



बिहार पशु विज्ञान
विश्वविद्यालय

BIHAR ANIMAL SCIENCES
UNIVERSITY



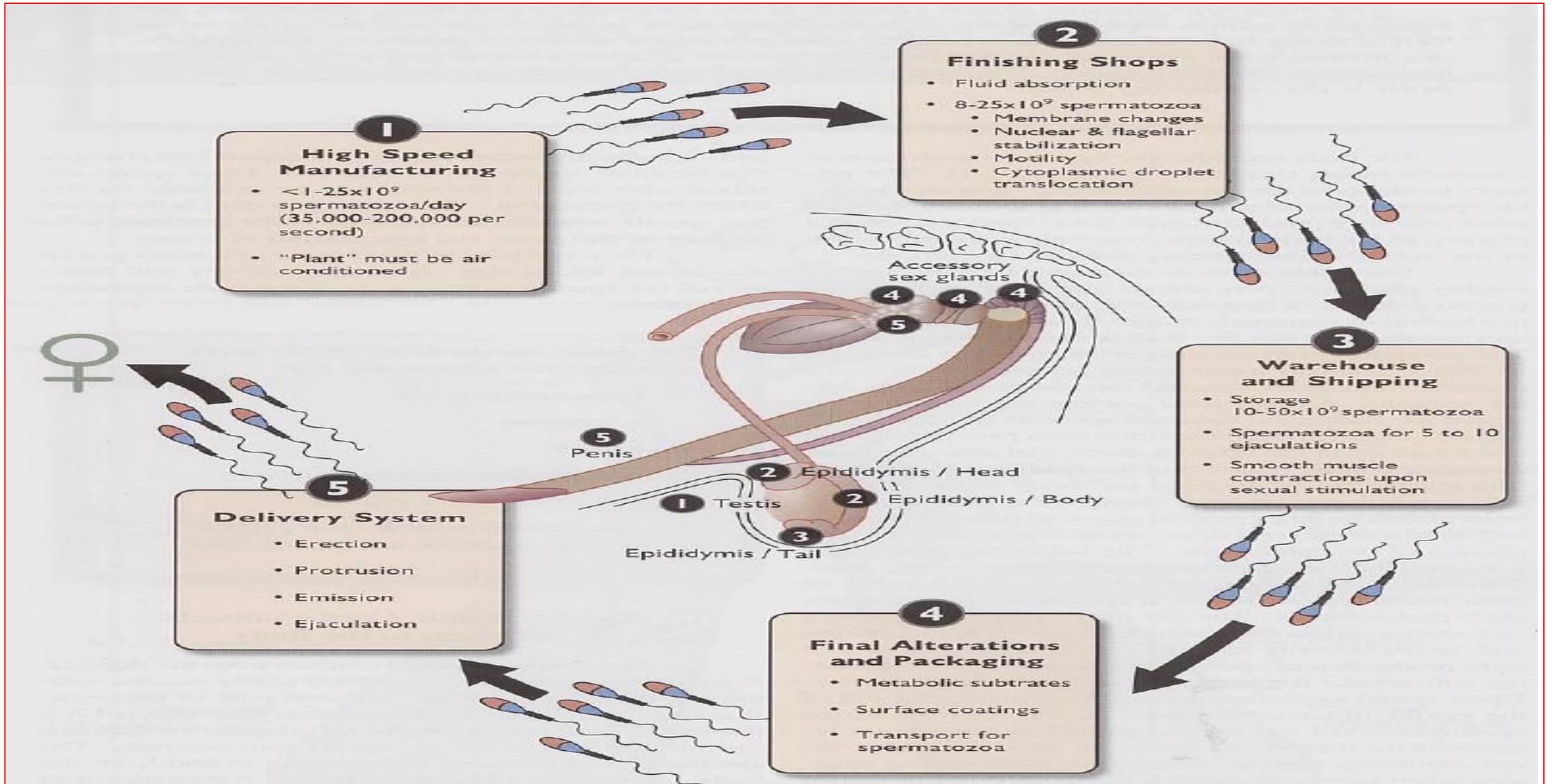
STRUCTURE AND FUNCTION OF MALE REPRODUCTIVE TRACT

UNIT 1 VGO 604

DR ANKESH KUMAR

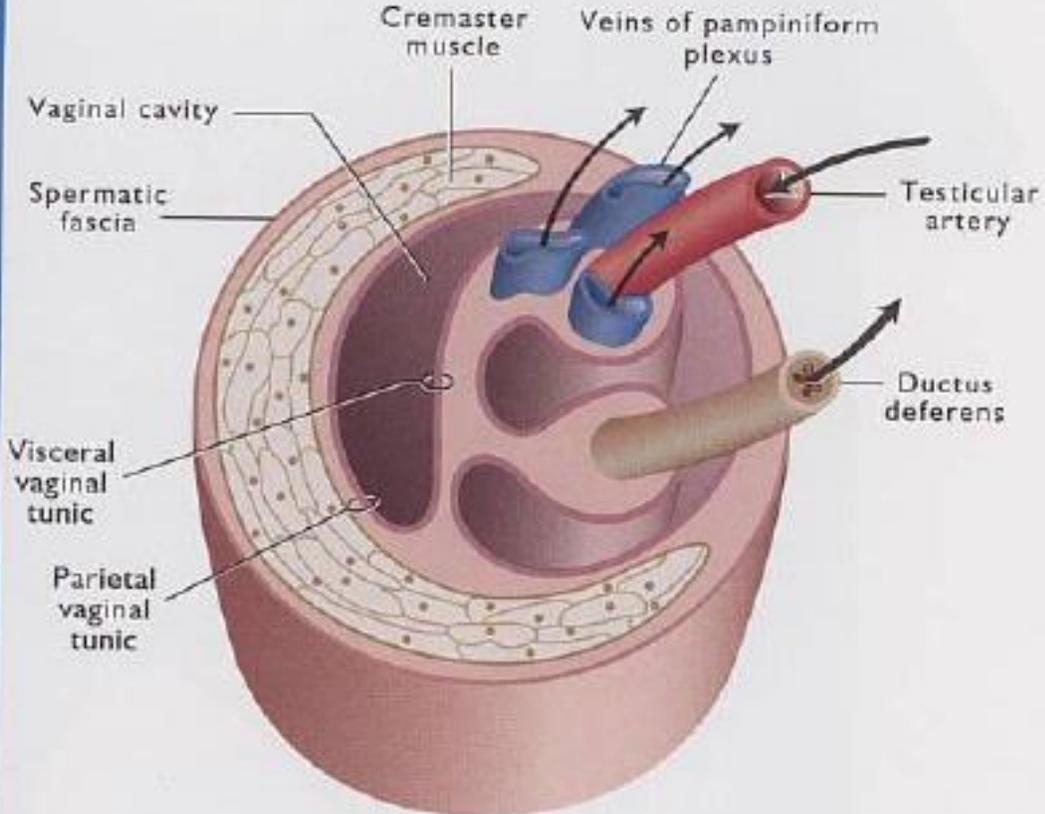
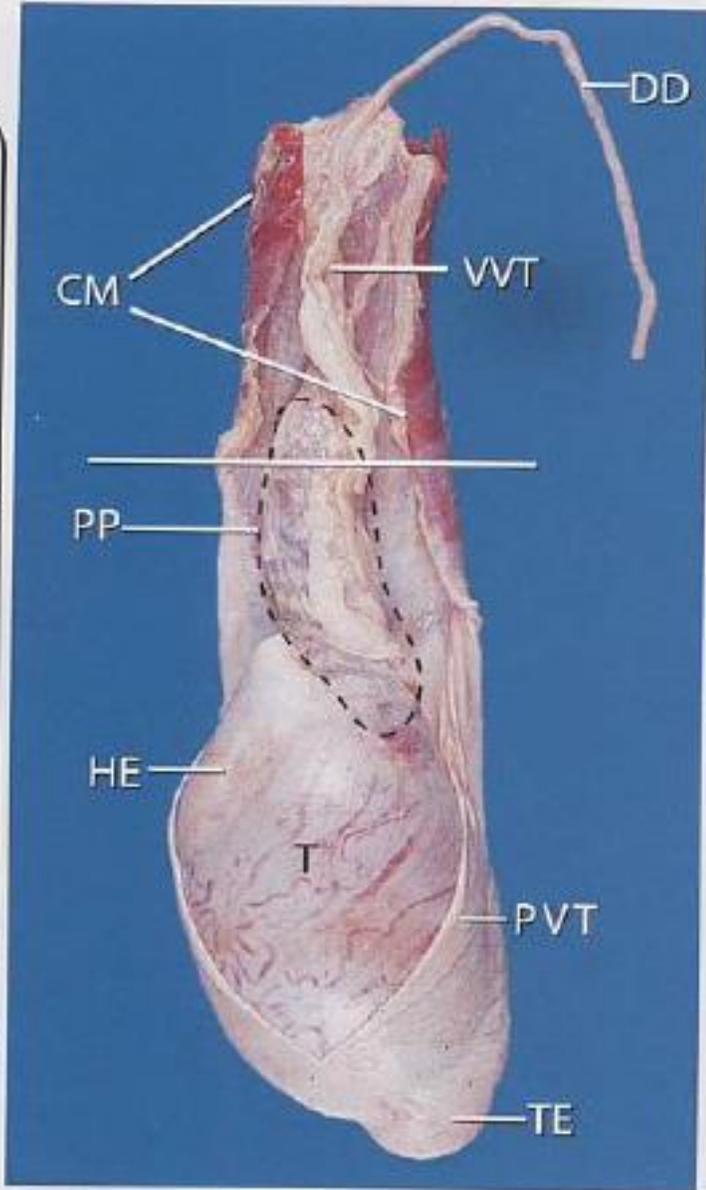
The basic component of the male reproductive system are:

1. Spermatic Cord
2. Scrotum
3. Testis
4. Duct system
5. Accessory sex gland
6. Penis and muscle for protrusion, erection and ejaculation



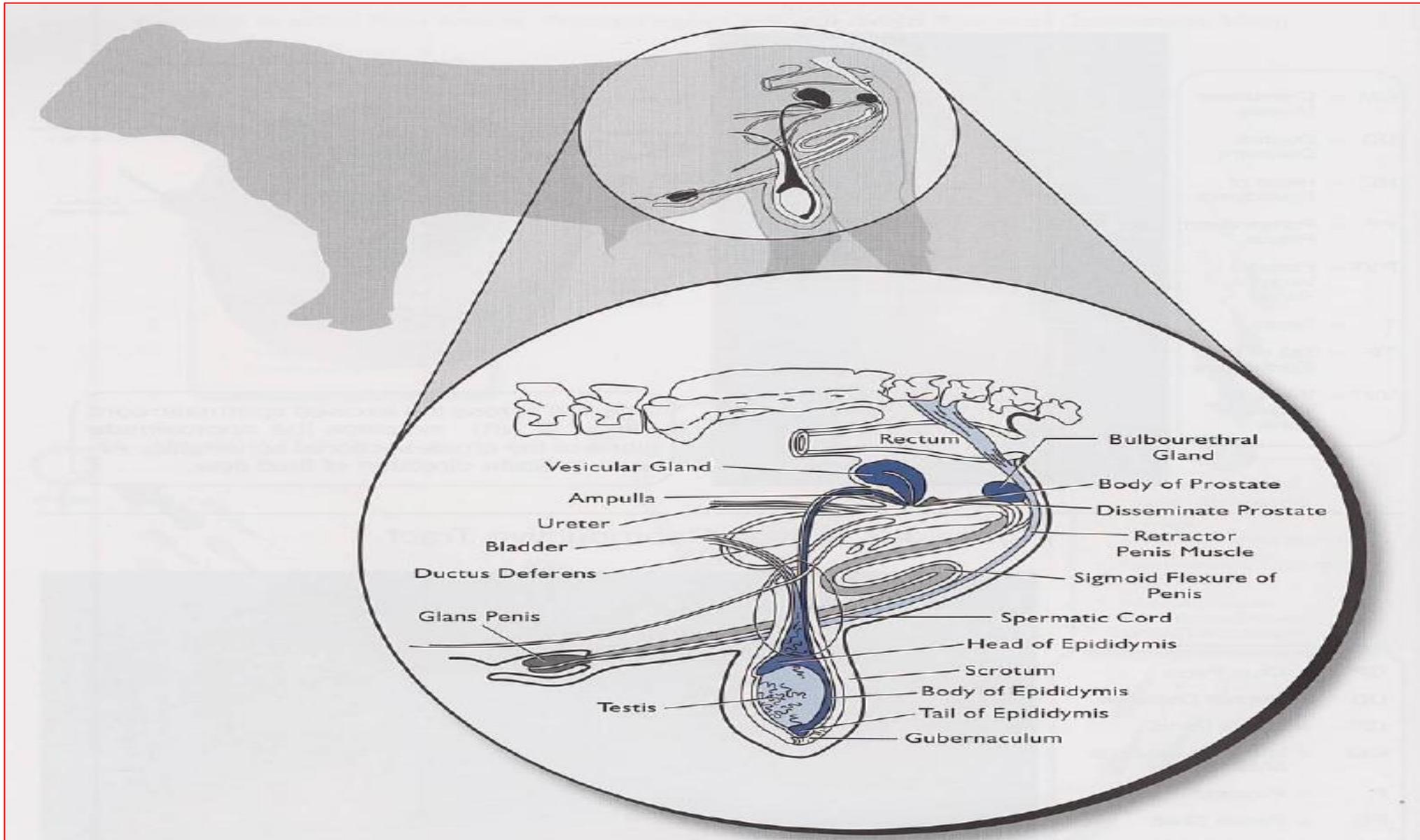
THE SPERMATIC CORD AND ITS COMPONENTS

- 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

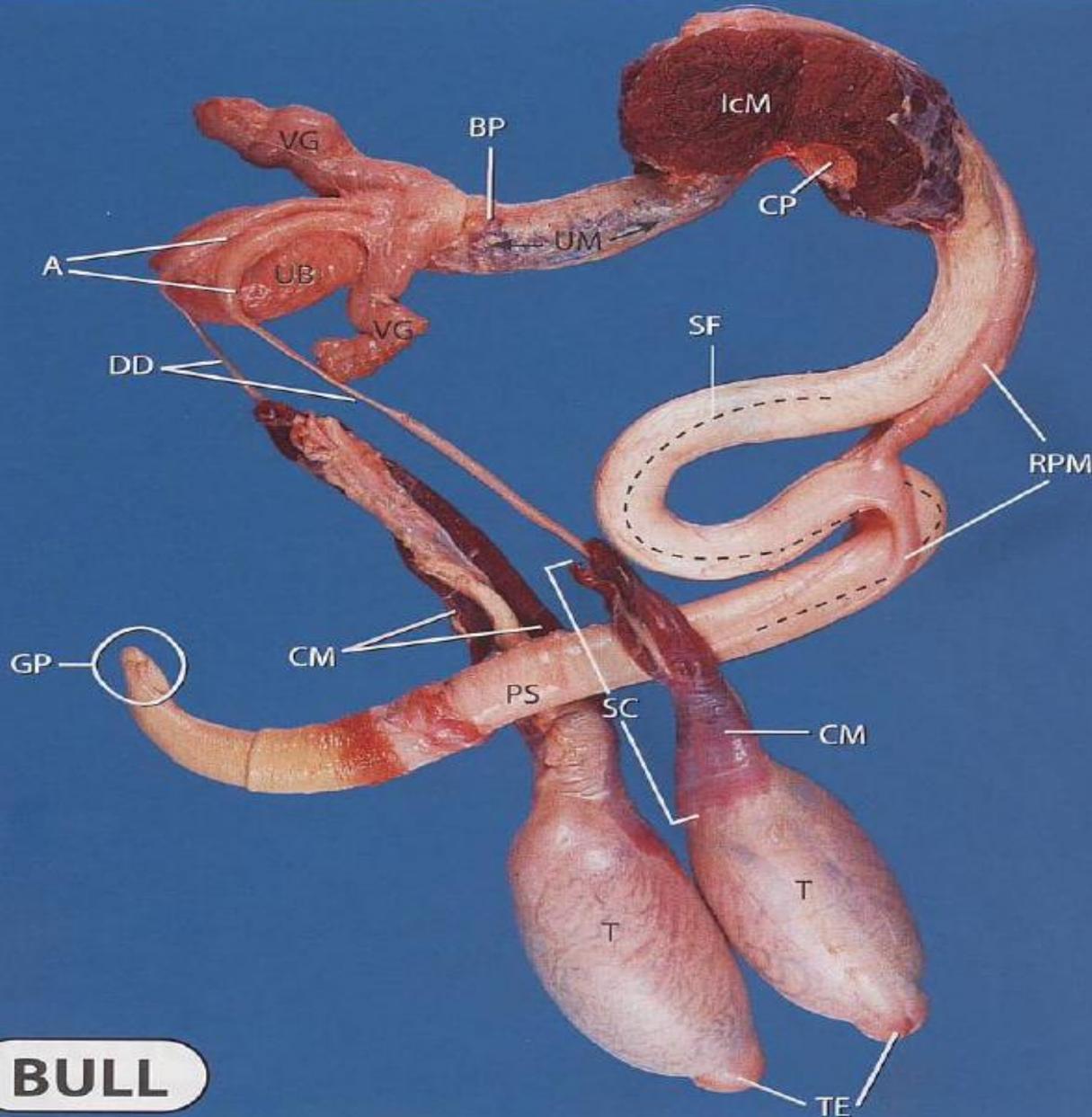


The line across the excised spermatic cord (photo at left) indicates the approximate plane of the cross-sectional schematic. Arrows indicate direction of fluid flow.

THE BULL REPRODUCTIVE TRACT

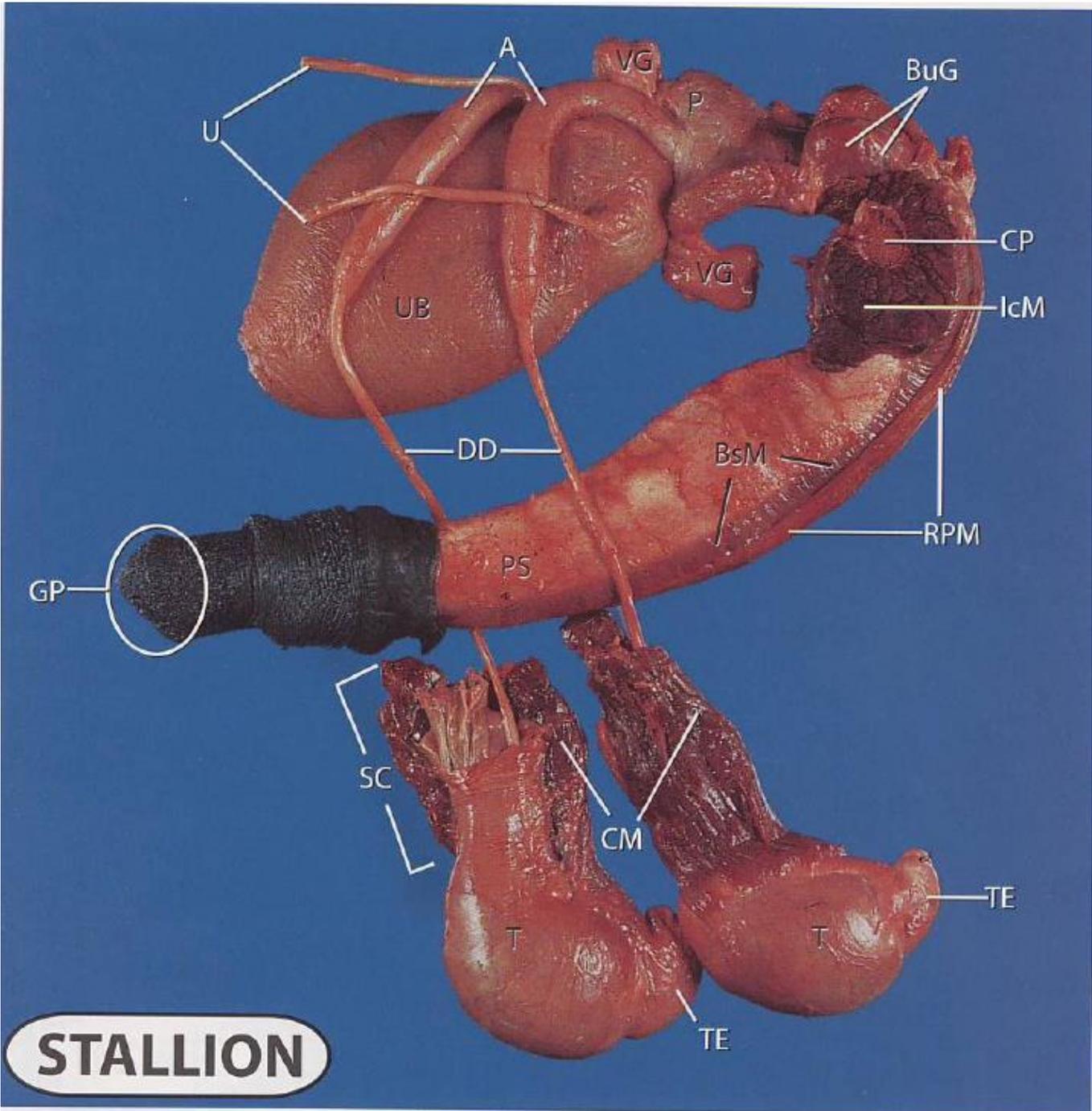


The Bull reproductive tract



BULL

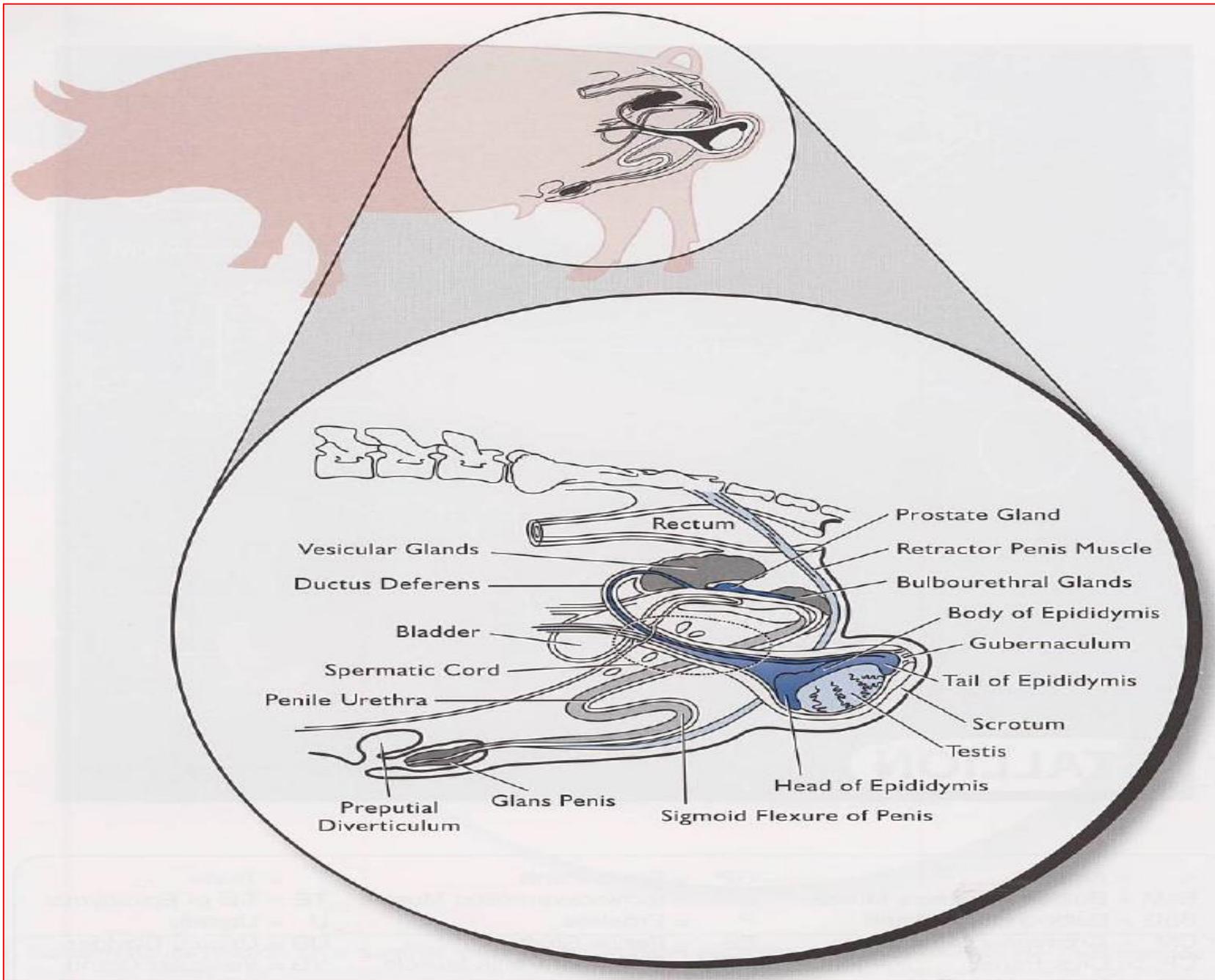
A = Ampulla	IcM = Ischiocavernosus Muscle	TE = Tail of Epididymis
BP = Body of Prostate	PS = Penile Shaft	UB = Urinary Bladder
CM = Cremaster Muscle	RPM = Retractor Penis Muscle	UM = Urethralis Muscle
CP = Crus Penis	SC = Spermatic Cord	VG = Vesicular Gland
DD = Ductus Deferens	SF = Sigmoid Flexure	
GP = Glans Penis	T = Testis	



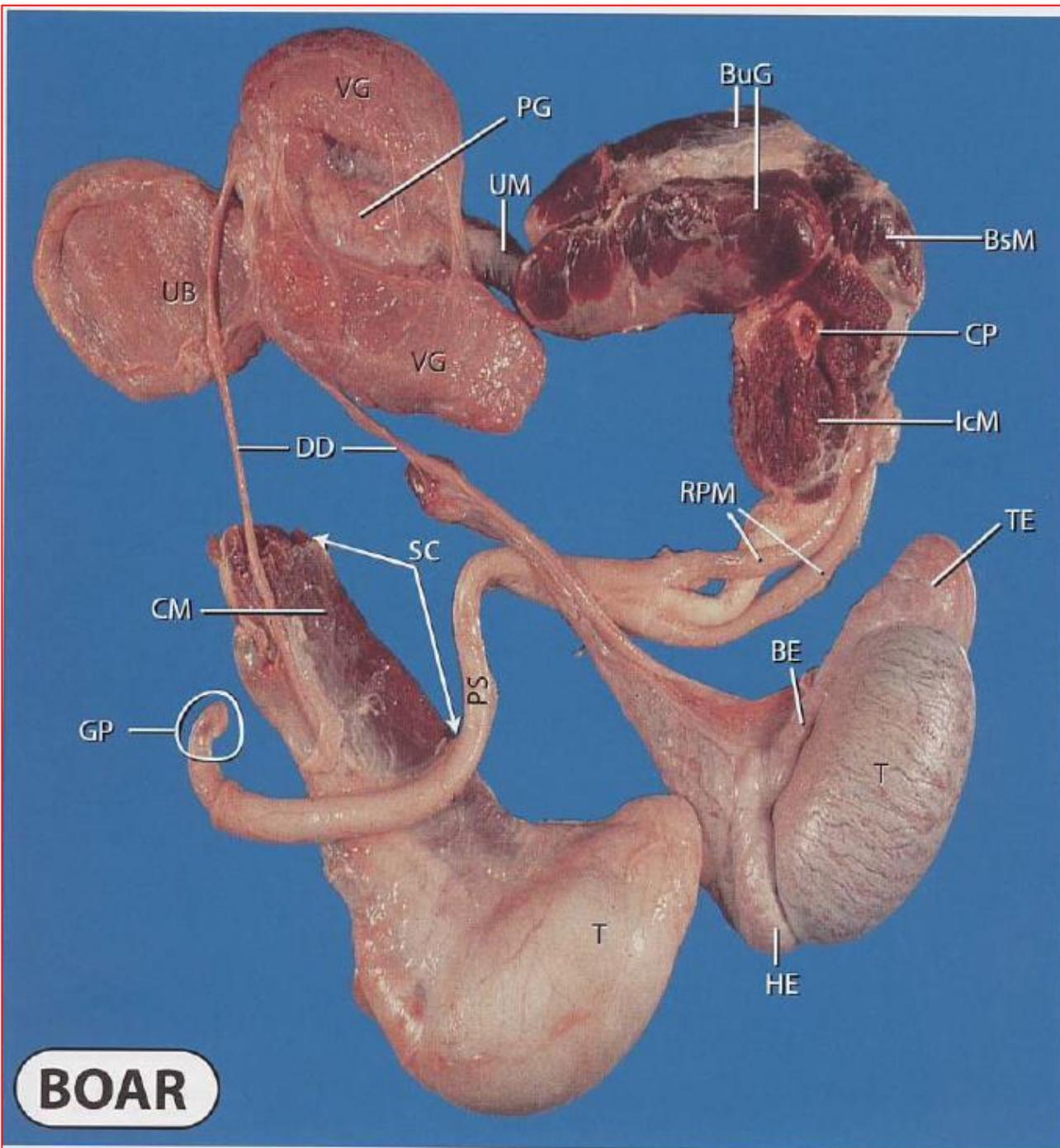
STALLION REPRODUCTIVE TRACT

A = Ampulla	GP = Glans Penis	T = Testis
BsM = Bulbospongiosus Muscle	IcM = Ischiocavernosus Muscle	TE = Tail of Epididymis
BuG = Bulbourethral Gland	P = Prostate	U = Ureters
CM = Cremaster Muscle	PS = Penile Shaft	UB = Urinary Bladder
CP = Crus Penis	RPM = Retractor Penis Muscle	VG = Vesicular Gland
DD = Ductus Deferens	SC = Spermatic Cord	

STALLION



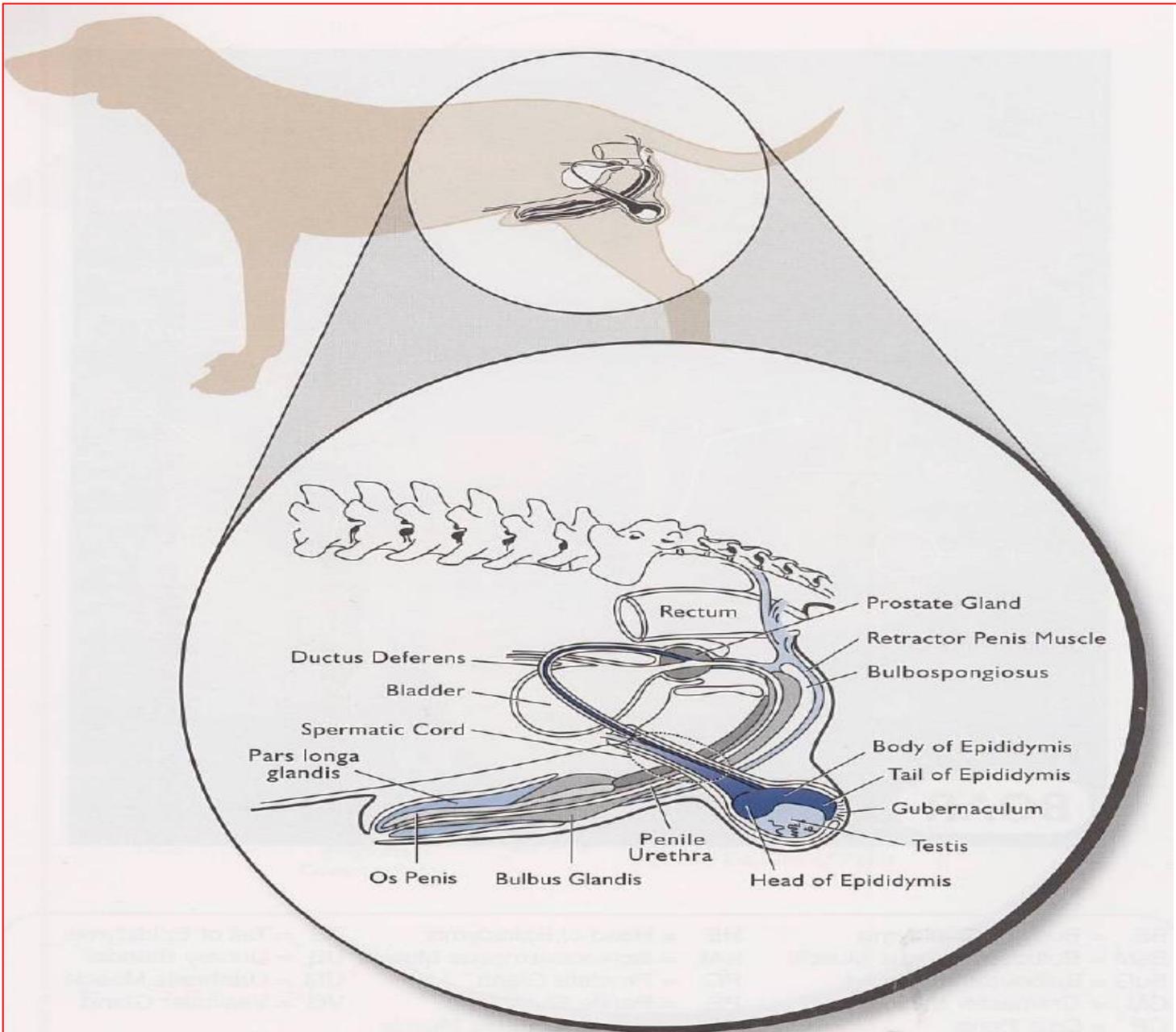
Boar Reproductive tract



Boar Reproductive tract

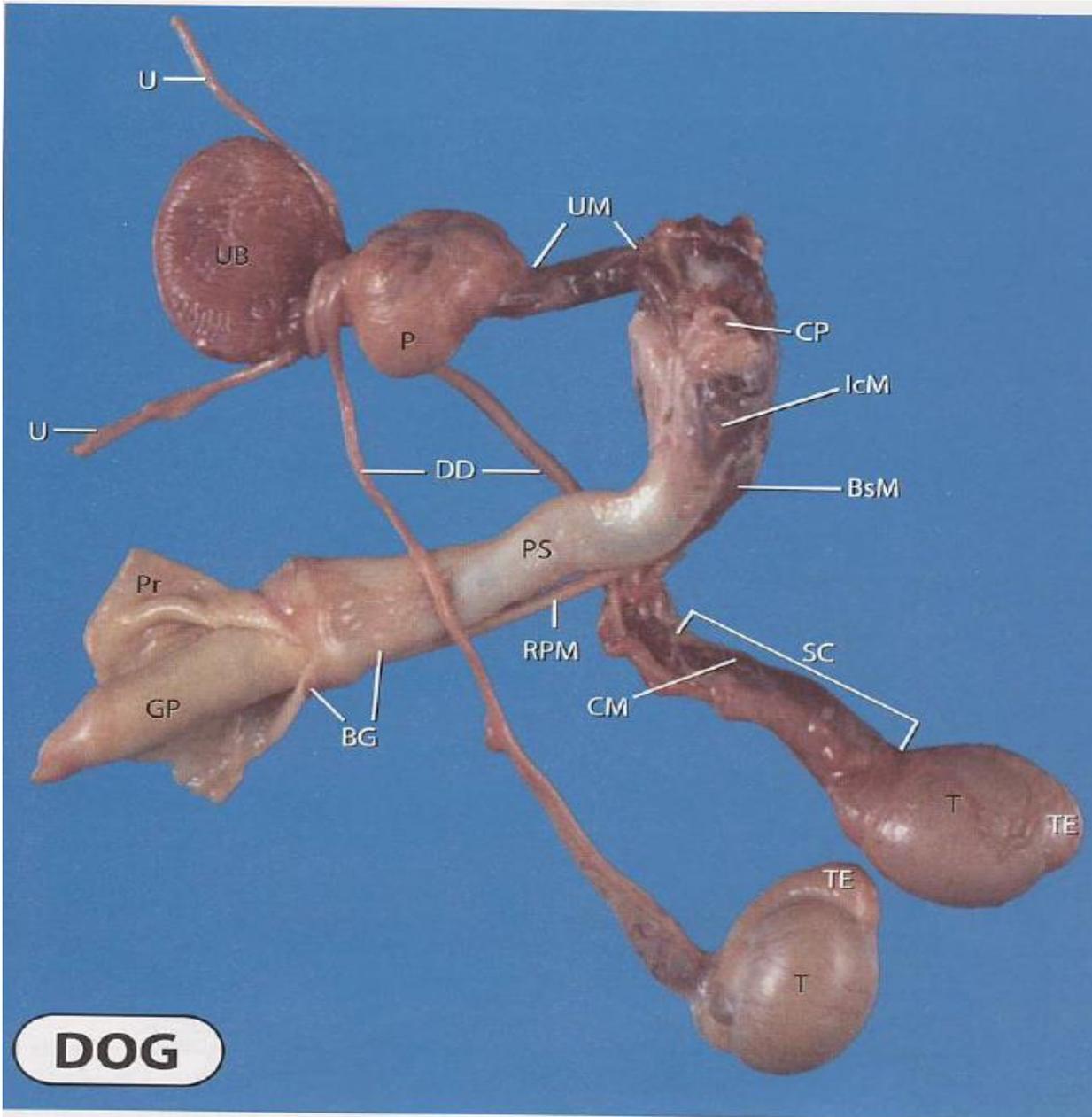
BE = Body of Epididymis	HE = Head of Epididymis	TE = Tail of Epididymis
BsM = Bulbospongiosus Muscle	IcM = Ischiocavernosus Muscle	UB = Urinary Bladder
BuG = Bulbourethral Gland	PG = Prostate Gland	UM = Urethralis Muscle
CM = Cremaster Muscle	PS = Penile Shaft	VG = Vesicular Gland
CP = Crus Penis	RPM = Retractor Penis Muscle	
DD = Ductus Deferens	SC = Spermatic Cord	
GP = Glans Penis	T = Testis (left T-parietal vaginal tunic intact; right T-parietal vaginal tunic removed)	

BOAR



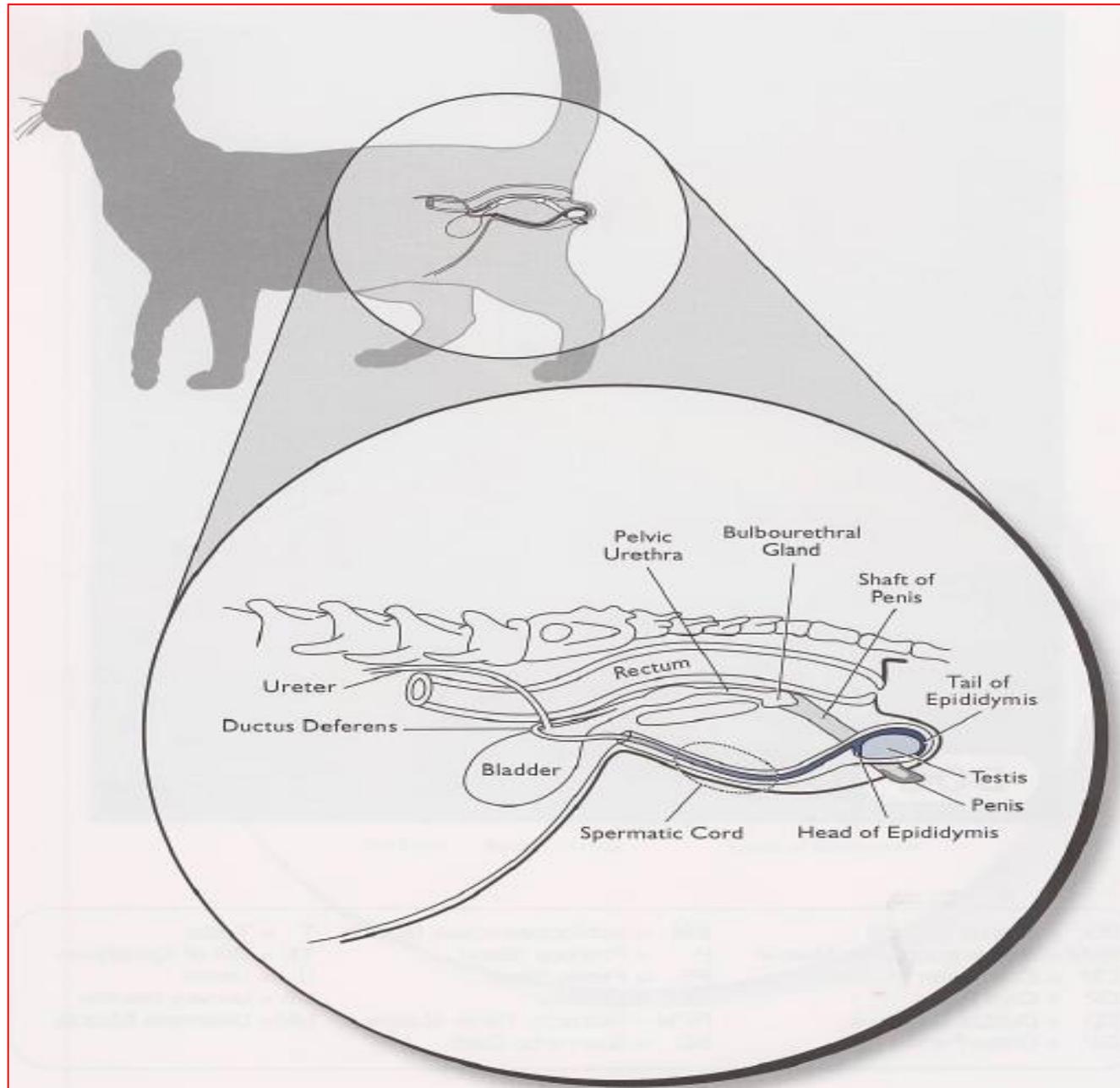
Dog Reproductive tract

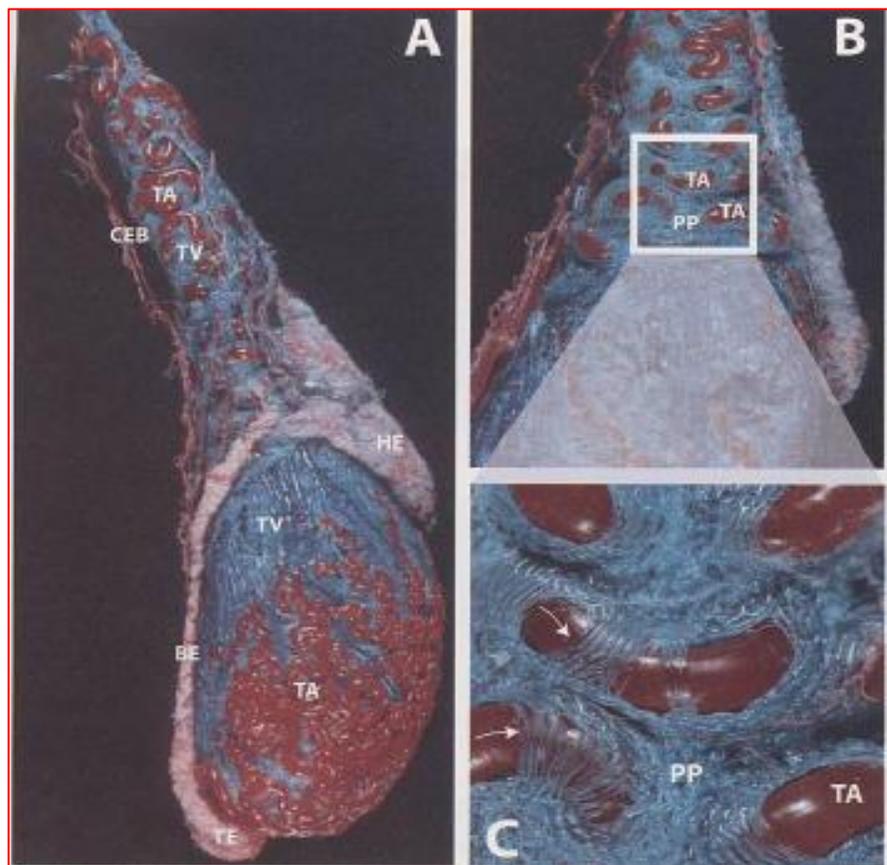
Dog Reproductive tract



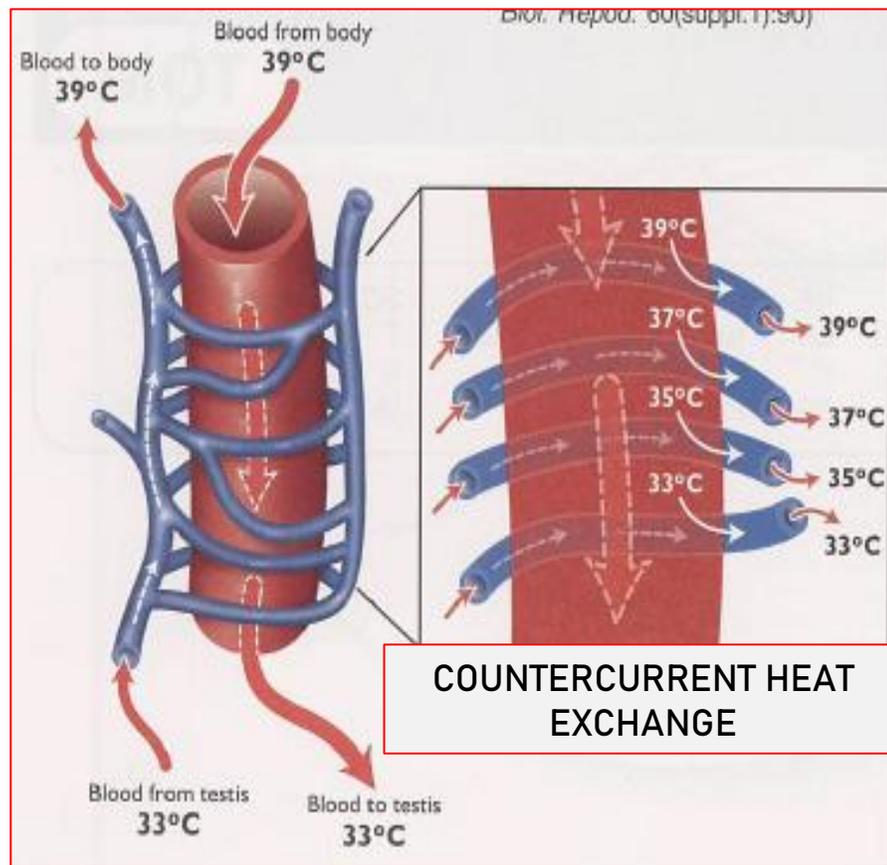
BG = Bulbus Glandis	IcM = Ischiocavernosus Muscle	T = Testis
BsM = Bulbospongiosus Muscle	P = Prostate Gland	TE = Tail of Epididymis
CM = Cremaster Muscle	PS = Penile Shaft	U = Ureter
CP = Crus Penis	PR = Prepuce	UB = Urinary Bladder
DD = Ductus Deferens	RPM = Retractor Penis Muscle	UM = Urethralis Muscle
GP = Glans Penis	SC = Spermatic Cord	

Tom Reproductive tract





B
An enlarged view of a portion of the vascular cone. The highly convoluted testicular artery (TA) has an intimate relationship with the veins of the pampiniform plexus (PP).



C
A highly enlarged photograph showing the intimate relationship of the pampiniform plexus with the testicular artery (TA). Notice the finger-like "wrappings" (arrows) of the pampiniform plexus surrounding the testicular artery (TA). This intimate relationship provides the anatomical basis for the countercurrent heat exchanger.

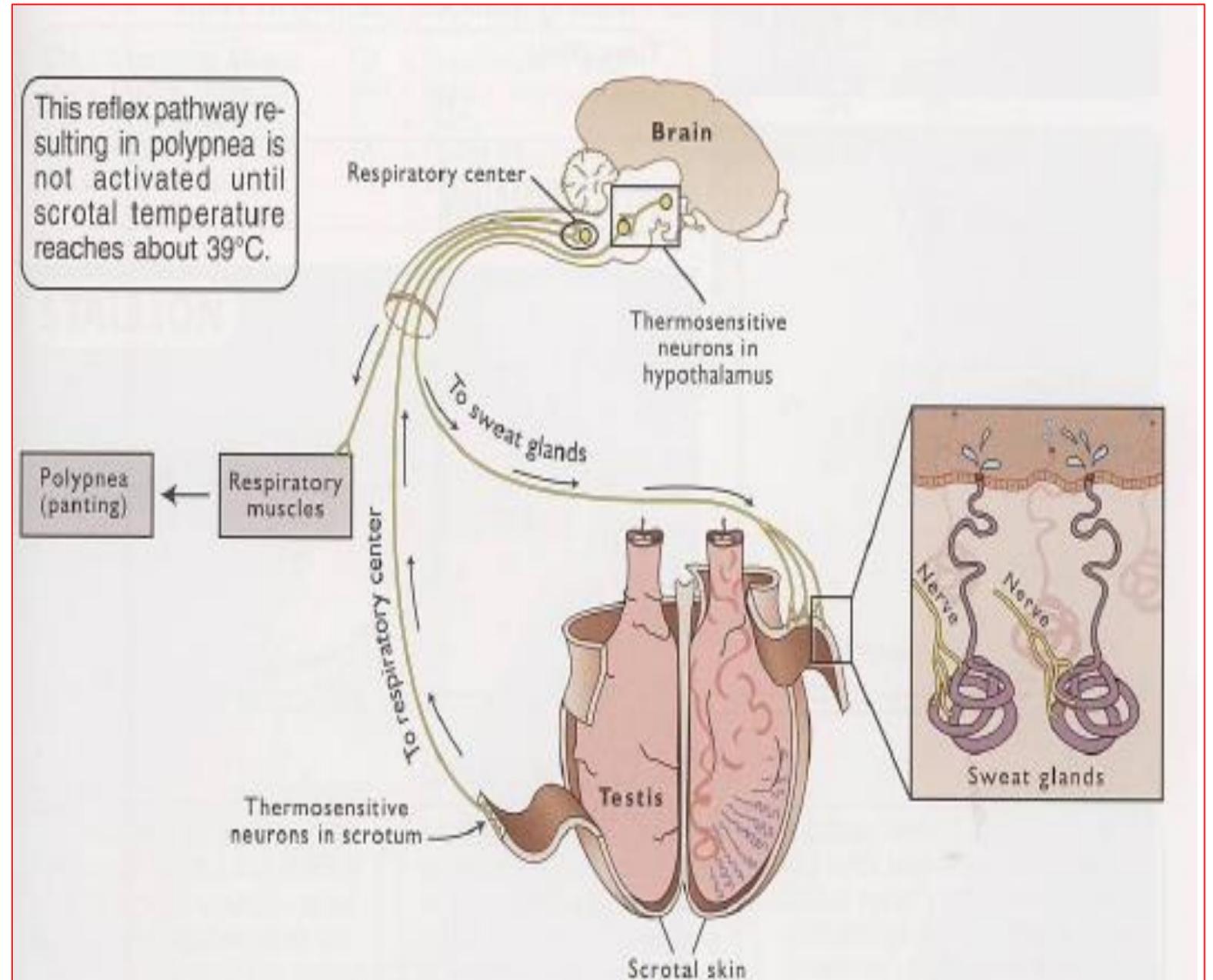
A
This photo enables visualization of the arterial and venous blood supply to the bull testis and epididymis. The testicular artery (TA) is highly convoluted and passes through the spermatic cord and surrounds the testis in the ventromedial area. In the spermatic cord, the testicular veins (TV) are in close proximity to the torturous testicular artery. The testicular veins (TV) seen on the surface of the testicle return venous blood to the spermatic cord. A branch of the testicular artery, the caudal epididymal branch (CEB) can be observed. The head of the epididymis (HE), body of the epididymis (BE) and tail of the epididymis (TE) can be seen.

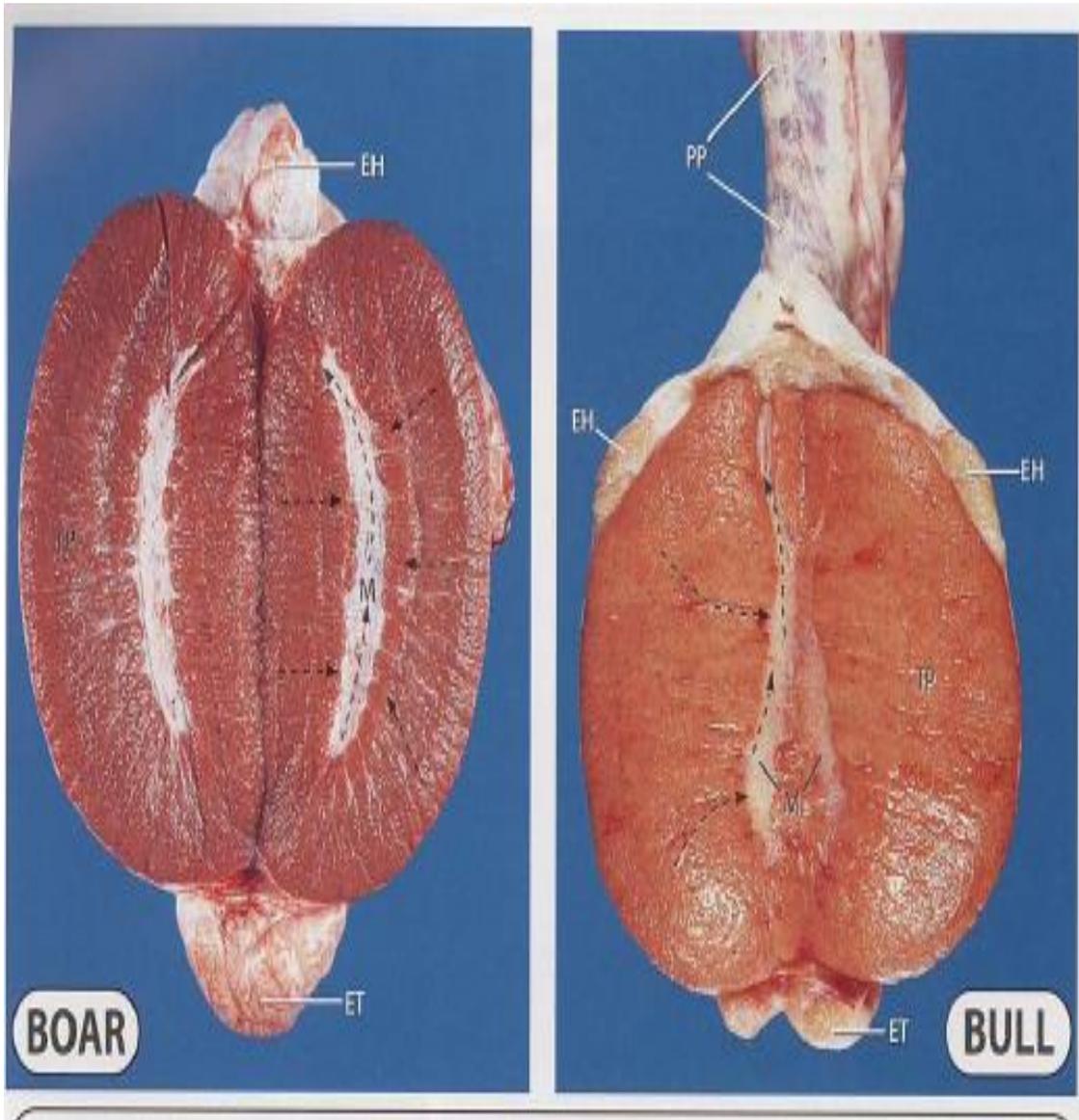
A large (6°C) temperature gradient exists between the body and the testes. Warm (39°C) arterial blood coming from the body is cooled on its way to the testes because the artery lies in close apposition to the veins that are returning cooler blood (33°C) from the testes.

The scrotum is a:

- *thermosensor*
- *swamp cooler*
- *protective sac*

Scrotal Sweating





Excised Testis

These testes have been incised longitudinally to expose the testicular parenchyma (TP) and the mediastinum (M). Arrows denote direction of flow of spermatozoa and fluids toward the efferent ducts and the head of the epididymis.

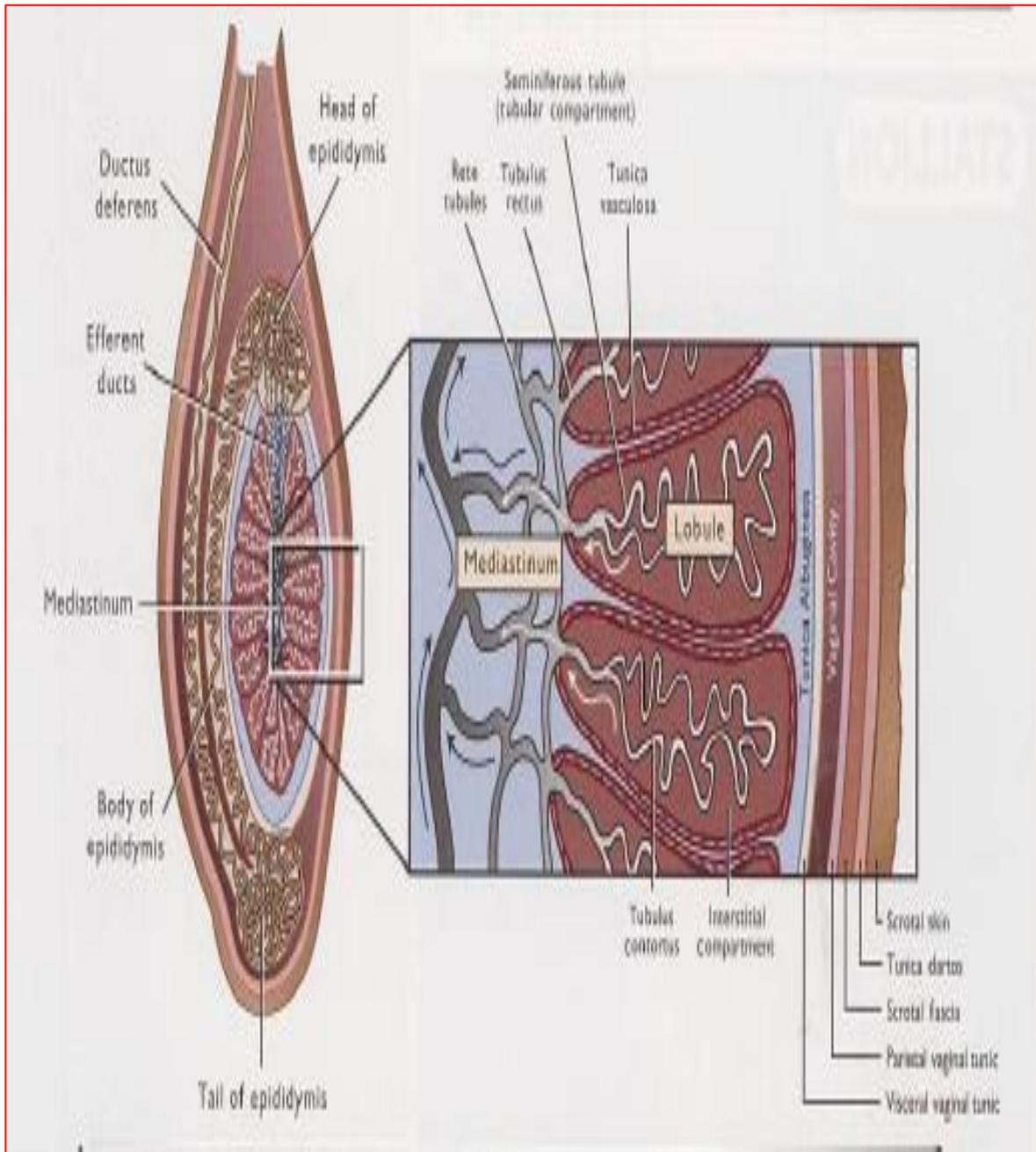
EH = Epididymal Head

PP = Pampiniform Plexus

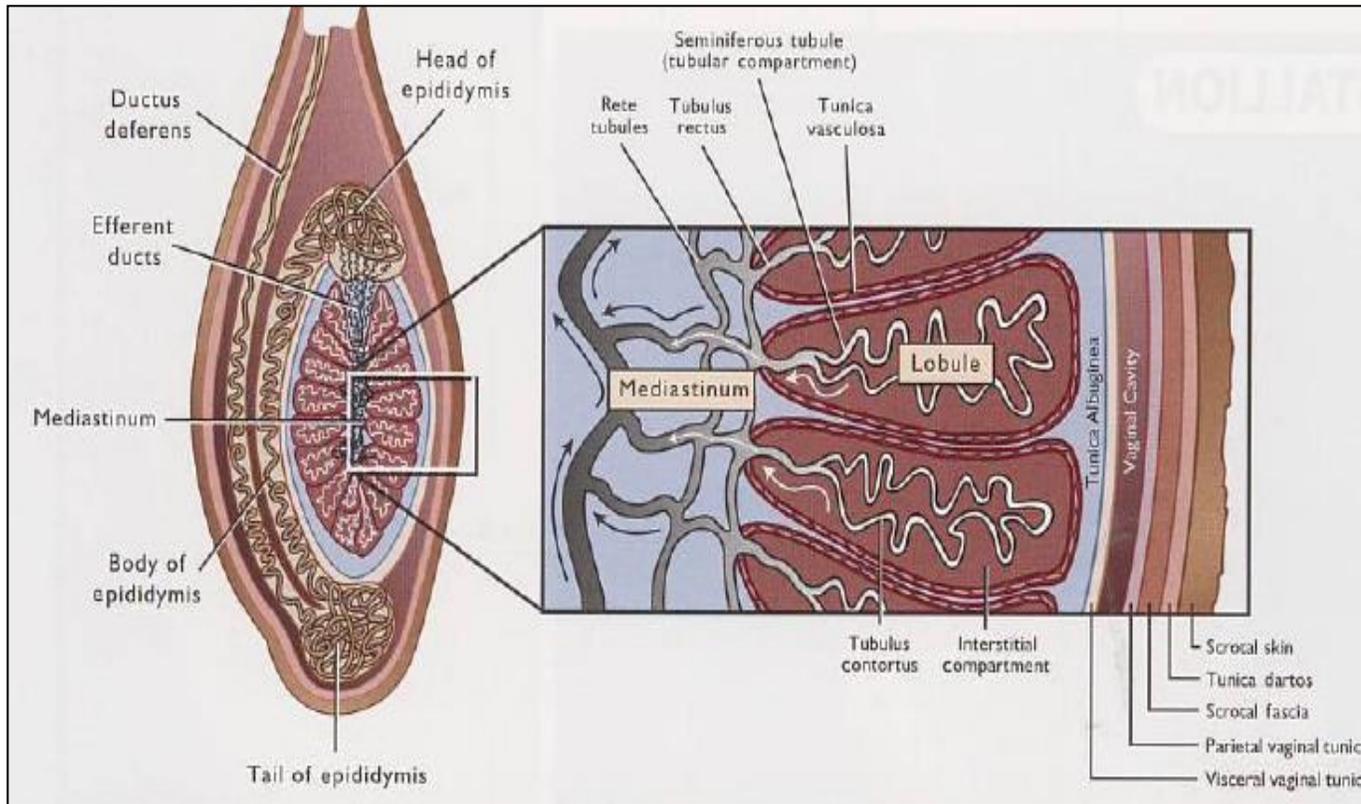
ET = Epididymal Tail

TP = Testicular Parenchyma

M = Mediastinum



Scrotum and surrounding connective tissue structure with Tubular pathways



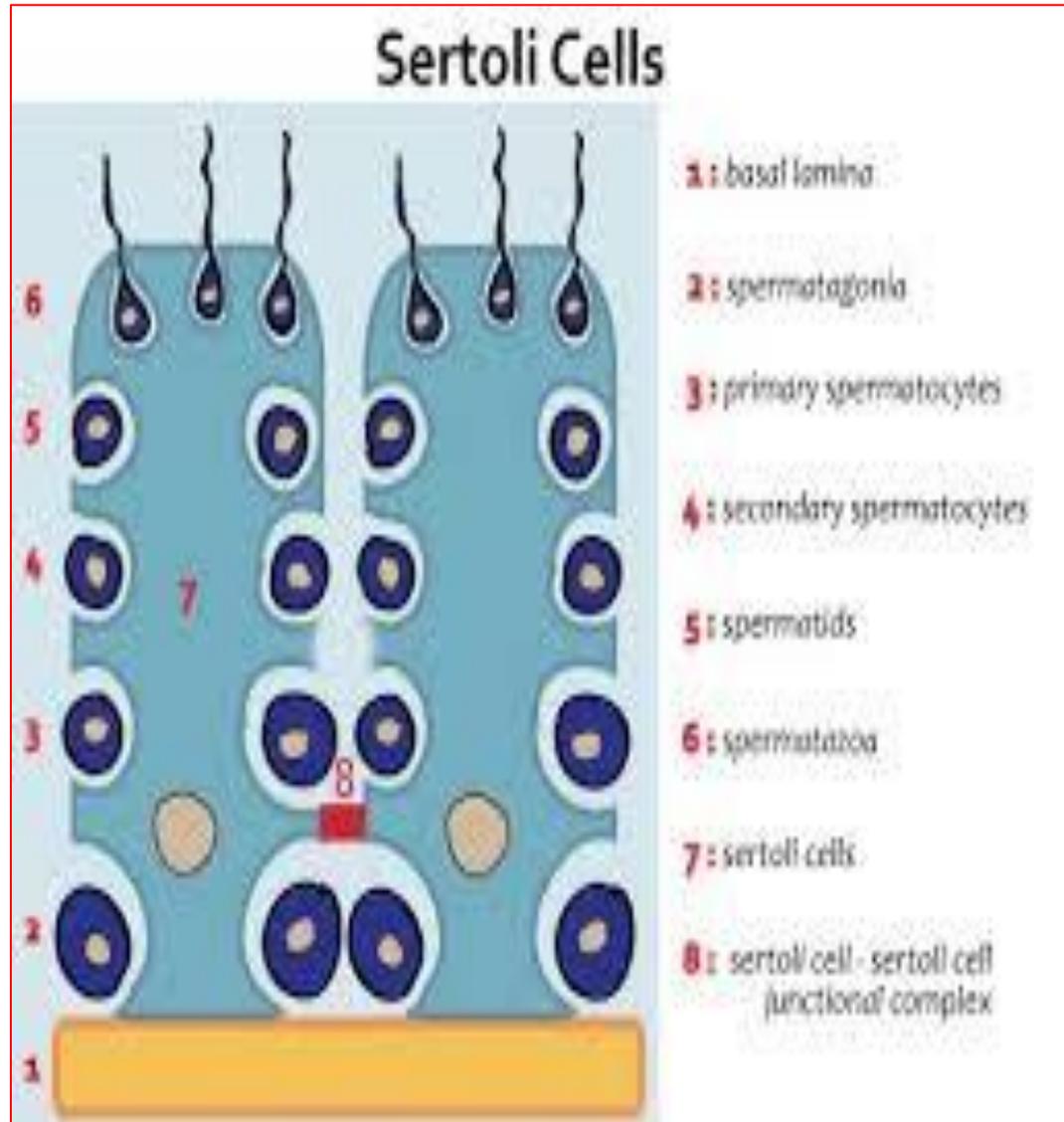
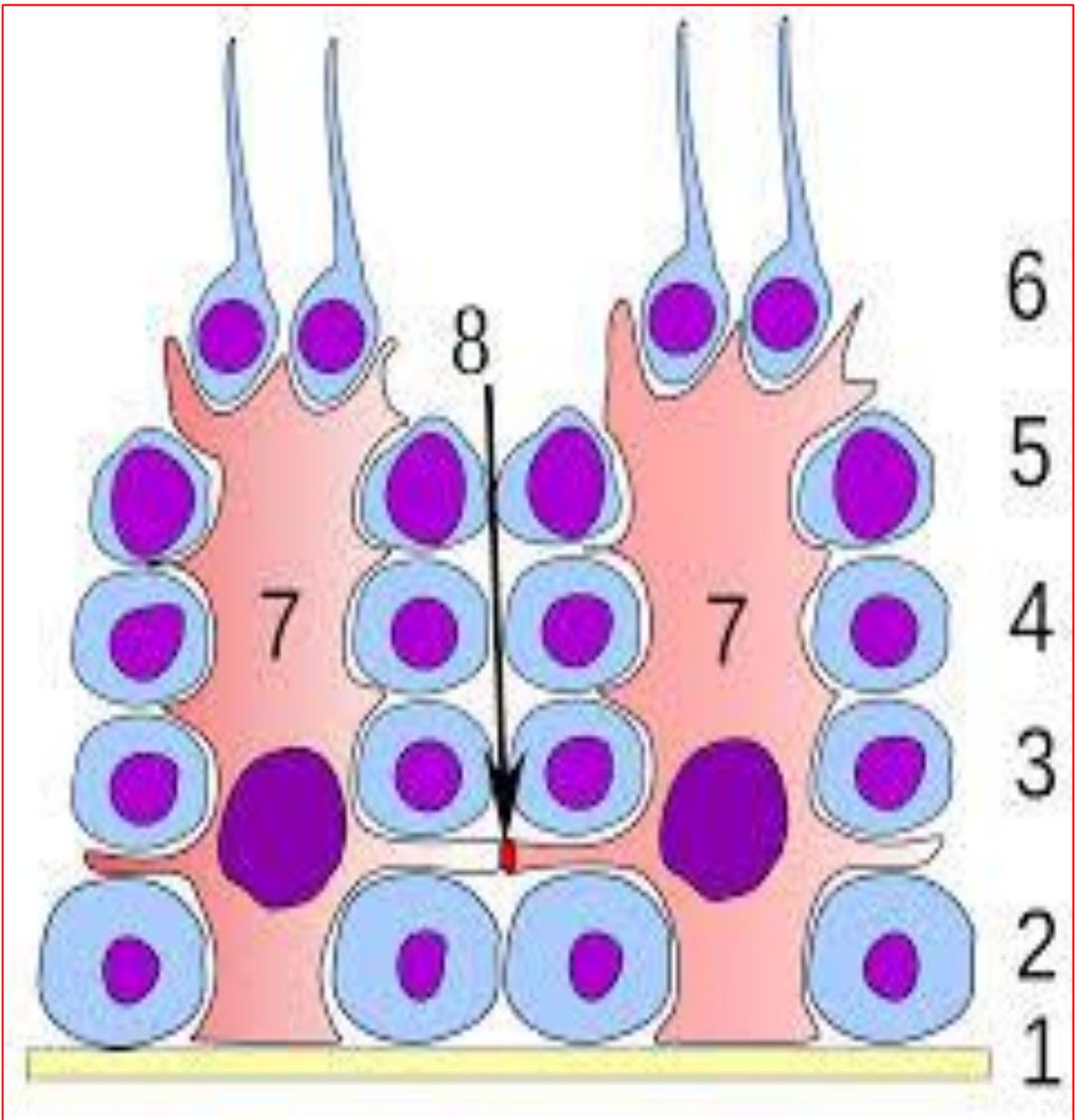
The testicular parenchyma consists of:

- *seminiferous tubules*
- *interstitial cells of Leydig*
- *capillaries*
- *lymphatic vessels*
- *connective tissue*

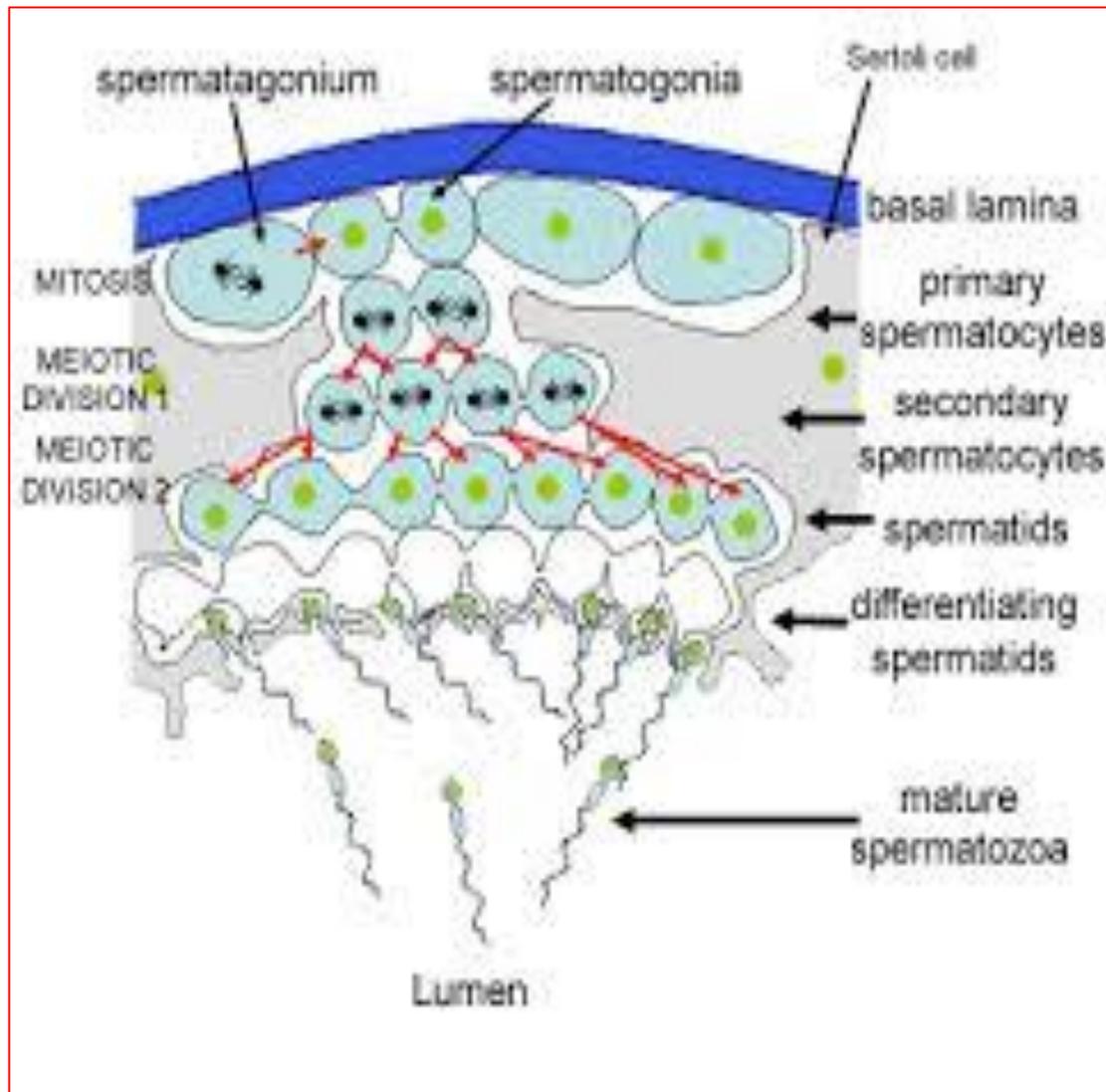
The tubular compartment consists of:

- *seminiferous epithelium*
- *Sertoli cells*
- *developing germ cells*
- *peritubular cells*

The scrotum, connective tissue, associated supportive structure and tubular pathway of mammalian Testes

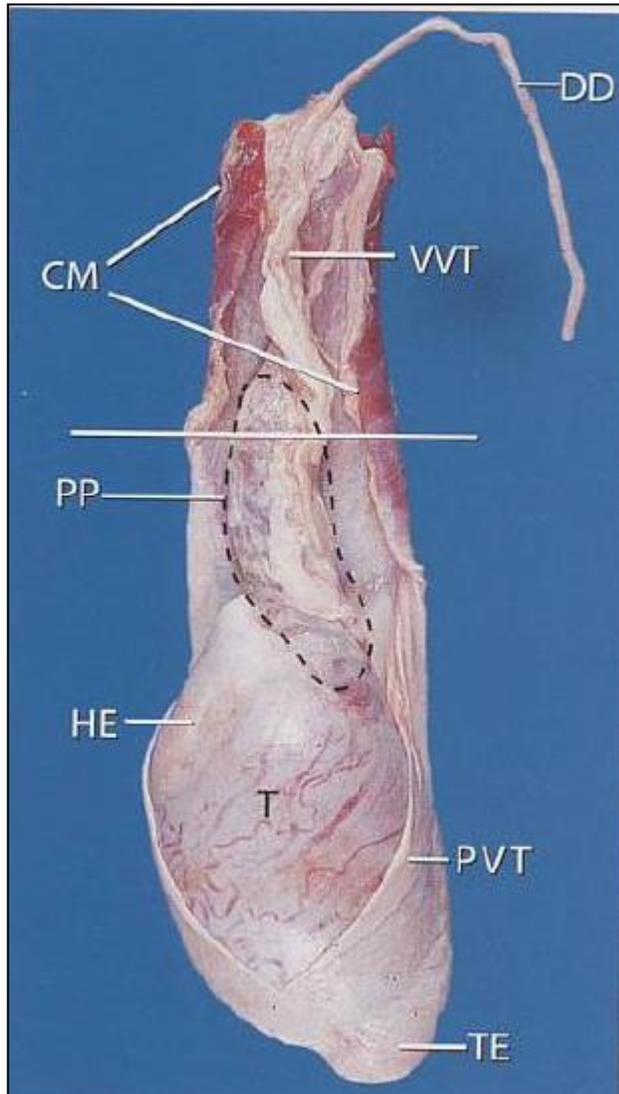


BLOOD TESTIS BARRIER



BLOOD TESTIS BARRIER

CREMASTER MUSCLE

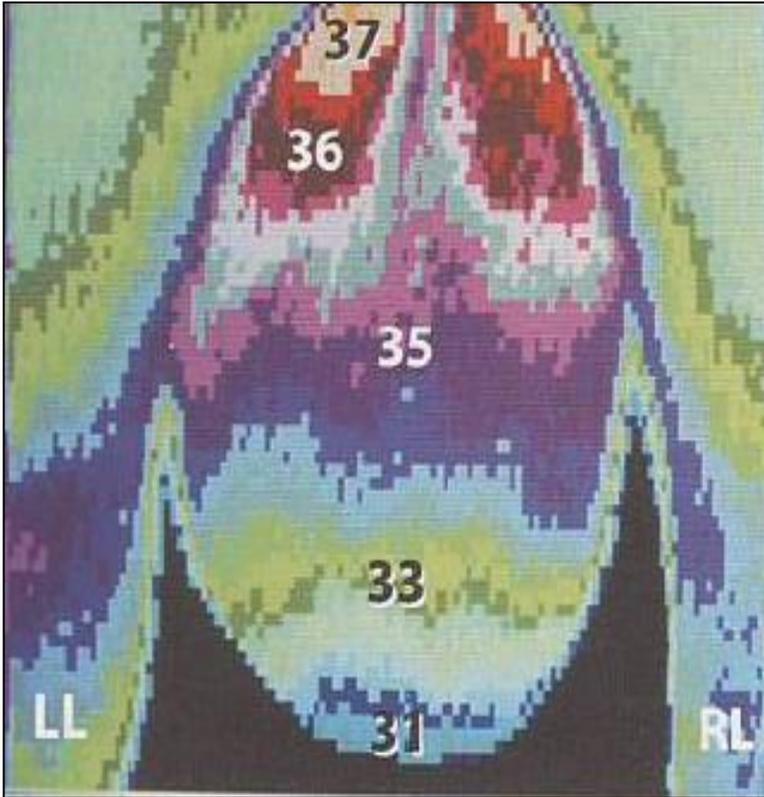


1. The Testes are supported by the cremaster muscle
2. This cremaster muscle courses the entire length of the spermatic cord
3. It helps testis in controlling of testicular temperature
4. It has pumping action like function over the pampiniform plexus.
5. Contraction action of CM promotes venous return of testicular blood subsequently facilitates heat exchange

Note :

1. Bird, Elephant, sloth and some marine animals have testes located inside the body in a retroperitoneal position
2. Testes of rat and rabbit move into and out of the body cavity throughout their lives through a patent inguinal canal

Thermogram of Bull Scrotum



1. A non- invasive technology called Infrared thermography used for study the cooling capacity of testes
2. This technology measures the I E from a heat producing body.
3. This technique quantify faulty testicular cooling system and bull can be identified & eliminated for breeding purpose

Tunica Dartus (Dartus Muscle) - Smooth muscle lying just beneath the scrotal skin

- ❑ Very adjustable smooth muscle in response to change in scrotal skin temperature
- ❑ The sensory nerves initiating the changes in the tone (Degree of contraction) of TD located in the scrotal skin
- ❑ Unlike CM, this can maintain sustained contractions-----this characteristic allow the testes to be held close to the body for sustained period during cold temperature
- ❑ The contraction ability of testes is under the influence/control of Testosterone hormone /androgen

The testes are the primary reproductive organs in the male. Their functions are to produce:

- *spermatozoa*
- *hormones and proteins*
- *fluids*

The testis consists of the:

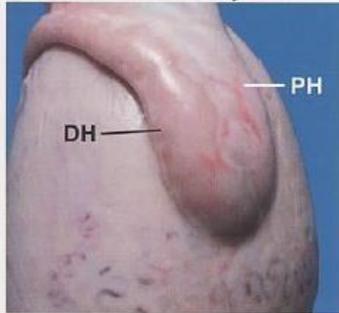
- *testicular capsule*
- *parenchyma*
- *mediastinum*
- *rete tubules*

The testicular parenchyma consists of:

- *seminiferous tubules*
- *interstitial cells of Leydig*
- *capillaries*
- *lymphatic vessels*
- *connective tissue*

Head (Caput)

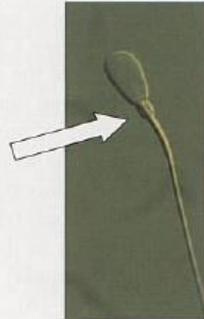
25-50 x 10⁶ sperm



The head of the epididymis is subdivided into the proximal head (PH) and the distal head (DH). The proximal head re-absorbs a significant amount of rete fluid while the distal head secretes fluid into the lumen of the epididymal duct. Thus, concentration of sperm within the head of the epididymis increases and then decreases significantly.

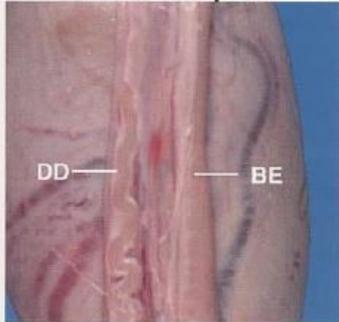
Spermatozoal Characteristic

- Not motile
- Not fertile
- Proximal cytoplasmic droplet
- Low disulfide crosslinking



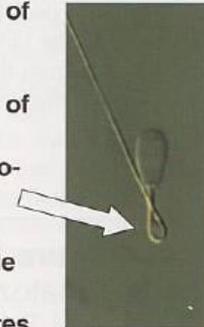
Body (Corpus)

8-25 x 10⁹ sperm



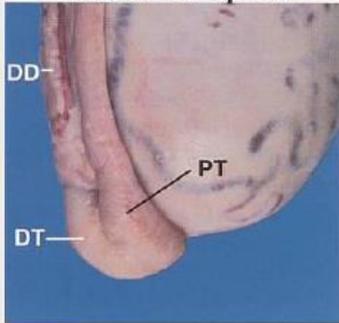
The body of the epididymis (BE) lies parallel to the ductus deferens (DD). Concentrations of sperm throughout the body of the epididymis remain relatively constant.

- Some expression of motility after dilution
- Some expression of fertility
- Translocating cytoplasmic droplet
- Moderate to high degree of disulfide crosslinking
- Can bind to oocytes



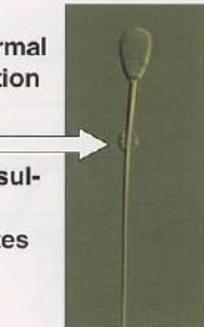
Tail (Cauda)

10-50 x 10⁹ sperm



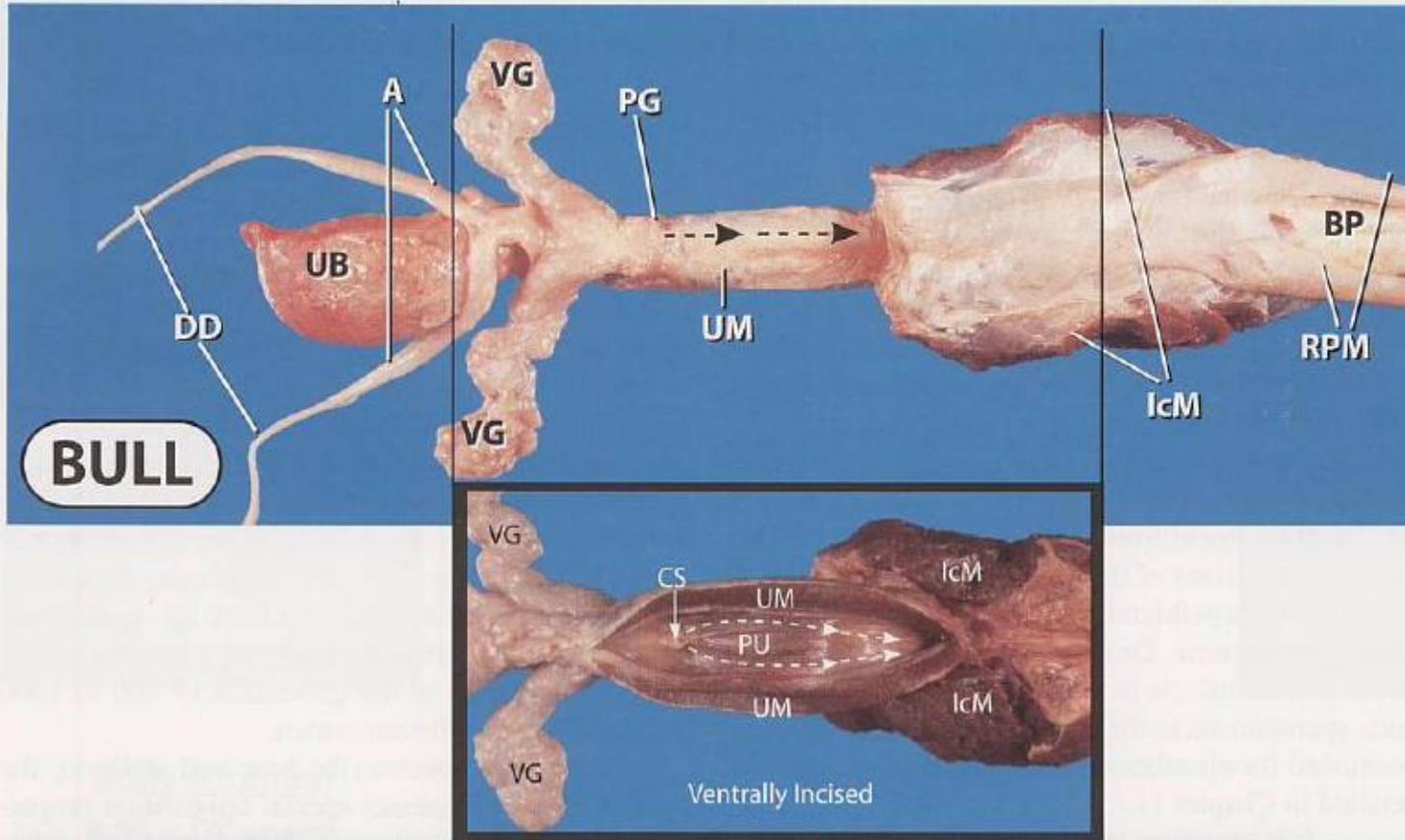
The tail of the epididymis consists of the proximal tail (PT) and the distal tail (DT). Sperm within the distal tail are eligible for ejaculation. Sperm in the proximal tail cannot be moved into an ejaculatory position following sexual stimulation. However, the sperm in the distal tail move through the ductus deferens (DD) and into the pelvic urethra during sexual stimulation.

- Expression of normal motility after dilution
- Fertile potential
- Distal droplet
- High degree of disulfide crosslinking
- Can bind to oocytes



The total spermatozoal content of the epididymal duct, the ductus deferens and the ampulla is referred to as the **extragonadal reserves (EGR)**. Only the distal tail reserves are eligible for ejaculation. On a per ejaculate basis, the number of sperm removed from the tail reserves can be increased dramatically when the male is subjected to a series of sexual preparation maneuvers such as false mounting or restraint from mounting. Sexual preparation likely stimulates release of oxytocin from the posterior pituitary. This causes contractions of the smooth muscle surrounding the tail of the epididymis that move spermatozoa into the ductus deferens. Oxytocin also causes contractions of the smooth muscle in the ductus deferens that transports spermatozoa to the pelvic urethra where they are positioned for ejaculation. These mechanisms will be detailed in Chapter 11

Figure 3-19. Dorsal View of the Accessory Sex Glands

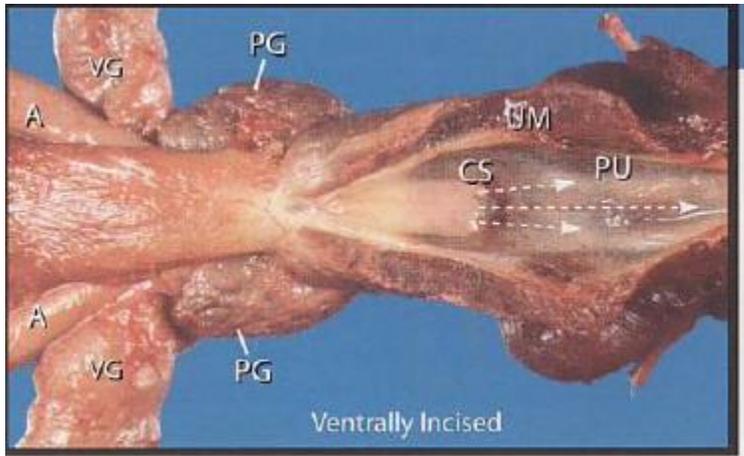
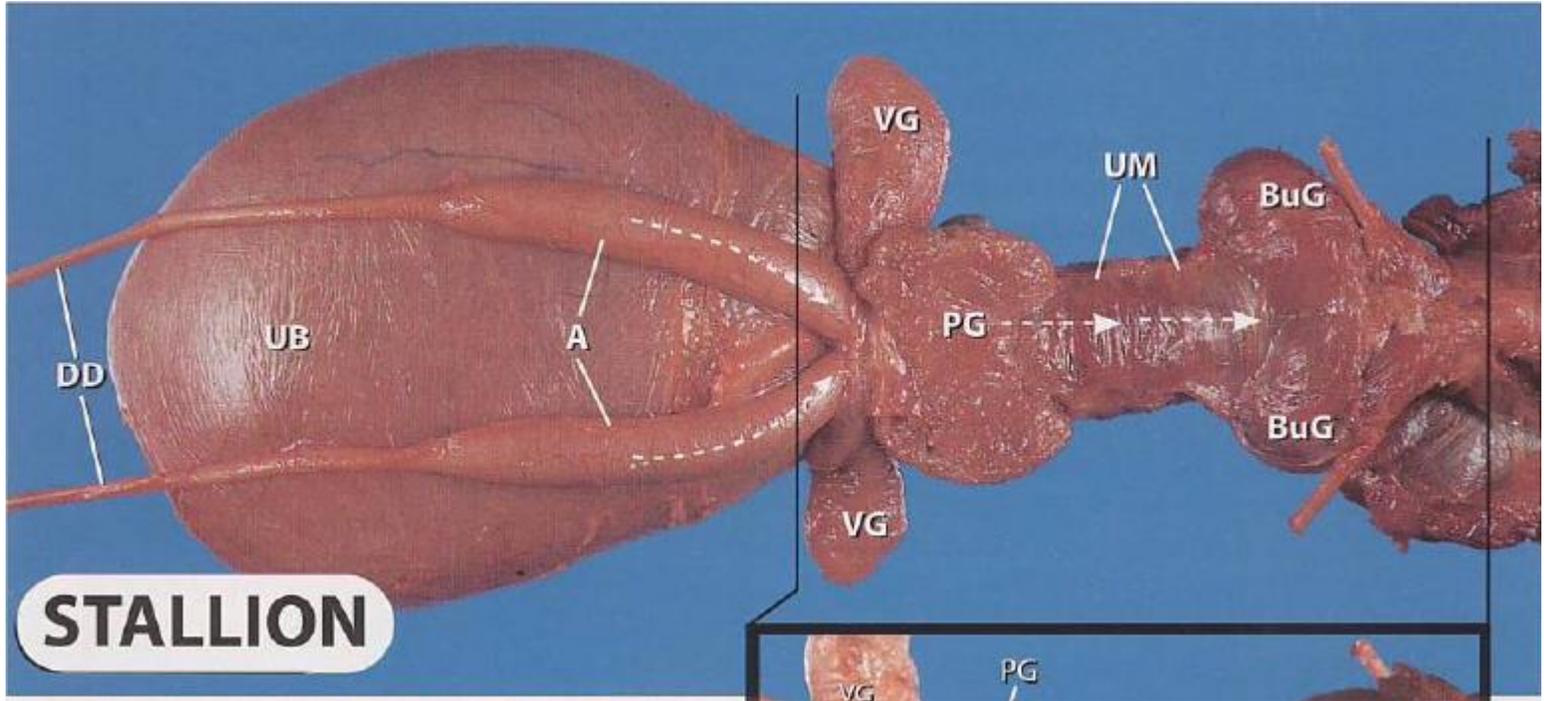


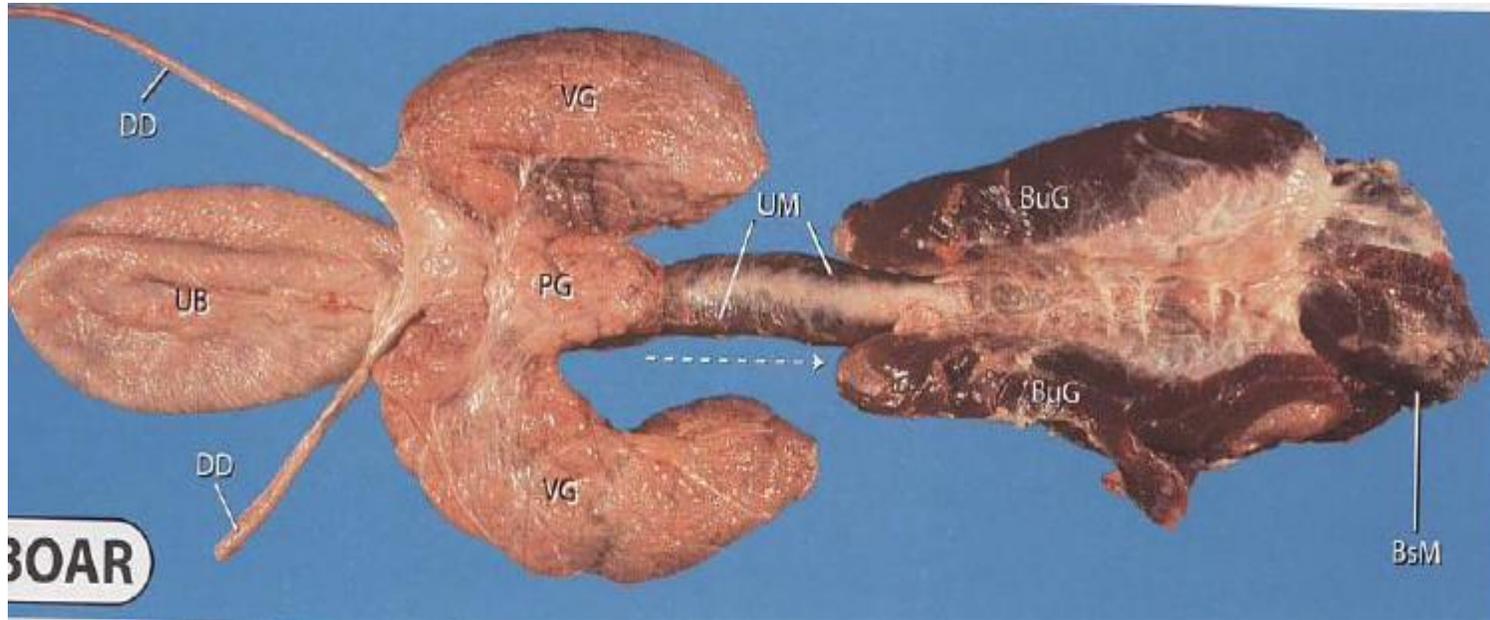
Seminal plasma is produced by the:

- *epididymis*
- *ampulla*
- *vesicular glands (seminal vesicles)*
- *prostate gland*
- *bulbourethral glands (Cowper's glands)*

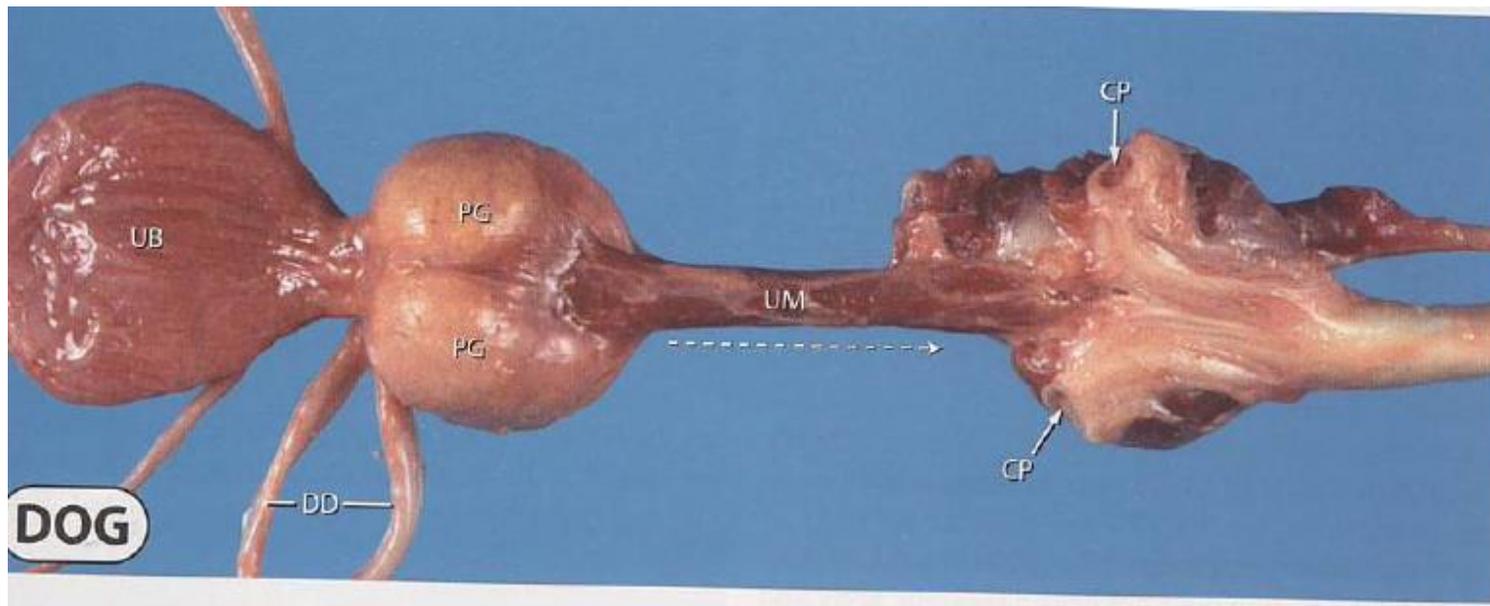
- A = Ampulla
- BP = Base of Penis
- BuG = Bulbourethral Glands
- CS = Colliculus Seminalis
- DD = Ductus Deferens
- IcM = Ischiocavernosus Muscle
- PG = Prostate Gland (Body)
- PU = Pelvic Urethra
- RPM = Retractor Penis Muscle
- UB = Urinary Bladder
- UM = Urethralis Muscle
- VG = Vesicular Glands

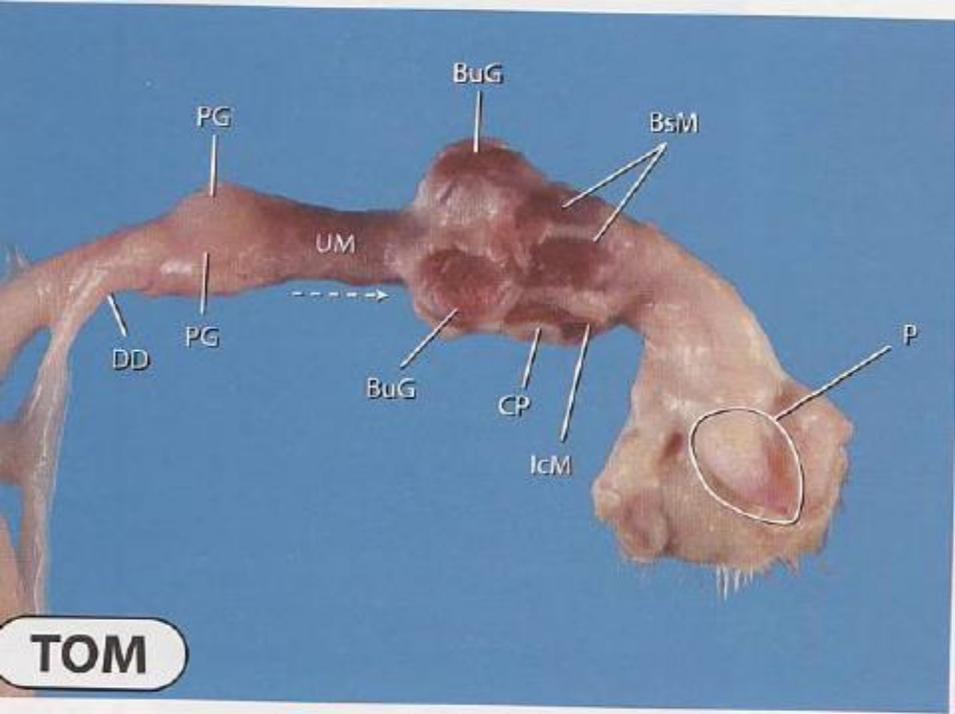
Arrows indicate the direction of fluid flow during emission and ejaculation



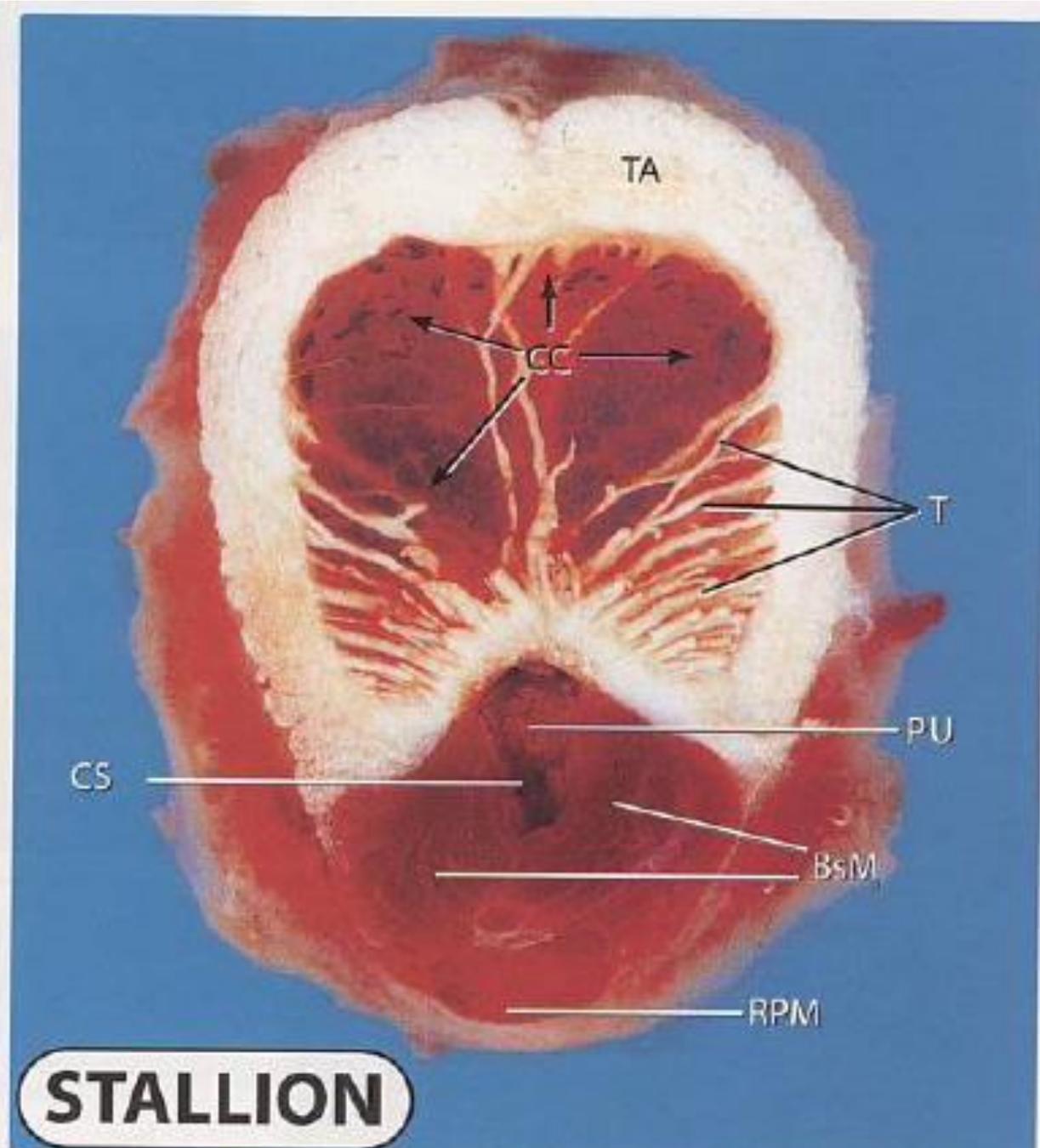
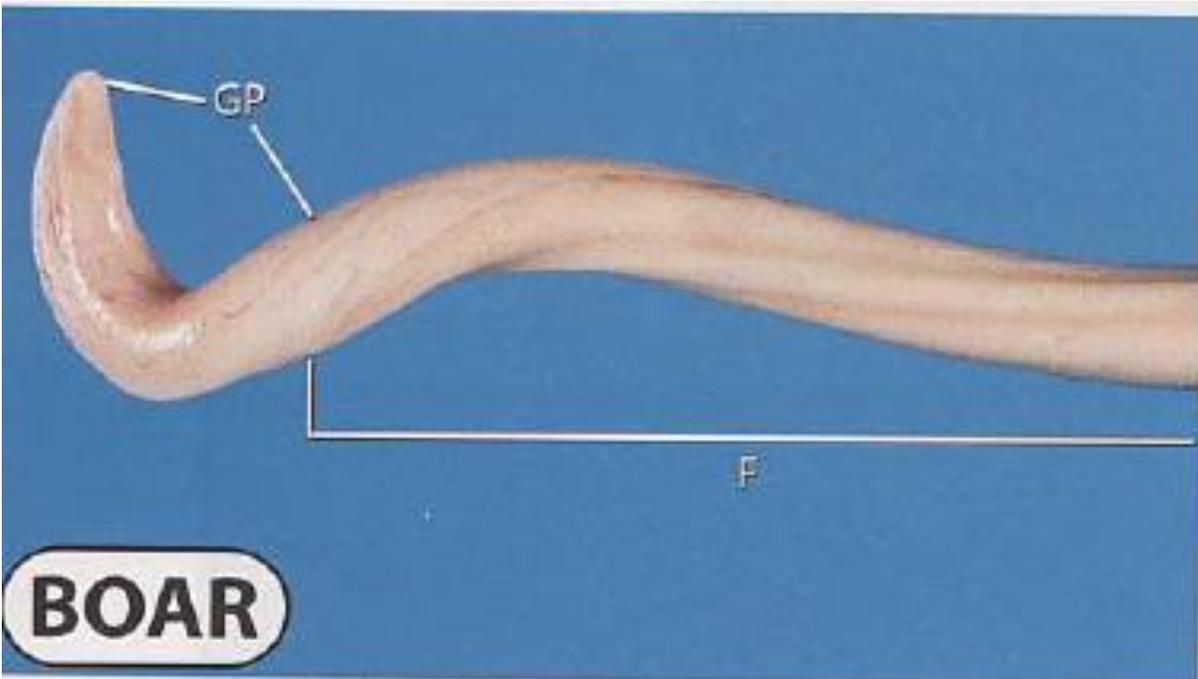


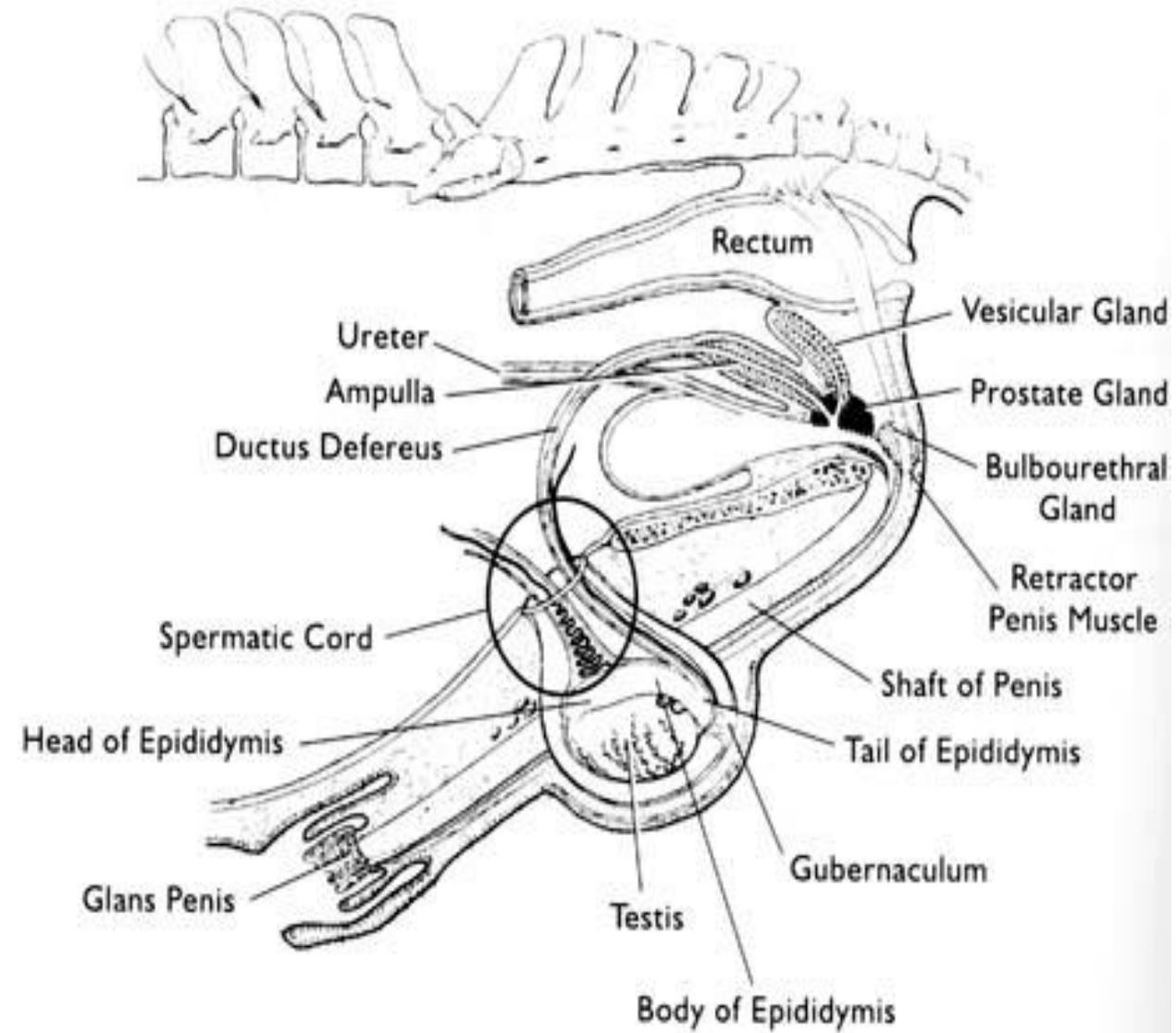
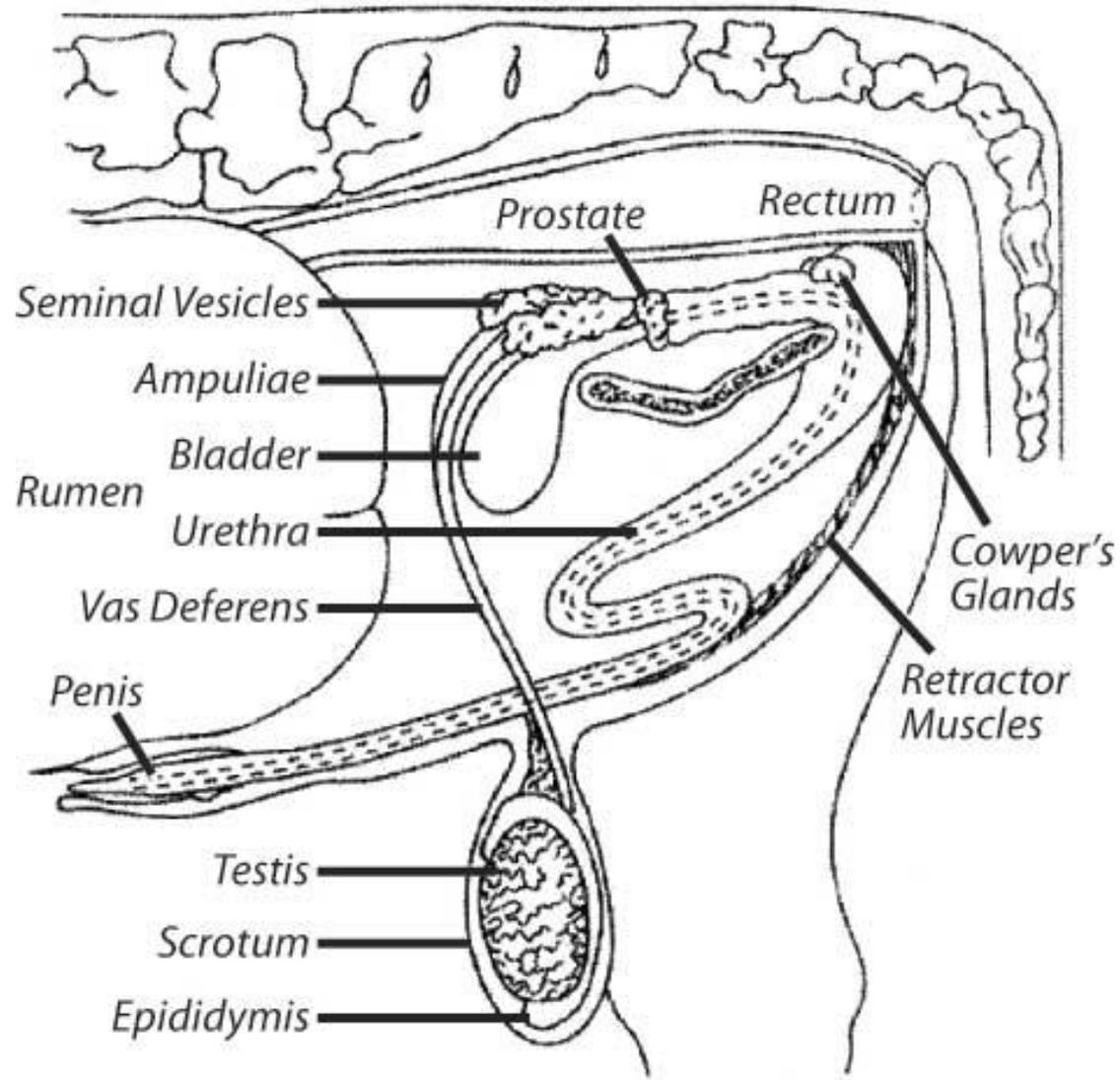
BsM	=	Bulbospongiosus Muscle
BuG	=	Bulbourethral Glands
CP	=	Crus Penis
DD	=	Ductus Deferens
IcM	=	Ischiocavernosus Muscle
P	=	Penis
PG	=	Prostate Gland (Body)
UB	=	Urinary Bladder
UM	=	Urethralis Muscle
VG	=	Vesicular Glands

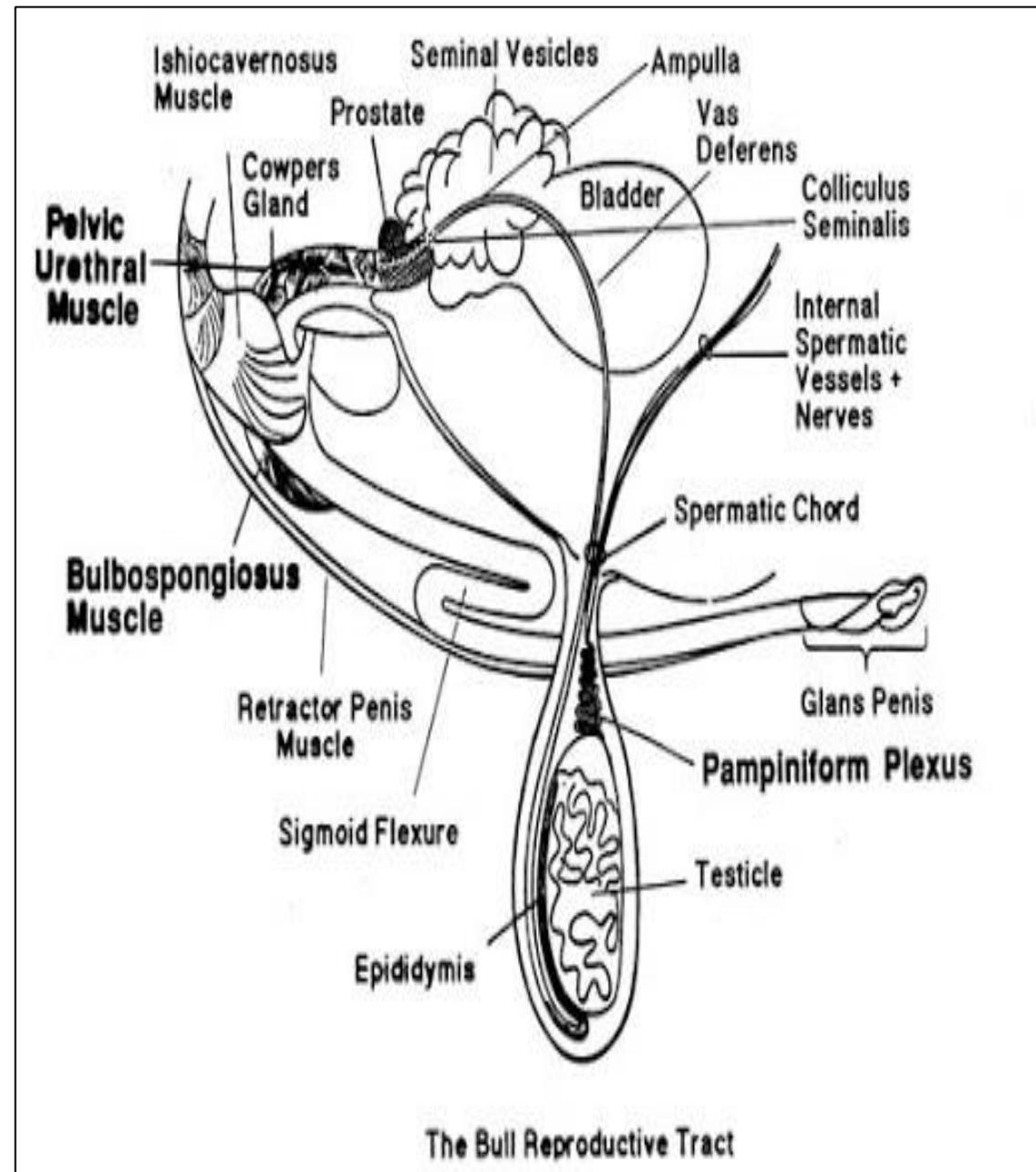
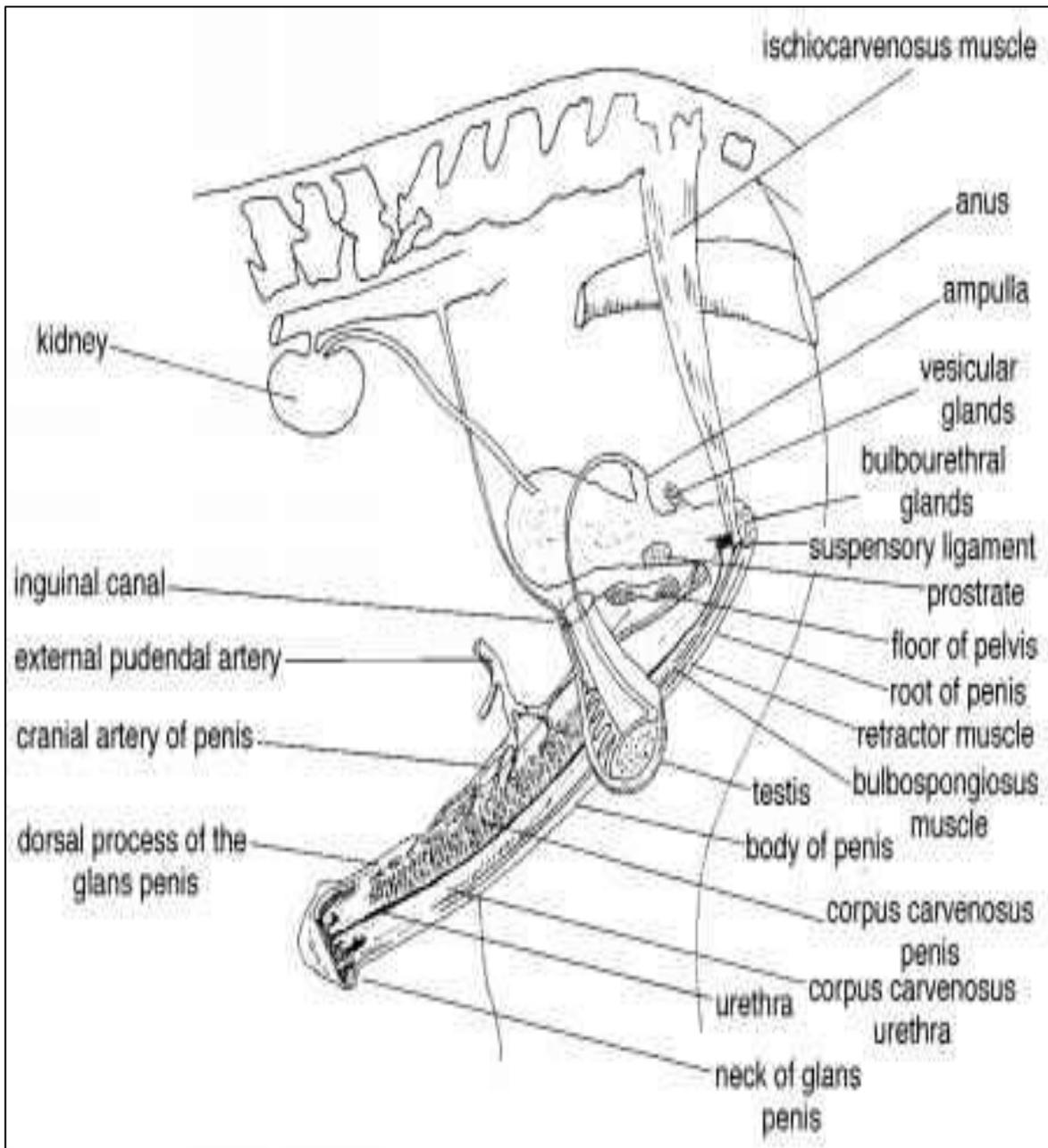


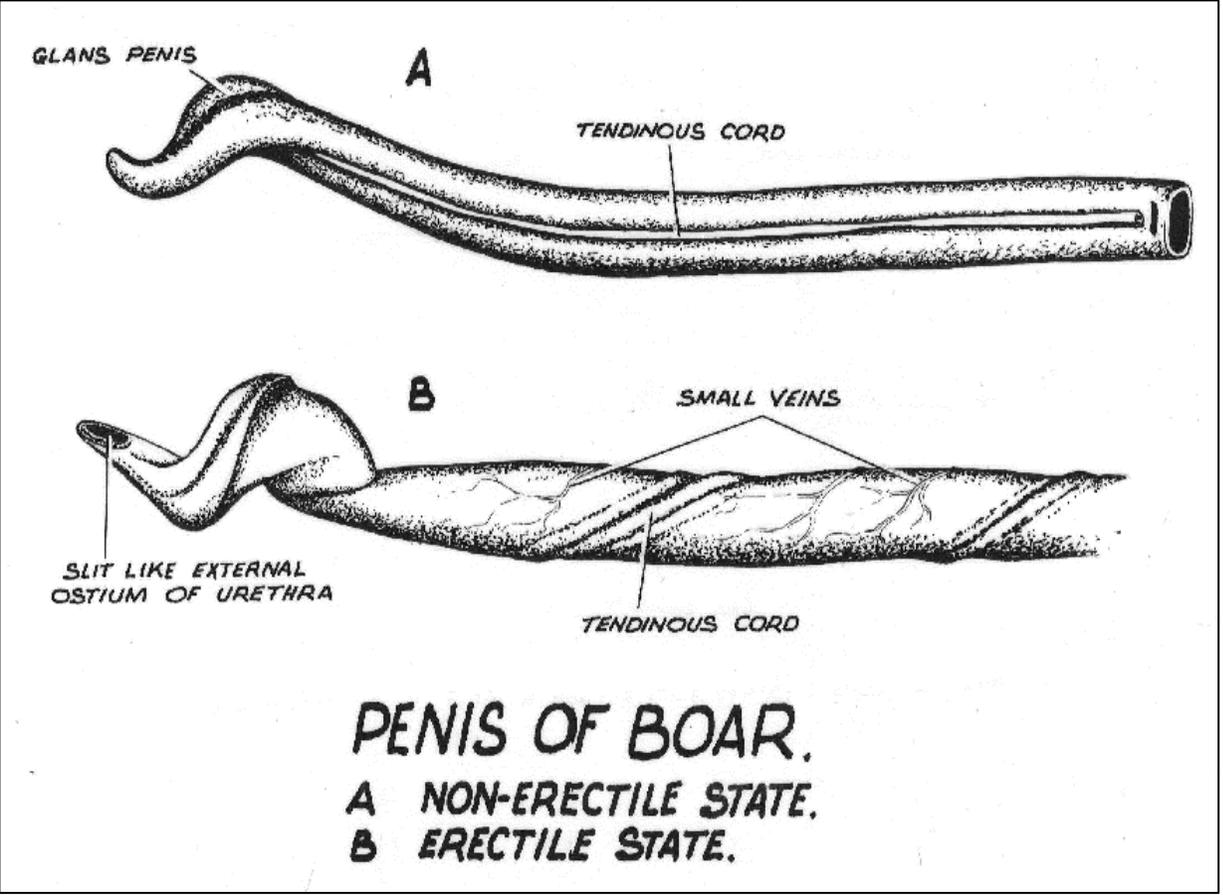
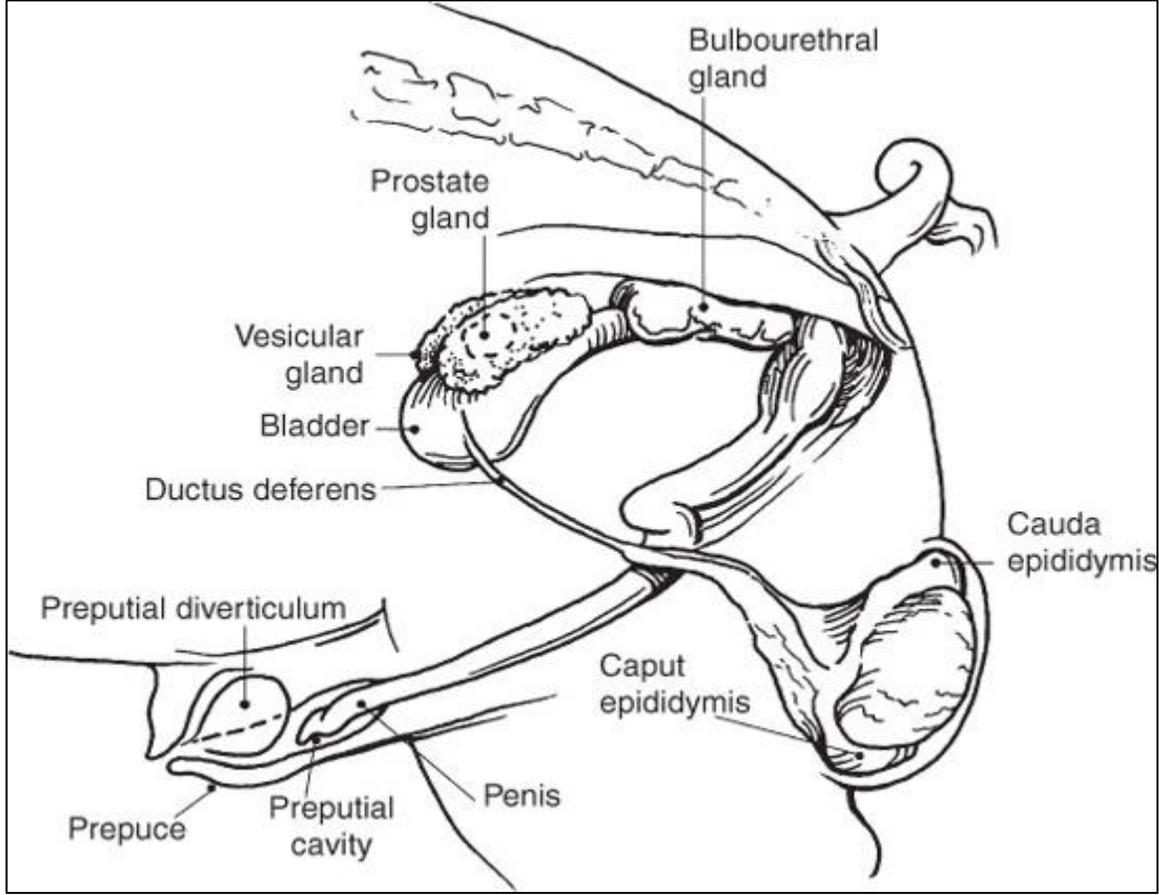


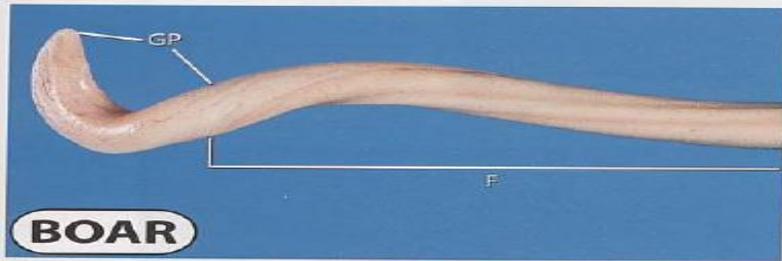
- BsM = Bulbospongiosus Muscle
- BuG = Bulbourethral Glands
- CP = Crus Penis
- DD = Ductus Deferens
- IcM = Ischiocavernosus Muscle
- P = Penis
- PG = Prostate Gland (Body)
- UB = Urinary Bladder
- UM = Urethralis Muscle
- VG = Vesicular Glands



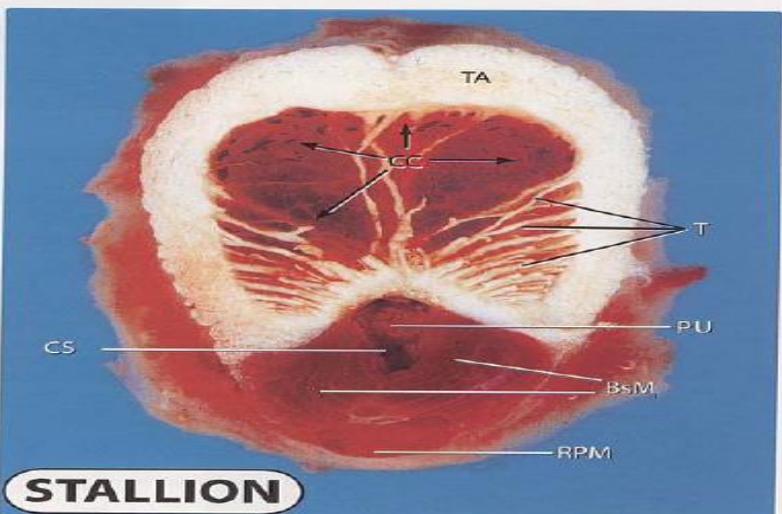
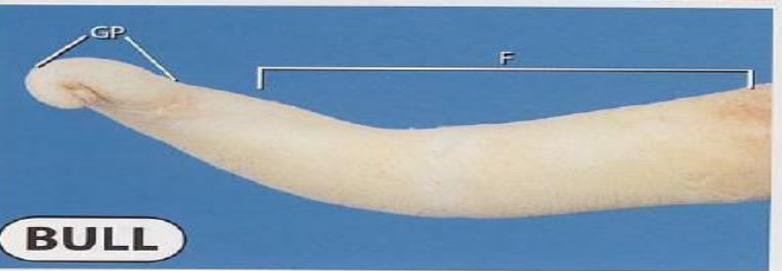
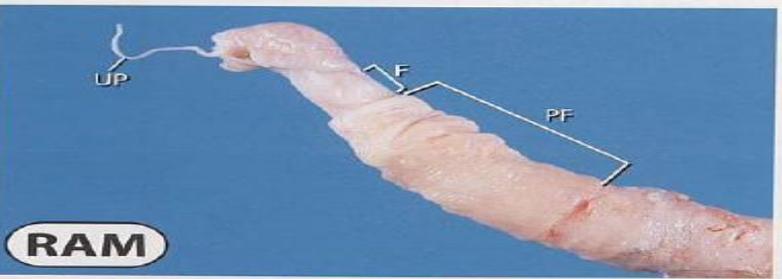




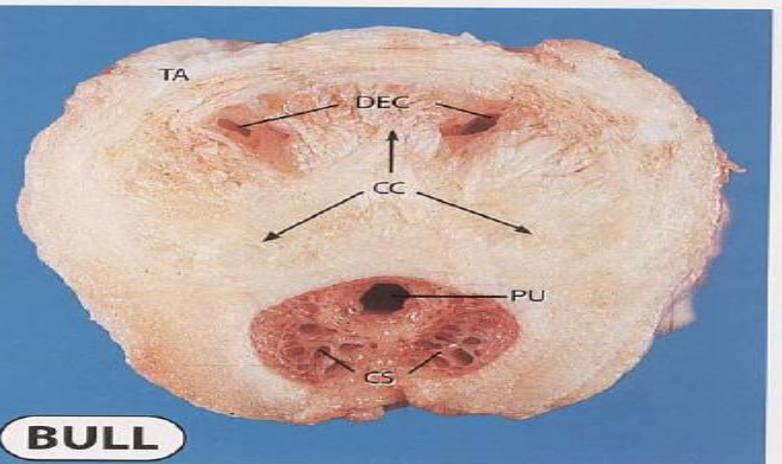




F = Free end of penis
 GP = Glans Penis
 PF = Preputial Fold
 UP = Urethral Process

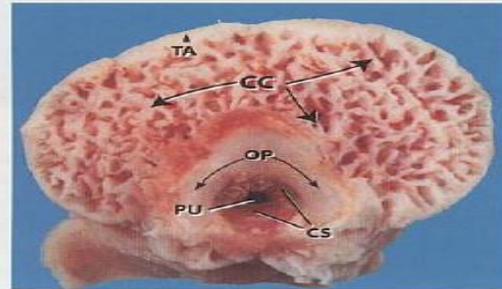
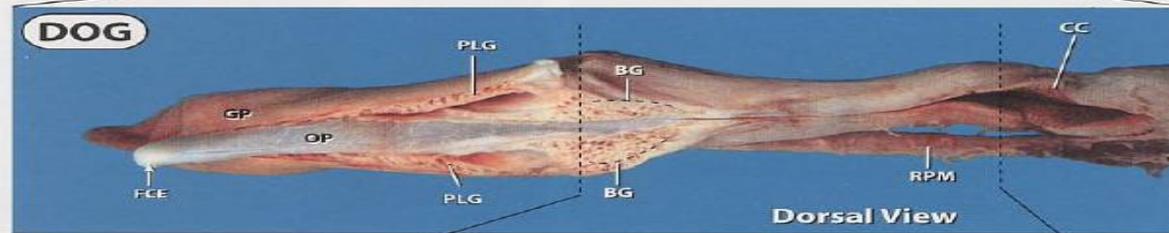


BsM = Bulbospongiosus Muscle
 CC = Corpus Cavernosum
 CS = Corpus Spongiosum
 DEC = Dorsal Erection Canals
 RPM = Retractor Penis Muscle
 TA = Tunica Albuginea
 T = Trabeculae (from tunica albuginea)
 PU = Penile Urethra



BULL

Figure 3-22. Glans Penis (Dog, Tom and Alpaca) and Penile Shaft (Dog)



- 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

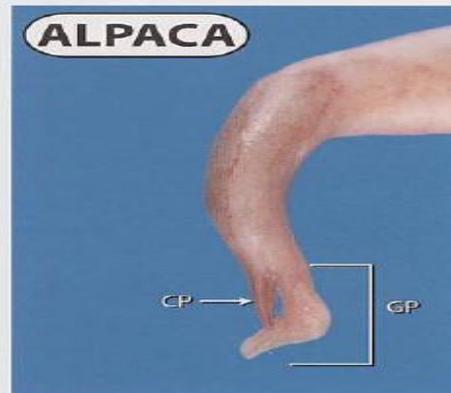
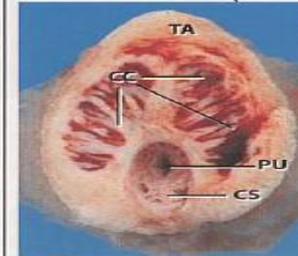


TABLE 2.1. Relative size of accessory sex glands in different animals

Species	Ampulla	Prostate	Vesicular gland	Bulbourethral gland
Cattle/buffalo	(+)	++	+++	+
Sheep	(+)	++	+++	+
Horse	++	++	++	+
Pig	Absent	+	++	+++
Dog	Absent	+++	Absent	Absent
Cat	Absent	++	Absent	++

Ampulla are present in species marked (+) but are not anatomically prominent.

1. External cremaster muscle

- It is formed from the caudal fibres of the **internal abdominal oblique muscle**.
- It passes through the inguinal canal and attaches to the outside of the parietal layer of tunica vaginalis.
- This muscle pulls the testis upward in cold weather.

INTERESTING FACT

The cremaster muscles are responsible for the testes being drawn into the abdominal cavity of the elephant, deer, and rabbit during times other than breeding season.

2. Internal cremaster muscle: It helps to hold the spermatic cord structures together.

3. Urethralis muscle: Peristaltic action of this muscle assists in the transport of urine or semen through the pelvic urethra. Thus it **aids in micturition and ejaculation**.

4. Bulbospongiosus muscle: It continues the action of the urethralis muscle in employing the extrapelvic urethral content.

5. Ischiocavernosus muscles: Described earlier.

6. Retractor penis muscles: Described earlier.

BLOOD SUPPLY TO MALE REPRODUCTIVE SYSTEM

Testicle	— Internal spermatic artery
Scrotum	— External pudental artery

- **Three types of muscles are associated with penis.** These are described below.

1. **Erector penis muscles or Ischio-cavernosus muscles**

- They are **paired** muscles.
- They extend from ischial to the lateral surface of penis.
- They help in erection of penis.
- When these muscles contract, they pull the penis upward against the floor of the pelvis. Much of the venous drainage from the penis is obstructed and erection is thereby assisted.

2. **Bulbospongiosus muscle**

- It extends from ischial arch to the glans penis.
- At the root, it is bulky and then diminishes.
- It helps to empty the extra pelvic portion of urethra during ejaculation or urination.

3. **Retractor penis muscles**

- They are paired muscles.
- They extend from first and second coccygeal vertebrae to the distal end of the sigmoid flexure.
- The muscles pull the penis back into the sheath after ejaculation.

STALLION'S PENIS

- *At the base of the glans, there is a border known as **corona glandis**.*
- *Projecting end of the urethra outside the glans is called **urethral process**.*
- *The urethral process is situated at the **fossa glandis**.*

EPIDIDYMIS

On the posterolateral side of each testis, there is an elongated structure called epididymis. It is differentiated into three parts: **head (caput)**, **body (corpus)** and **tail (cauda)**. The head of the epididymis is flattened at the upper end of the testis, where 12 to 15 vasa efferentia merge into a single duct of epididymis.

Functions

- **Transportation of spermatozoa:** The ciliated epithelium and peristaltic contraction of smooth muscle fibre of epididymis help in transportation of spermatozoa through epididymis.
- **Concentration of spermatozoa:** The head of the epididymis is the site of absorption of excess fluid. More than 90% of fluid leaving testis is absorbed in the head of the epididymis.
- **Storage:** The cauda of epididymis is the site of storage of spermatozoa. The conditions of cauda of epididymis are optimum for preserving the viability of spermatozoa for an extended period.
- **Maturation:** The freshly formed spermatozoa in testes have neither motility nor fertility i.e. they are immature spermatozoa. The maturation of spermatozoa occurs in the head and body of epididymis. The spermatozoa lose its protoplasmic droplet form during spermatogenesis.

The penis consists of:

- *a base*
- *a shaft*
- *the glans penis*

Muscles associated with the pelvic urethra and the penis are:

- *urethralis*
- *bulbospongiosus*
- *ischiocavernosus*
- *retractor penis*

Sigmoid Flexure- This is S shaped configuration along the shaft of the penis. This allows the penis to be retracted inside the body until erection occurs. This sigmoid flexure is maintained by a pair of smooth muscle known as RPM. This is attached dorsally to coccygeal vertebrae. This RPM hold the penis inside the sheath and when relaxed, the penis protrude

Erection in penis:- Erection in the bull, boar, ram, stallion and camel is brought about by a combination of relaxation of the retractor penis muscle and the rushing of blood into the corpus cavernous and corpus spongiosum

