Anatomy, embryology and functional activities of male genital organs.

Anatomy and physiology of male reproductive system

- The male reproductive system consists of:
  - ¬ Paired testis enclosed with in the scrotum (which produce gametes and sex hormones),
  - ¬ The duct system (which transports the sperm from its site of production),
  - ¬ Copulatory organ (which deposits semen in to the female reproductive organs) and
  - ¬ Accessory genital glands (which contribute the bulk of the semen).

θOrigin and early development (Embryology) of the reproductive organs, *sexual differentiation*

Early embryonic development:

- the ***Primordial germ cells*** migrate into the **Urogenital ridge** (dorsal side of the abdominal cavity)

- ***fetal*** reproductive system consists of two sexually ***non-differentiated gonads***, bipotential system or sexual indifferent stage
- two pairs of **ducts** (Muellerian and Wolffian ducts, urogenital sinus and a genital tubercle

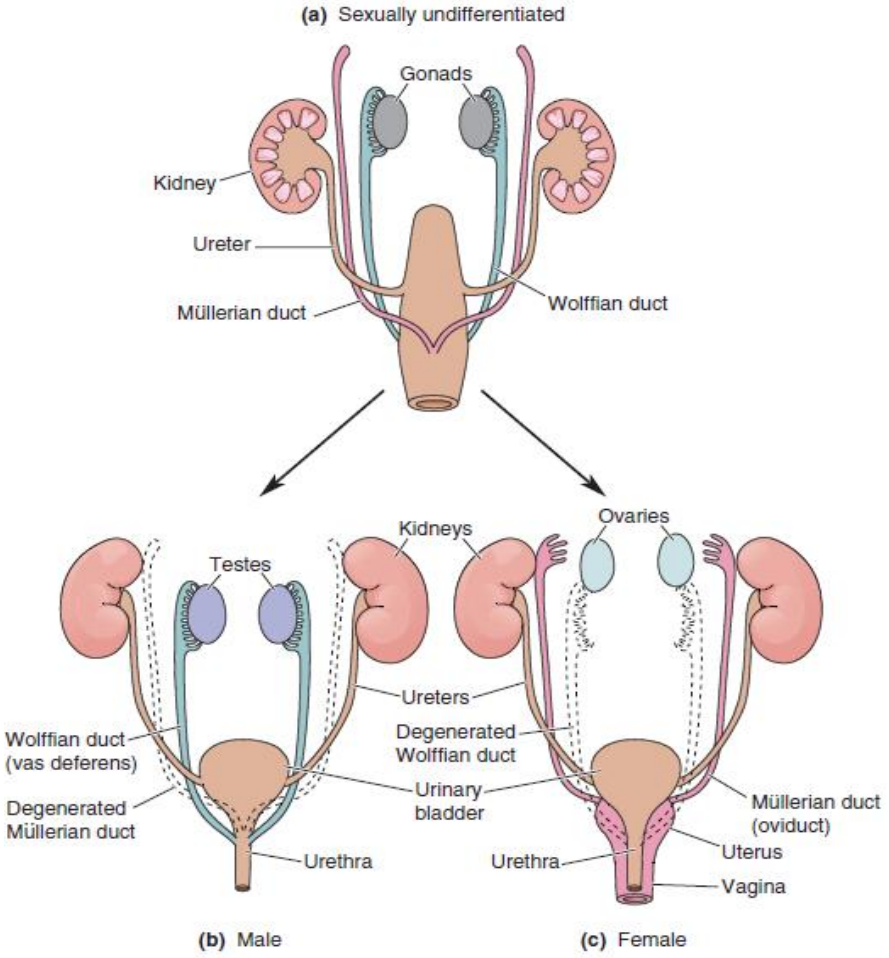
embryonic bisexuality

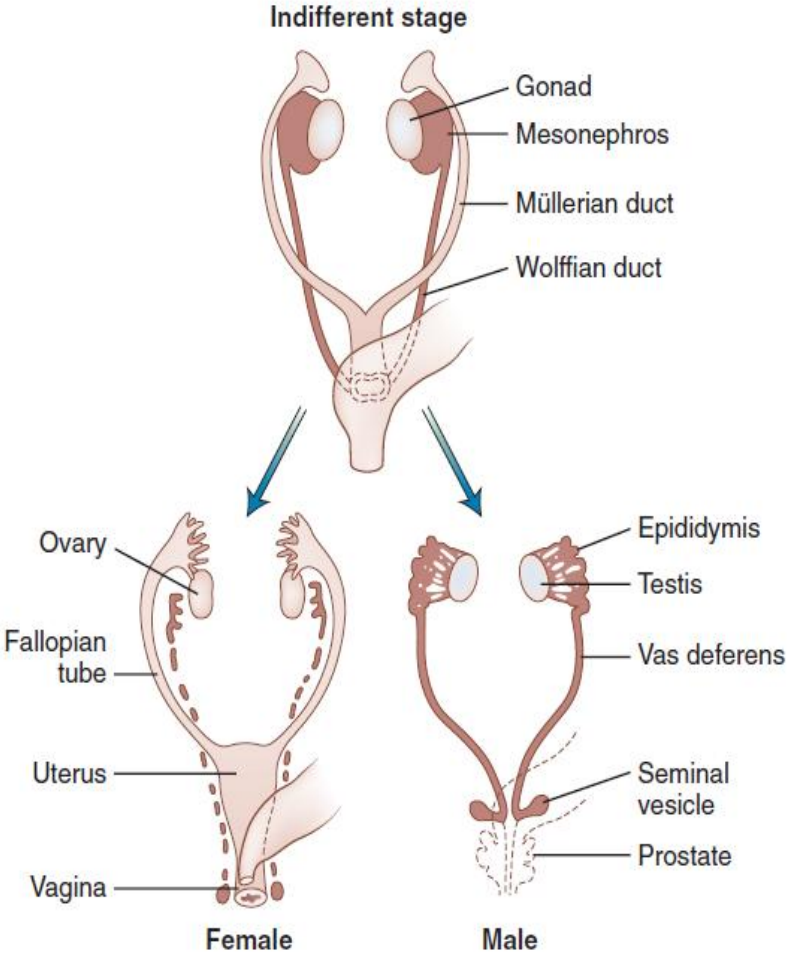
Origin … (cont'd)

differentiation into a **male** and **female** system (about 2 months after fertilization)

- **Gonads** either ***ovary/testis***
- **Muellerian ducts** develops into
  - oviducts,
  - uterine horns, uterus
  - cervix and anterior vagina
- **Wolffian ducts** develops into
  - epididymis,
  - vas deferens, seminal vesicles and the ejaculatory ducts
- **Urogenital sinus** develops into the external genitals in both females and males

Sexual differentiation (cont'd)





Sex of the fetus depends on inherited ***genes*** and the ***formation*** and ***maturation*** of accessory reproductive ***ducts.***

A. Genetic sex

ϖThe process of sperm formation in most mammals results in two types of spermatozoa relative to sex chromatin.

ϖMammalian males are *heterogametic* in that one-half of the spermatozoa contain an X-chromosome and the other half a Y-chromosome.

ϖ→***the genetic sex is independent of the ovum***

⎫***Ovum*** fertilized by an ***X-spermatozoon,*** the offspring is XX, **a female**

⎫***Ovum*** fertilized by a ***Y-spermatozoon,*** the offspring is XY, **a male.**

- ϖ But the males of avian species, however, are *homogametic* in that they produce spermatozoa with only one kind of sex chromosome.
- ϖ Sex determination in birds occurs with the egg.

B. Gonadal sex - by the presence of normal **ovaries** or **testes.**

ϖ Male phenotype sexual differentiation is directed by the function of the ***fetal testis.***

as the **testes** grow ***leydig cells*** produce ***testosterone***

(***Testosterone*** *and* ***5-dihydrotestosterone*** *stimulate the growth and differentiation of the Wolffian ducts in the male*)

Sexual differentiation (cont'd)

The muellerian ducts regress by the ***anti-muellerian hormone*** (***Muelerian–inhibiting factor, MIF***) from the Sertoli cells

Absence of the ***testis***, ***female differentiation*** ensues irrespective of the genetic sex (no need of extra stimulatory or inhibitory mechanism)

In the female fetus

- there is a developing ovary
- no antimuellerian hormone

Sexual differentiation (cont'd)

•the muellerian ducts develop into the female reproductive tract

- the fallopian tube (oviduct)
- the uterine horns
- the uterus
- the cervix and
- the upper (cranial portion) vagina

•When a normal female fetus is exposed to ***androgens*** during the period of differentiation of the external genitalia, an ***apparent male*** can result

Descent of the testes

- Testis formed in abdominal cavity then descend in to the scrotal sack (Exceptions – Birds, Elephants)
- This descent from abdominal cavity via Inguinal Ring/Canal in to scrotum occurs Before or After birth, depending on species.
- **Half gestation-** Bull and Ram: **Last quarter-** Boar; **After birth**-Stallion; **After birth**-dogs
- Testicular descent is made possible by rapid growth and subsequent regression of the gubernaculum (ligament)
- As each testicle descends in to scrotal sac it takes with it the peritoneal lining of the abdominal cavity

- Cryptorchid testes are those that fail to descend. This condition seems to be most prevalent in pigs and horses.
- When the testis is in the inguinal canal, but not in the scrotum, the horse is referred to as a high flanker.
- Often the testis or testes are retained entirely within the abdominal cavity.

Reproductive Tract of the Male

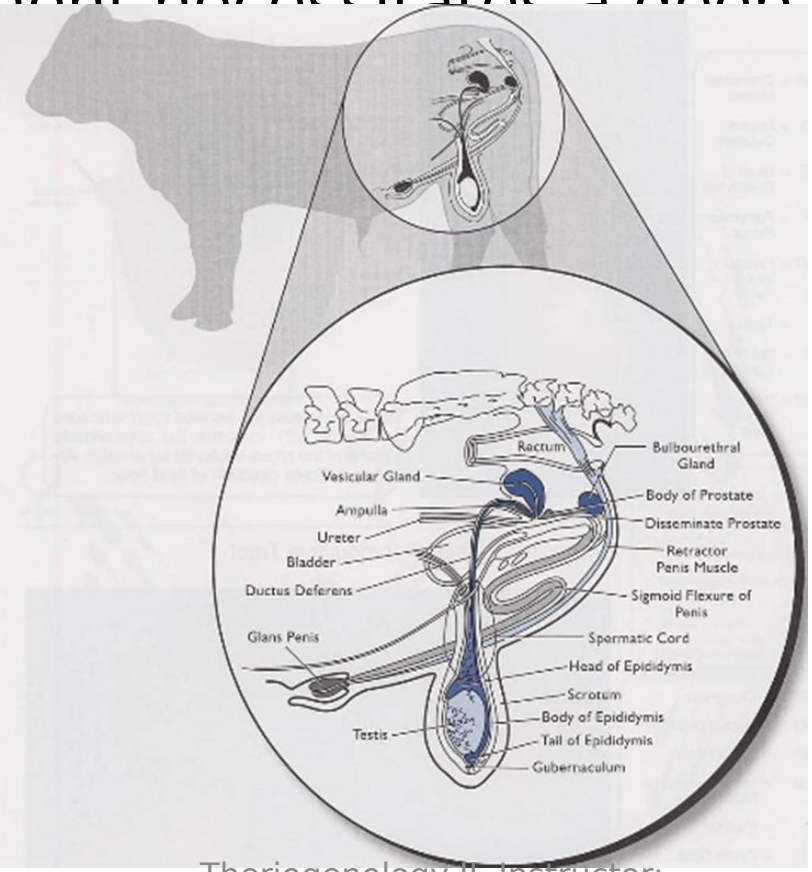
1. Testis

- **Gross anatomy - varies with species**
  - Location – Suspended by spermatic cord in to scrotum - inguinal (Ruminants/Equines) to Perineal (Pets)
  - Shape – ovoid shape, (free and epididymal borders)
  - Size – varies with species/breed, age, season, etc

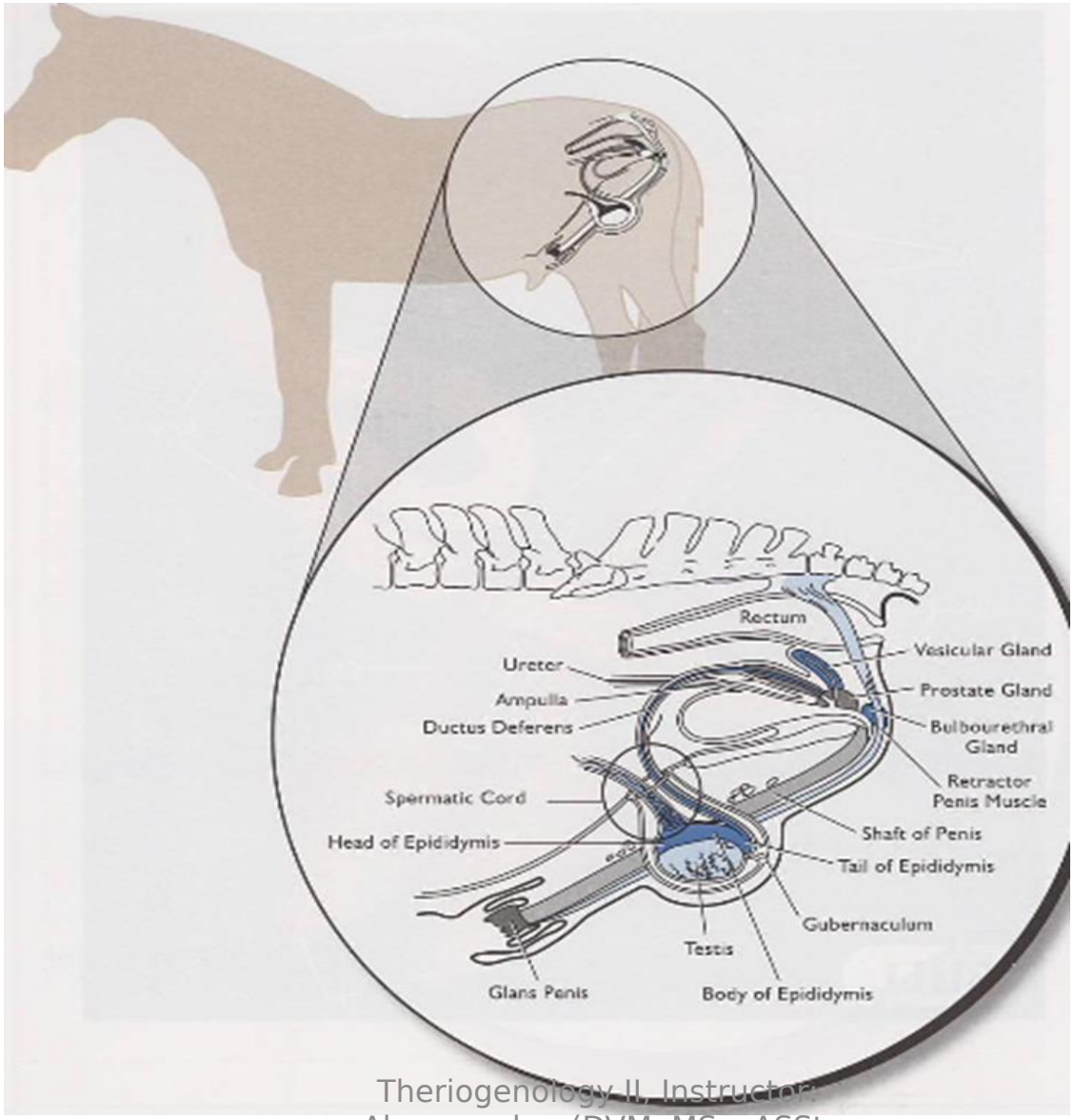
Orientation:

- orientation of the testes within the scrotum varies among the species.

θ Ruminants: The long axis of the testis is vertical and This arrangement necessitates a deep and pendulous scrotum.

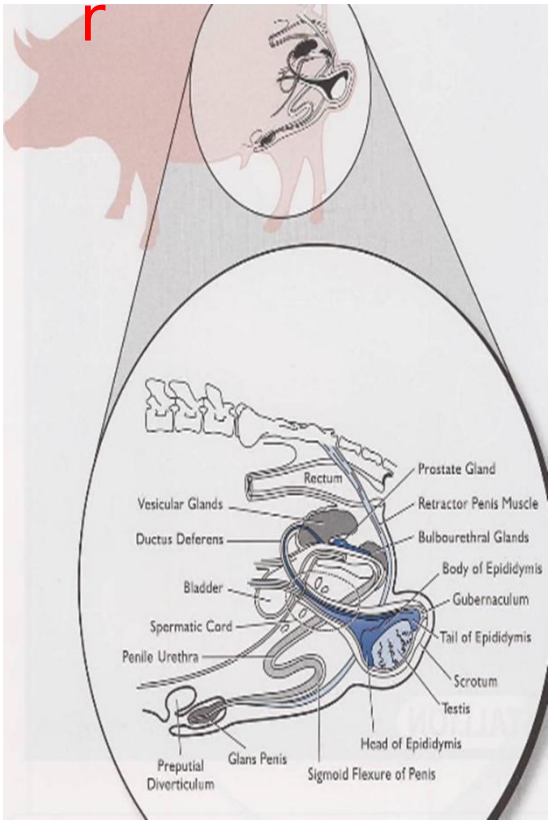


θ Horse: The long axis is nearly horizontal.

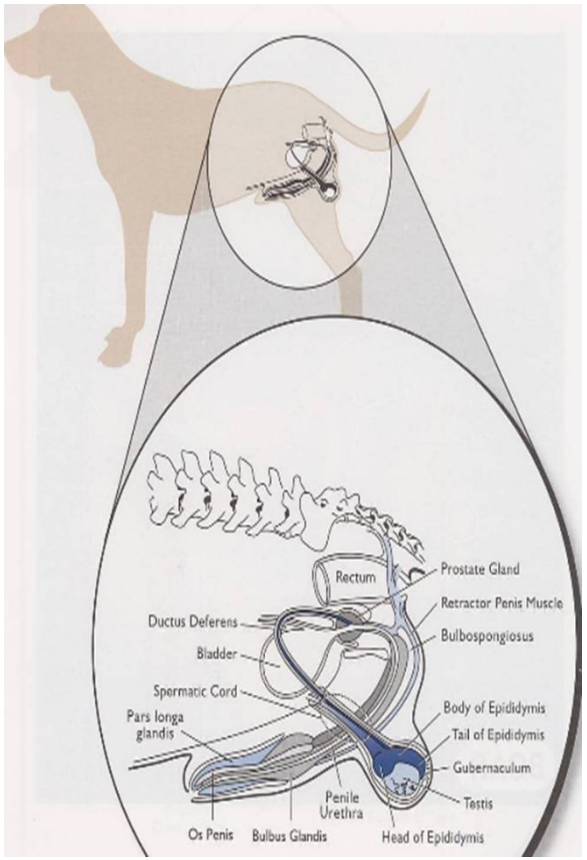


- Dog, Cat and Pig: - The Capital extremity is lower than the caudal extremity

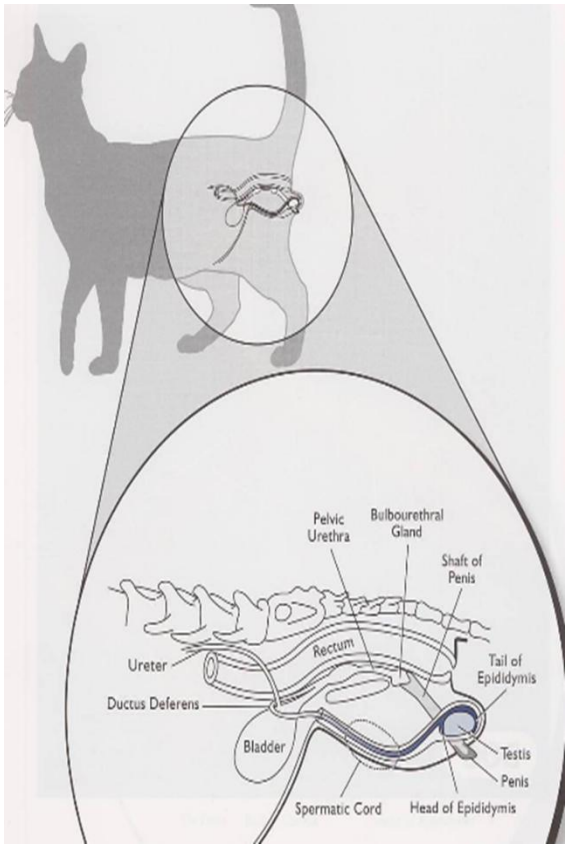
Boar



Dog

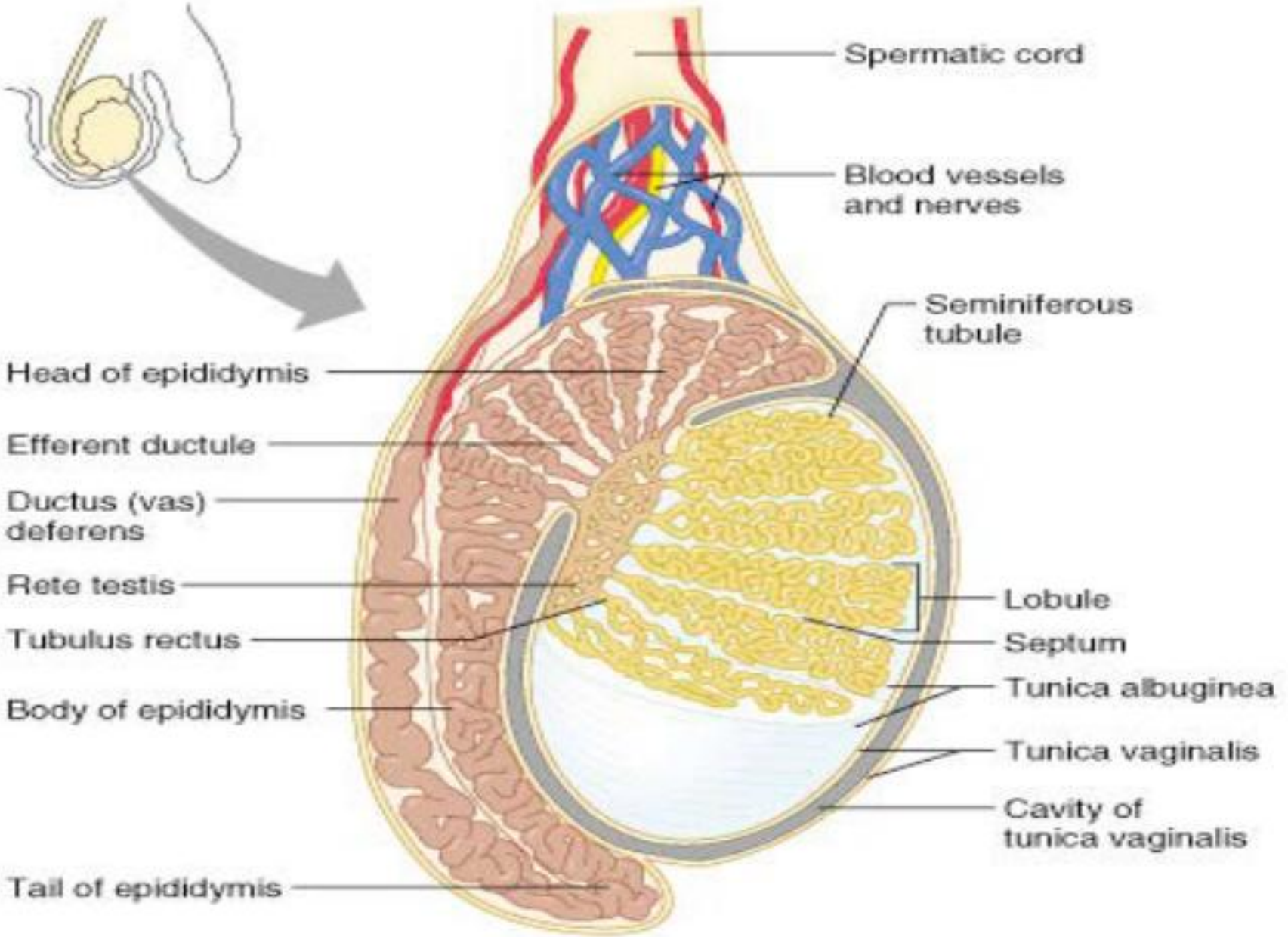


Cat



Testis cont'd

- The testes are a pair male gonads located outside the abdomen within the scrotum.
- Each testis lies within the vaginal process, a separate extension of peritoneum which passes through the abdominal wall at the inguinal canal.
- The inguinal canal has the internal and external rings, deep and superficial respectively.
- This canal is also a passage for important vessels and nerves that supply external genitalia via spermatic cord that run through the neck of the vaginal process.
- The testis is supplied by testicular artery which originate from the dorsal aorta (near the embryonic site of the testis).
- Afferent and efferent sympathetic nerves accompany the testicular artery and enter the testis.


Spermatic cord
Blood vessels and nerves
Seminiferous tubule
Head of epididymis
Efferent ductule
Ductus (vas) deferens
Rete testis
Tubulus rectus
Body of epididymis
Lobule
Septum
Tunica albuginea
Tunica vaginalis
Cavity of tunica vaginalis
Tail of epididymis

Testis cont'd

- The position of the testis in the scrotum and direction of its long axis relative to the body differs with species.

- The surface of the testis is covered by:
  - an extension of the parietal peritonium.
  - Beneath this lies a tough fibro-muscular (tunica albuginea) from which the extensions penetrate the parenchyma of the testis to join mediastinum, a cord of connective tissue running through testis.
- These fibrous septa divide the parenchyma into lobules of coiled semniferous tubules.

- The tubules in each septum join to form a larger straight tubule that lead into rete testes.

- Spermatogenesis (formation of spermatozoa) occurs in the epithelial lining of the **seminiferous tubules**.
- Seminiferous tubules composed of – basal lamina, contractile peri-tubular cells, Sertoli cells (supporting/ protecting developing spermatozoa) and spermatogenic (production of spermatozoa) cells.
- Sertoli cells are endocrine cells - they secrete the polypeptide hormone, **inhibin**.
- Development of the female tract is suppressed by a hormonal factor secreted by the Sertoli cells.
- The **interstitium** is composed of loose connective tissue and **Leydig cells (interstitial cells)**

Testis cont'd

- Spermatozoa produced in the seminiferous epithelium move through the lumen of the tubules to the **tubuli recti** (straight tubes) which extend to a network of spaces in the mediastinum, the **rete testis**.
- **Efferent ductules** (ductuli efferentes) carry the spermatozoa from the rete testis, then converge to form the **ductus epididymis,** a convoluted duct.
- The ductus epididymis straightens and becomes the

Functions of the testis

I. Production of spermatozoa(gametogenesis)

- The tubule is lined by the seminiferous cells which are of two types: the spermatogenic cells or spermatogonia, which give rise to spermatozoa; and the Sertoli cells which supply nutrients to the spermatogonia.
- Production increase as age advances, peaks at some age and then declines (bull peak at 5 years).
- Production is grater than the total output at ejaculation.

II. **Production of male sex hormone (steroidogenesis)**

- Testosterone is secreted by interstitial (Leydig) cells which occupy the space between the semniferous tubules.

- The steriodogenic activity is LH dependent.

III. Exocrine activity

- Upon leaving the testis spermatozoa are suspended in a special fluid.
- This fluid is known as **rete-fluid** and secreted by sertoli cells.
- The fluid markedly differs from plasma and lymph.
- Help to flush sperm cells from the semniferous tubules.

Blood-testis barrier

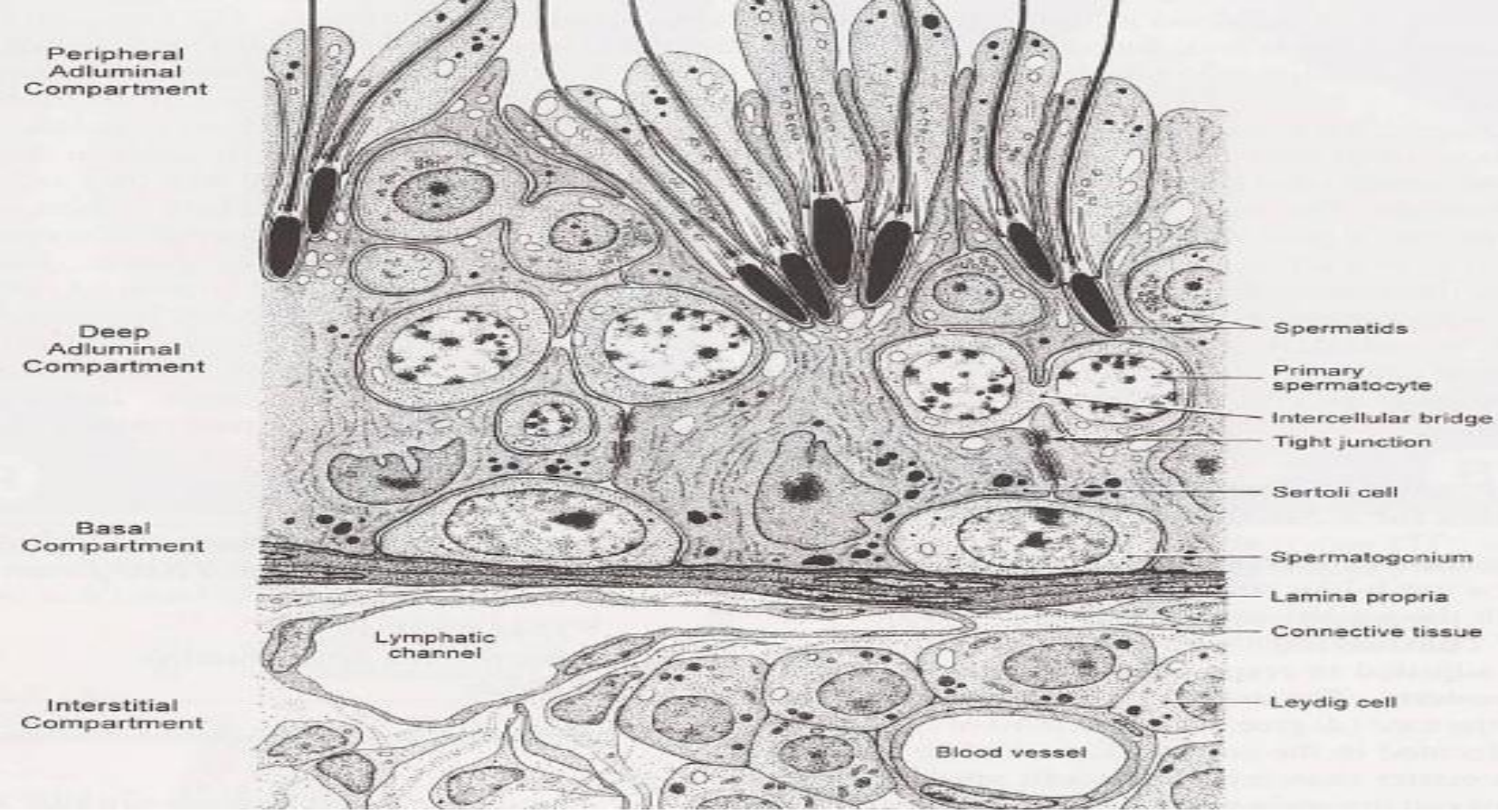
- A major role of the Sertoli cell is to define two separate and physiologically different compartments in the seminiferous tubule. The **basal compartment**, near the periphery, is sealed off from the **luminal compartment** by processes of adjacent Sertoli cells that reach out and make contact: where the processes are in contact they form **occluding junctions.**

- Large molecules cannot pass from the blood into the lumen of a seminiferous tubule due to the presence of tight junctions between adjacent Sertoli cells

- The spermatogonia are in the basal compartment (deep to the level of the tight junctions) and the more mature forms such as primary and secondary spermatocytes and spermatids are in the adluminal compartment. The two compartments are separated by the blood-testis barrier

- The **function of the blood-testis barrier may be to prevent an auto-immune reaction.** Mature sperm (and their antigens) arise long after immune tolerance is established; therefore, a male animal is capable of making antibodies against his own sperm

- This suggests the presence of **blood-testis barrier** which separates semniferous epithelium from general circulation.
- This appears to be due to cells of the semniferous basement membrane and sertoli cells.
- Even parent spermatogonia are separated from their progeny by sertoli cells.
- The integrity of this barrier is essential



Blood Testis Barrier –

Formed from –

- Peri-tubular cells in basement memberane – 1st layer
- Tight junction between Sertoli cells – 2nd layer

Function – protect germ cells from auto-immunological and chemical destruction (germ cells are foreign to body's immunity)

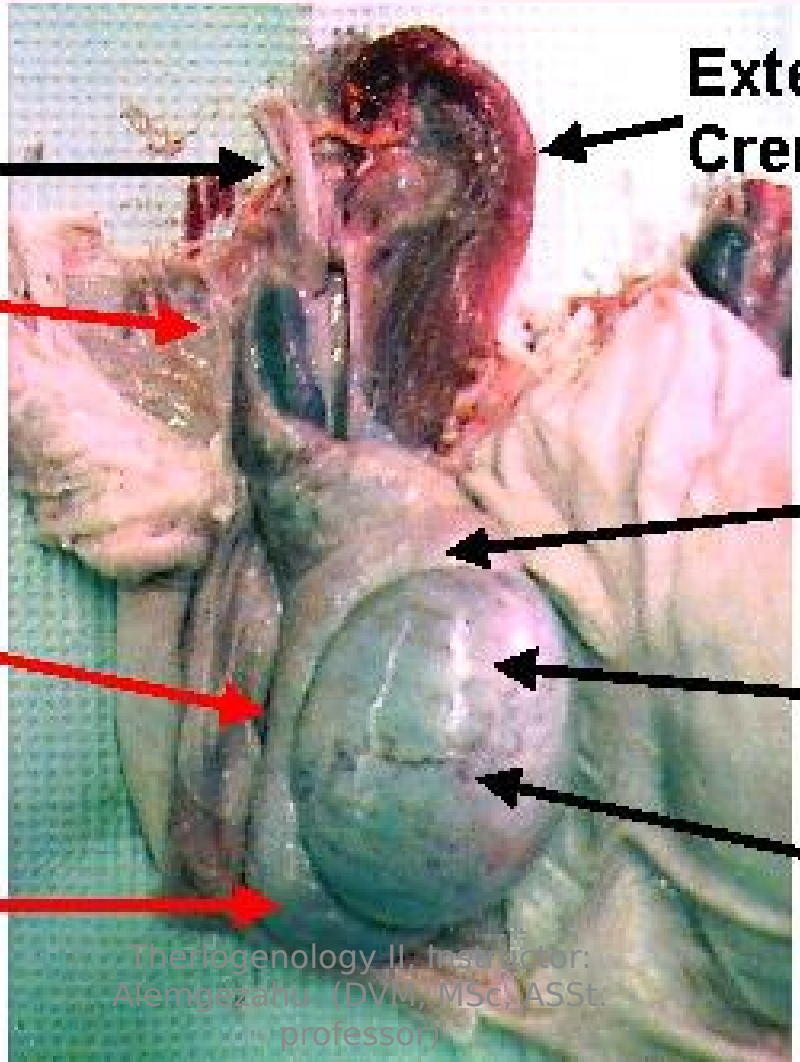
IV. **Thermoregulation**

- The mammalian sperm are produced at the temperature lower than that of body temperature.
- The testicular temperature is adjusted by the temperature receptors located in the scrotum.
- Anatomic features of the testis and scrotum play a role in the regulation of

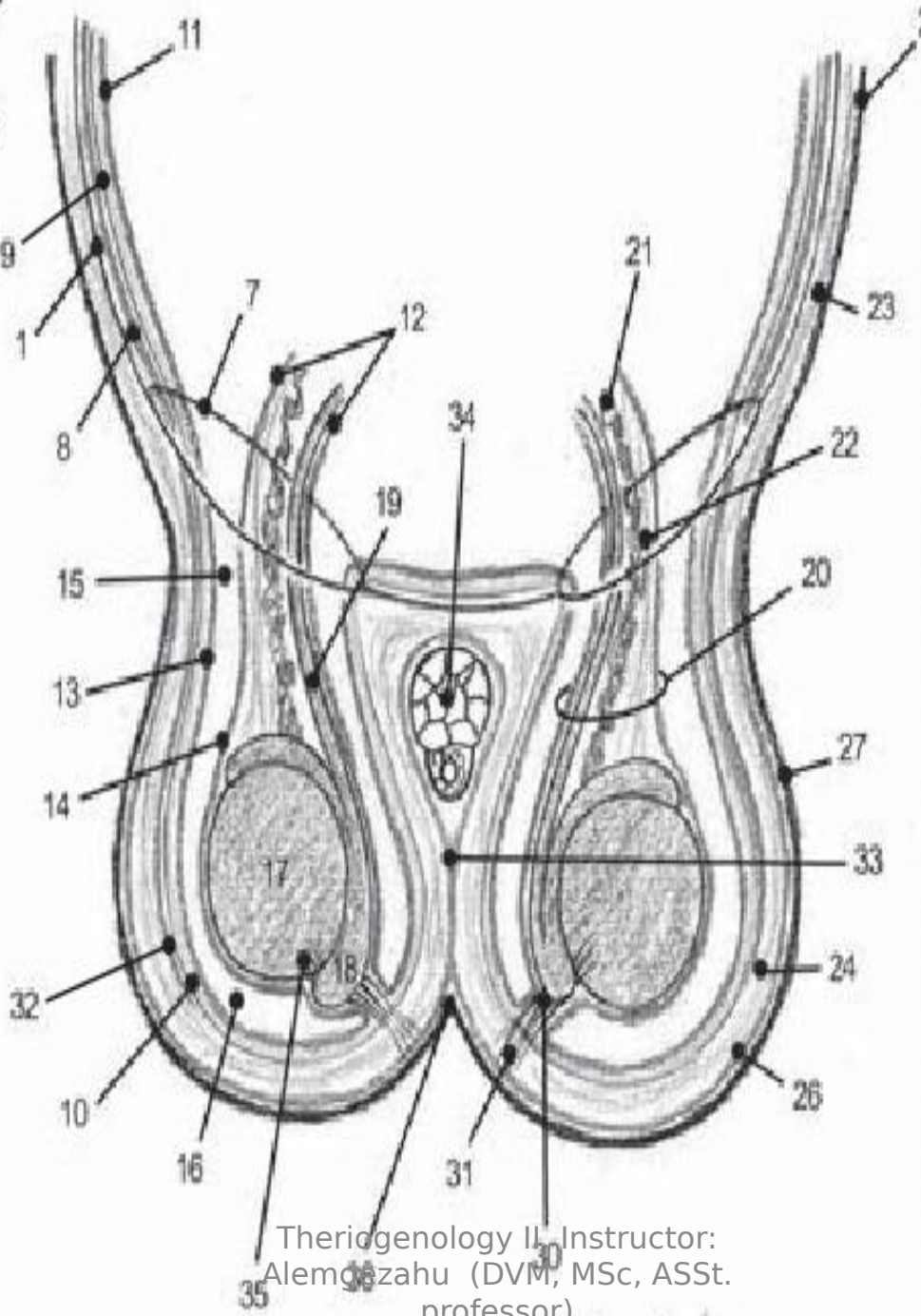
Scrotum

- **Scrotum** - a two lobed sack which protects/ supports testes and is required for testicular temperature regulation
- The base of the testis is anchored in the scrotum by **scrotal ligament**.
- **Composed of *Scrotal skin:*** *scrotal raphe* , sweat glands controlled by sympathetic nerves & thermosensitive sensory free nerve endings
- ***Tunica dartos***: mesh like smooth muscles bellow scrotal skin, builds the *scrotal septum* .
- ***Spermatic and scrotal fascia***: continuation of the transverse abdominal fascia
- ***Parietal Tunica vaginalis;*** fold of peritoneum that lines internal surface of scrotum
- ***Visceral tunica vaginalis***: fold of peritoneum that intimately covers the spermatic cord, testis and

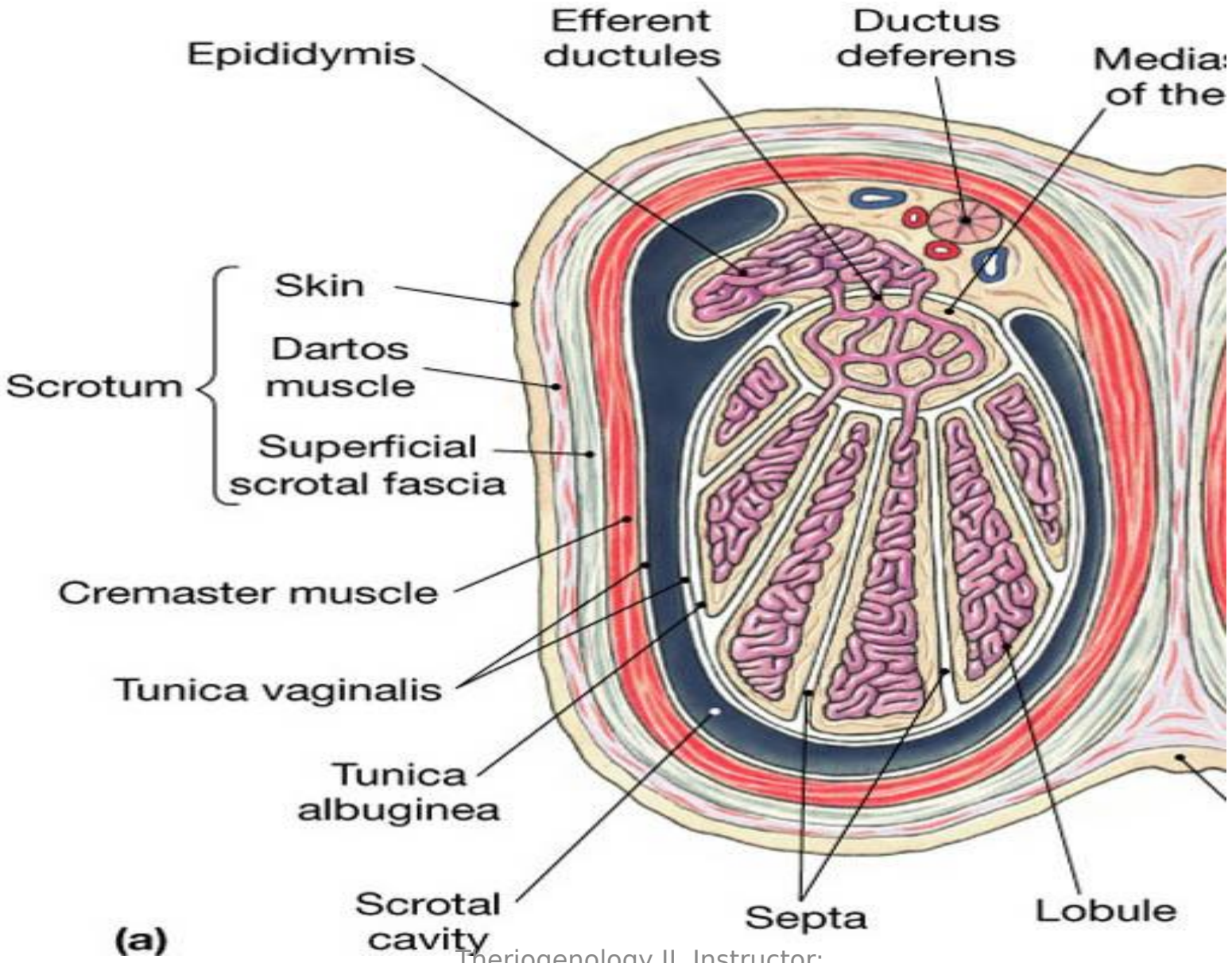
Testis


Vas Deferens
External Cremaster Muscle
Spermatic Cord
Caput Epididymis
Corpus Epididymis
Testis
Testicular Artery
Cauda Epididymis

1. external abdominal oblique
7. inguinal canal
8. internal abdominal oblique
9. transverse fascia
10. internal spermatic fascia
11. parietal peritoneum
12. visceral peritoneum
13., 14. vaginal tunic
    13. parietal lamina
    14. visceral lamina
15. vaginal canal
16. vaginal cavity
17. testicle
18. epididymis
19. ductus deferens



20. spermatic cord
21. testicular vessels
22. smooth muscle fibers
23. loose connective tissue
24. external spermatic fascia
25. skin
26. tunica dartos
27. scrotal skin
30. ligament of the tail of the epididymis
31. scrotal ligament
32. cremaster m.
33. interdortoic (scrotal) septum
34. penis
35. proper lig. of testis
36. scrotal raphe


Epididymis
Efferent ductules
Ductus deferens
Media
of the
Skin
Dartos muscle
Scrotum
Superficial scrotal fascia
Cremaster muscle
Tunica vaginalis
Tunica albuginea
Scrotal cavity
Septa
Lobule
(a)

Testicular Thermoregulation

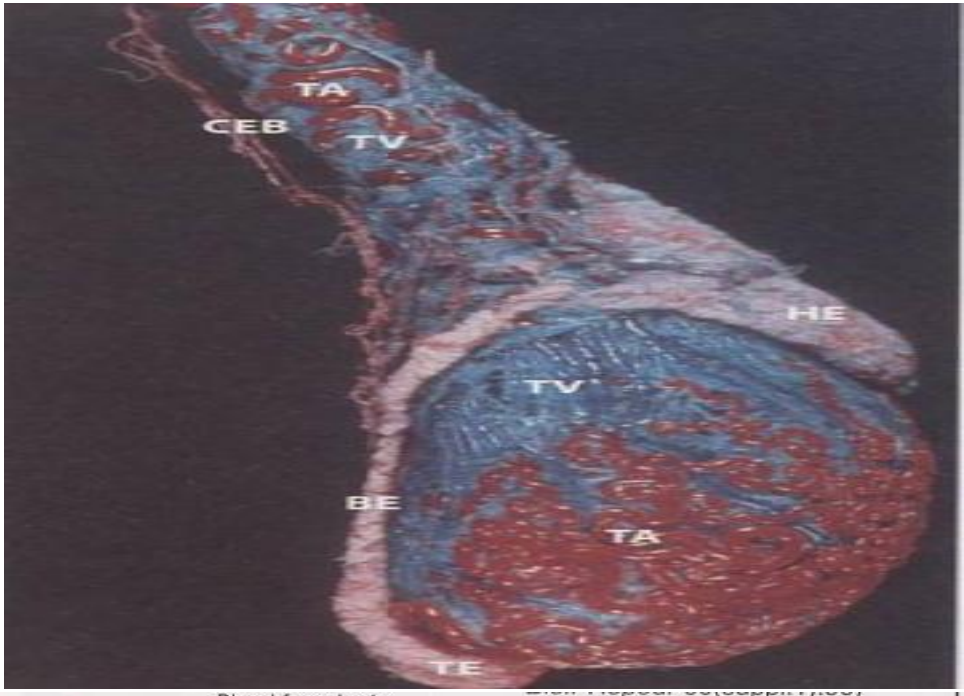
Vascular cooling mechanism

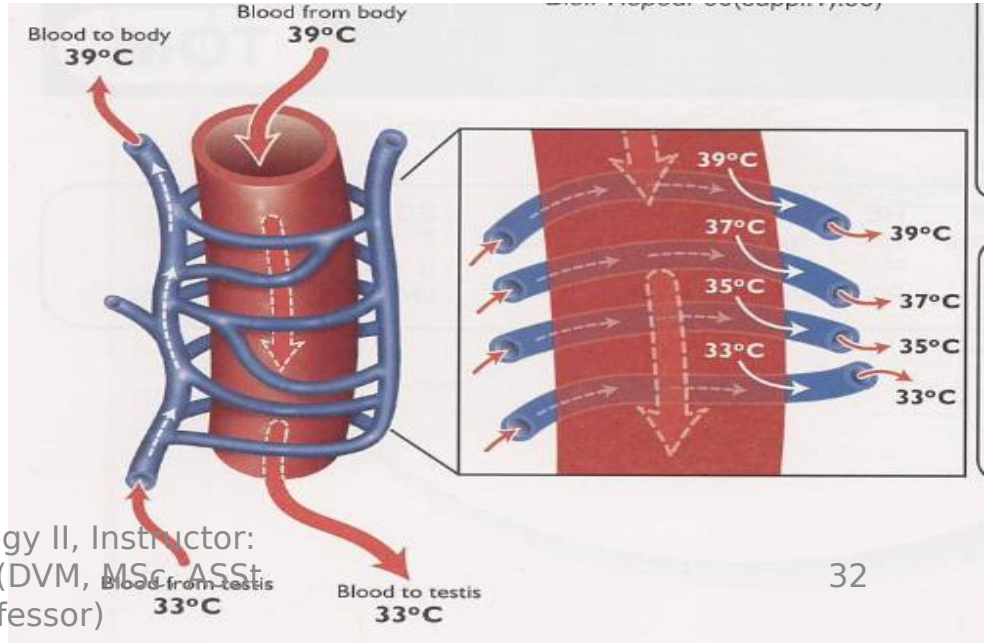
Testicular artery - straight in inguinal canal but becomes highly convoluted once it enters spermatic cord.

Testicular vein - starts of as a highly branching network of vessels (**pampiniform plexus**) at base of spermatic cord.

The pampiniform plexus are intimately wrapped around branching testicular artery.

Testicular veins (colder 35^{o}C) takes the heat in testicular artery (warmer 39^{o}C) thereby reducing temperature of blood supply reaching the testes and





Cont …

- **External cremaster muscle** contact and raise testis towards body wall, lies during cold weather. Contracts and relaxes at hot times exerting pumping effect which improves venous return from pampiniform plexus
- **Scrotal skin - w**hen scrotal temperature rises – thermosensitive sensory free nerve endings get stimulated and send message to hypothalmus - Hypothalmus stimulates increased sweating (scrotal skin) and respiration (more heat exhaled out)– increase heat loss and return or physiological temperature in tests and body
- **Tunica dartos** produce sustained contraction on cold and help to raise testis closer to abdominal wall for heating. During hot weather it relaxes and increases surface area of scrotal skin for higher sweating and cooling. Function under androgen control
- Practical relevance of knowing about testicular

2. Epididymis

- The epididymis is closely apposed to the surface of the testis.
- It has 3 parts of epididymis:
  - Head of epididymis,
  - Body of epididymis and
  - Tail of epididymis.

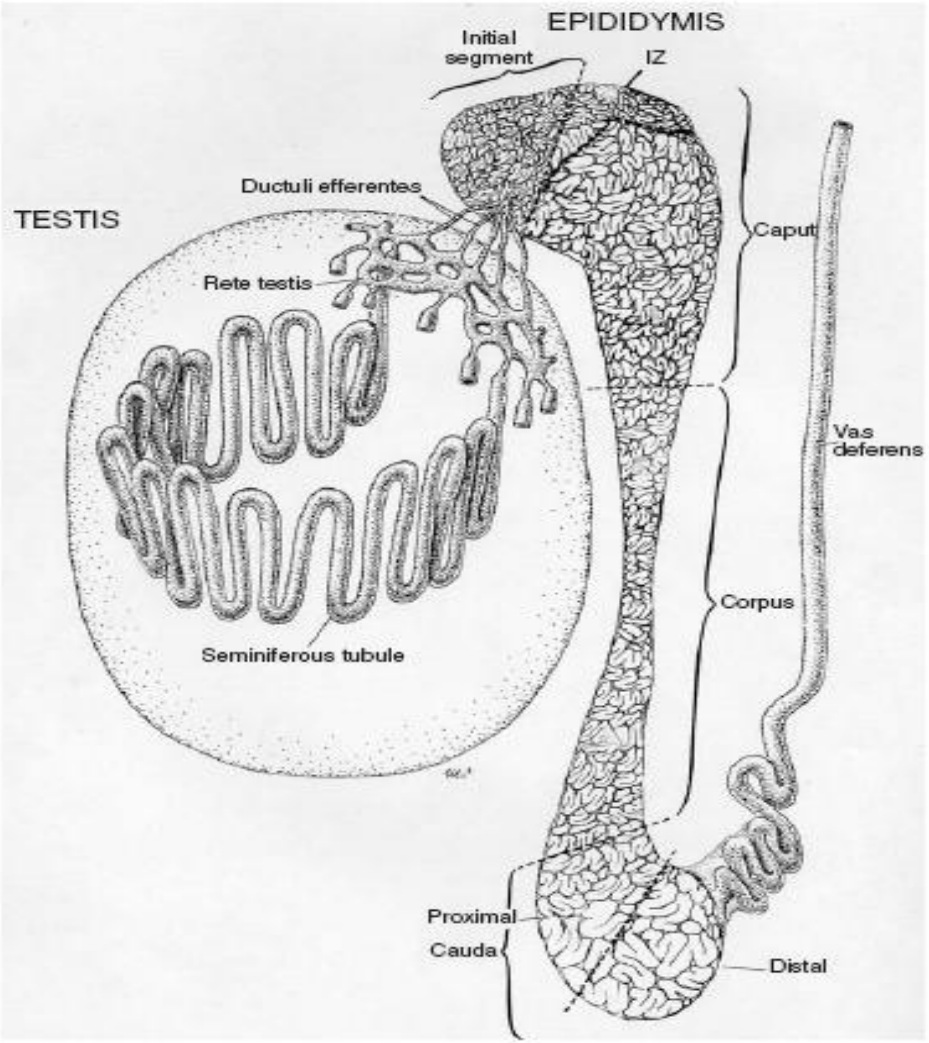


FIG. 3. Diagrammatic representation of the testis showing a seminiferous tubule and the rete testis, the ductuli efferentes, the epididymis, and vas deferens. The major regions of the epididymis (i.e., the initial segment, intermediate zone, caput, corpus, and proximal and distal cauda) are indicated. (Adapted from Robaire, B., and Hermo, L. [1988]. Efferent ducts, epididymis and vas deferens: structure, functions and their regulation. In *The Physiology of Reproduction* [E. Knobil and J. D. Neill, Eds.], pp. 999–1080. Raven Press, New York.)

Functions of the epididymis

1. **Sperm transport**

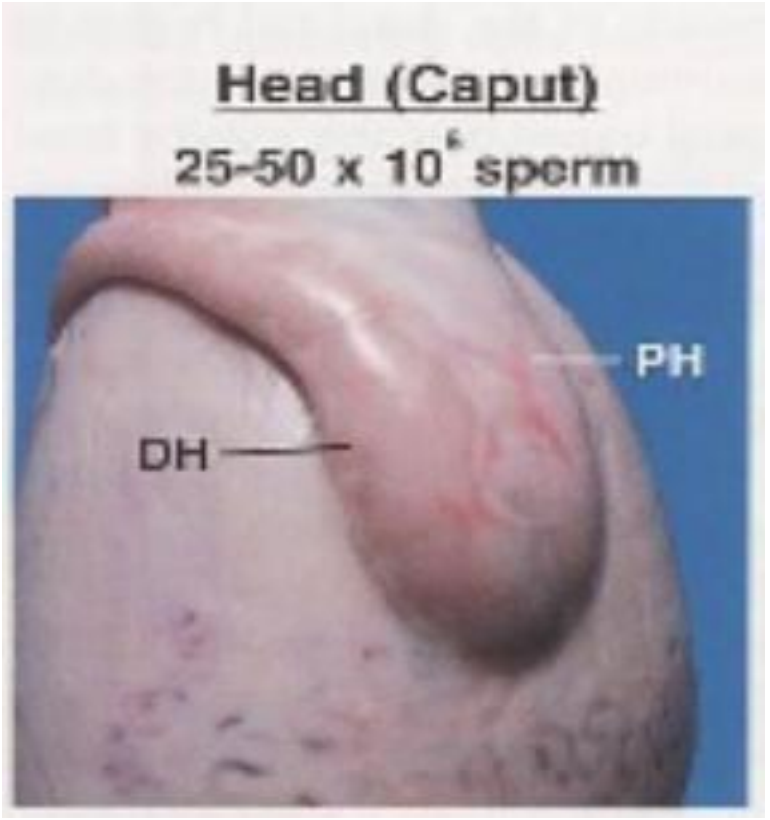
- Sperm are transported from testis through the efferent ducts of the epididymis by pressure from rete-fluid aided by movement of cilia.
- There is a peristaltic movement of muscle layer that drive the sperm.
- This process takes 5-25 days in bull.

2. **maturation of sperm**

- Sperm ripening involves some acrosomal change and the conspicuous migration of cytoplasmic droplet from the cytoplasm further down the tail.
- By the time of ejaculation these droplets have been completely detached.
- Membrane changes, increase in the specific gravity and fertilizing capacity are other features.

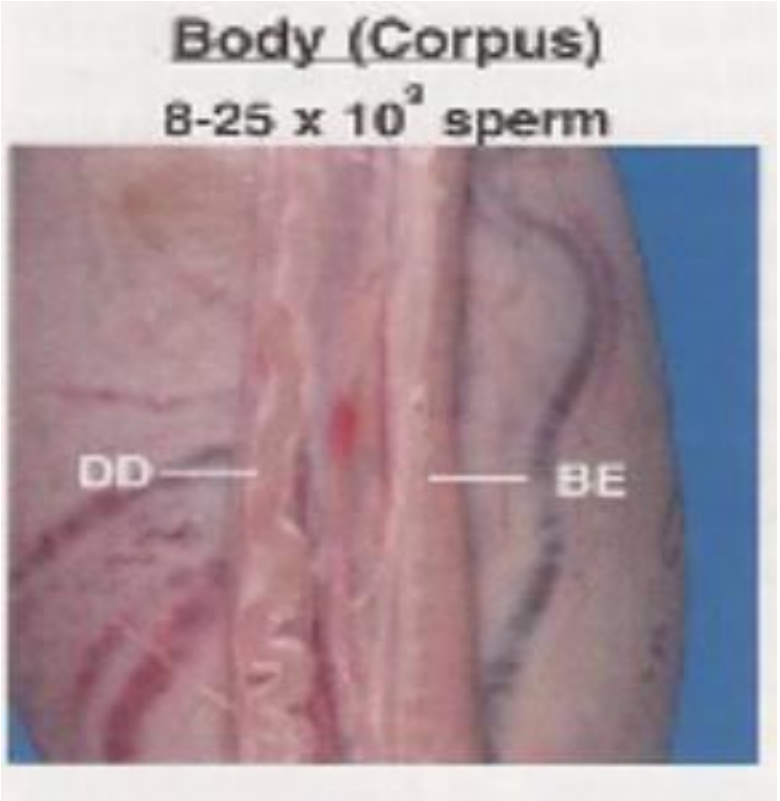
I. Head of Epididymis

- Head (caput) is a flattened structure located at one of the poles of the testis.
- Consists of variable number of efferent ductules which join main duct of epididymis.
- Spermatozoa characteristics:
- Non motile
- Not fertile
- Proximal cytoplasmic droplet
- Low disulfide



II. Body of epididymis

- Body (corpus) consists of the narrow part which terminates at the opposite pole in the expanded part that makes the tail.

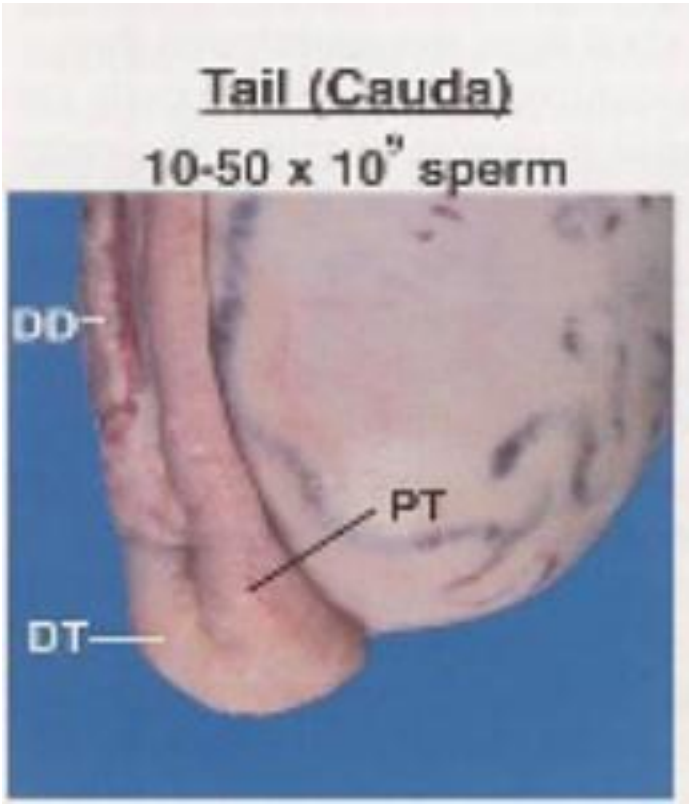


Spermatozoa characteristics:

- Some expression of motility after dilution
- Some expression of fertility
- Translocating cytoplasmic droplets
- Moderate to high

III. Tail of epididymis

- The tail is an expanded part with a contour of which is visible in live animals.
- 4 – 8 days of Sperm production can be stored in epedidymal tail
- Sepermatozoa characteristics:
- Experssion of normal motility after dilution
- Distal droplets
- High degree of disulfide crosslinking
- Can bind to oocytes



3. **Ductus Deferens (Vas Deferens)**

- first accompanies at first accompanies the vessels and nerve tracts but later at the internal inguinal canal leaves them and then join the pelvic urethra.
- Readily separable from the rest of the spermatic cord (ex vasectomy).
- Has a tick muscular wall; at its terminal end it gets wider thickened, and this portion is furnished with branched tubular glands and forms **ampulla**.
- The vas deferens transports sperm from the tail of the epididymis to the urethra by peristaltic movement usually during courtship and pre-coital stimulation.
- Vasectomy – cutting and ligating the ductus deferens, which is a nearly 100% effective form of birth control

4. **Accessory Male Sex Glands**

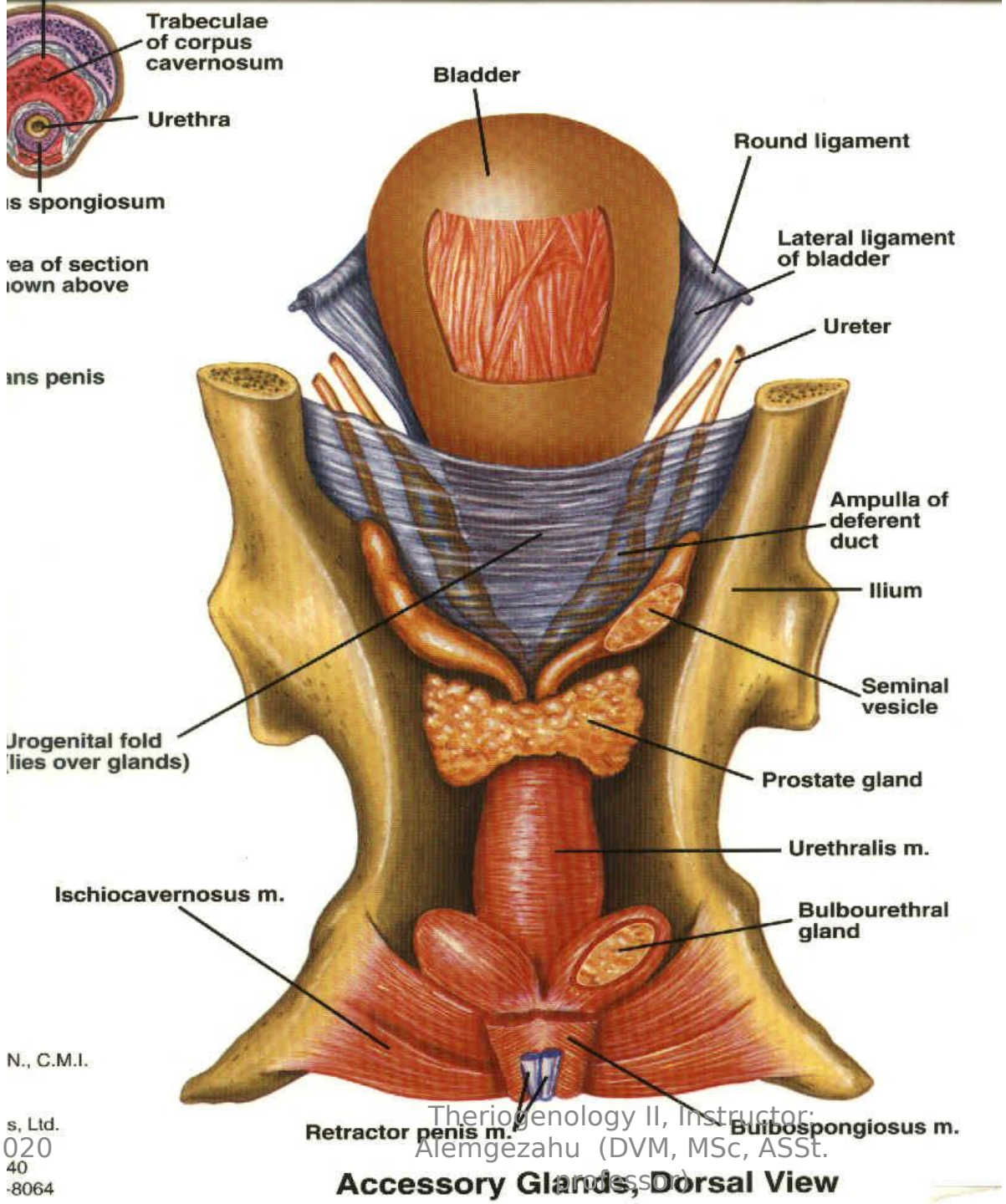
- It includes ampullary, vesicular, prostate and bulbourethral
- The products of these glands serve to nourish and activate the spermatozoa, to clear the urethral tract prior to ejaculation, serve as the vehicle of transport of the spermatozoa in the female tract, and to plug the female tract after placement of spermatozoa to help ensure fertilization.

4.1. Ampullae

- The ampulae also have muscular layer which expel the sperm from vas deferens.
- Ampula also contribute to seminal secretion to ejaculate (ex, horse).
- N**ot conspicuous in boars**

4.2. Seminal vesicles/seminal glands

- Paired glandular tissue that lie lateral to the terminal portion vas deferens (ampullae).
- It is found lying over neck of the urinary bladder Form; Lobulated in bull and ram, prominent in boar, truly vesicular (large pyriform glandular sac) in equines.
- Seminal vesicle and vas deferens have a common ejaculatory orifice into urethra.
- Vesicular secretion is significant portion of the ejaculate eg.
  - ¬ fructose, sorbotol, citric acid, inositol): energy sources
  - ¬ Phosphate & bicarbonate: buffers
- Entry of semen into the bladdder is prevented by engorgement of **colliculus seminalis** during


Trabeculae of corpus cavernosum
Urethra
s spongiosum
ea of section own above
ans penis
Urogenital fold (lies over glands)
N., C.M.I.
s, Ltd.
40
-8064
Bladder
Round ligament
Lateral ligament of bladder
Ureter
Ampulla of deferent duct
Ilium
Seminal vesicle
Prostate gland
Urethralis m.
Ischiocavernosus m.
Bulbourethral gland
Retractor penis m.
Bulbospongiosus m.
Accessory Glands, Dorsal View

4.3. Prostate gland

- Has two components

1. Lobulated external part:

- Body of the prostate that lie outside the thick pelvic urethral muscle surrounding the urethra.

2. Internal disseminate part:

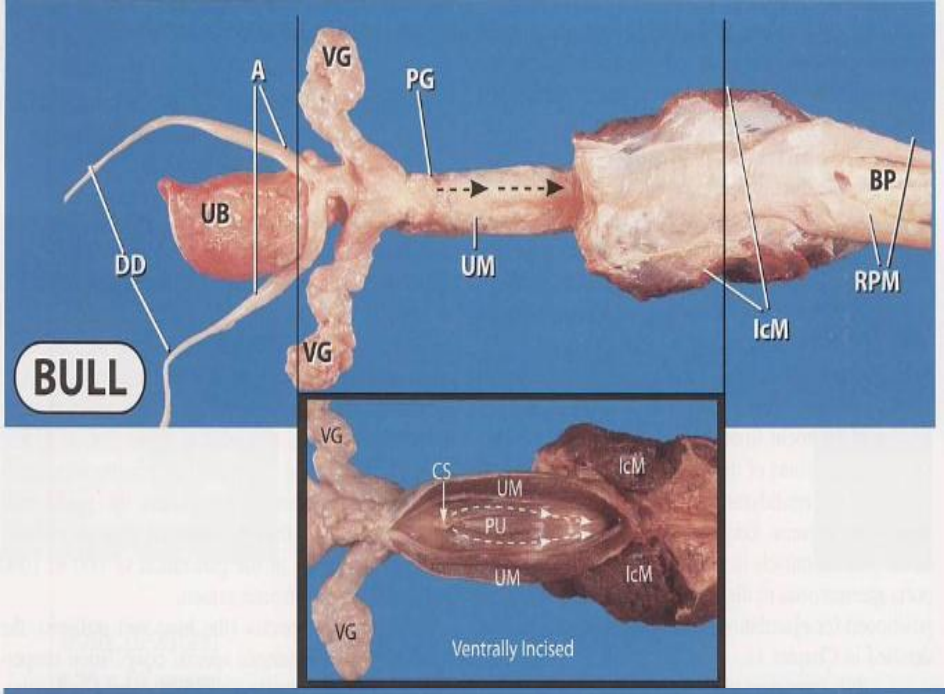
- Distributed along the length of the pelvic urethra below the urethral muscle.
- The body of prostate in the ram is not visible while it is totally external in equines.
- The contribution of prostate to the volume of ejaculate is minimal in farm animals.
- Well develop in man and dog and the bulk of

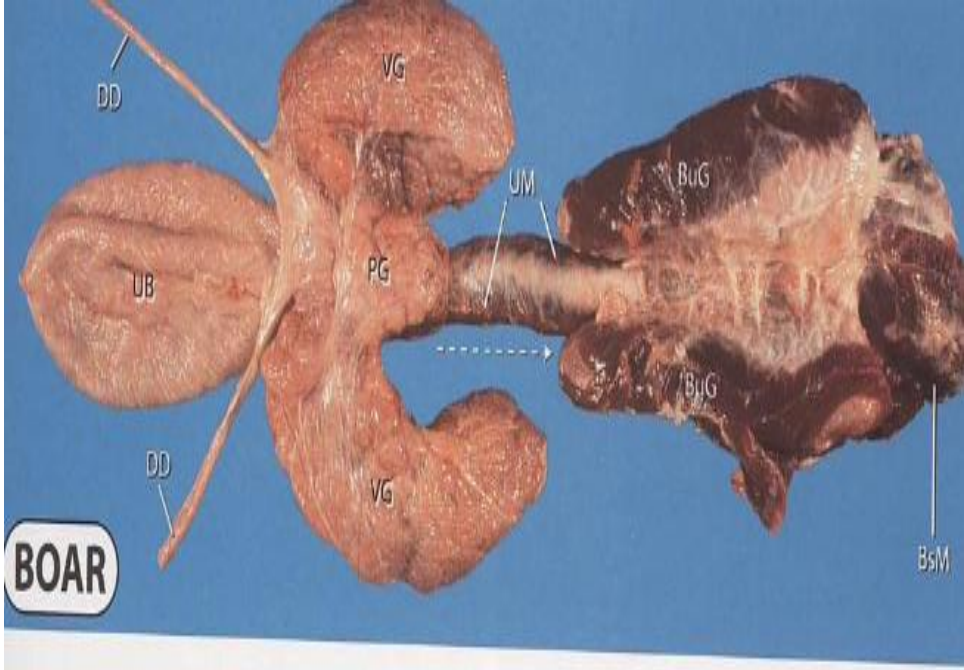
4.3. Prostate gland…

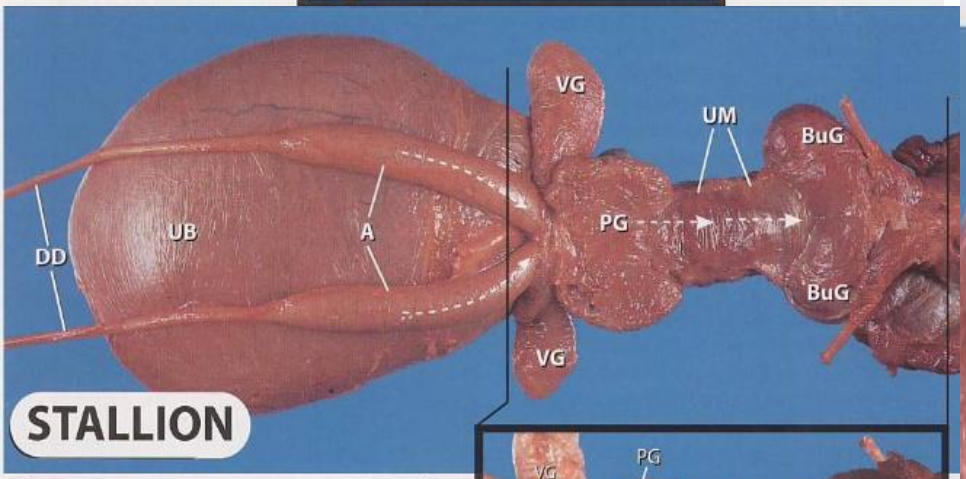
- Bull- body located at bladder neck and disseminated part in PU
- Ram – only disseminated part
- Boar- – heart shaped body may be covered by VG + disseminated part
- Stallion – no disiminated part but a two lobed H shaped body
- Dog – prostate gland found around pelvic urethra at bladder neck (only gland)
- Toms - a four lobed prostate gland on top of urethra.

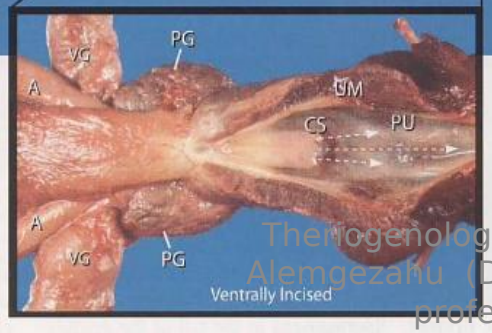
4.4. **Bulbourethral Glands/BUG** (Cowper's Glands)

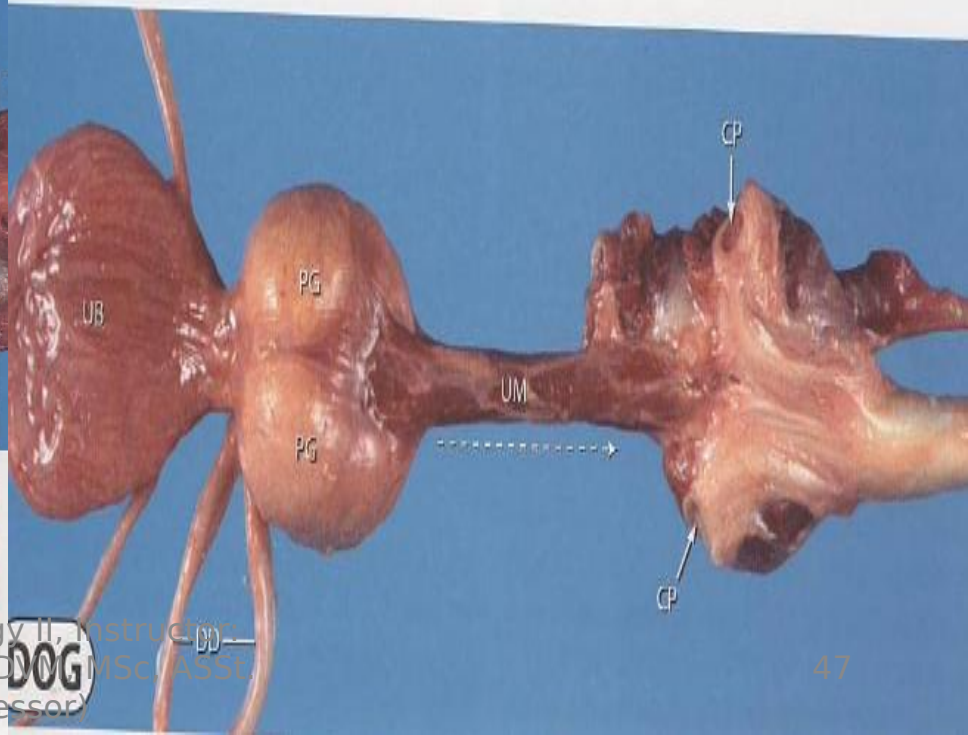
- **It is paired glands** located on either side of pelvic urethara **at ischial arch**.
- In ram bull and stallion - small and buried under bulospongiosus muscle.
- **All domestic species have these glands except the dog.**
- Large in boar > stallion > ram > bull.
- In boar BUGs are very large, dense and lie on top of the last 2/3rd or pelvic urethra.
- The glands secrete a **viscous secretion** which allows coagulation of ejaculate in FRT (important-prevent back flow).
- The dribbling from prepuce before mounting are bulbo-urethral secretions.











A	=	Ampulla
BP	=	Base of Penis
BuG	=	Bulbourethral Glands
CS	=	Colliculus Seminalis
DD	=	Ductus Deferens
IcM	=	Ischiocavernosus Muscle
PG	=	Prostate Gland (Body)
PU	=	Pelvic Urethra
RPM	=	Retractor Penis Muscle
UB	=	Urinary Bladder
UM	=	Urethralis Muscle
VG	=	Vesicular Glands

Cont ...

- Accessory sex gland secretions and secretions from the epedidymis form the fluid part of ejaculate referred to as **Seminal Plasma**
- The development and function of accessory sex glands is under control of **testosterone** (implication relative to castration ?).
- The secretions from accessory sex glands contain a variety of chemical constituents mostly coming from the blood stream (composition varies from species to species).
- The most important component is **fructose** which serves as a source of **energy** for spermatozoa.
- Accessory secretions also provide a vehicle for transport of semen during ejaculation.
- Coagulation of some accessory gland secretions is

Cont ...

- In most mammals, the accessory sex gland secretions make up the majority of the seminal plasma during ejaculation.
- The species differences are mainly anatomical in terms of the accessory glands for the production of seminal plasma during ejaculation.
- In the bull and stallion, the accessory sex glands can be manipulated via the rectum to stimulate ejaculation for collecting semen for a fertility check (breeding soundness exam).
- In the pig/camel, the bulbourethral (Cowper's) glands are large and are the source of the gelatinous material found in boar semen.

Spermatic Cord

- **Spermatic cords** suspend scrotal structures and contribute to testicular thermoregulation
- Located within *vaginal canal* outlined by *parietal lamina* of the *vaginal tunic*
- Pass in to abdominal cavity through **inguinal canal** through a ring formed between the bony pelvis and abdominal muscles.
- Length of suspension – varies with species (pendulous in ruminants, short in equine and pets – clinical significance ?)
- **Composed of**

⎫ The *ductus deferens* - posterior

⎫ The *blood supply (internal spermatic/testicular artery)* and *venous drainage (spermatic/testicular vein)* - anterior

⎫ Smooth muscle fibers (internal cremaster muscle)

The functions of the spermatic cords are to:

- ***provide vascular, lymphatic and neural connection to the body***
- ***provide a heat exchanger***
- ***house the cremaster muscle***

CM = Cremaster Muscle

DD = Ductus Deferens

HE = Head of Epididymis

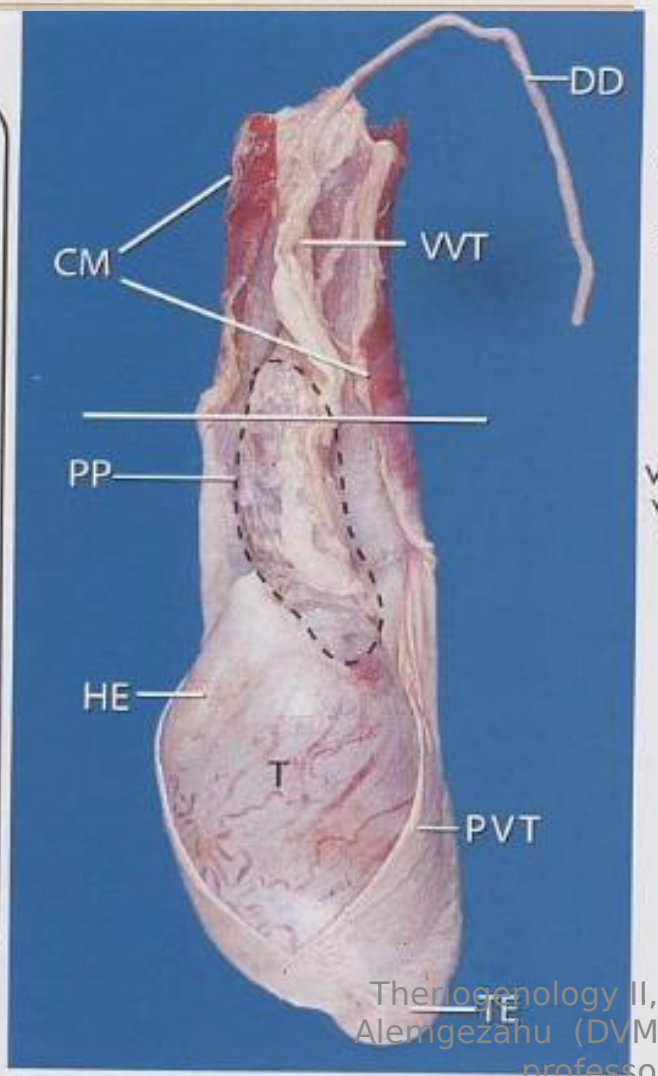
PP = Pampiniform Plexus

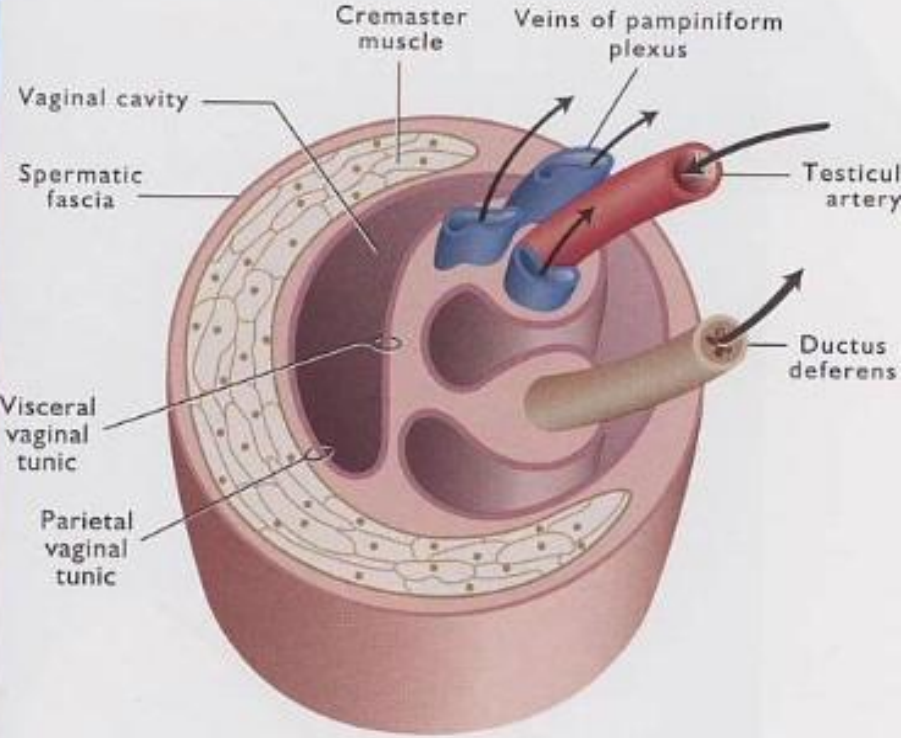
PVT = Parietal Vaginal Tunic

T = Testis

TE = Tail of the Epididymis

VVT = Visceral Vaginal Tunic





The line across the excised spermatic cord (photo at left) indicates the approximate plane of the cross-sectional schematic. Arrows indicate direction of fluid flow.

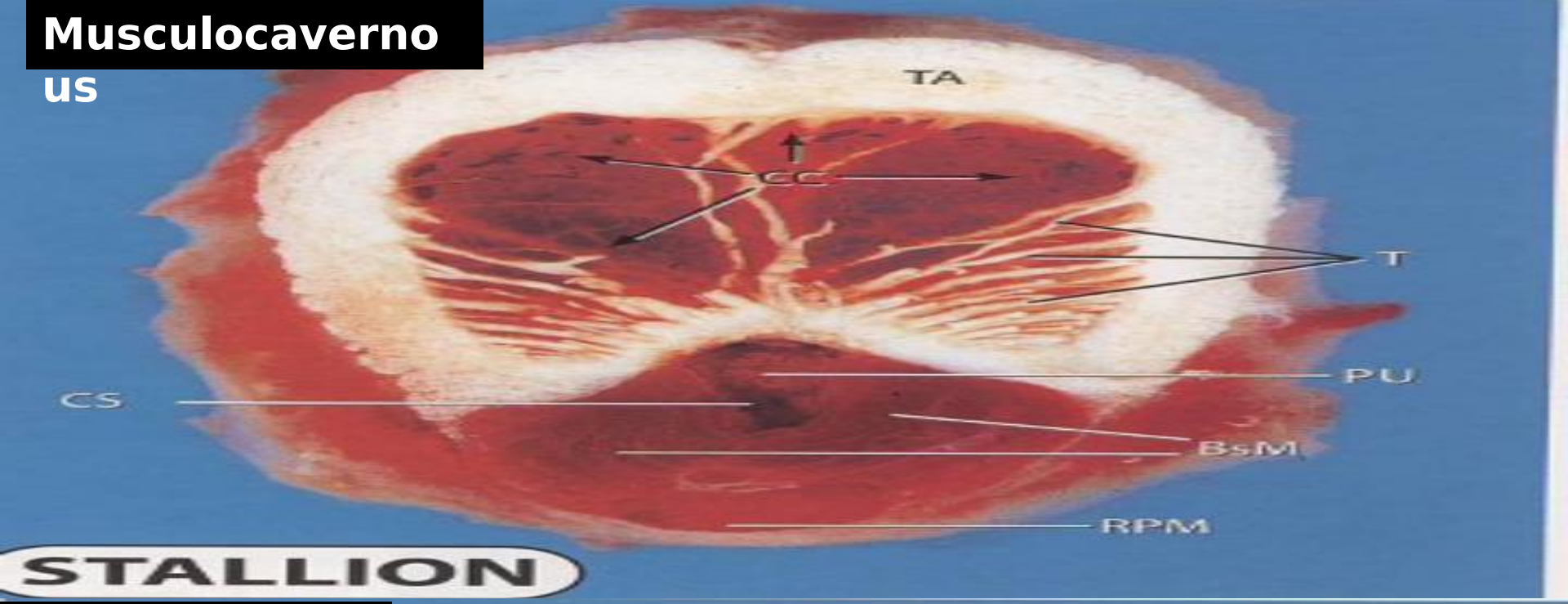
Penis & Prepuce

- **Penis** is an external genital organ, the male organ of copulation responsible for transferring spermatozoa to the female reproductive tract for fertilization
- Grossly the penis consists of three parts

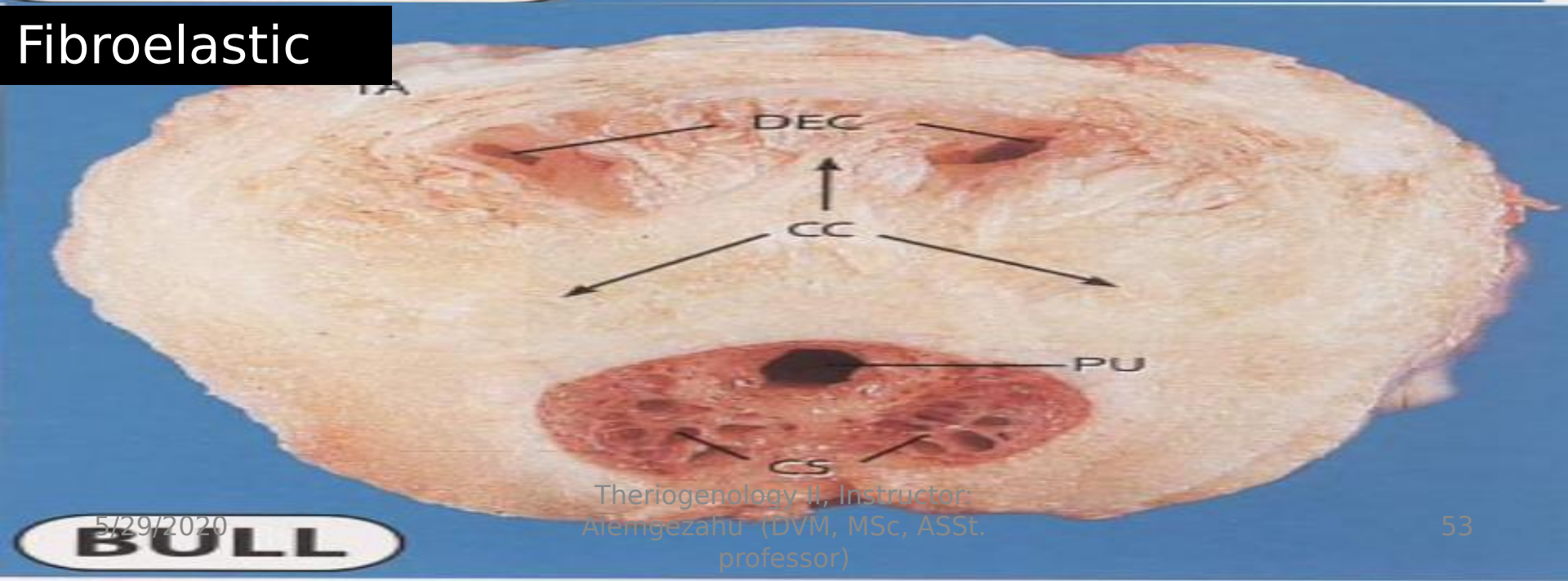
1. The root/ base of penis
2. The body/shaft of pens
3. The free part/ head & glans penis surrounded by the **prepuce**

- Two types of penis - **Musculocavernous** and **Fibroelastic** based on composition
- Musculocavernous penis **–** has large erectile tissue covered by small dense CT cover – stallion, dog, man
- Fibroelastic penis – little errectile tissue covered by thick dense CT cover and folded in to S happed Sigmoid flexure - ruminants, pigs and camels

Musculocavernous



Fibroelastic



Cont …

- **Penile root:**

  Consists of two **crura** (proximal end of the CCP) and **bulbus penis (**caudal extent of *CSP)*.

  Is attached to the Ischial arch by Ischiocavernous musccle

- **Penile body**

  Long segment of penile shaft in abdominal cavity

  Contains erectile tissues (CSP and CCP- elastic fibers and vascular sinuses- spp variation) , tunica albuginea and penile urethra

- **Free penile segment**

  Starts from the attachment of the prepuce on the penis and ends as the glans penis.

  The *glans penis* contains the corpus spongiosum

Cont …

- **Composition of the penis**

1. Penile urethra
2. Corpora cavernosa penis (CCP) – internal erectile tissue
3. Corpus spongiosum penis (CSP) – external erectile tissue
4. Tunica albuginea – external dense CT cover

- **Vasculature**

  Pudendal artery

  Venous Drainage; CCP via root of penis into pudendal vein and CSP into dorsal vein of penis from its distal extremity.

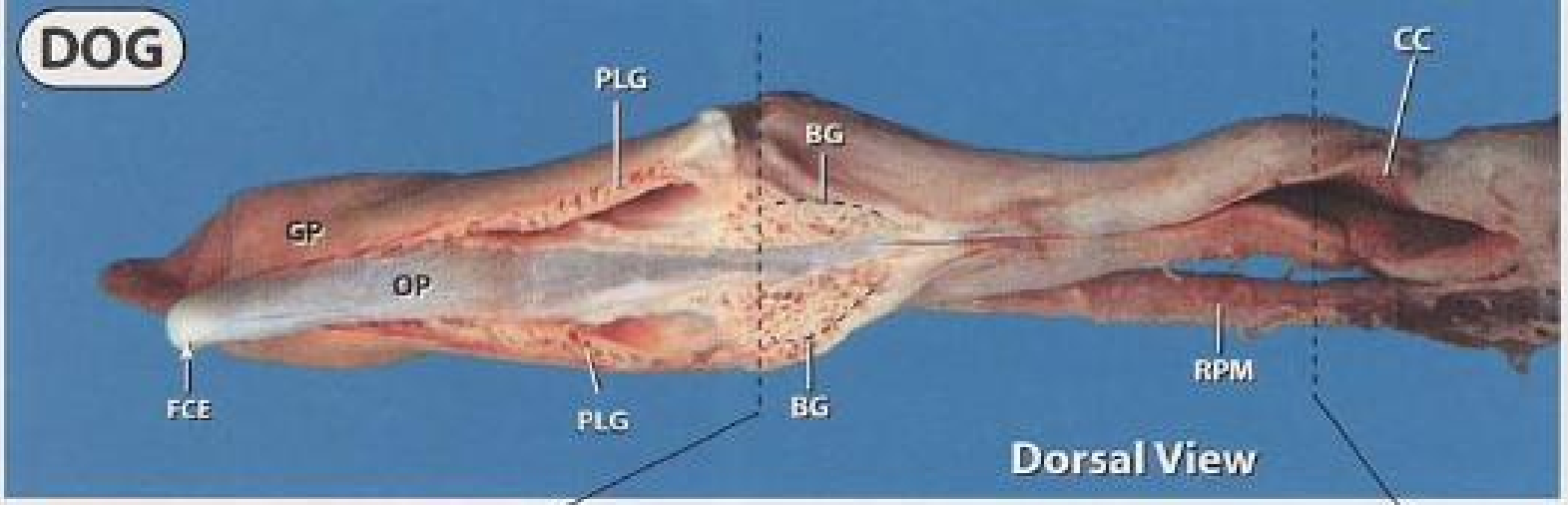
- **Innervations**

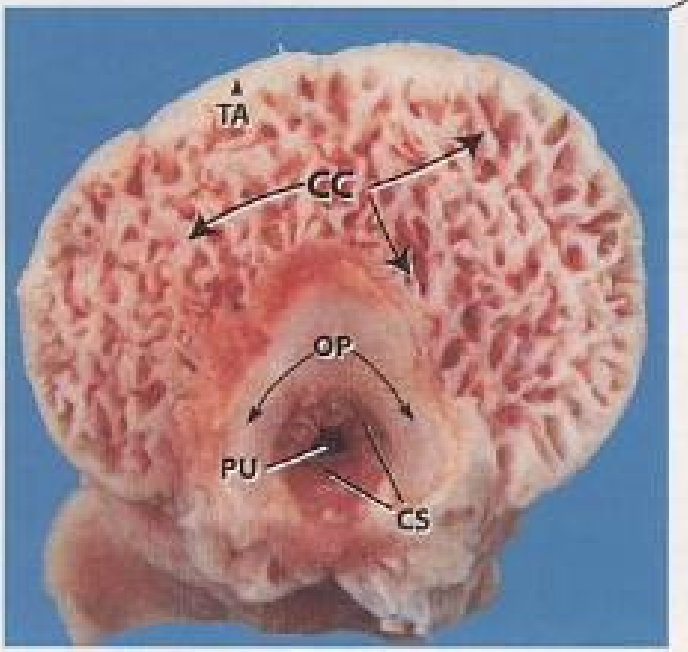
  Rich free nerve endings on glans penis

  Dorsal nerve of the penis, a branch of the pudendal nerve

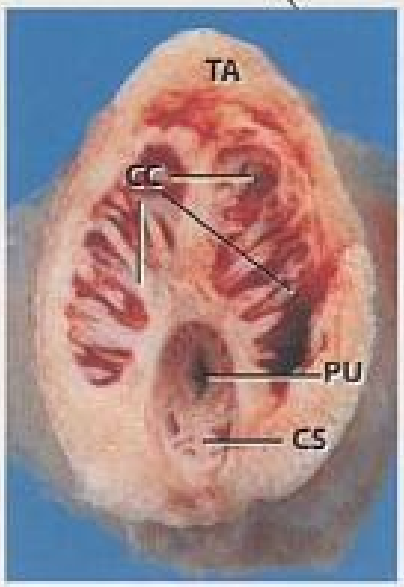
  Lower lumbar and sacral segments of spinal cord

- **Associated Muscles** – Ischiocavernous muscle (around root of penis), bulbospongiosus muscle (from root penis going caudally down), urethralis (circularly covers pelvic urethra), retractor penis (forms Sigmoid flexure)

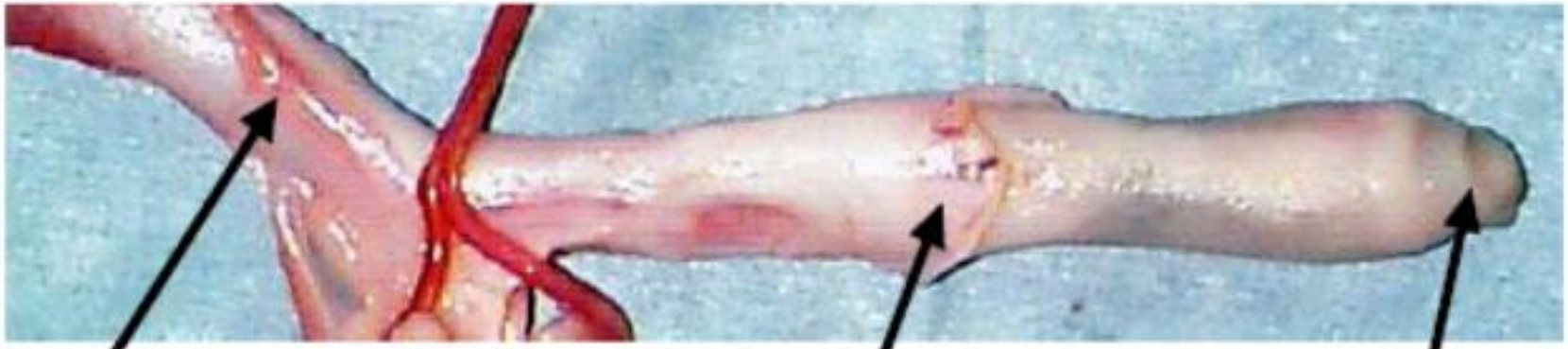




BG = Bulbus Glandis
CC = Corpus Cavernosum
CP = Cartilaginous Process
CS = Corpus Spongiosum
FCE = Fibrocartilaginous end of Os Penis
GP = Glans Penis
OP = Os Penis
PLG = Pars longa glandis
PS = Penile Spines
PU = Penile Urethra
RPM = Retractor Penis Muscle
TA = Tunica Albuginea



Bulbus Glandis



Penis

Bulbus Glandis

Glans Penis

- Vascular shunting allows swelling of penis for erection.
- Penis swells at bulbus glandis, locking penis into the vagina of the female.

Function of the Penis

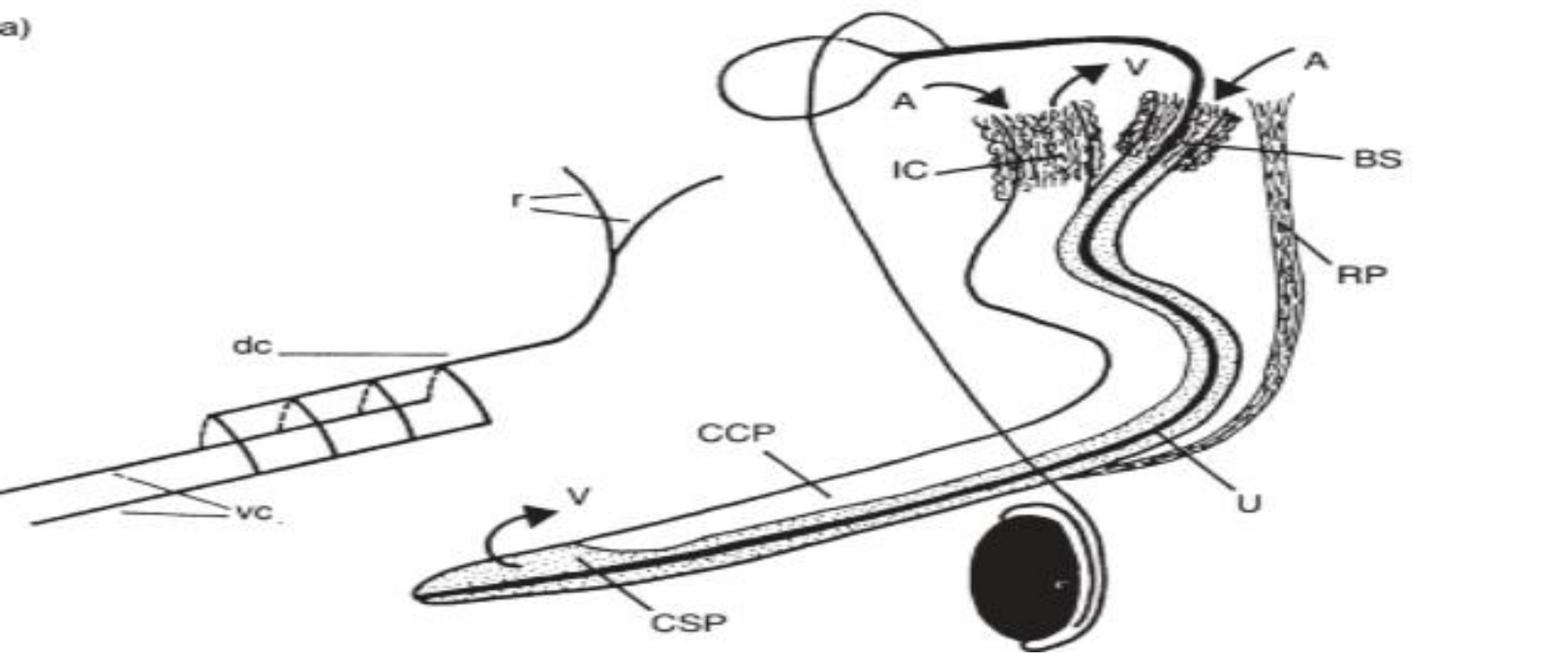
- Mechanism of penile **erection and protrusion** from prepuce

1. **Sexual stimulation** (sight, smell of female in heat)
2. **Engorgement of cavernae**

   Neural stimuli - contraction of ischiocavernosus (IC) muscles found at root of penis occludes superficial venous drainage of CCP. Meanwhile, arterial blood supply continues and engorges the cavernae with blood.

   Engorgement causes increase in diameter and length (musculocavernous) or rigidity (fibroelastic) of the penis

3. **Relaxation of the retractor penis** muscle (fibro-elastic penis) causes elongation of the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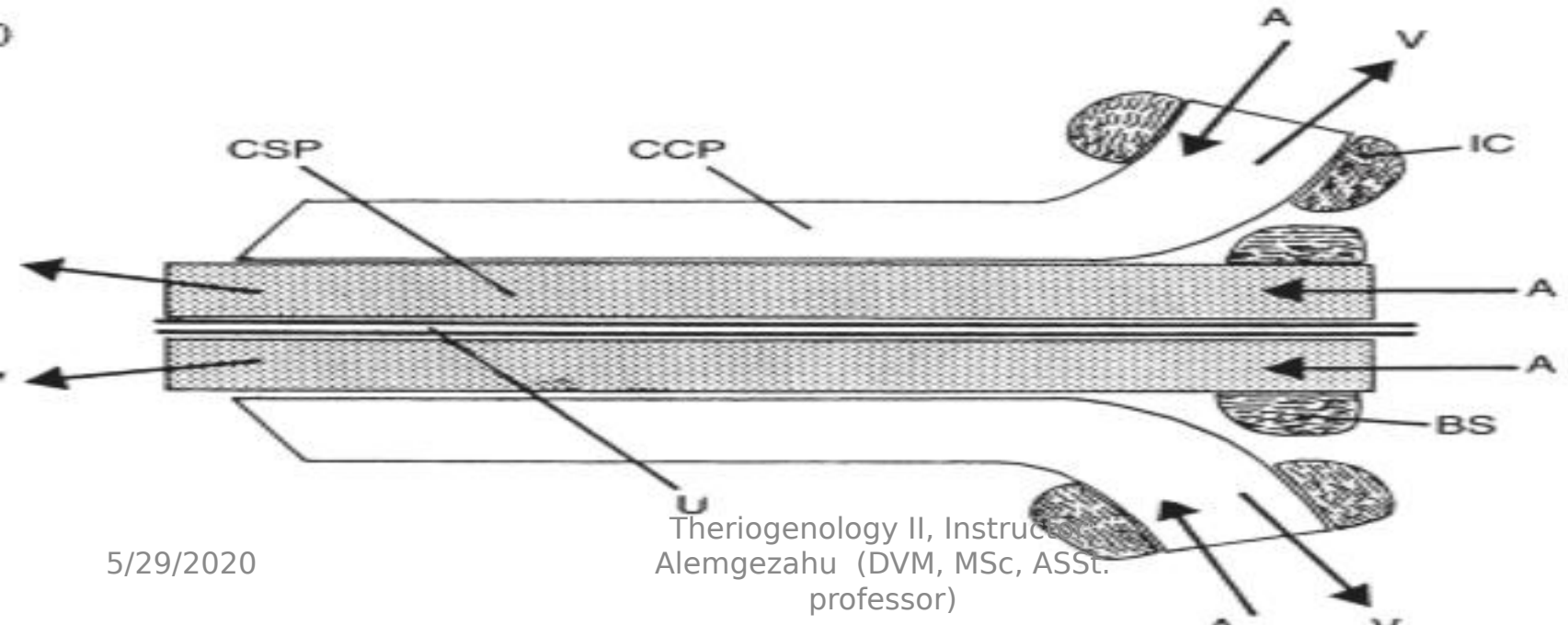
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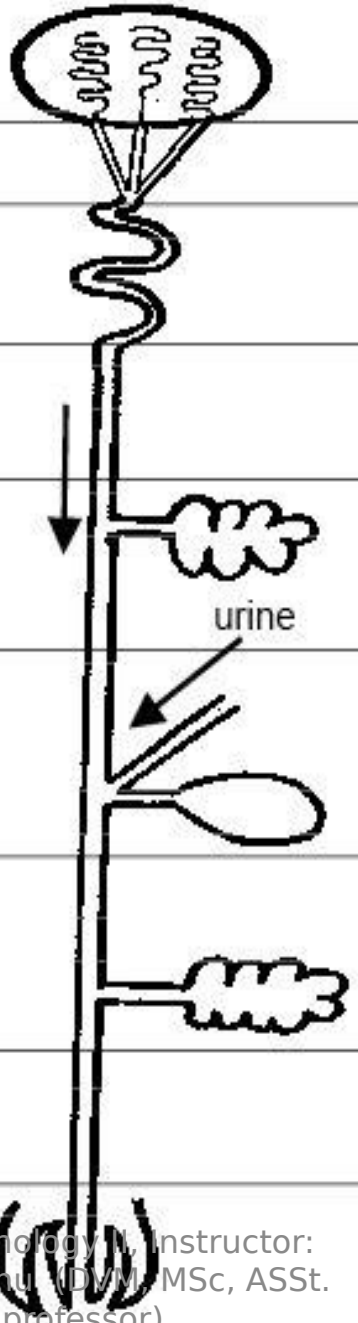
Emission and Ejaculation

- **Copulation**
- Sensory free nerve endings on skin of glans penis become excited and send impulse to the autonomic nervous system in SC through dorsal nerve of the penis
- Sympathetic stimulation of smooth muscles in cauda epedidymis, ductus difference and accessory sex glands initiates the process of **emission** i.e. passage of spermatic fluid through ductus difference to pelvic urethra and mixing with accessory secretion – Semen formed.
- Somatic motor impulse to urethralis and bulbuspongiosus muscle - pumping contraction - **Ejaculation** i.e. passage of semen through the

Diagram summarizing the functions of the male reproductive organs



organ	function
testis with seminiferous tubules	sperm production
collecting ducts	transport and storage
epididymis	transport, maturation and ejaculation
vas deferens (sperm duct)	transport and ejaculation
seminal vesicles	secrete thick liquid to transport sperm
prostate gland	secretes thin alkaline solution to neutralise urine and female system
cowper's gland	secretions may lubricate, flush out urine or form a gelatinous plug
urethra	passage for urine and sperm
penis	copulation