“Testes:

The Powerhouse of Males–

Anatomical & Clinical Perspectives”

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Learning objectives

At the end of session audience will able to

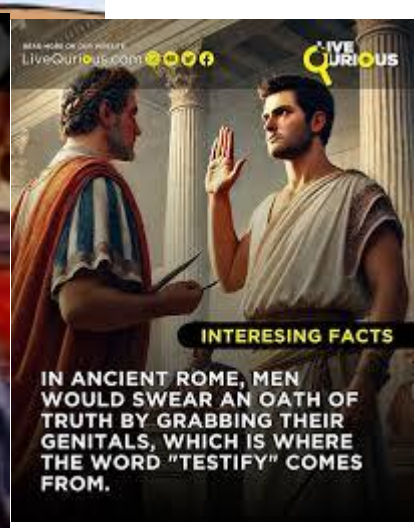
- Discuss the external features of the testes
- Describe the neurovascular supply & lymphatic drainage of the testes along with its clinical significance
- Explain the role of pampiniform plexus in thermoregulation

Learning objectives

contd…

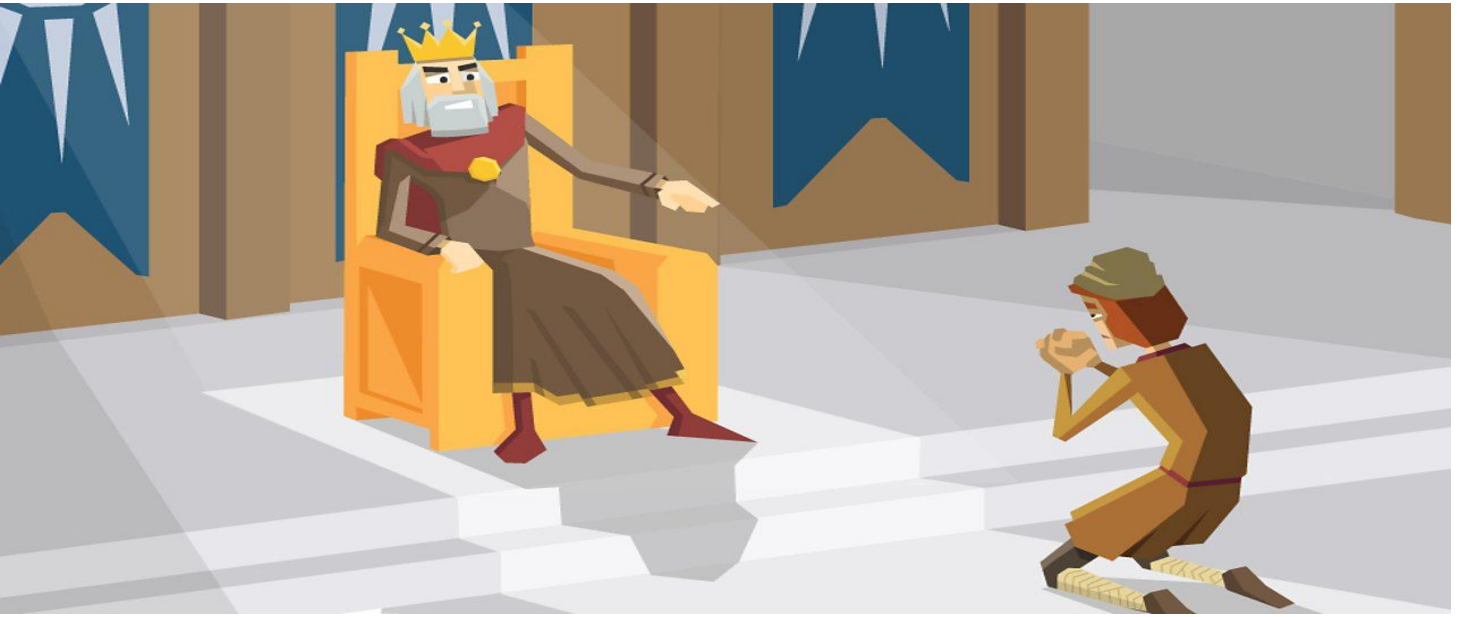
- Discuss the embryological development of the testes & its clinical implications
- Explain the histological organization of the testes
- Describe the function of the testes

❖ Etymology



- Latin word which meant ‘witness’
- Metaphorically considered “witnesses” to a man’s virility and reproductive ability
- Men in ancient Rome might have placed their hand on their testes while taking oaths, reinforcing the idea of bearing witness
- Greek term for the testes was “orchis”
- The testes (singular testis) commonly known as testicles

Castrated Men to Seize Their “Power"



for serving as slaves to the royal palaces for the **Queen** & other noblewomen…..

After battles in some cases, winners castrated their captives or the corpses of the defeated to symbolize their victory and seize their "power"

Control Over the Mind of Male Sex Offenders

- Castration has also been used in the **United States** for sex offenders

- Roman Catholic Church, where 10 children were allegedly punished by **castration** in 1950 for reporting sexual abuse by Roman Catholic priests

Sex Offenders….

- In 1952,
  Alan Turing—the father of computer science was criminally prosecuted for homosexual acts & chose **chemical castration** as an alternative to a period of imprisonment

Alan Mathison Turing was an English mathematician, computer scientist, logician, cryptanalyst, philosopher and theoretical biologist. Turing was highly influential in the development of theoretical computer science, providing a formalisation of the concepts of algorithm and

Sex Offenders….

So, it was observed that males were punished by castration to seize their power…..

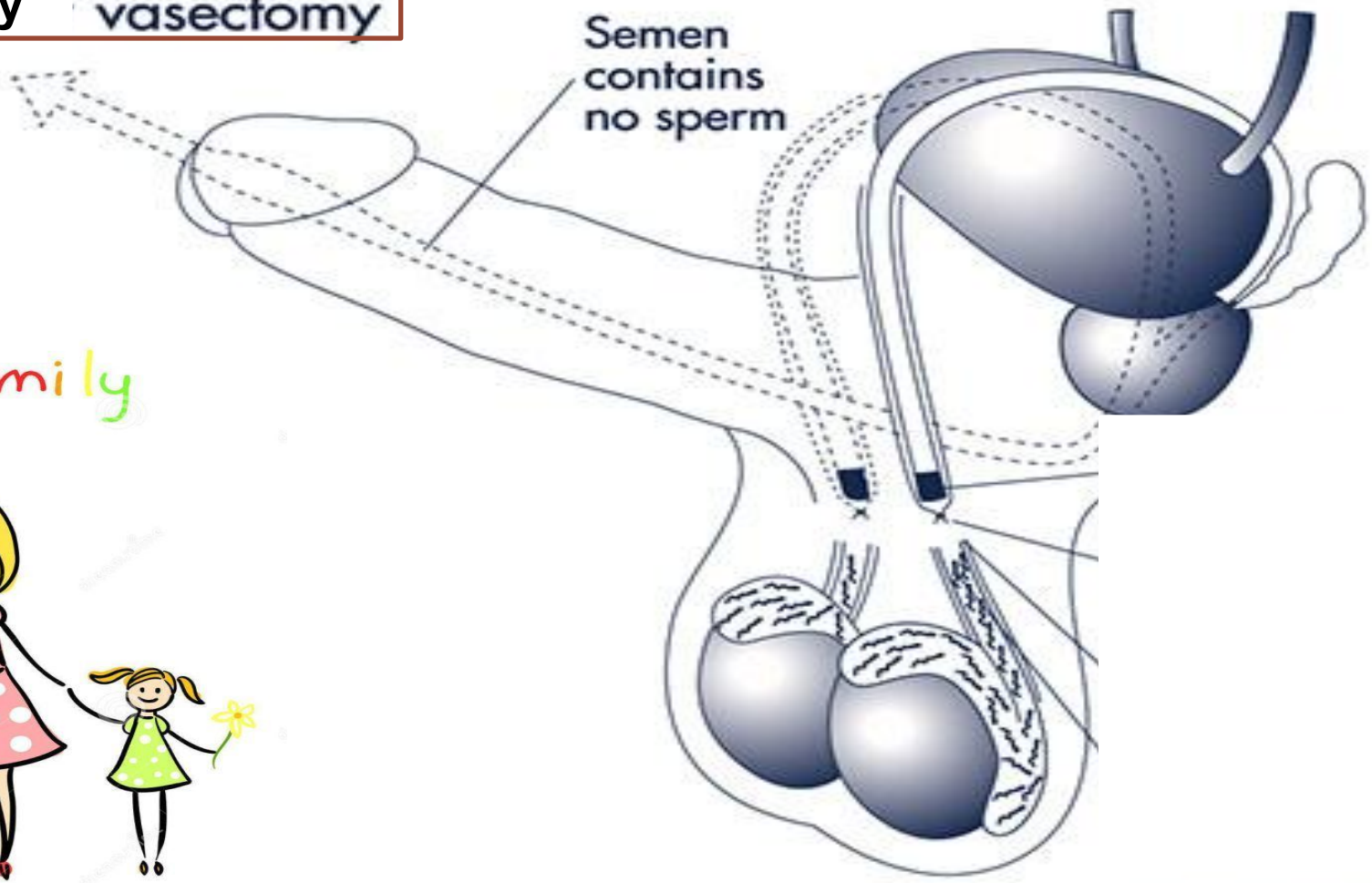
Castration

- **Castration** is any action, surgical, chemical or otherwise by which an individual loses use of the testicles: the male gonad & become sterilized

In Bangladesh

Local term
খোজা (khoja)/খাসি(khashi)

By vasectomy



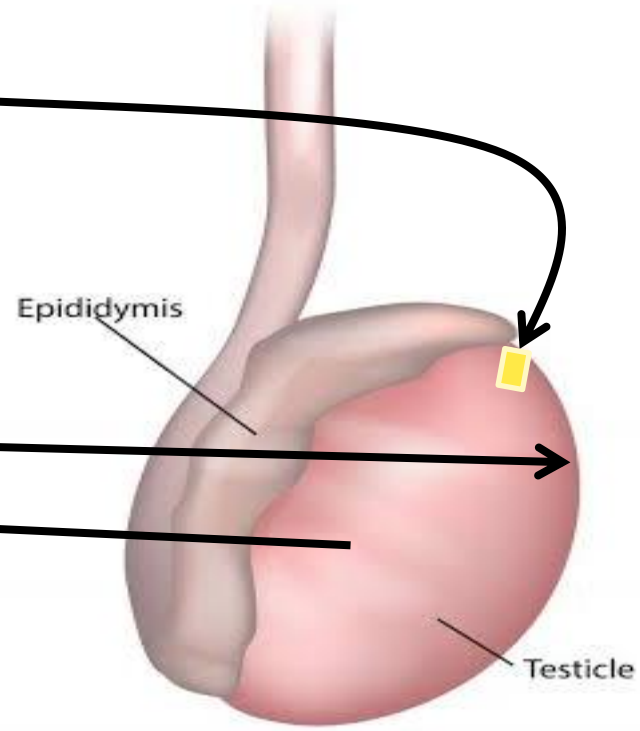
External Features:

Shape- oval

Size- 4 cm long, 2.5 cm broad & 2 cm thick

Weight- 10-15 gm

Two poles (end)- upper & lower
Two borders- anterior & posterior
Two surface- medial & lateral



From the BBC Earth program The Life of Mammals. 5 January 2015

Biggest testes of the world

North Atlantic right **whales**
Weight exceed **900** kg &
producing gallons of sperm.

Smallest testes

Showy Monkey

Stefan Lüpold,
evolutionary biologist at University of Zurich

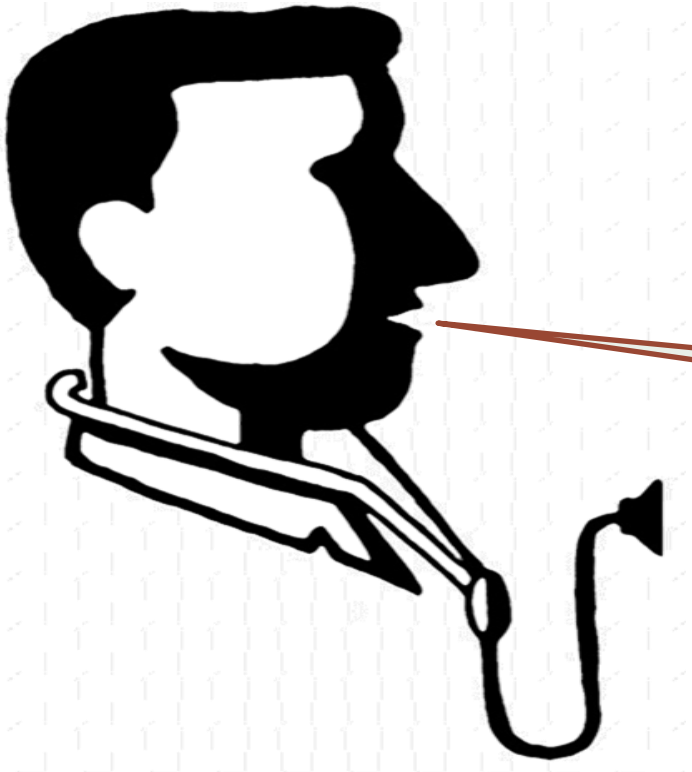
Parent came to physician with child…

- have small **testicle**

Examine by doctor

Other causes of small testicle:

- ❑ Side effect of extratesticular disease
- ❑ Certain drugs & irradiation
- ❑ Cryptorchidism

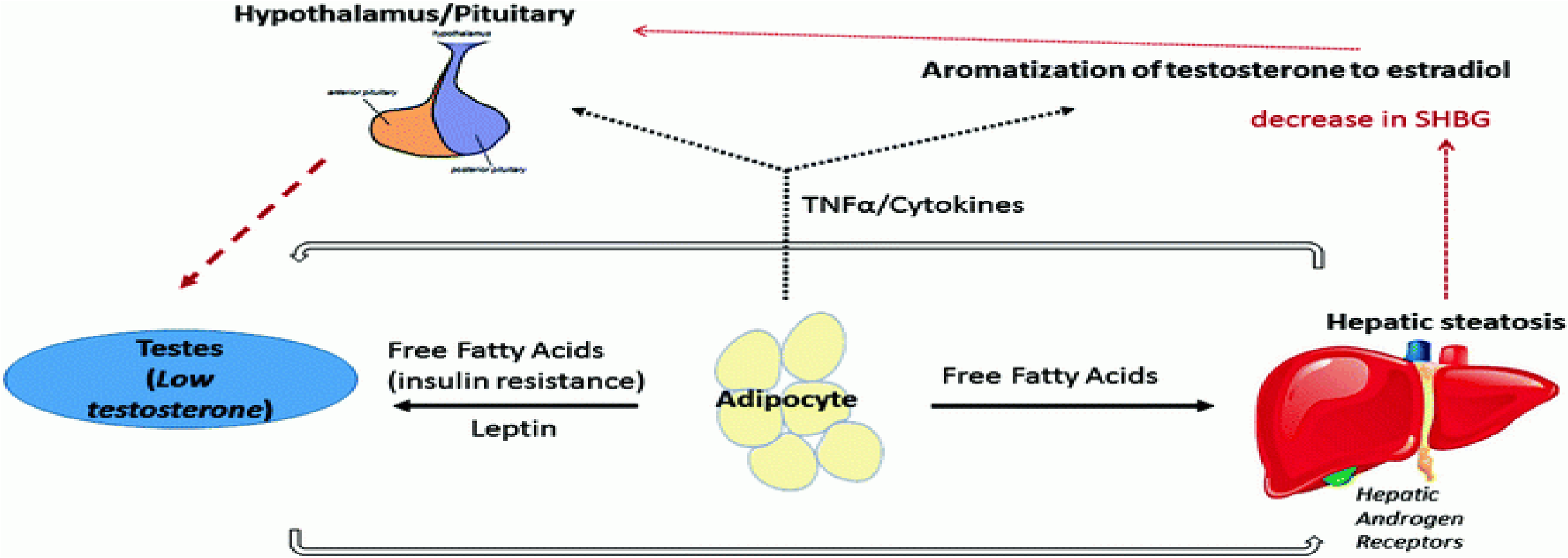


Klinefelter syndrome

the most frequent cause of small testicle

Hepatic cirrhosis may causes

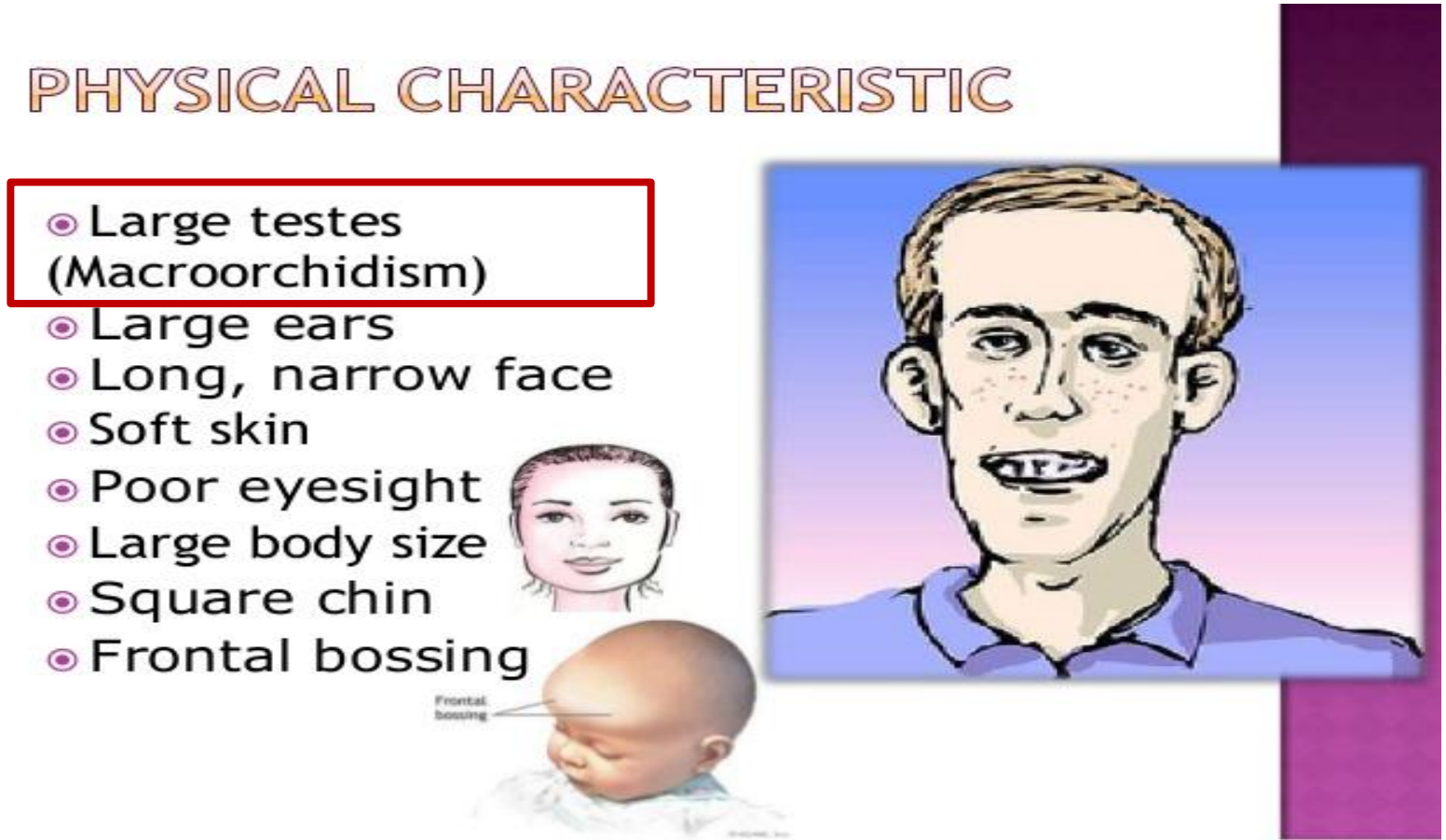
testicular atrophy



Certain diseases or infections may increase the risk of testicular atrophy including mumps (50%)

Macroorchidism

found in **fragile X syndrome**, most common genetic cause of intellectual disability

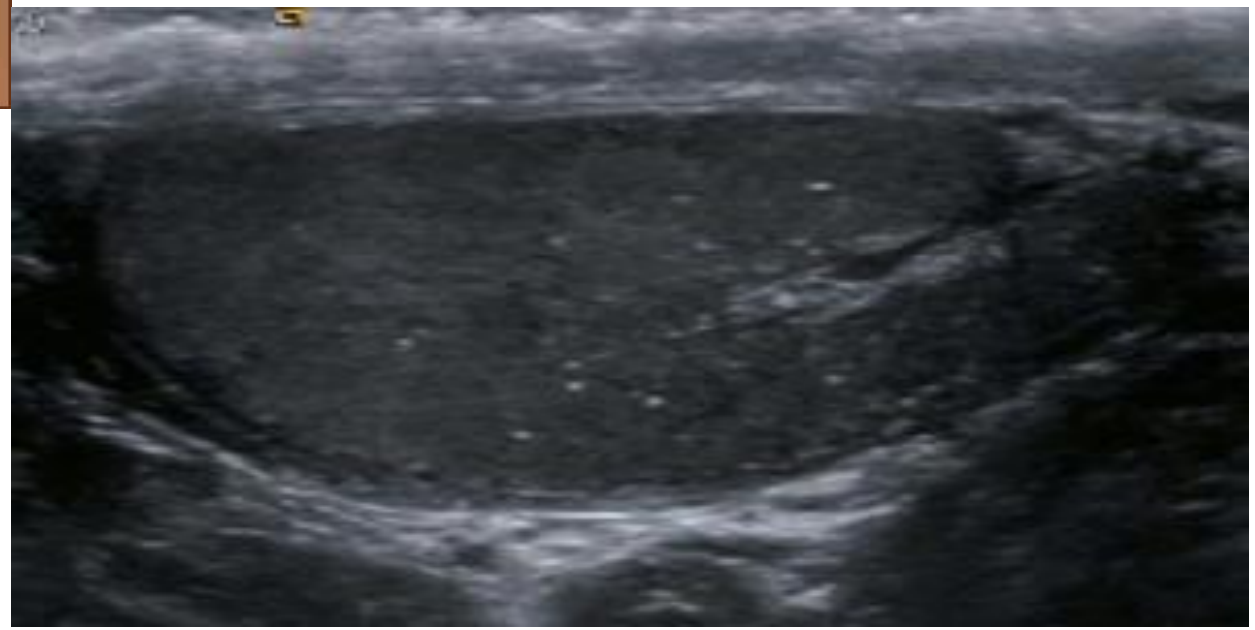


Regular testicular self-examination is recommended

Big brain means small testes, finds bat study

Read more: https://www.newscientist.com/article/dn8429-big-brain-means-small-testes-finds-bat-study/#ixzz607u2gs6Y

USG anatomy



Size, Shape & volume are determined

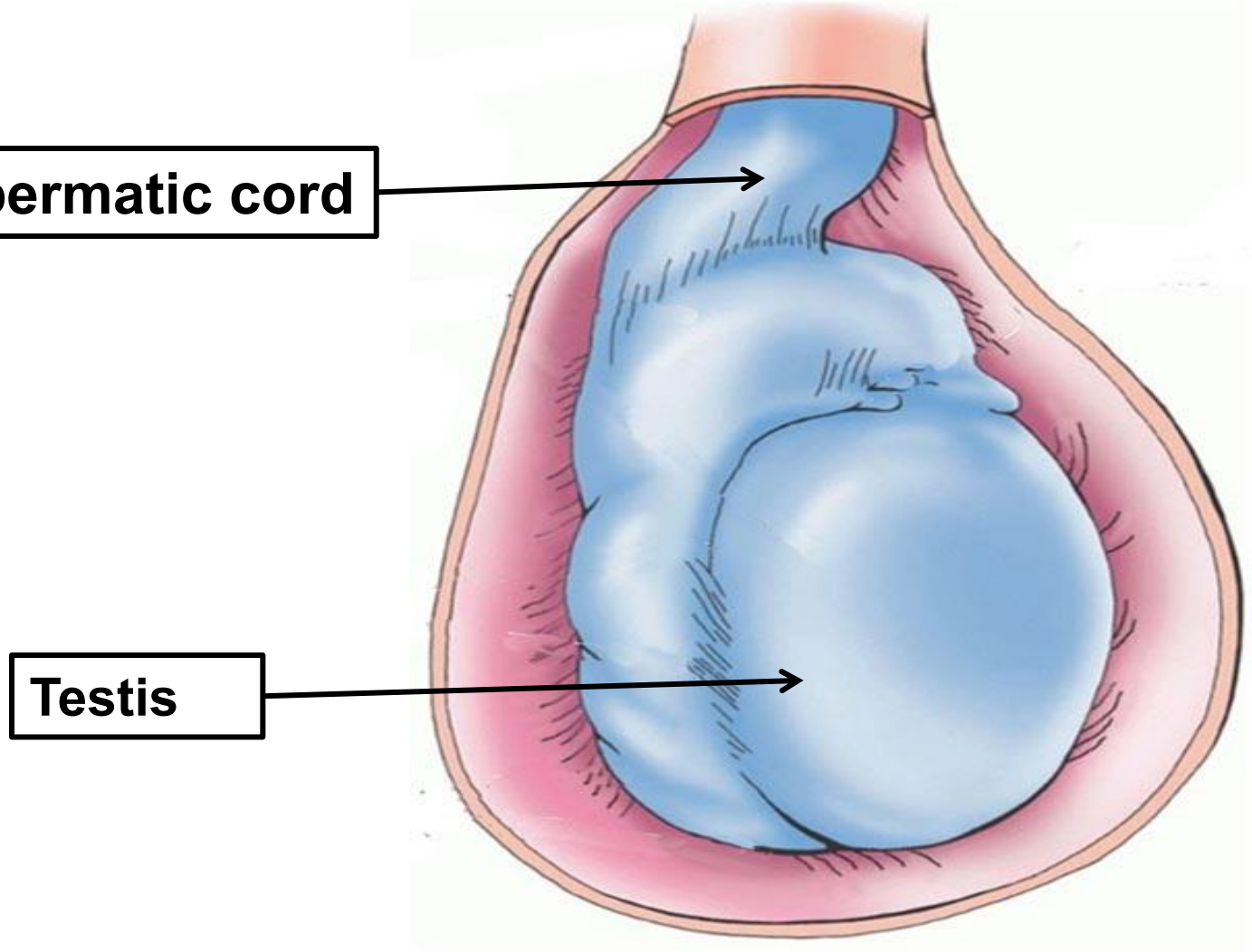
Testicular microlithiasis is an unusual condition diagnosed on **testicular** ultrasound.

Ultrasonographic image of testicular microlithiasis
(28-year-old infertile man)

- Microliths may occupy 30 to 40% of the seminiferous tubules
- uninvolved seminiferous tubules often have abnormal spermatogonia
- Usually Leydig cell unaffected

Location

The testes are suspended in the scrotum by the spermatic cords with the left testis usually suspended (hanging) more inferiorly than the right testis.



The testes un
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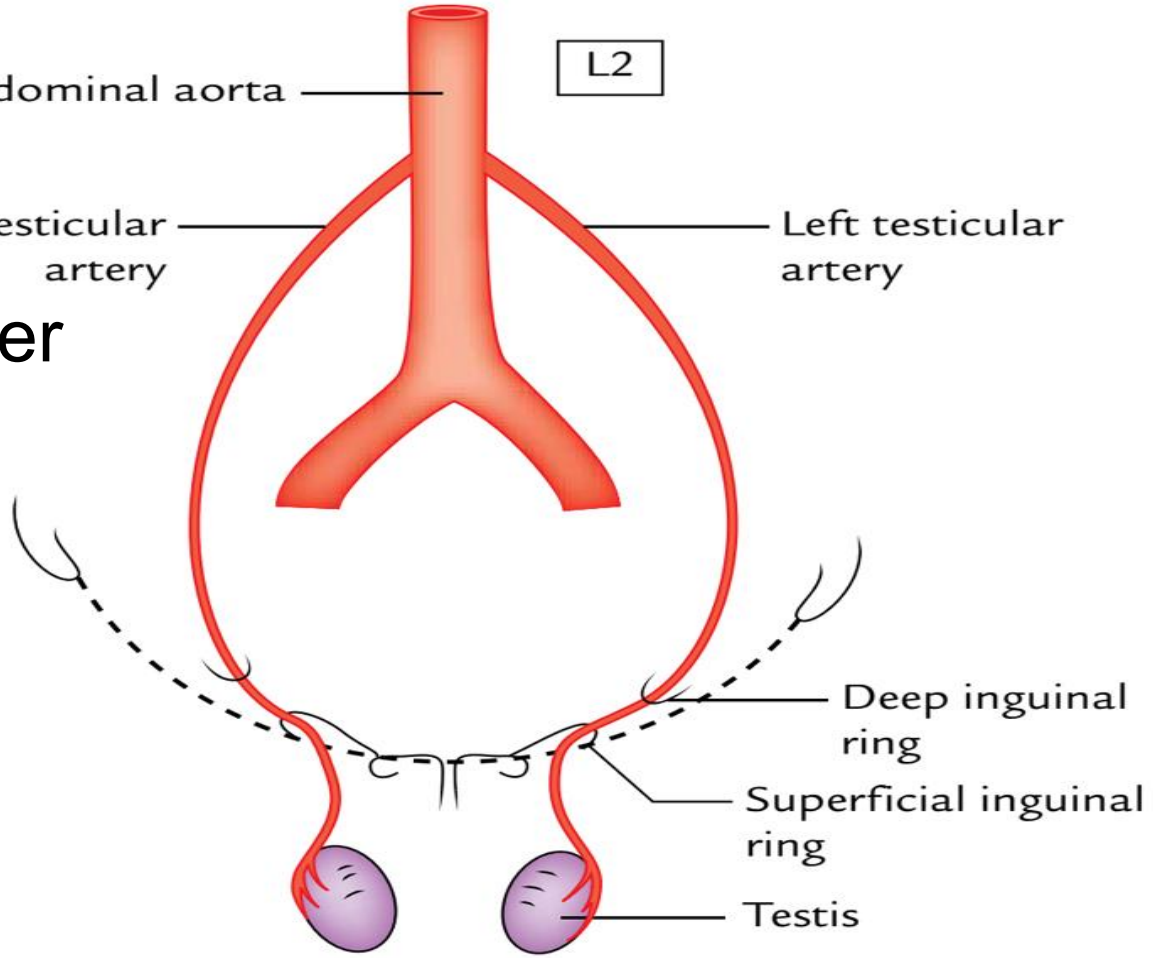
Example- whales and bats

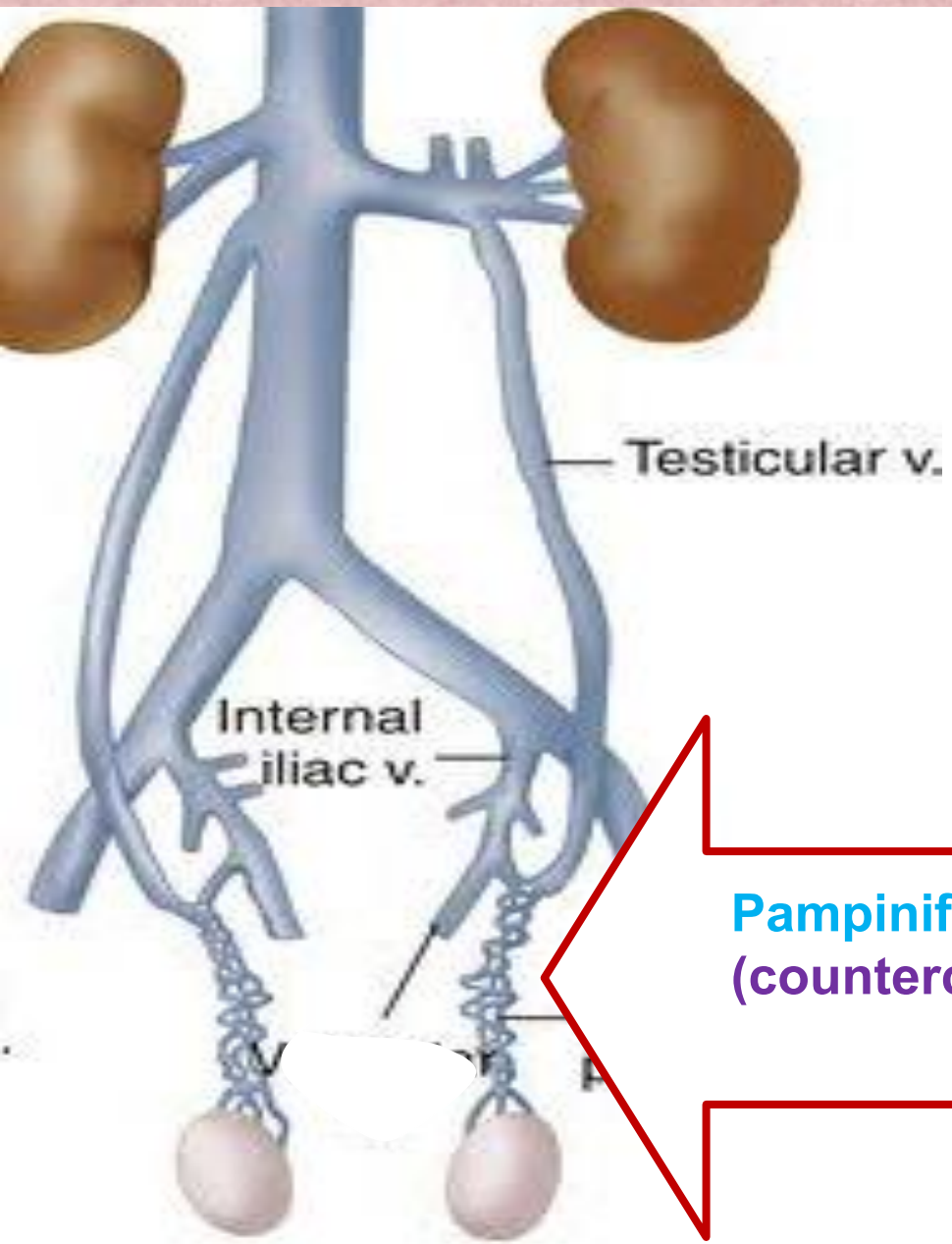
Artery Supply

supplied by testicular arteries for better nutrition



Arteries carry blood with body temperature

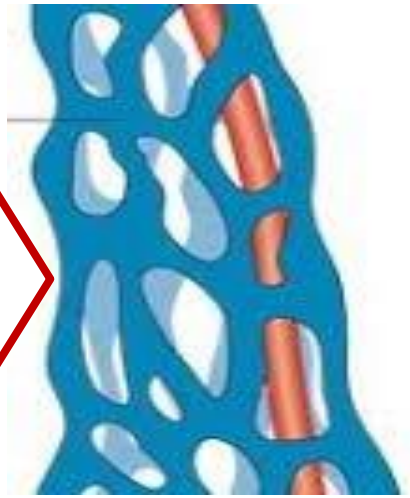
Venous Drainage



Vein carry blood with cool temperature

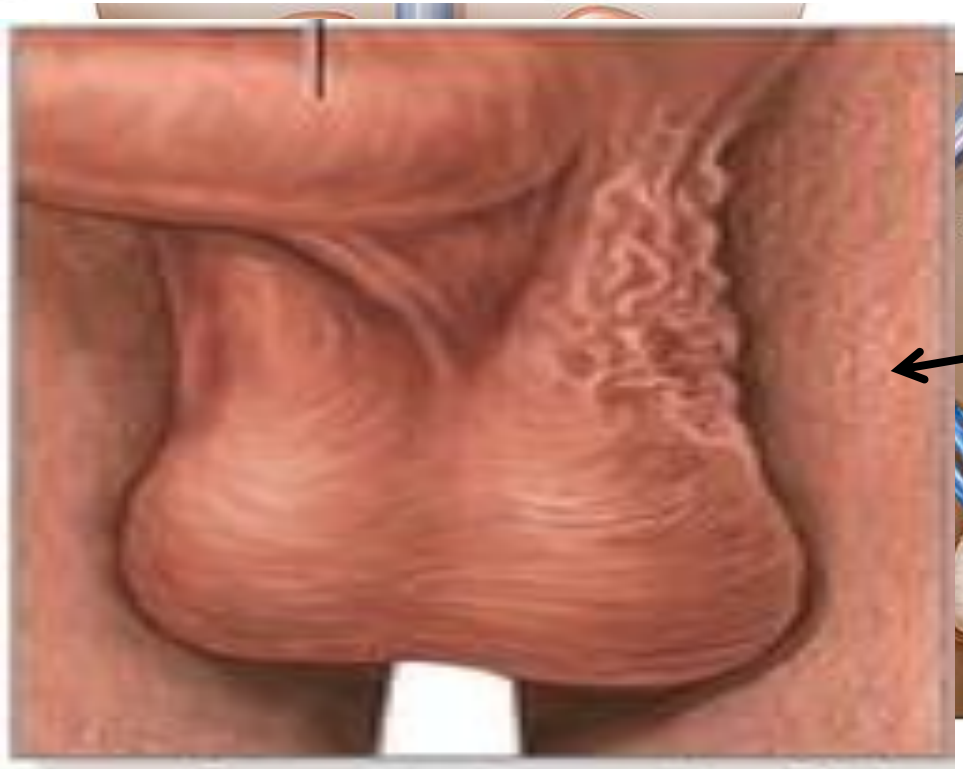
Testicular artery

Pampiniform venous plexus
(countercurrent thermal exchange)

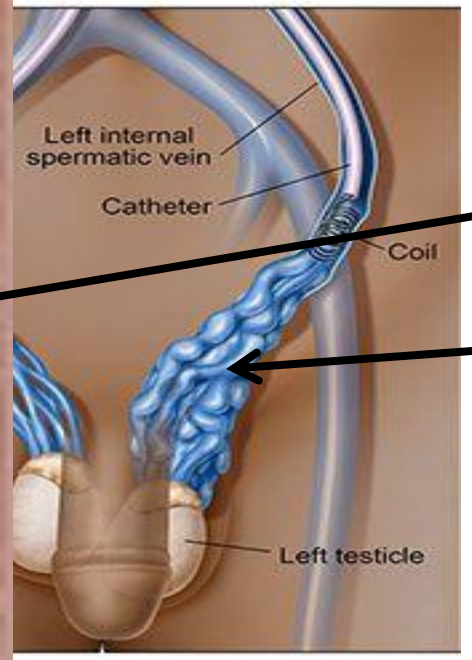


Venous drainage….

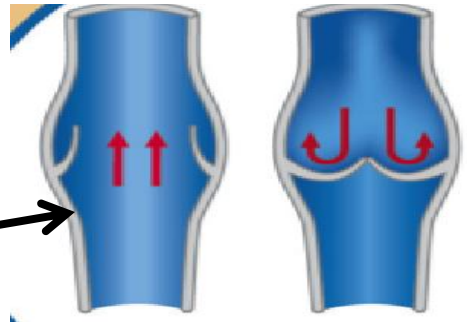
Varicocele
(Bag of Worms Appearance)

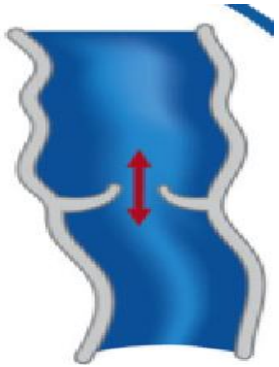


A varicocele can be felt and sometimes be seen as a tortuous mass on the surface of the scrotum



Competent valve





Incompetent valve

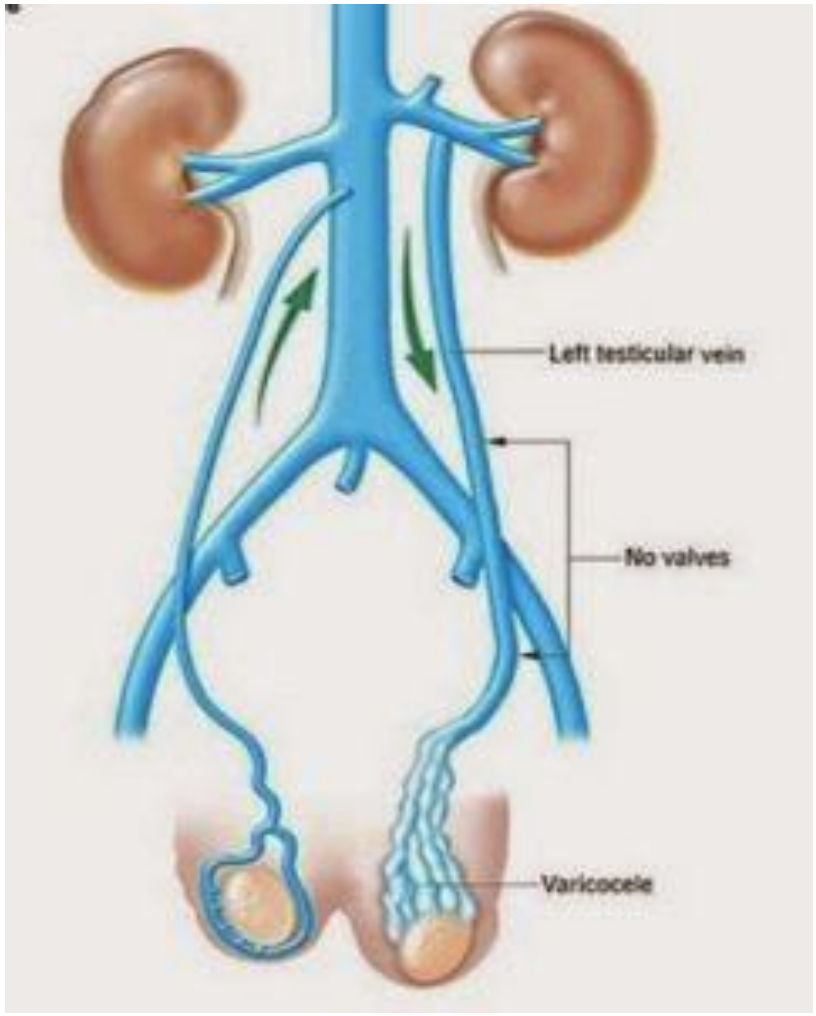
Venous drainage….

VARICOCELE

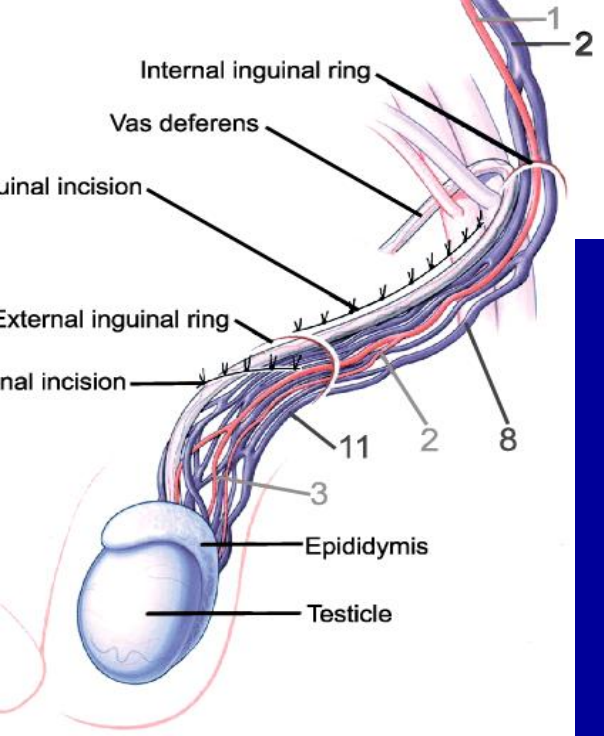
98% OF VARICOCELE ARE LEFT SIDED

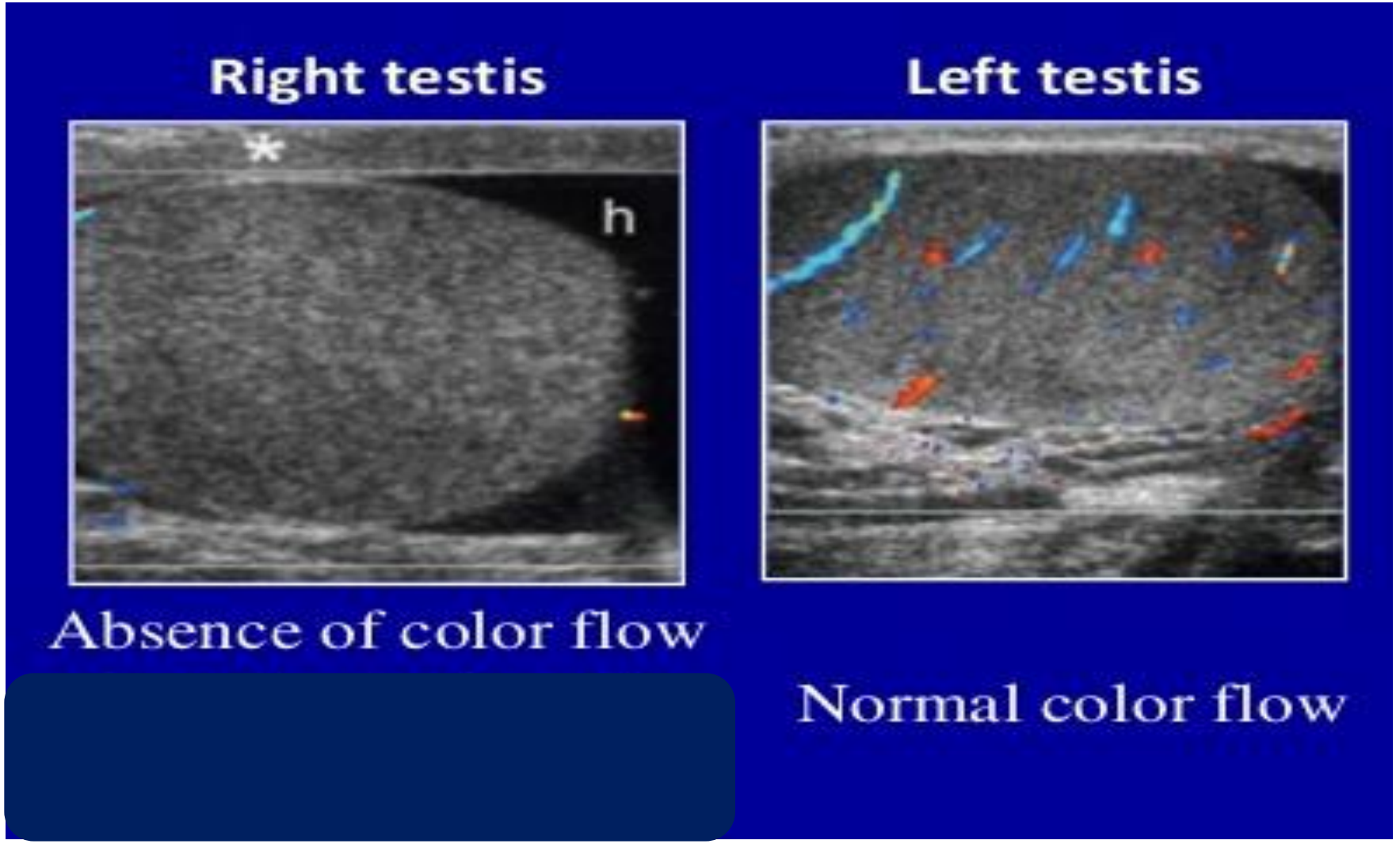
WHY?

- Left spermatic vein is more vertical where it connects to left renal vein.
- Left renal vein can be compressed by colon
- Left testicular vein is longer than the right
- Lacks of terminal valve



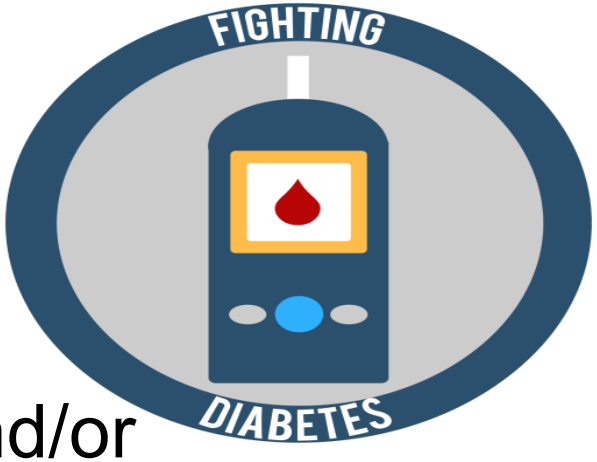
blood supply ….





Doppler study of testes

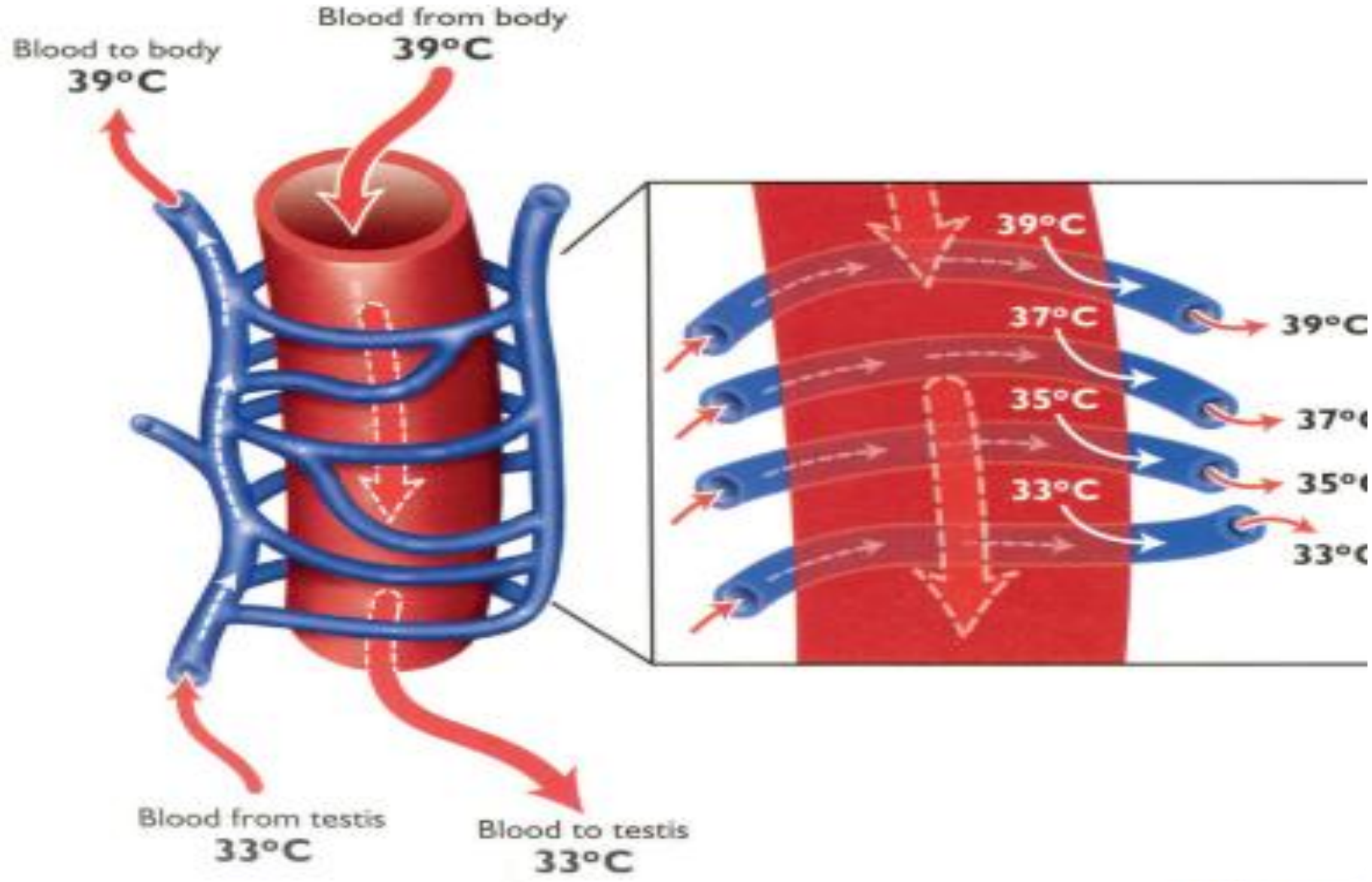
blood supply….



A history of diabetes may suggest a vasculopathy and/or liver disease may induce a hyperestrogenic state with a resultant low level of circulating free testosterone.

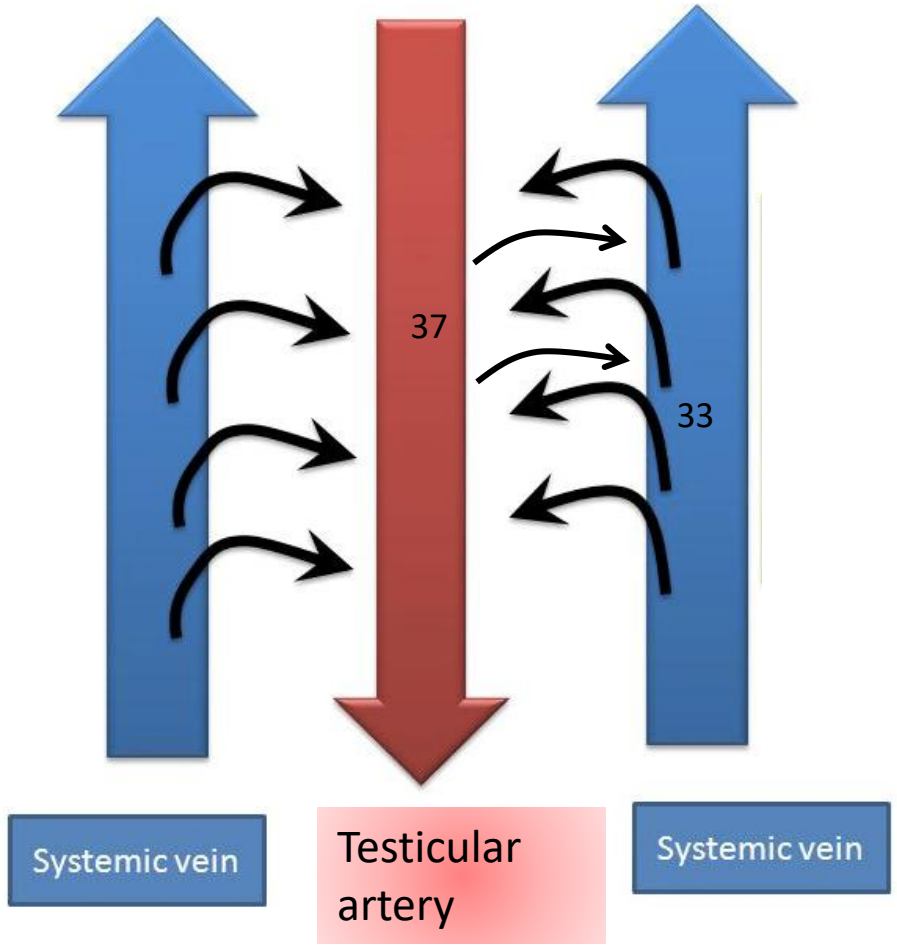
low testosterone low **libido** include lose interest in sex

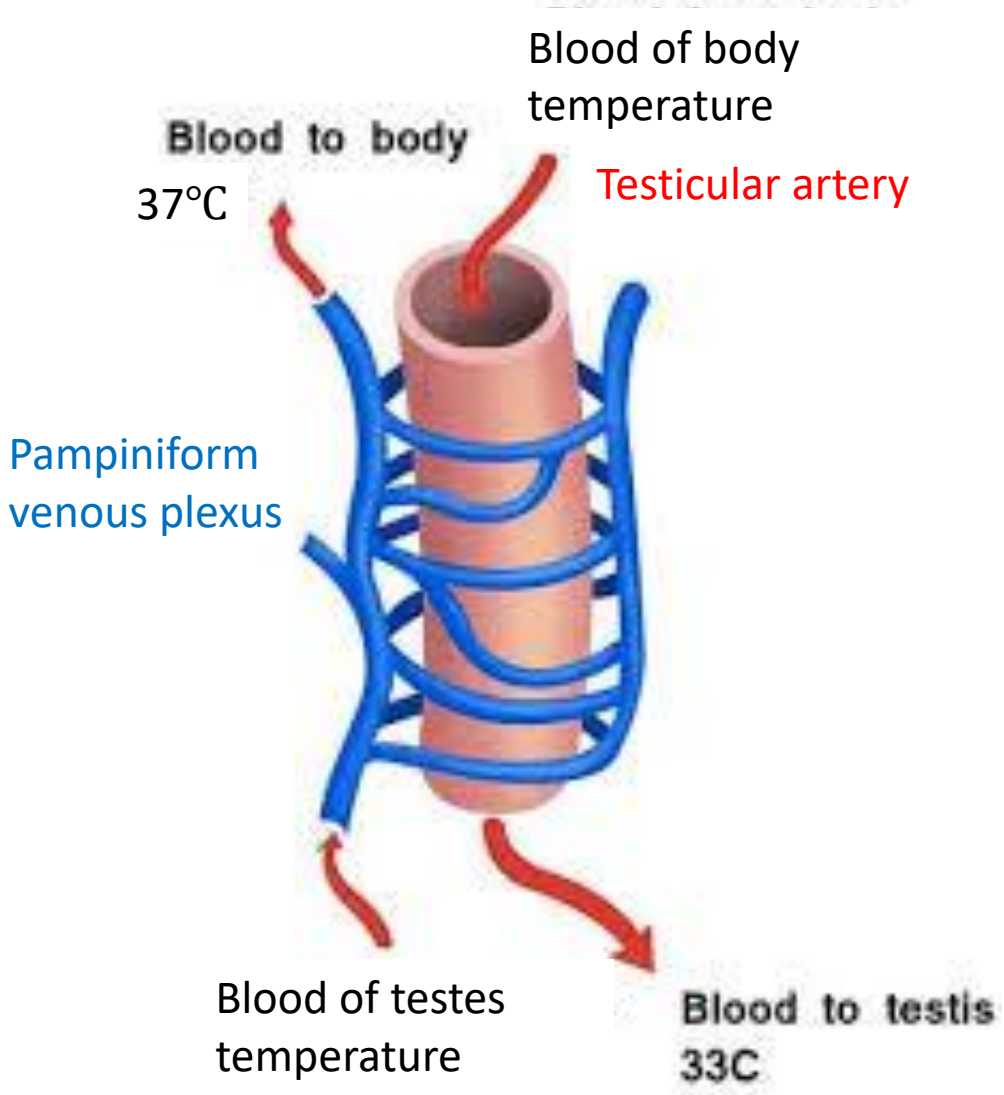
Testicular Thermoregulation



Blood supply regulate temperature

Counter flow heat exchange



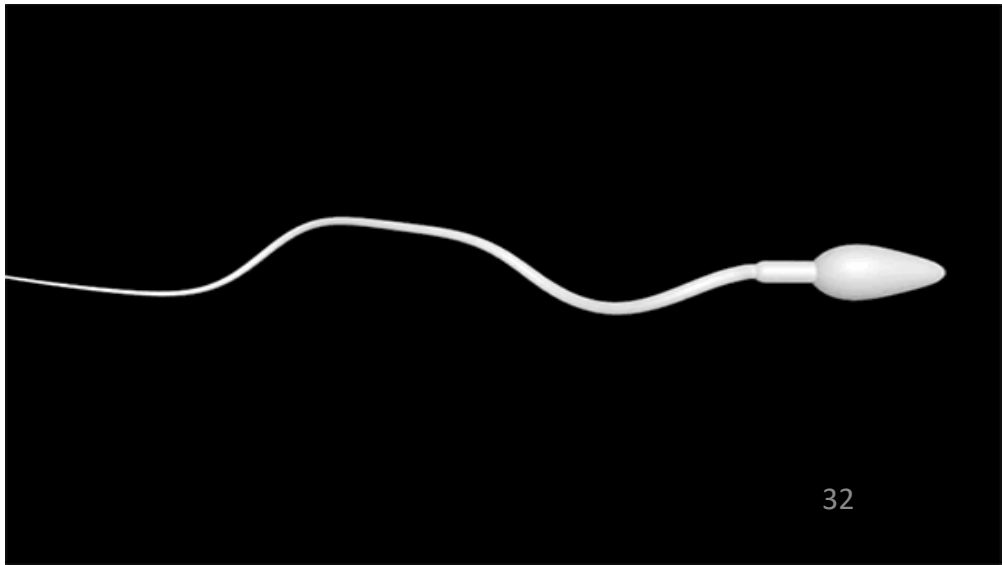


Climate control system

The temperature of the testes
is maintained at 34-35°Celsius

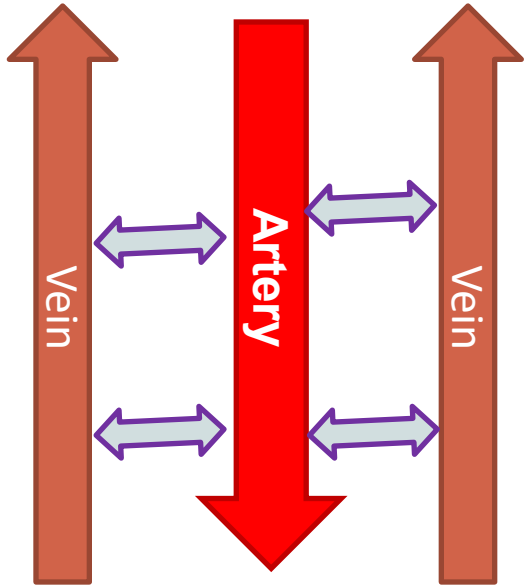
two-three degrees below the body temperature of 36–38°Celsius

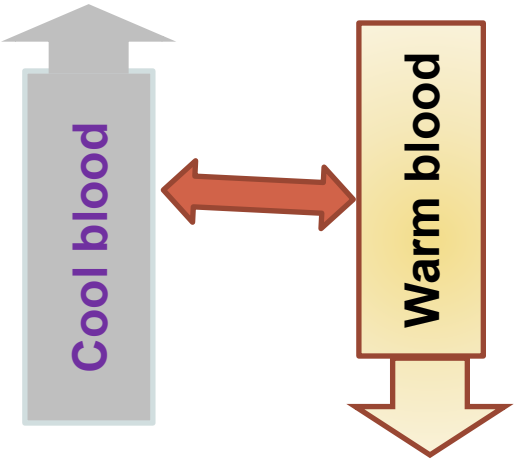
Spermatogenesis



Temperature is maintained by…

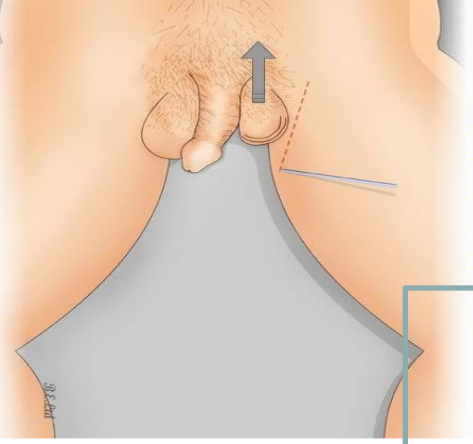
3 mechanism





- ❑ Counter-current heat exchange

- ❑ Sweating of scrotum



- Muscular effect

When warm is required

Contraction of cremasteric muscle

↓

Testicle moves up closer the body

↓

provides more warmth

When cooling is required

Relaxation of cremasteric muscle

↓

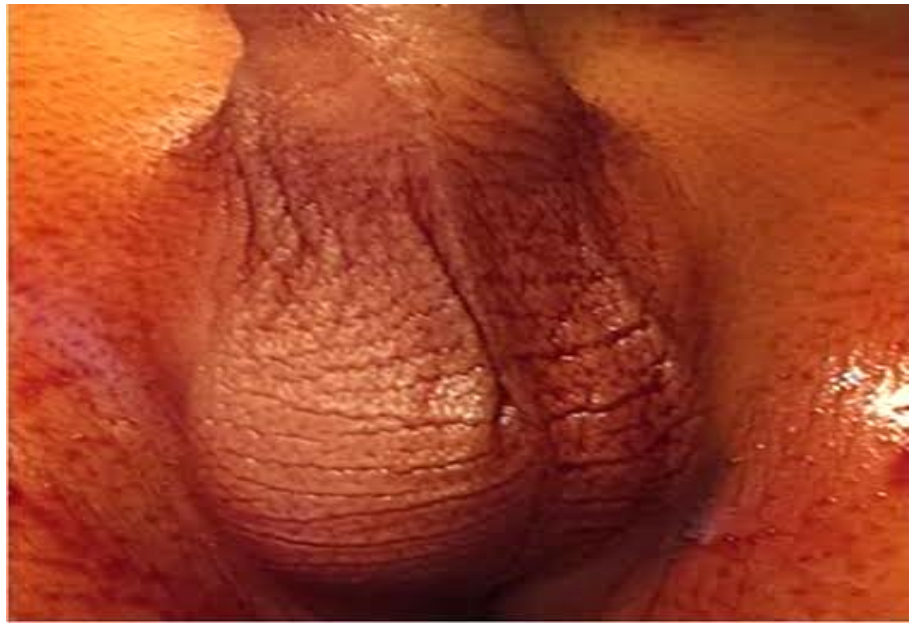
Testicle moves away from the body

↓

provides coolness

A Cremasteric muscle

❑ Muscular effect….



When warm is required

Contraction of dartos muscle

↓

wrinkling of scrotum

↓

reducing surface area of scrotum

↓

provides more warmth

When cooling is required

opposite events occur

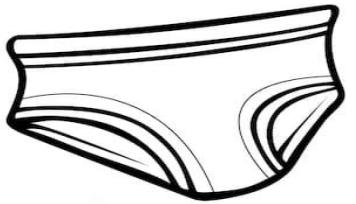
B Dartos muscle

Lifestyle impact on testicular thermoregulation

- Wearing of nappies (diapers) increases in scrotal temperature of 1–2˚ C

- Cloth nappies- small effect on scrotal temperature

Ref: research paper; journal article



- Exposure to 36°C for 12 hours per day, can impair spermatogenesis

- Scrotal temperature
  Clothed & sitting with thighs apart- about 35˚ C
  Clothed & sitting with thighs together- above 36˚ C

Thermoregulation..

Higher driving time

↓

Higher scrotal temperature

↓

lower sperm production

↓

reduced fertility

Lying in a warm bed in winter

↓

Testicle is relaxed in scrotum

↓

Sudden exposed to cold room air

↓

Abrupt temperature change

↓

Sudden scrotal muscle contraction

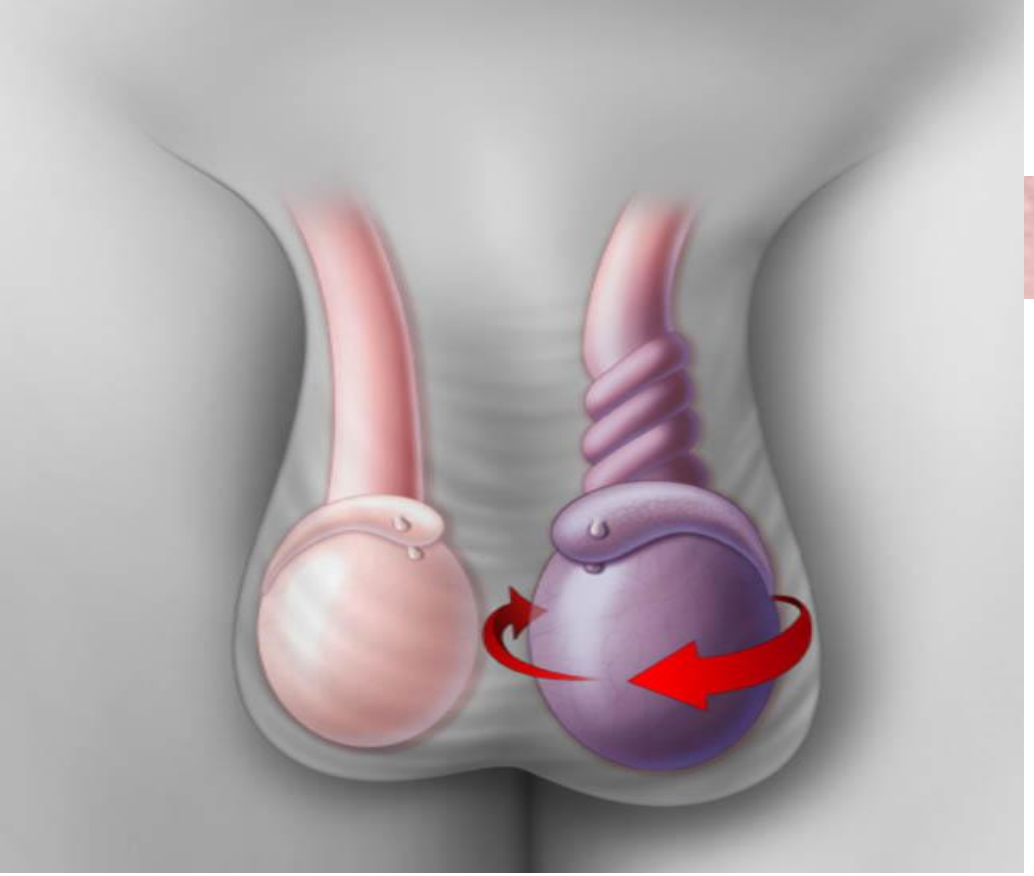
↓

Testicle is trapped

↓

Result **testicular torsion**

“Winter Syndrome”



Testicular Torsion

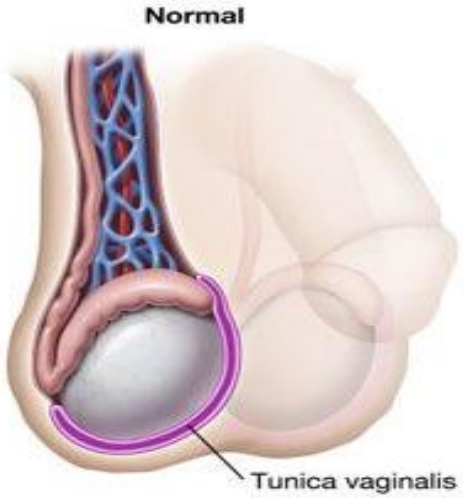
a
medical emergency

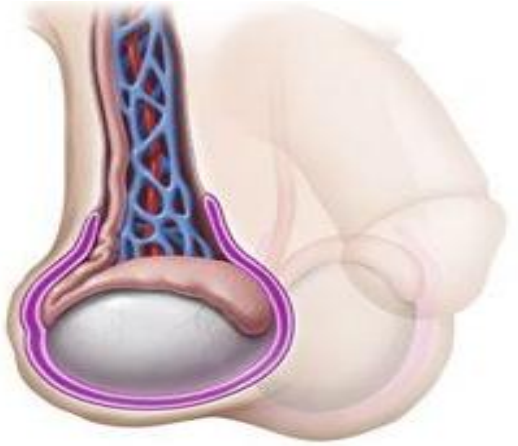
can happen at any time

those who are susceptible

Testicular torsion due to…

- horizontal lie of the testicle



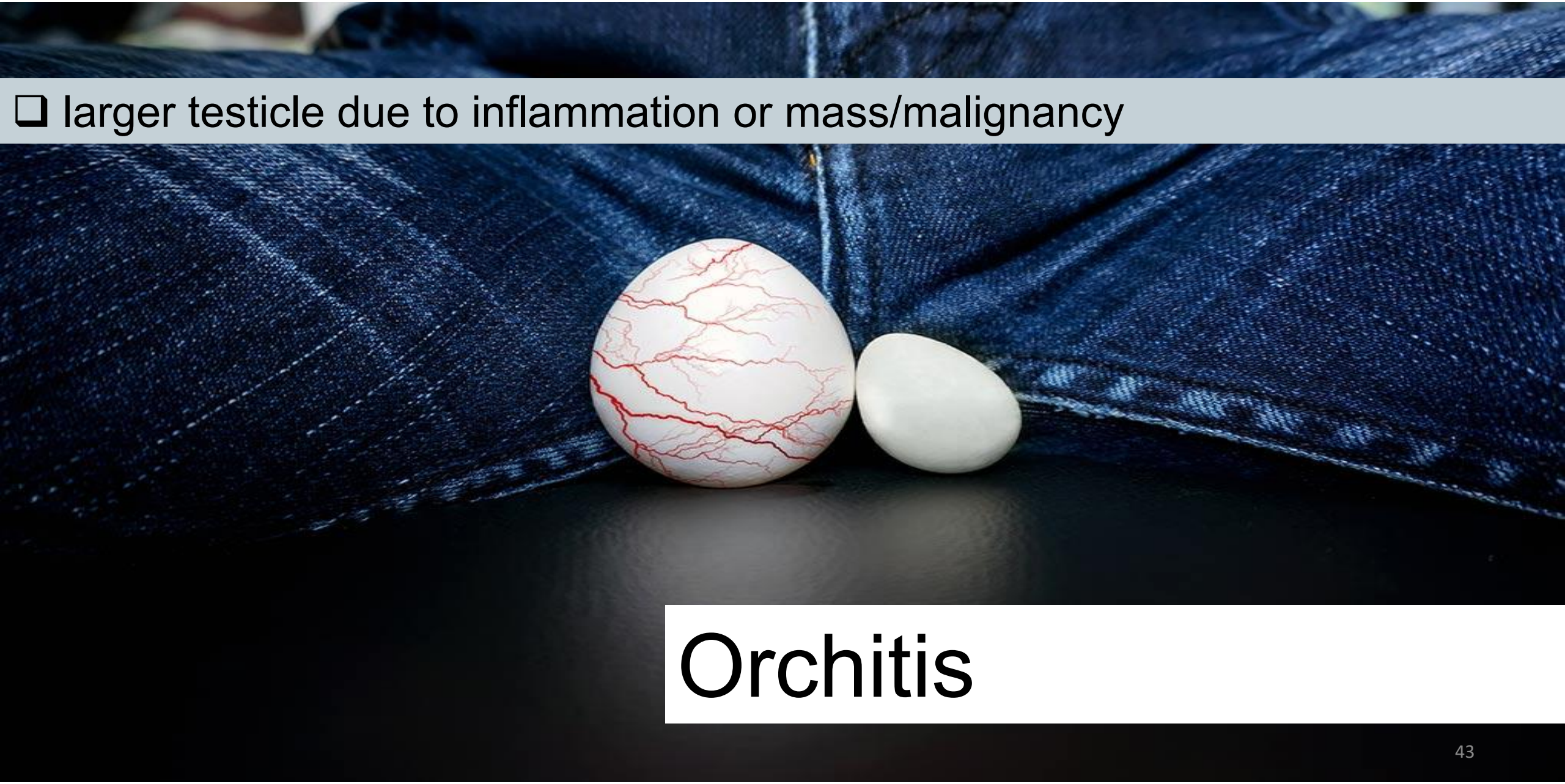


- bell clapper scrotum- testicle "swings" like a bell clapper where testicle is only attached to the spermatic cord not to the scrotum

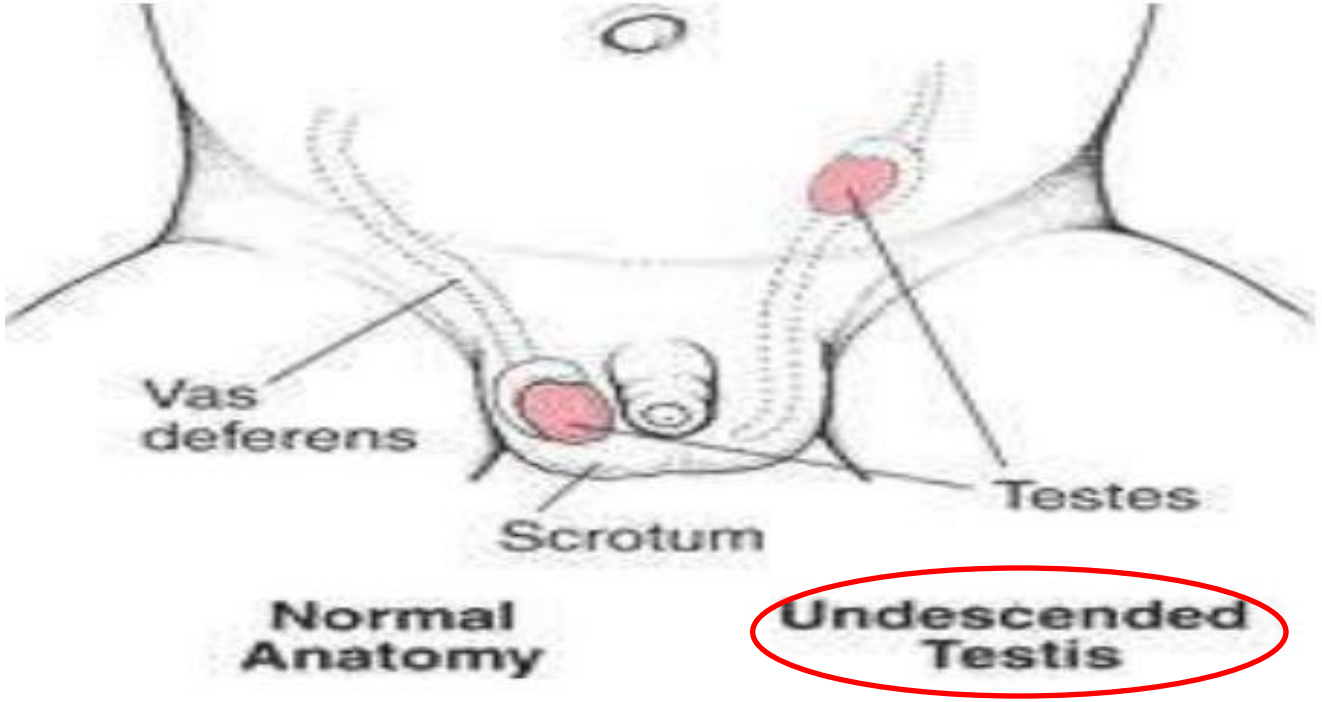
- rapid growth during puberty

- caused by trauma to the scrotum or exercise in particular, bicycle riding

- larger testicle due to inflammation or mass/malignancy



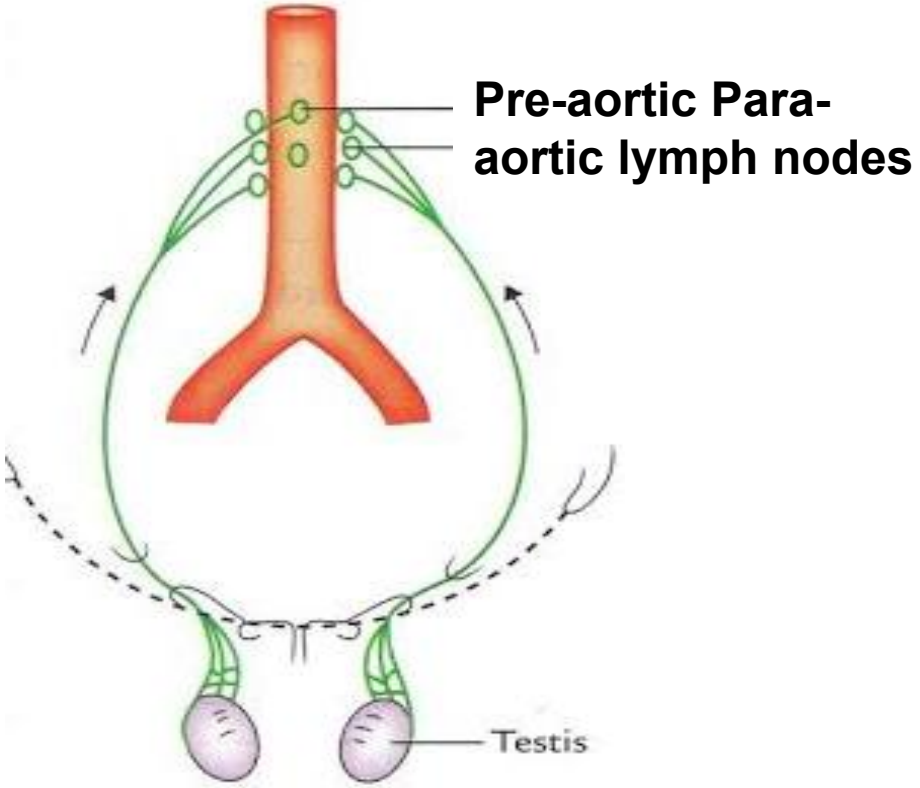
Orchitis



- **Cryptorchidisim-** proposing a 10-fold higher risk factor

Lymphatic Drainage

Para & pre-aortic lymph nodes



Despite the partial protection of spermatocytes by Sertoli cells & blood-testis barrier, some lymphocytes can pass into the seminiferous tubule & the immunosuppressive effect of testosterone suppresses antibody production.

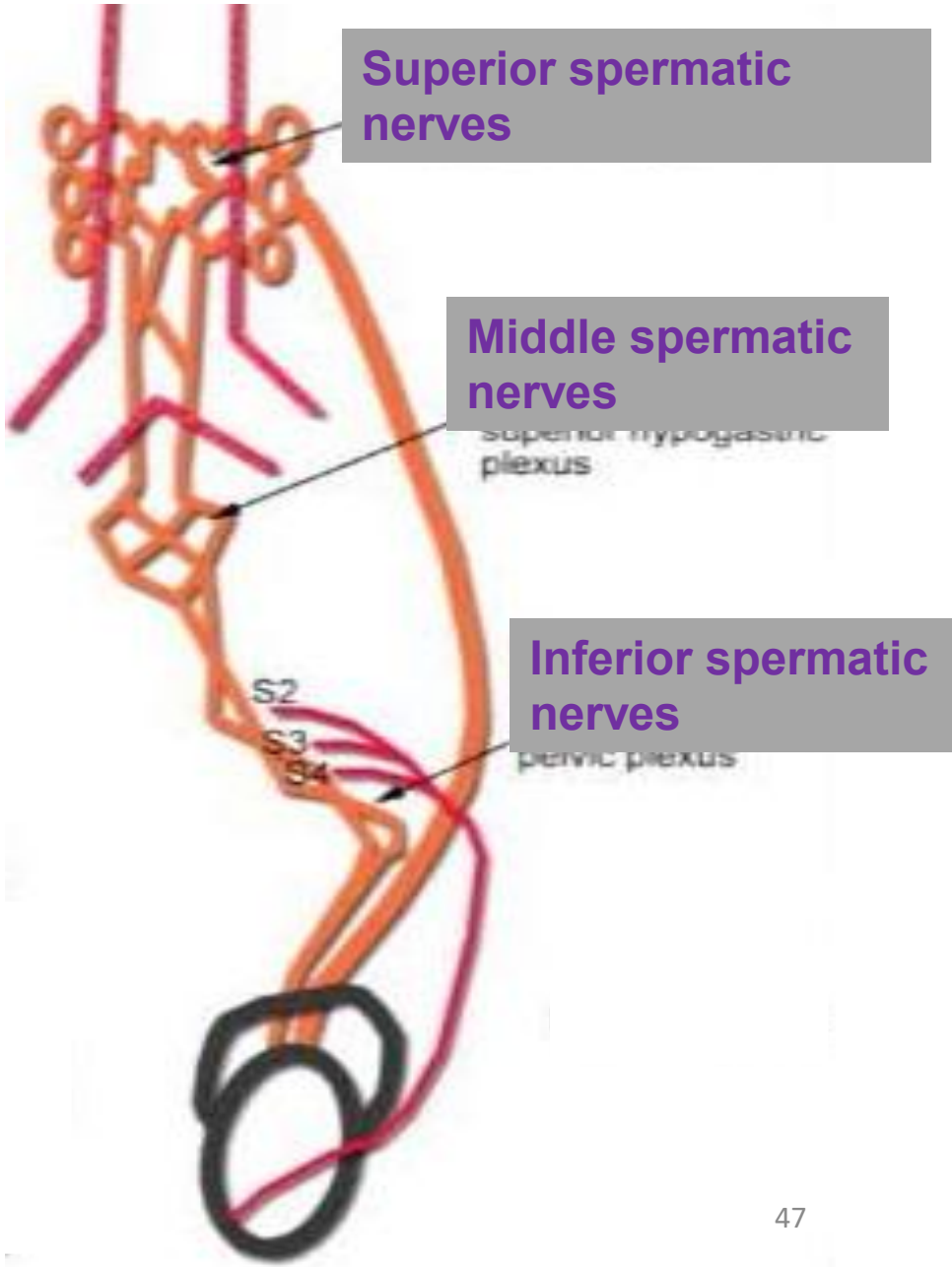
Scrotal elephantiasis

Man with the 132-pound scrotum

no abnormalities were shown in testes by ultrasonography

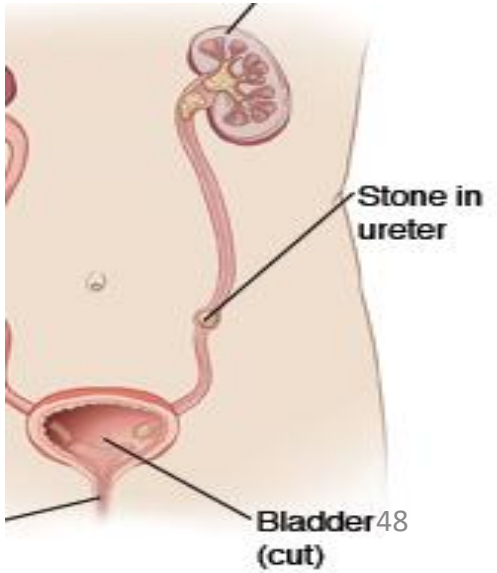
Nerve Supply

3 groups of autonomic nerves travel with the gonadal vessels & vas deferens



Superior spermatic nerves, composed of fibers from the renal and intermesenteric plexuses
which may explain the **“kick in the stomach”** feeling accompanying testicular injury.

Middle spermatic nerves arise from the superior hypogastric plexus which may explain pain radiation to the scrotum of an obstructing ureteric stone.



Inferior spermatic nerves originate from the pelvic plexus (inferior hypogastric plexus)

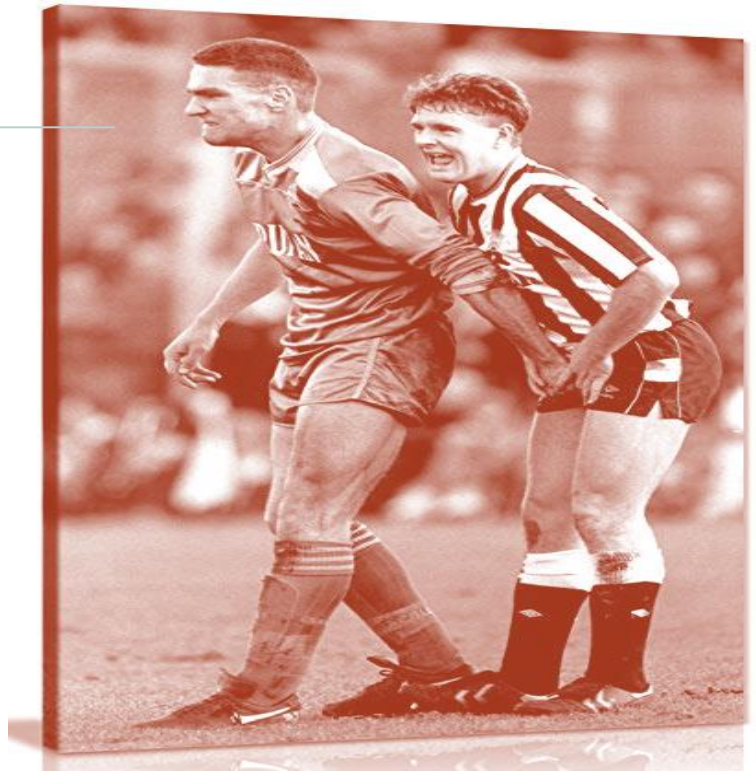
Some afferent and efferent fibers decussate to the contralateral pelvic plexus which may explain how lesions in one testis affect the function of the other testis.

Assault on the genitalia

- China News 24 reported woman kills man by squeezing testicles

- **Kapoor**, who is also an Associate Professor of urology at the Icahn School of Medicine at Mount Sinai Hospital, said that while the testicles are one of the most pain-sensitive areas of the male body pain was intense enough to make faint

Nerve supply……



The Deadly Science Behind Testicle Squeezing

A significant amount of force about **50 kg** is required to rupture

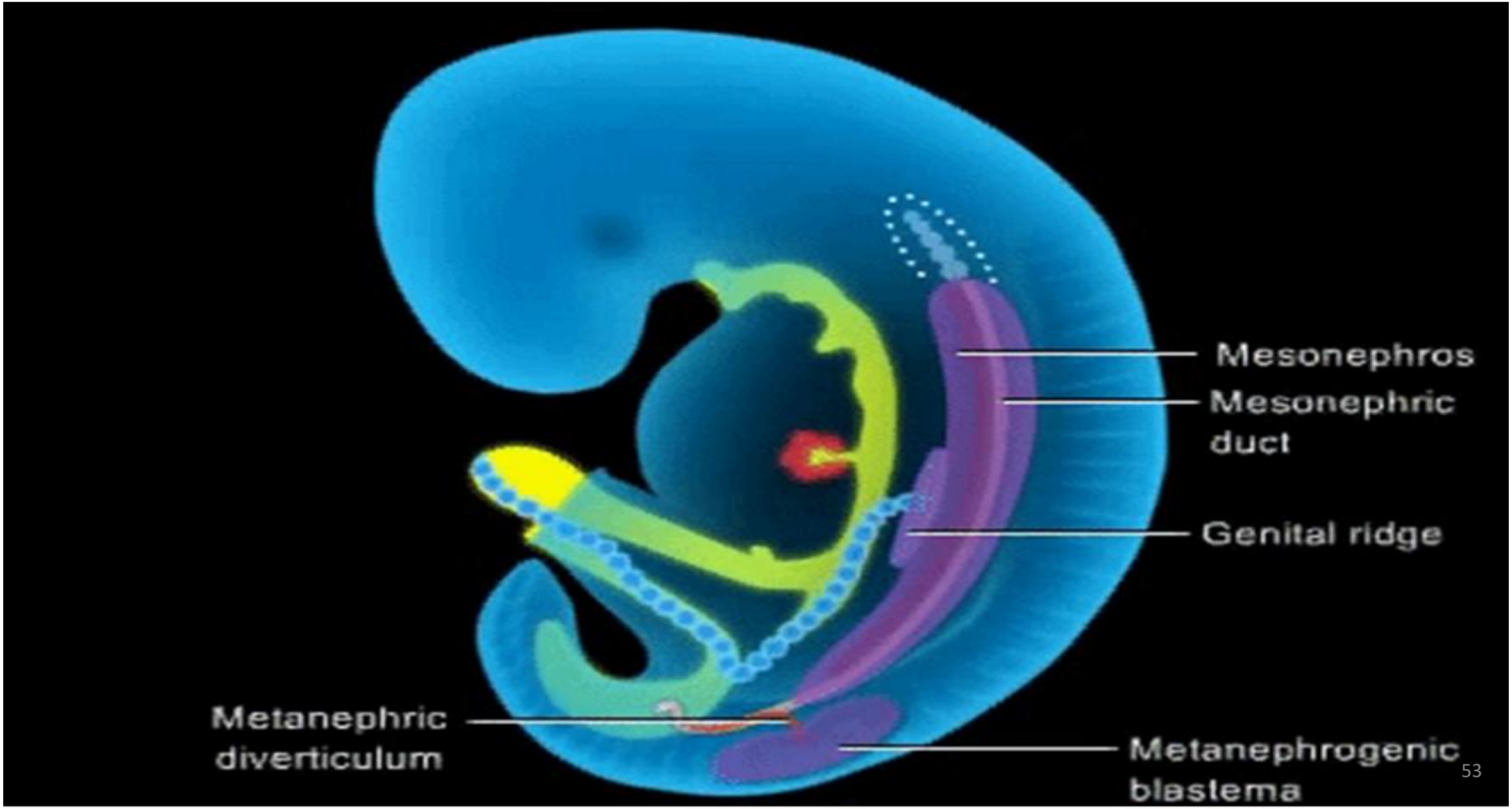
Development

Testes develops in extraperitoneal tissue of posterior abdominal wall at the level of L2 vertebra

Source of development

- ❑ Spermatogenic cell
  → Endodermal primordial germ cell
- ❑ Sertoli cell
  → Mesodermal surface epithelium of the gonad
- ❑ Leydig cell
  → Mesenchyme of the gonadal ridge

Primordial germ cells migration



Failure to reach male **Primordial germ** cells to genital ridges, the testes do not develop

Primordial germ cells carry XY sex chromosome

SRY **gene** present on the Y chromosome

encodes the testis-determining factor

Indifferent gonad

Testes

Development..

Testes

Müllerian inhibiting substance (Sertoli cells)

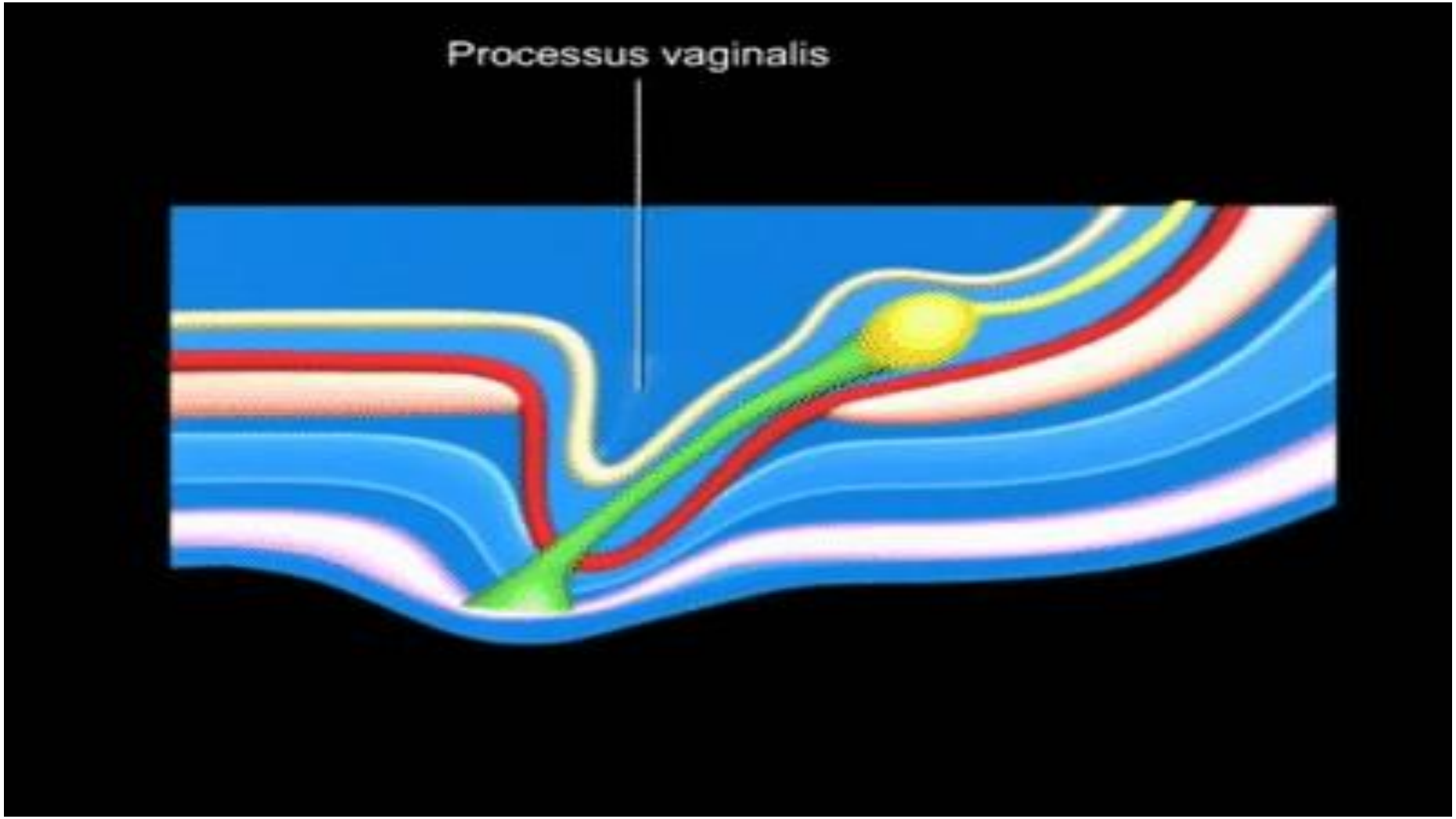
Paramesonephric ducts suppressed

Testosterone (Leydig cells)

Mesonephric ducts stimulated (vas deferens, epididymis)

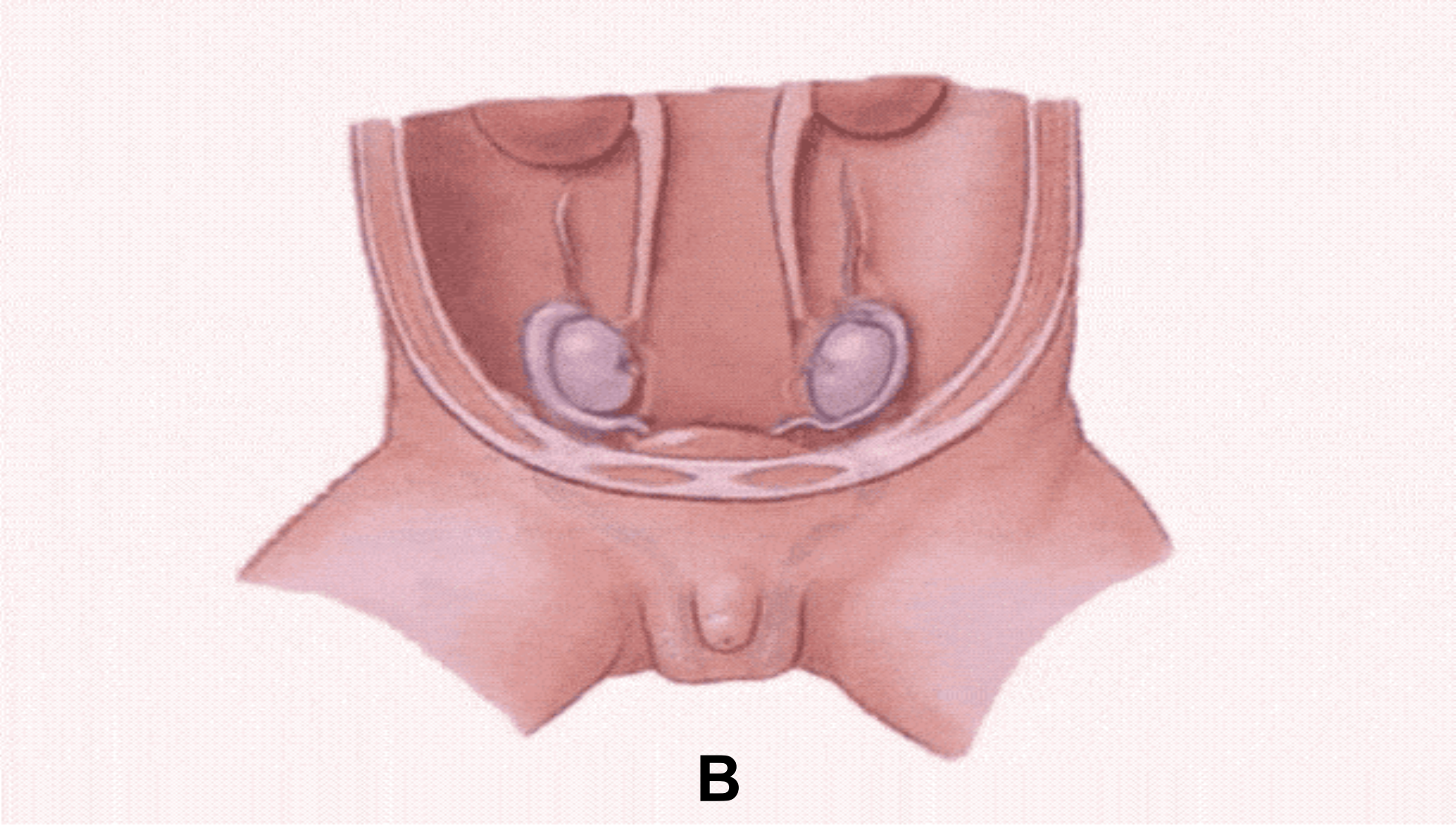
Dihydrotestosterone
External genitalia stimulated
Growth of penis, scrotum, and prostate

Process of relocation



A

Process of relocation

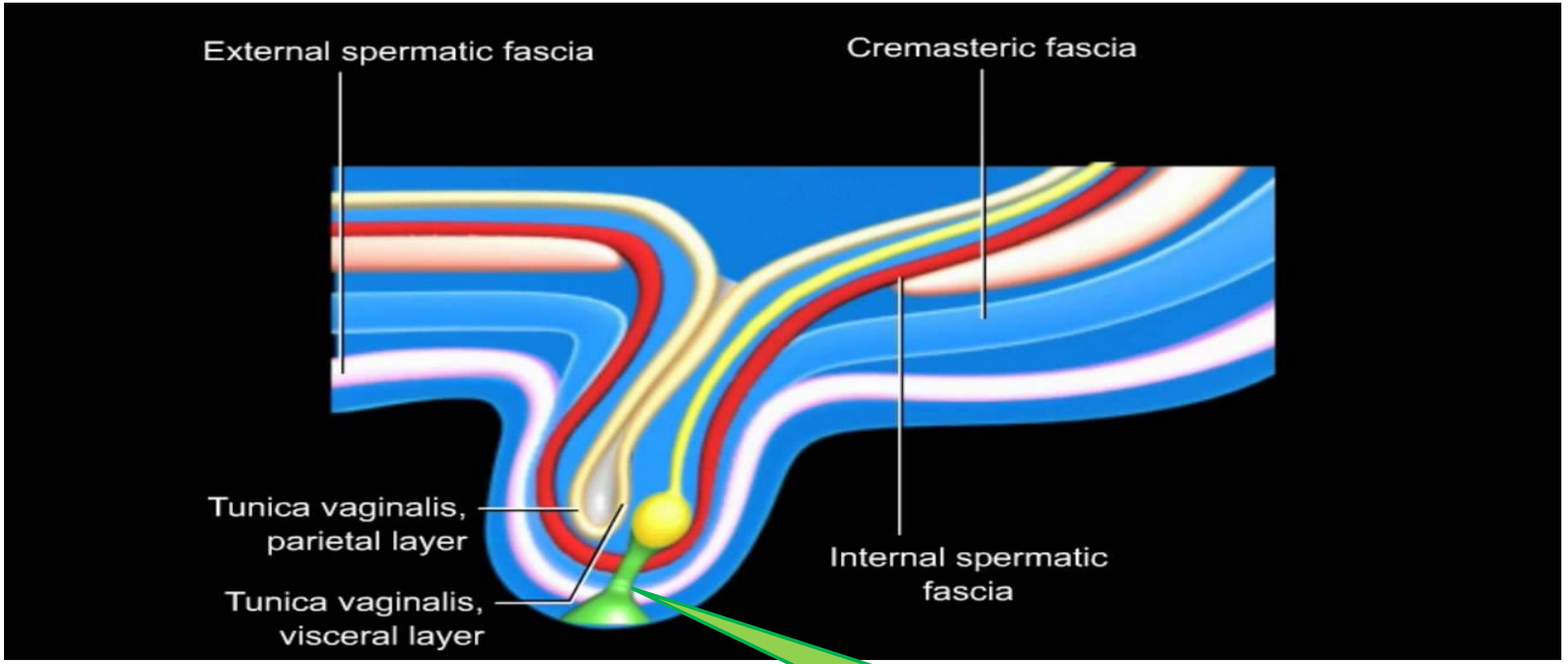


B

Factors for the descent

1. Gubernaculum testis
2. Increased intra-abdominal pressure
3. Intra-abdominal temperature→ scrotal temperature 4^{0}C lower than the abdomen
4. Contraction of the arched fibres of internal oblique muscle
5. Changing of the foetal curves
6. Secretion of testicular hormone

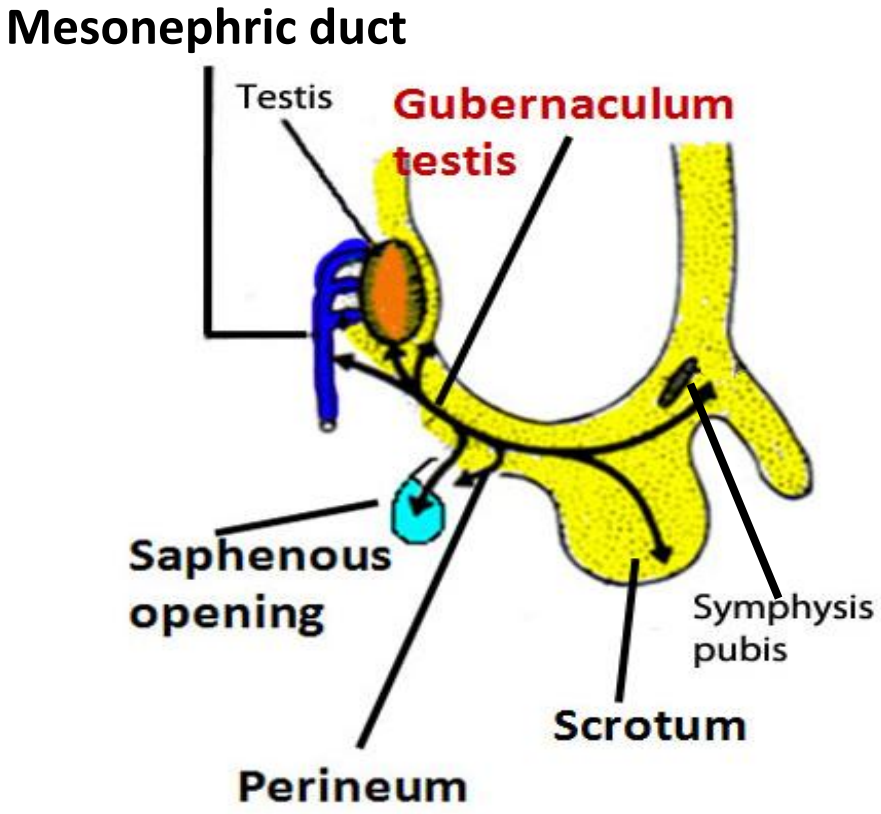
Role of gubernaculum testis



Gubernaculum Testis

-is a fibro-muscular band

Extension: Lower end of testis to the bottom of scrotum



Distally, It may be attached to-

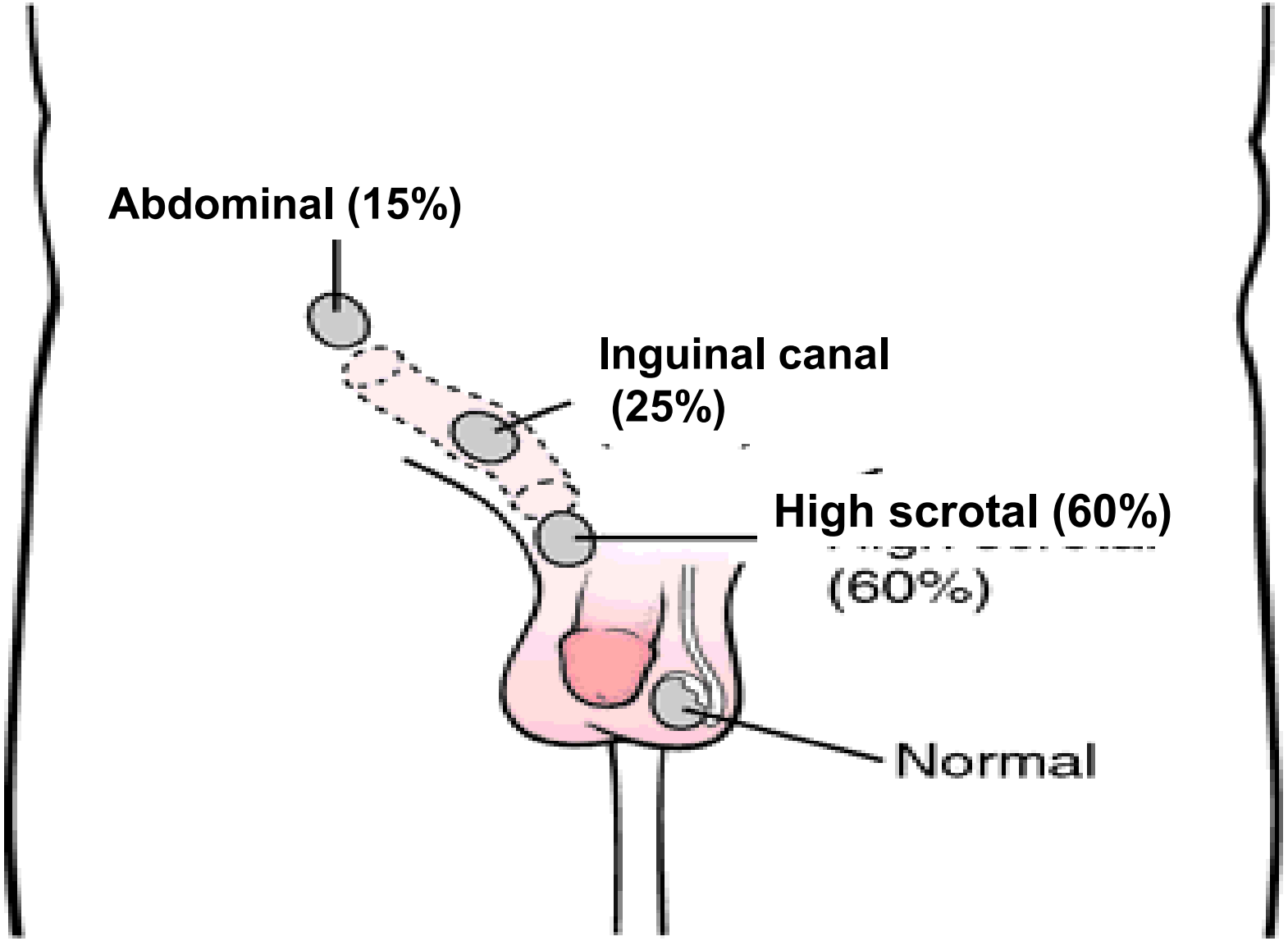
(a) Superficial perineal pouch

(b) Symphysis pubis above penis

(c) Saphanous opening of thigh

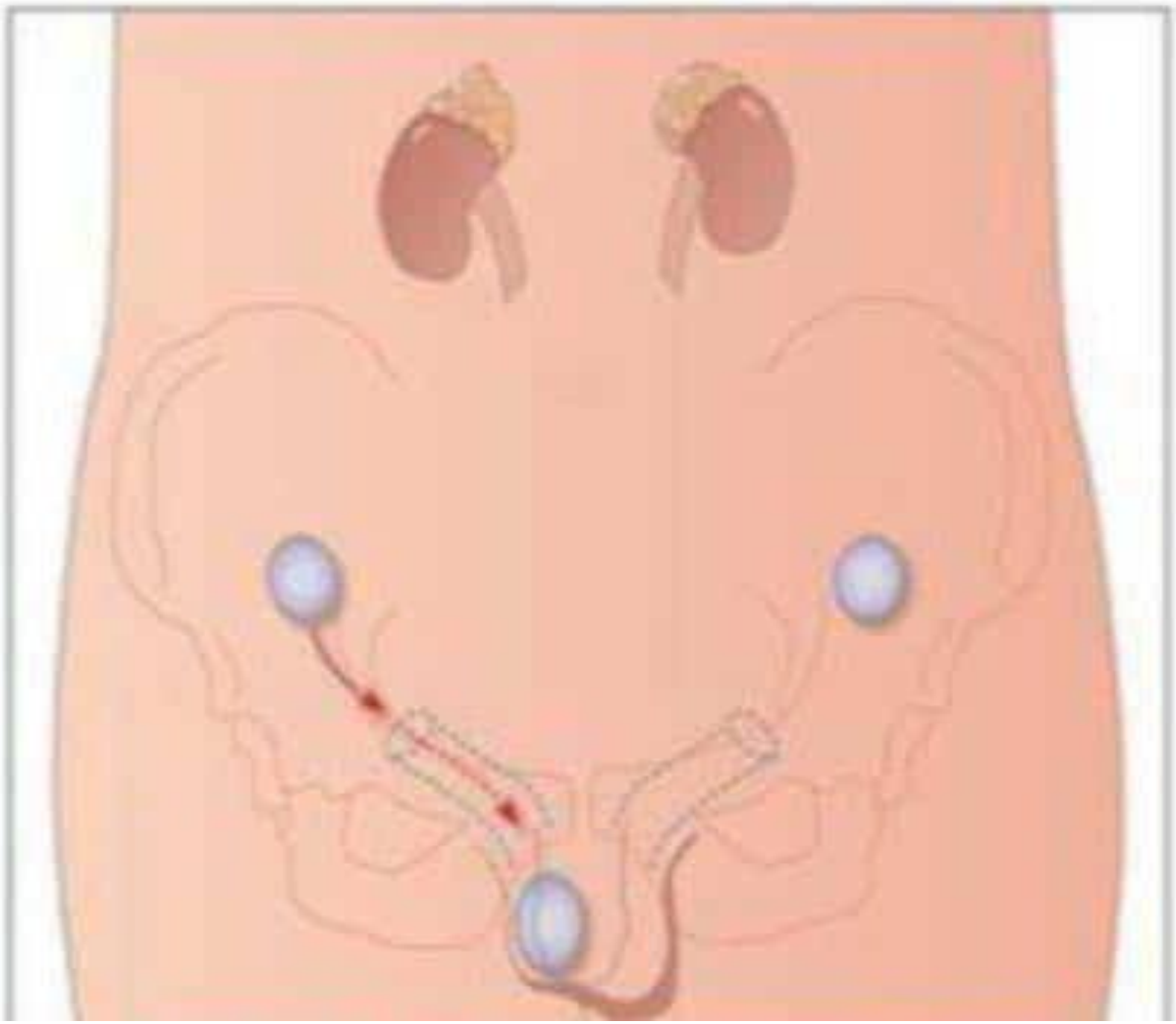
which cause ectopic testis

Ectopic testis



Left perineal ectopic testis

Penile ectopic testis



Cryptorchidism

The American Urological Association reported that

have an undescended testicle in
3–4 % of full-term male newborns &
21 % of those born prematurely.

Usually, one testicle does not descend.

Both are undescended in 10 % of cases.

Monorchism

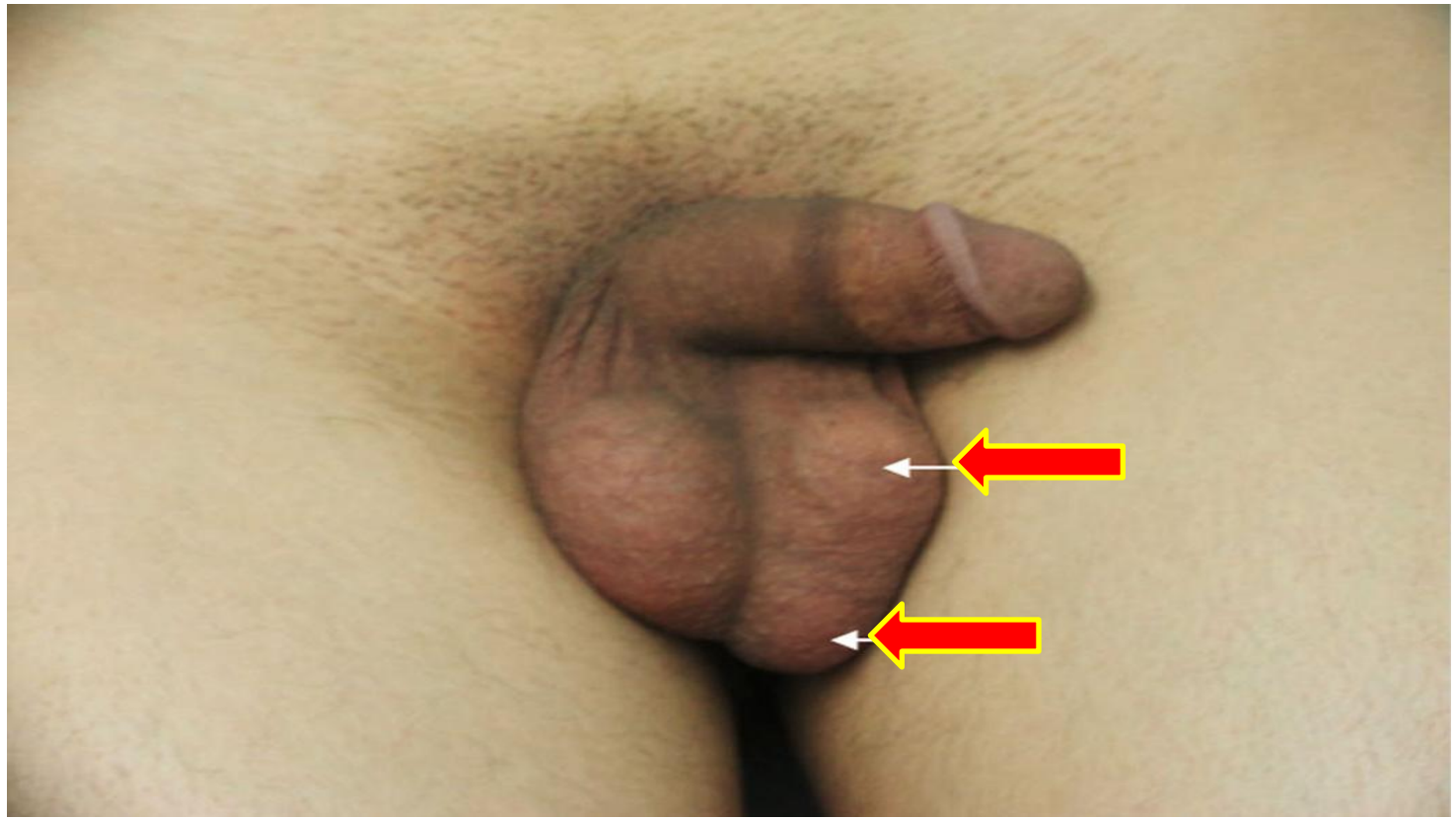
Anorchism/ vanishing testis

- Failure of development
  before 8 weeks-
  born with female sex organs

- Disappearence
  between 8 and 10 weeks
  born with ambiguous genitalia

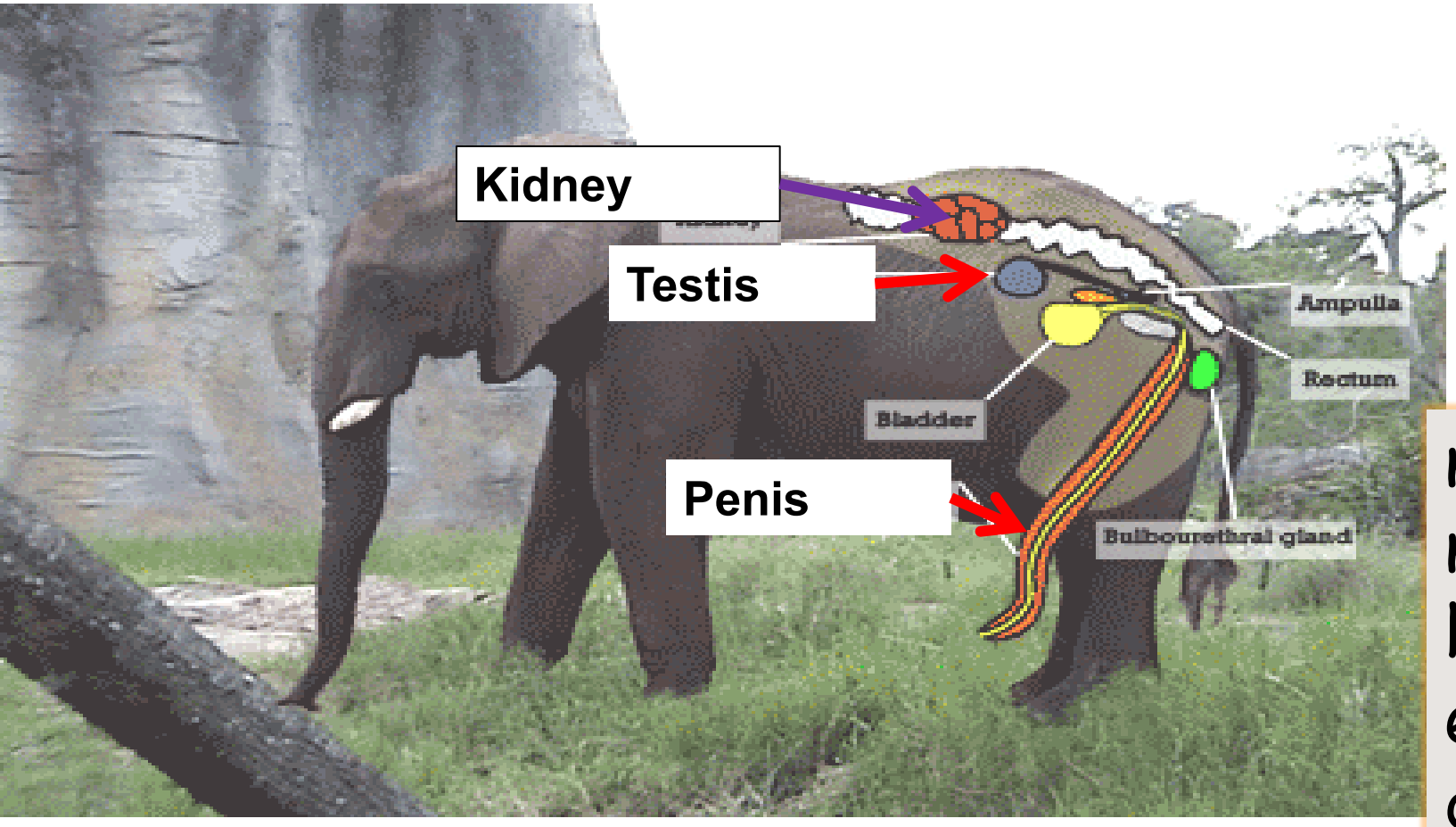
  between 12 and 14 weeks
  normal penis & scrotum

Testis Supernumerary/ Polyorchidism



More than two testes present in scrotum

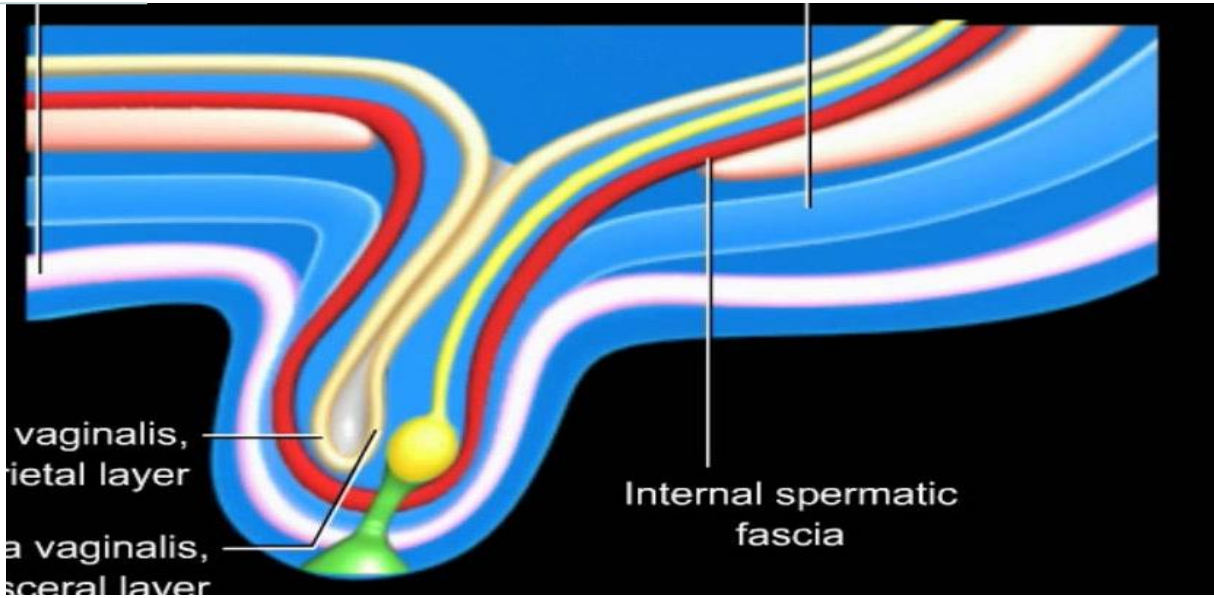
- ❑ Due to segmentation of primitive gonads
- ❑ Mistaken cause for extra testicular neoplasm



no gubernaculum,
no scrotum &
hence no means of effecting testicular descent

The testes of elephants
are completely abdominal

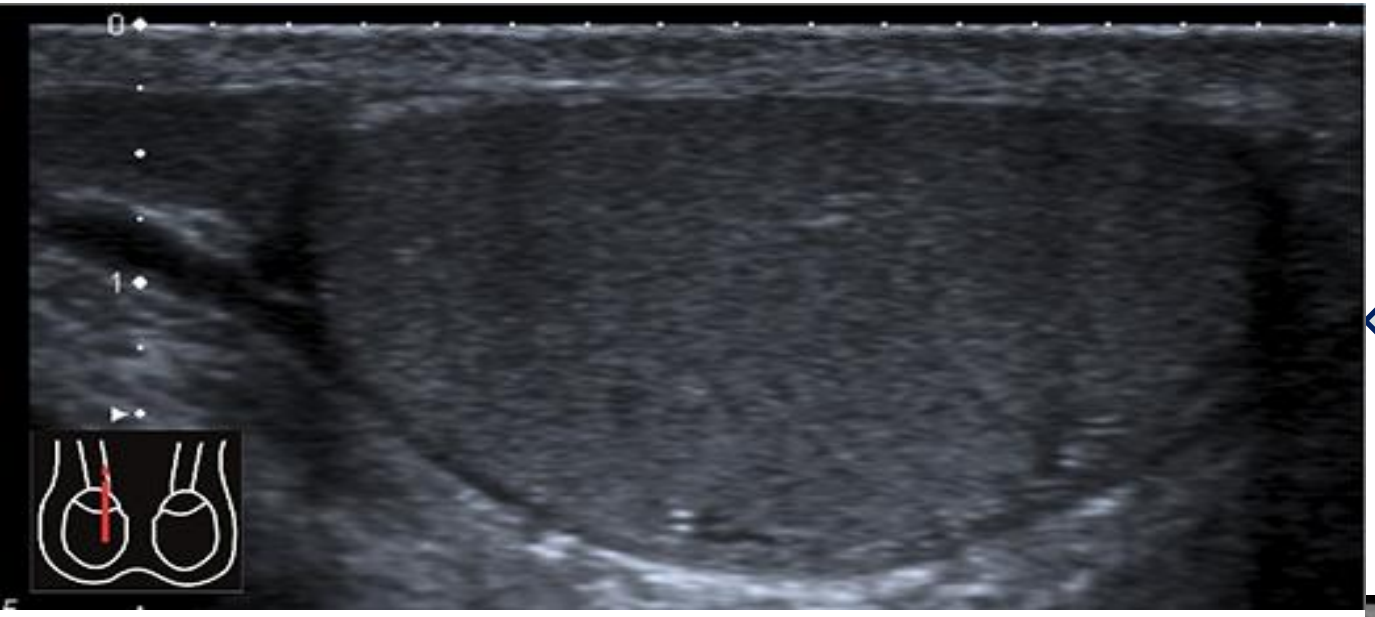
Hydrocele



accumulation of excess fluid between parietal & visceral layer of tunica vaginalis

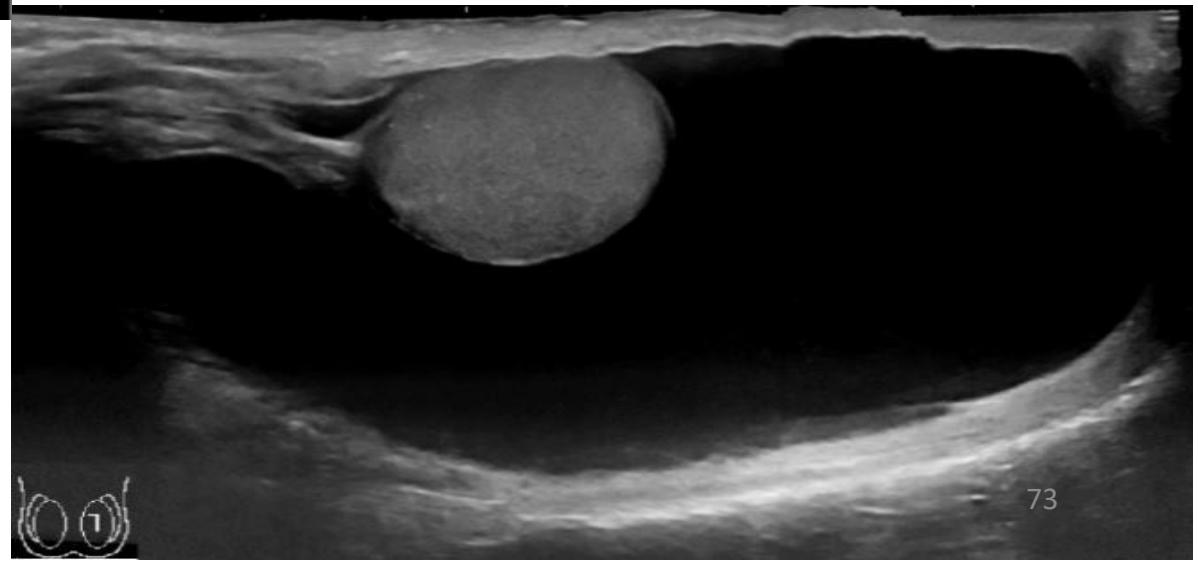

Normal
Non-communicating hydrocele
Communicating hydrocele
Hydrocele of the cord
Abdominal cavity
Testicle
Scrotum

USG finding

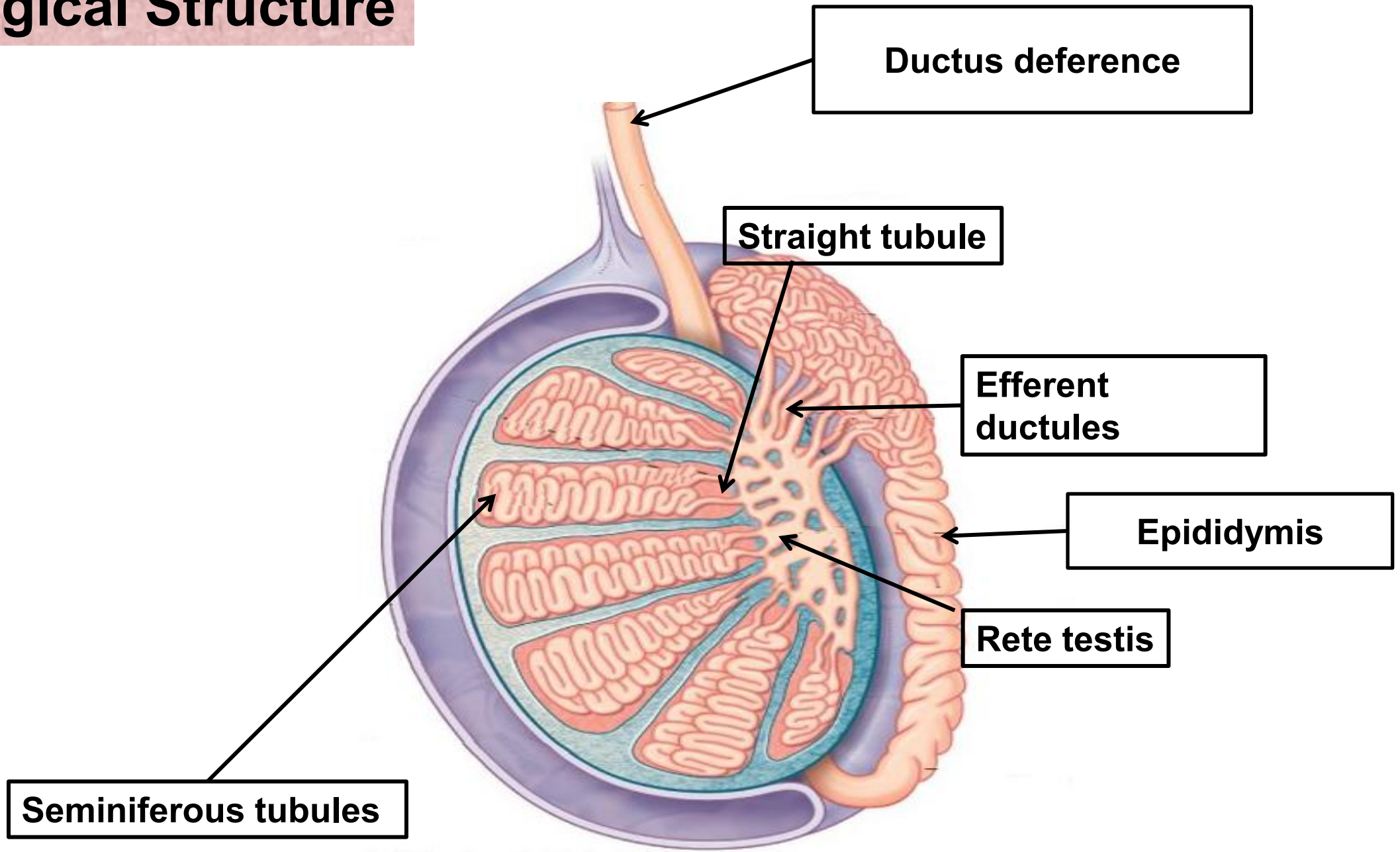


Normal study

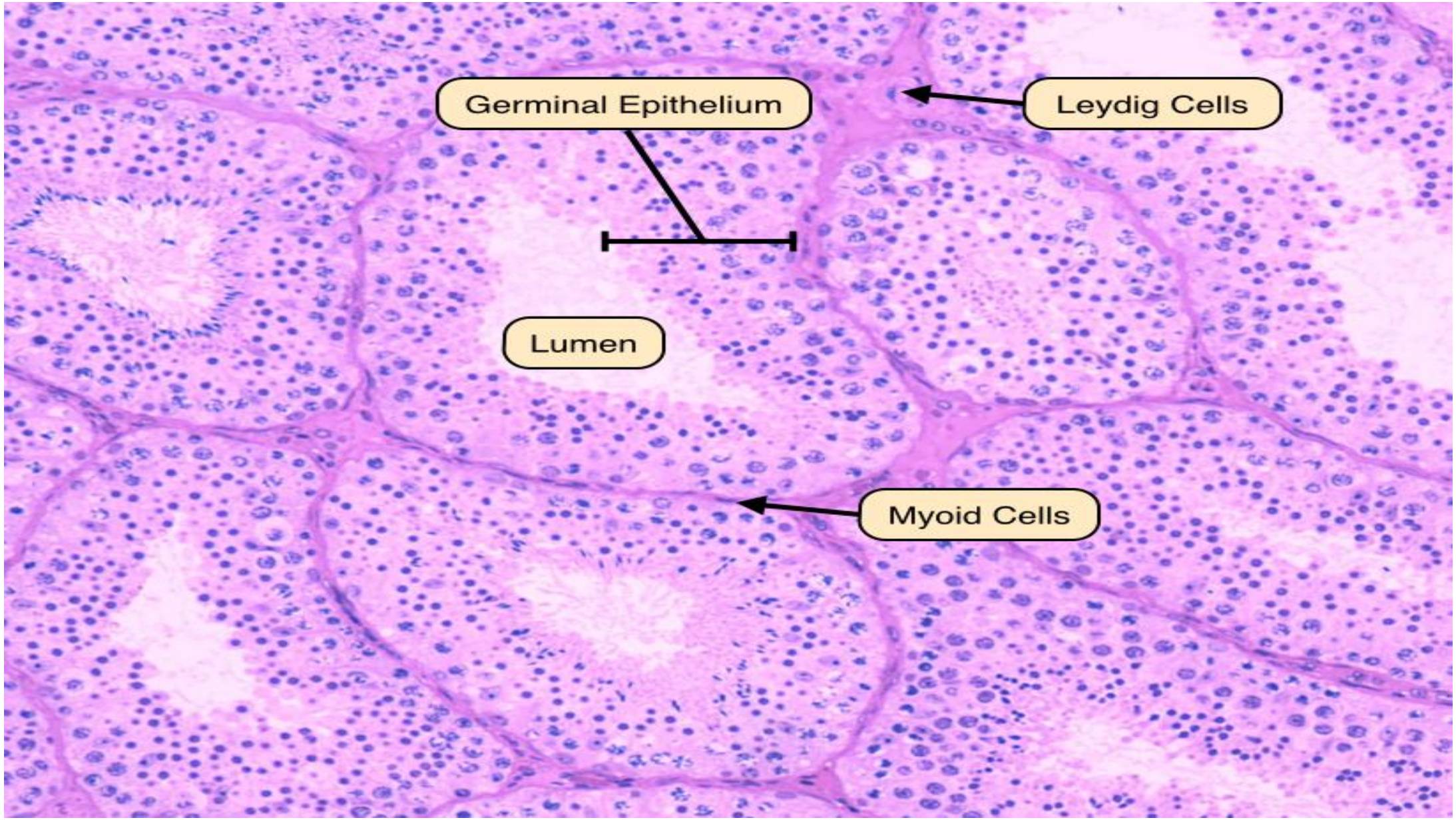
Showing hydrocele



Histological Structure



A



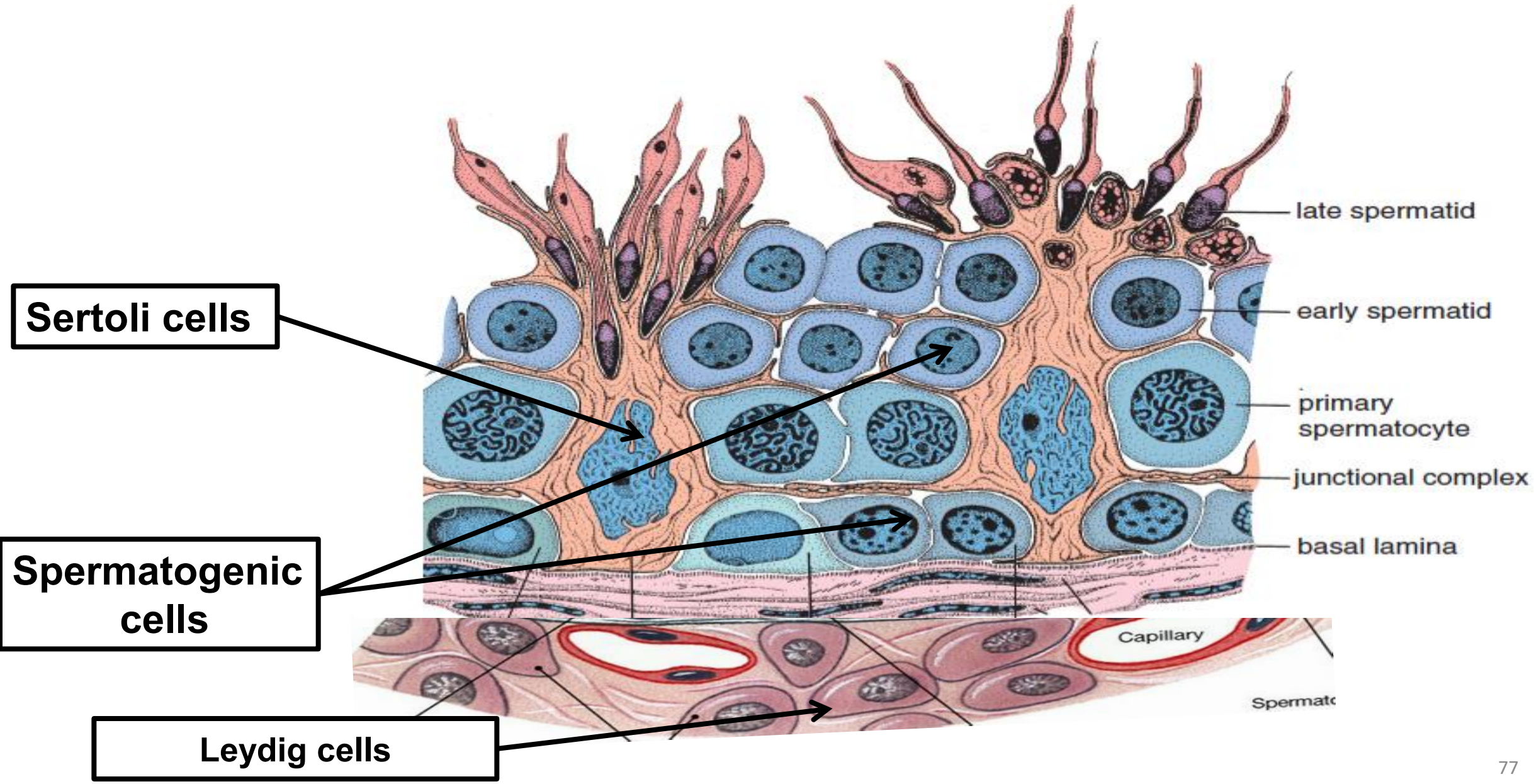
B

Cells of the testis

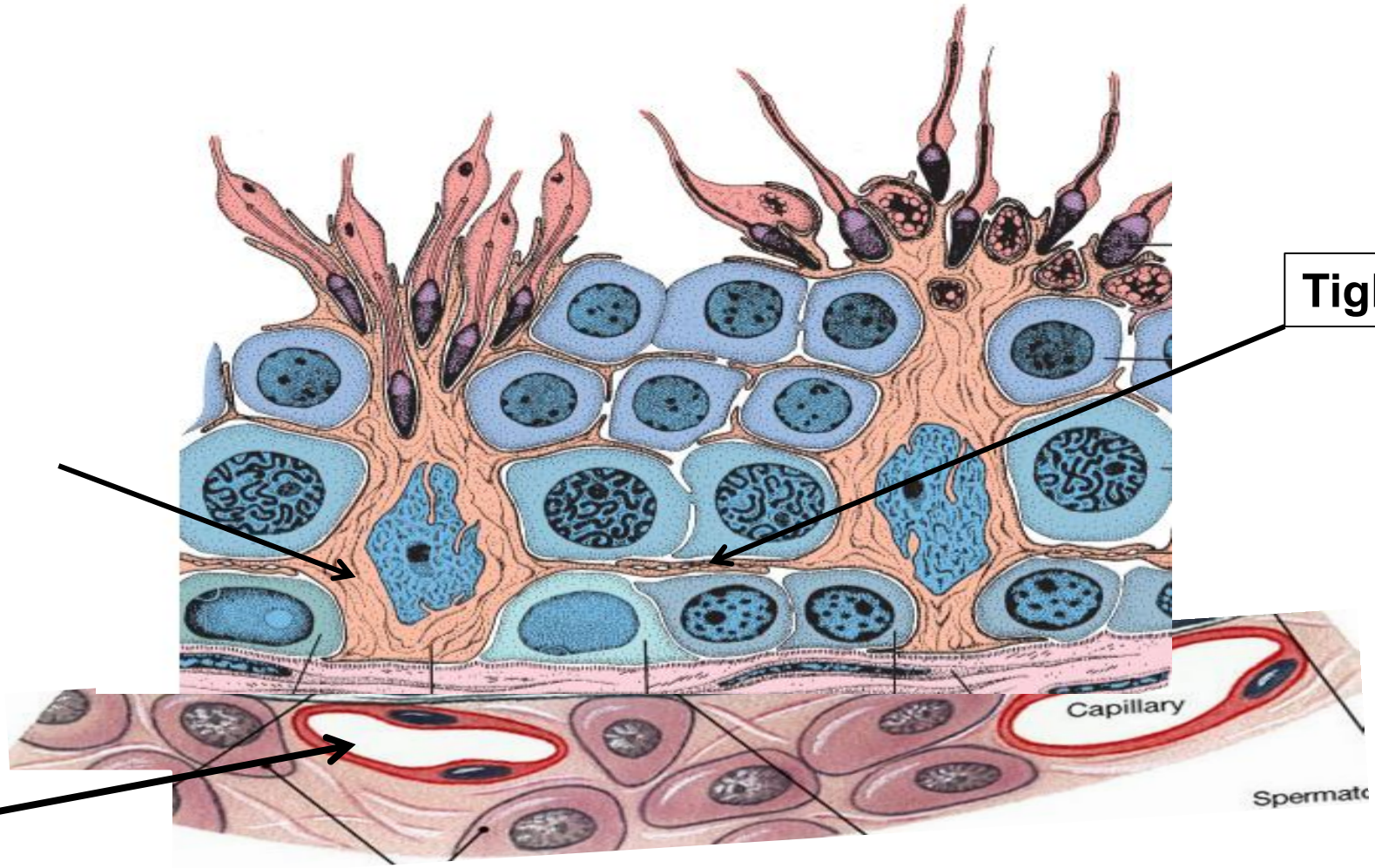
1. Sertoli cells or sustentacular cells or nurse cell
   support, protect & nourish to spermatogenic cell

2. Spermatogenic cells
   produce sperm

3. Leydig cells /Interstitial cells
   synthesize testosterone


Sertoli cells
Spermatogenic cells
Leydig cells
late spermatid
early spermatid
primary spermatocyte
junctional complex
basal lamina
Capillary

Sertoli cell

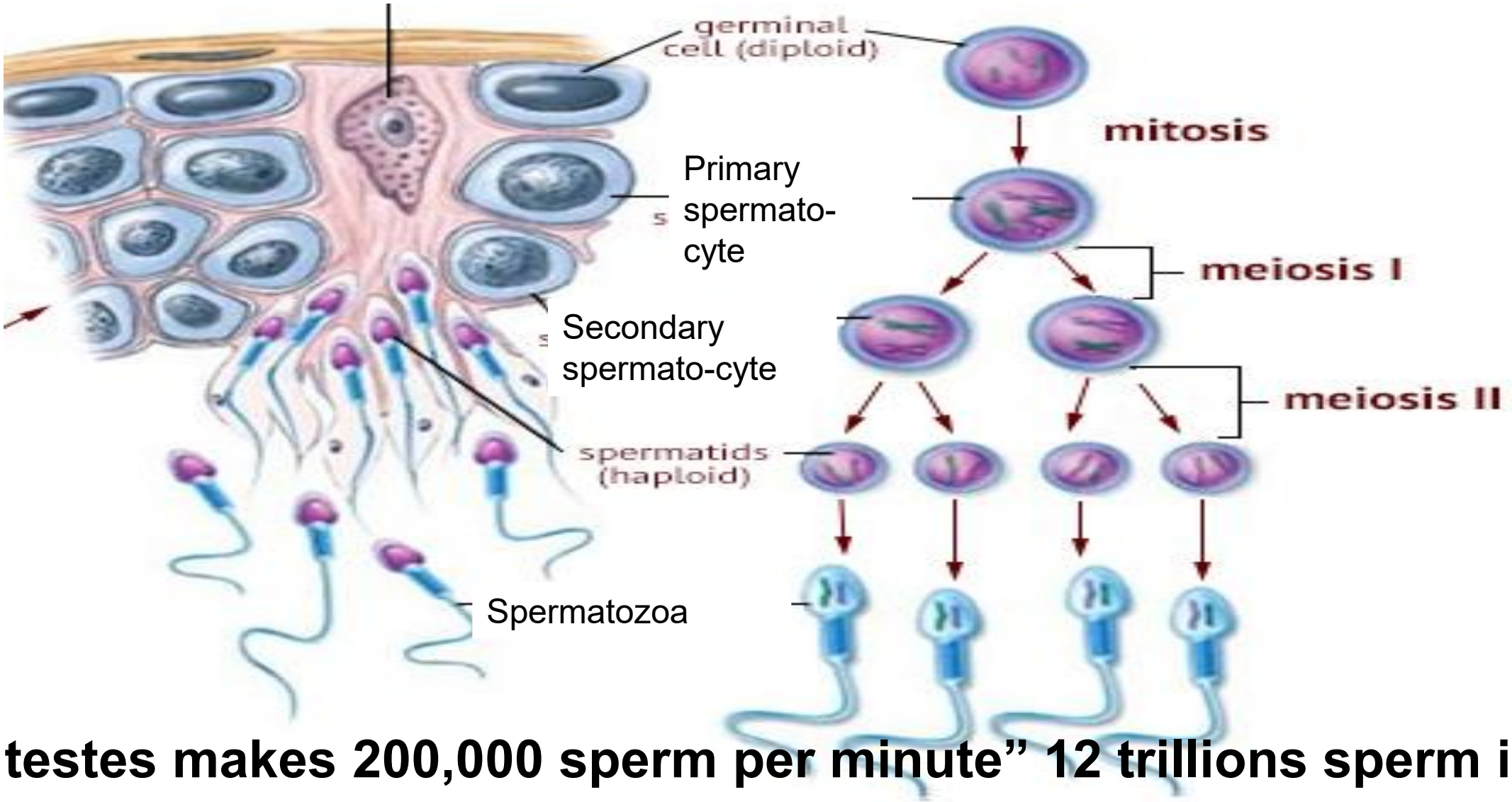


Blood–testis barrier prevents an auto-immune reaction

আমি হাট খোলা রাজা

Infertility

Spermatogenic cells



"The testes makes 200,000 sperm per minute" 12 trillions sperm in a male's lifetime

Normal sperm count
15 million to 200 million
sperm per milliliter of semen,
about 400 million released in a
single ejaculation

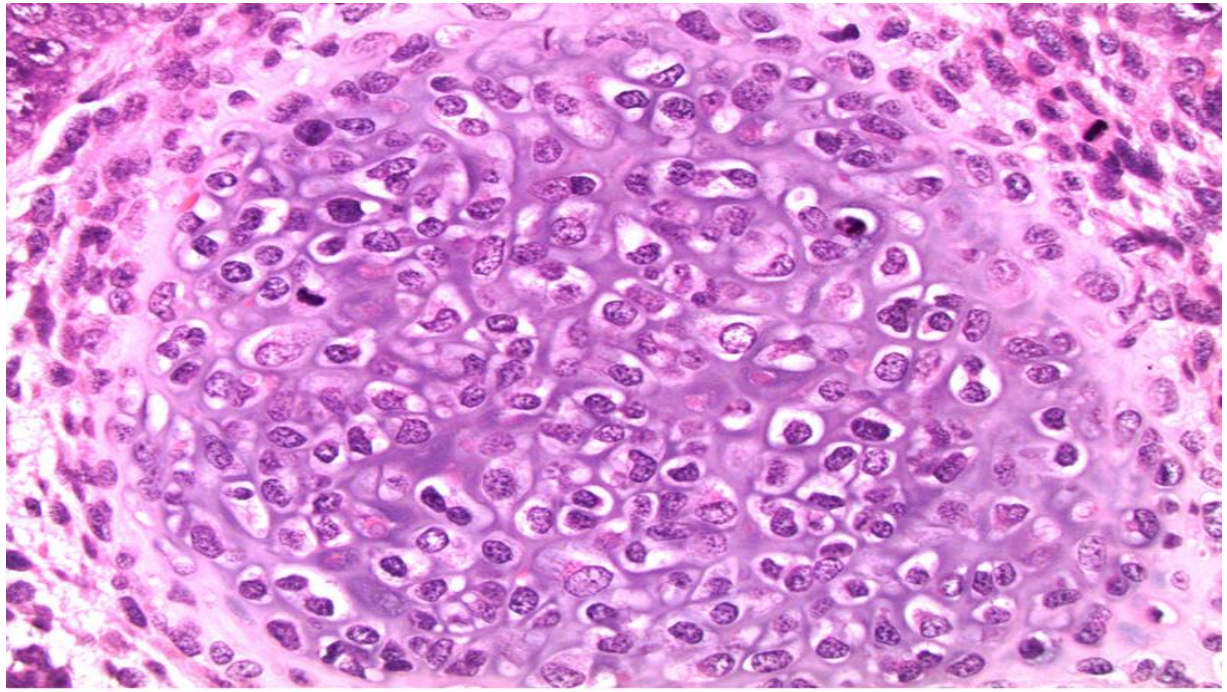
Azoospermia - absence of sperm in the ejaculate

Oligozoospermia - Total sperm count below lower reference limit

Hypospermia - semen volume below lower reference limit less than 1.5 ml

Hyperspermia when semen volume is above 5.5 ml

Germ cell tumours **teratoma** are by far the most common **testicular** tumours



Cartilage surrounded by mitotically active spindle cells

Avoid biopsies

Leydig cell

Testosterone is produced mainly in testes in males & in ovaries in females.

In both, testosterone can be synthetized in the adrenal gland cortex.

Ref: (Burger, 2002; Dohle et al., 2003)

Normal male testosterone levels range from 300 to 1,200 nanograms per deciliter.

If activation of the hypothalamic-pituitary-gonadal axis during the neonatal period (mainly in the first 3–6 months of both sex)

high gonadotropin and sex steroid levels

resulting **minipuberty**

It may also happen at mid-gestational period

Congenital Adrenal Hyperplasia

In males
there may be excessive body growth causing a condition called
Infant Hercules.

Congenital Adrenal Hyperplasia

In females

increased testosterone secretion

masculinization

enlarged clitoris

excess pubic hair

deepening of voice

Female pseudohermaphrodite

Male pseudohermaphrodite

testis is present

but develops the
secondary sex characteristic of female

due to
androgen non-responsiveness

Androgen non-responsiveness previously called “syndrome of testicular feminization”

True hermaphroditism

Disorders of Sex Development (DSD)

Now called Ovotesticular disorder of sex development

raised as females

Role of excess blood transfusions on testis function

A history of excess blood transfusions for certain hematologic diseases may **lead to hemochromatosis** which in turn may interfere with **testosterone production by the testes.**

Ref: research paper; journal article

Role of pharmacological agent on testes function

Certain medications such as antiandrogens, gonadotropin-releasing hormone agonists, cimetidine, ketoconazole, progestins & cannabis may alter the hypothalamic-pituitary-testicular axis and affect testosterone production or action.

Ref: research paper; journal article

Role of Testes function on

Men are known to experience more

severe infections than women

due to immunosuppressive role of testosterone

Ref: research paper; journal article

Effect of testosterone on mental power

- Testosterone levels may impact mental well-being

- Women show higher anxiety in comparison to men

(Mchenry et al., 2014)

- Depressive disorder is more prevalent in females

(Bebbington, 1996)

- Depression in males increases with age as plasma testosterone drops

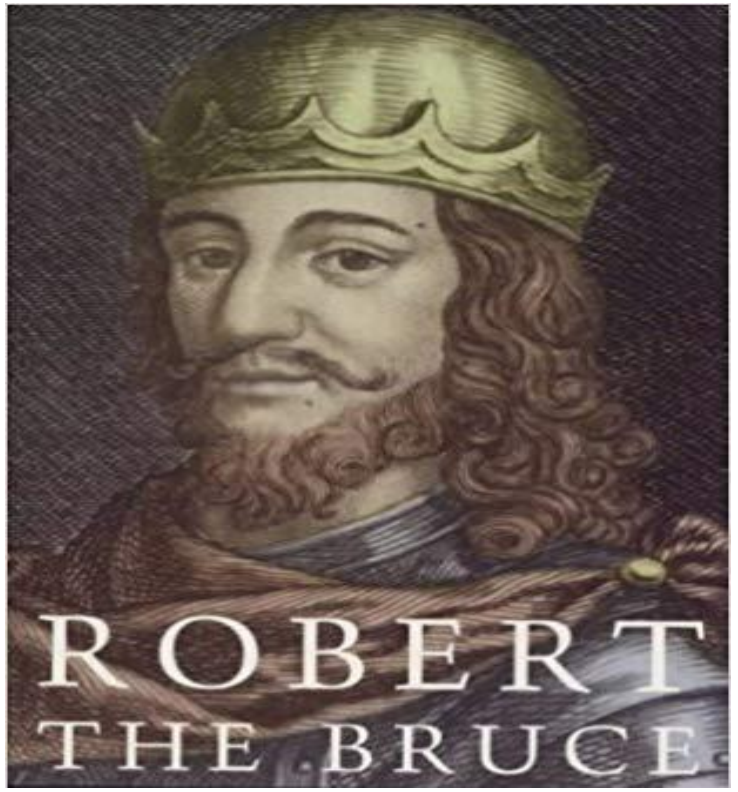
(Khera, 2013)

- Testosterone plays a role in certain behaviors including aggression & dominance

- Low testosterone may result loss of confidence & lack of motivation

Ref: research paper; journal article

- Testosterone increases the need for revenge



Six times had been beaten
"Yes!" cried Bruce, "I, too, will try a seventh time!"

England recognized Scotland as an independent country

Effect of testosterone on sex power

- Low testosterone low libido

Libido is centered in the medial preoptic area of hypothalamus which has androgen receptors &

it appears that testosterone or its metabolite dihydrotestosterone is necessary for normal sexual desire.

Effect of testosterone in physical power

- Testosterone increases muscle protein synthesis thus increased muscle mass

- Testosterone is important for both bone gain and maintenance

Ref: research paper; journal article

- Aging induces a Leydig cell dysfunction followed by change in fat mass & bend forward

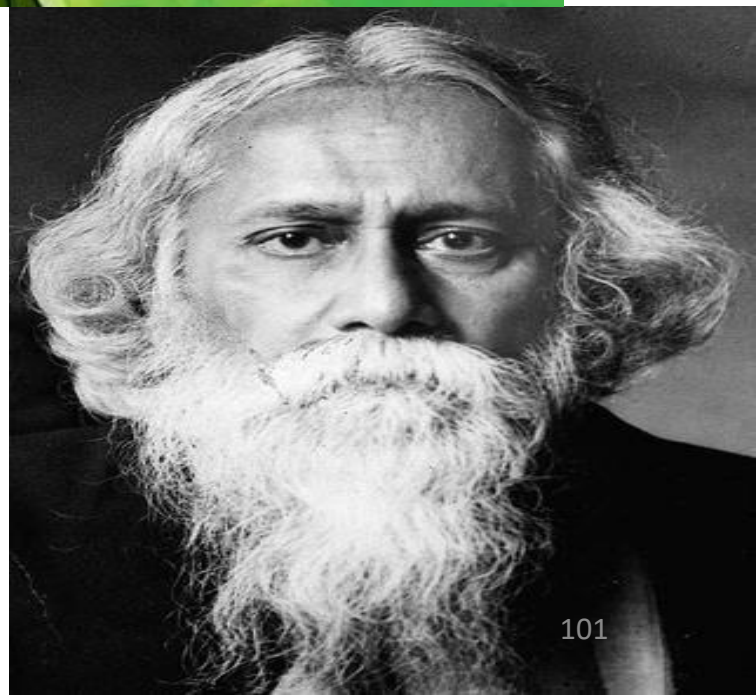
Ref: research paper; journal article

Effect of testes in forensic medicine

- In male bodies, after prostate gland, testes are decompose lastly

- Testosterone influence factors that may contribute to the slower degradation of testes

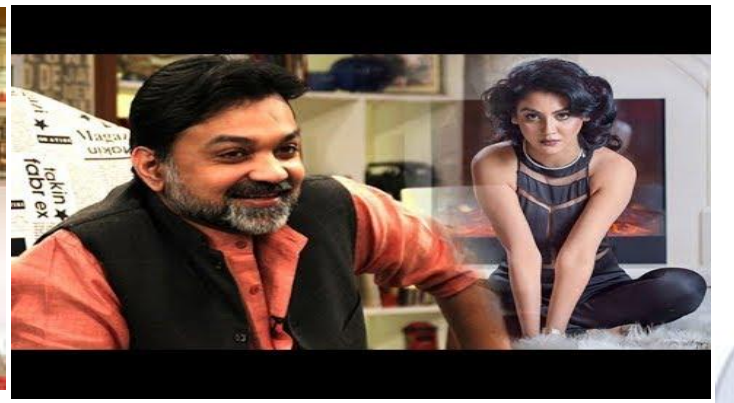
Effect of testes in man power



Testes plays role in increased population followed by may have a chance of development of man power.. .

WHO definition of health

Health is a state of complete
physical,
mental and
social well-being
& not merely the absence of disease or infirmity.



So, by considering all
in male, testes acts as power house in maintaining healthy & happy life


Thank You