosterone binds to an intracellular receptor
- Receptor /steroid complex binds to DNA in the nucleus, facilitate transcription of genes
- Testosterone is converted to DHT by 5α reductase in some target cells.
- Two types of 5α reductase
- DHT also bind to the same intracellular receptor as testosterone
- Testosterone –receptor complex is less stable than DHT –receptor complex in target cells

Mechanism of action



Testosterone –receptor complex	DHT –receptor complex
complex-maturation of wolffian ducts and the internal genitalia development	External genitalia formation
Increase in muscle mass	Enlargement of prostate
Development of sex drive and libido	Facial hair
	Acne
	Temporal recession

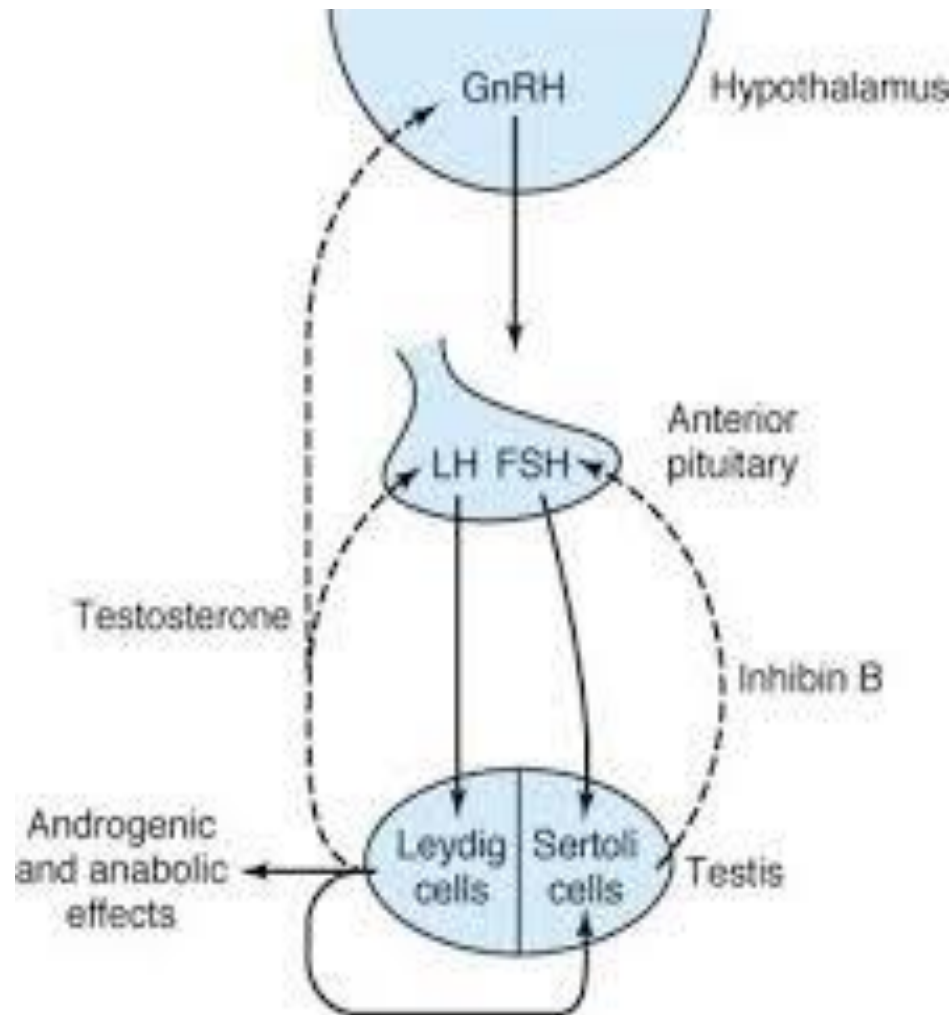
Congenital 5 α reductase deficiency

- Gene for type 2 5 α reductase is mutated
- Born with female external genitalia, but male internal genitalia, and raised as girls
- At puberty their LH and Testosterone levels increase
- Develop male body contours and male libido

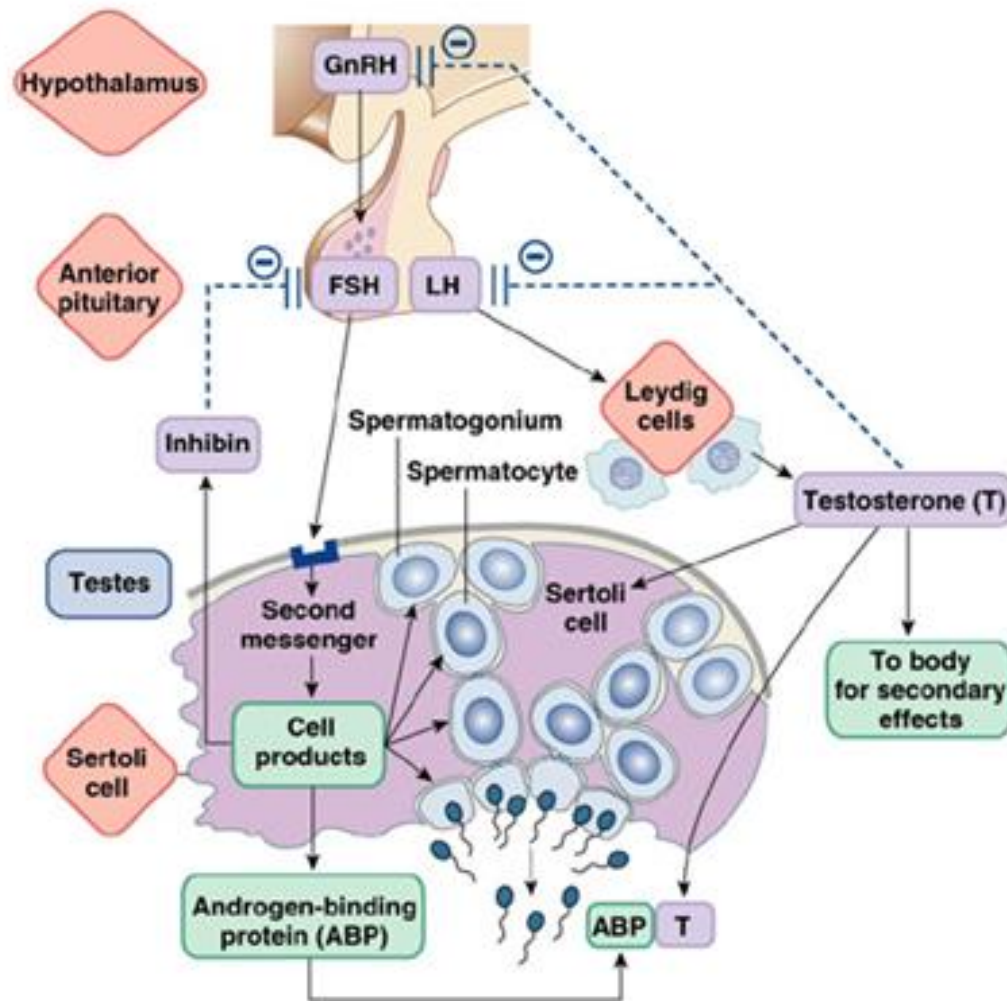
Control of testicular functions

- FSH
 - Tropic for sertoli cells
 - Maintain gametogenic function of testes
 - Stimulate ABP and inhibin
- LH
 - Tropic for leydig cells
 - Stimulate secretion of testosterone

Control of testicular functions



Control of testicular functions



Abnormalities of testicular function

- **Male hypogonadism**
 - Hypergonadotropic hypogonadism
Due to testicular disease
 - Hypogonadotropic hypogonadism
Pituitary/hypothalamus disease

Abnormalities of testicular function

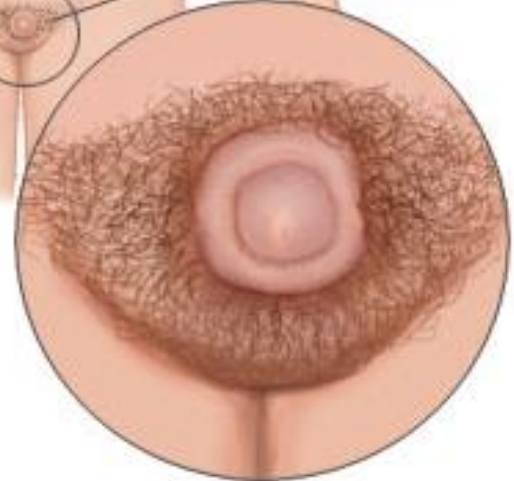
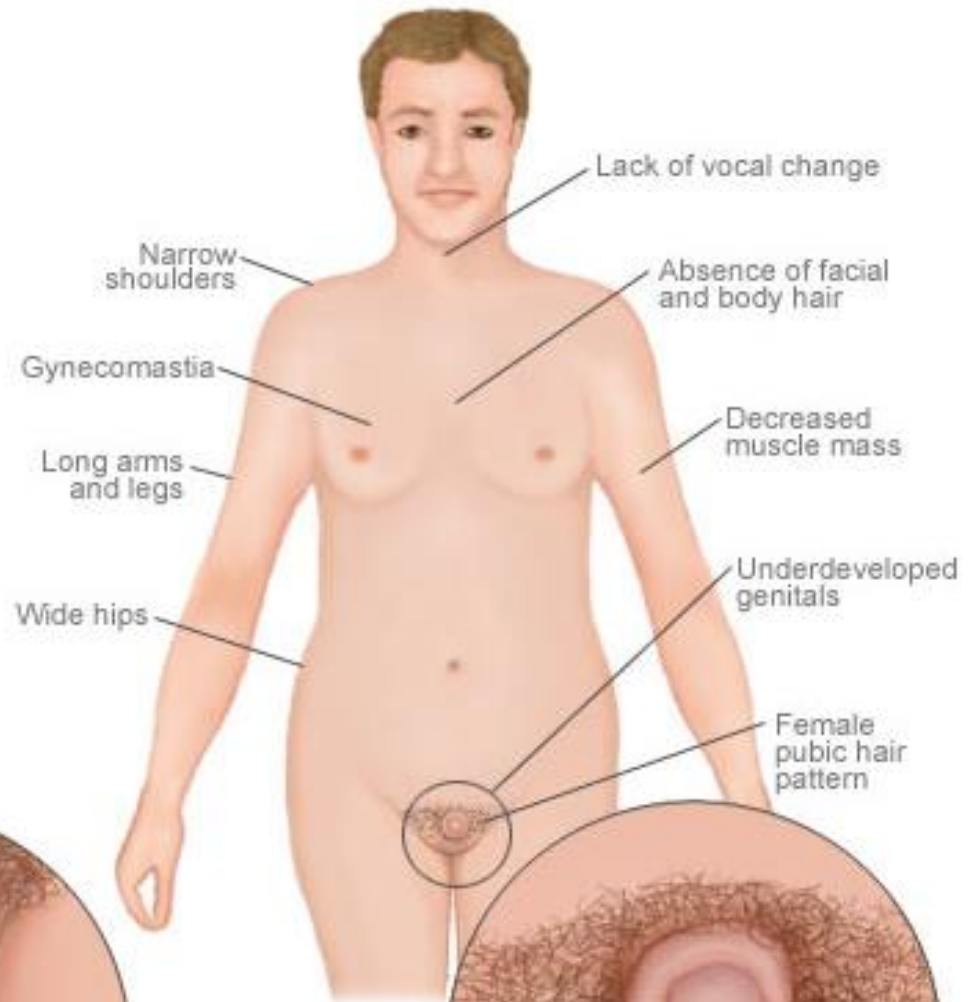
Cryptorchidism

- Is the absence of one or both testes from the scrotum.
- Due to undescended or maldescended testis.
- It is a common birth defect regarding male genitalia

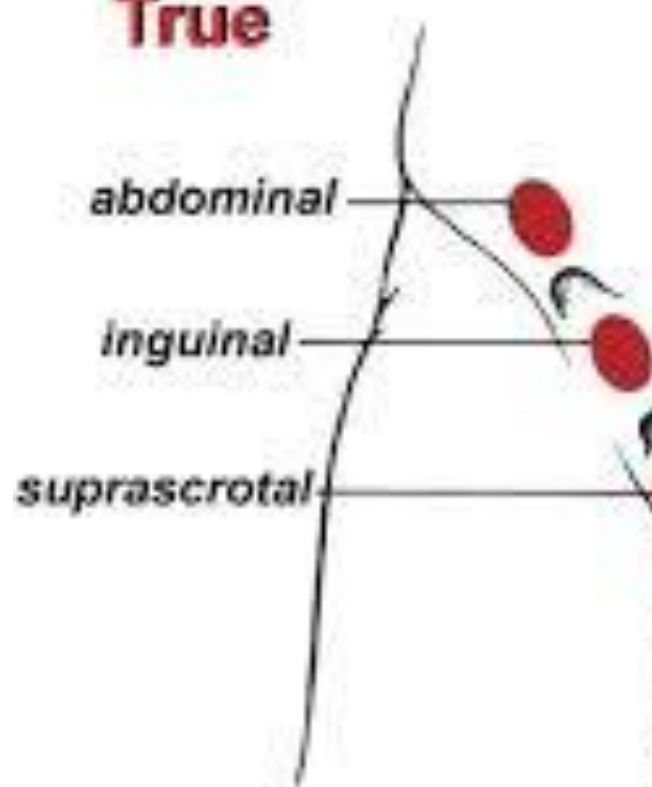
Normal



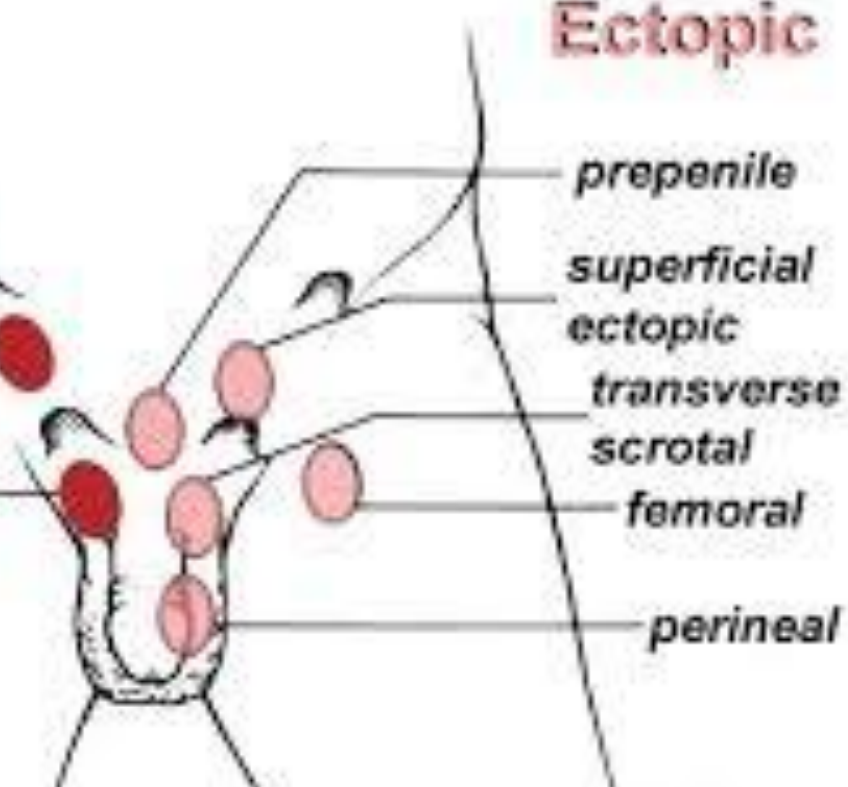
Hypogonadism



True



Ectopic



cryptorchidism

Summary

- Erection is mediated by parasympathetic system
- Ejaculation consists of emission and ejaculation proper.
- Testosterone is under control of LH
- DHT mediates the actions of testosterone

The reproduction of mankind is a great marvel and mystery.

~Martin Luther

