



# Introduction to Andrology Development of male genitalia and gonads



Prepared by-

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# INTRODUCTION


- The Study of patho-physiology of male reproductive system is known as **Andrology**.
- Functional anatomy of male genitalia is a basic point to understand andrology.
- The value of the bull is more than half of the herd in cattle breeding

# Development of male genitalia and gonads

- **Reproductive system = Mesodermal Origin**
- In early embryonic life **Nephric & Genital** regions → formed from mesodermal tissue → Finally modified into Urogenital Sinus
- Cranial portion of nephric region → **Pronephros**
- Caudal to pronephros → **mesonephros (Wolffian body)** and **mesonephric duct (Wolffian duct)**

- **Metanephros (Kidney)** → 3<sup>rd</sup> excretory organ develop from outgrowth of mesonephric duct.
- Pronephros → degenerate
- Mesonephros → degenerate
- Mesonephric tubules → persist
- Mesonephric duct → persist and utilized in males for transport of sperm from testes to pelvic urethra.

- ✓ Bulging structure from mesonephros → **Genital ridge/ Gonadal ridge/ Urogenital ridge/ Indifferent gonad/ Undifferentiated gonad/ primitive gonad/ primordial gonad**
- ✓ Position → **medial to the mesonephros**
- ✓ Appearance of genital ridge on mesonephros =
  - ❖ **Human/ Bull = 28 days**
  - ❖ **Horse = 27 days**
  - ❖ **Boar = 26 days**
  - ❖ **Dog/Sheep = 24 days**

- Origin of primary germ cells → extra gonadal
- 
- Wall of Yolk sac endoderm in the region of hind gut.
- **Migration of primordial germ cells =**
- → Amoeboid movement (Diapedesis)
- → Chemotaxis

Secondary sex cord → Medulla → Testis (Male)

Primary sex cord → Cortex → Ovary (Female)

# Origin of internal ducts

- Embryonic stage → double set of sex ducts in vertebrate
- During differentiation only one duct system persist
- **1. Mesonephric duct (Wolffian duct) = Male**
- **2. Paramesonephric duct (Mullerian duct) = Female**



# Testis

- **Sertoli cell formation** → Male
- Other name → **Sustentacular/Nurse cell** → derived from mesonephric tubule epithelial cells
- 
- Secrete AMH (Anti Mullerian Hormone) or MIH (Mullerian Inhibiting Hormone)



Inhibit the formation of **Mullerian duct**  
(**Paramesonephric duct**)

- Interstitial cells (Leydig Cells) → mesodermal mesenchymal cells



Secretes **Testosterone**

- Seminiferous tubule remain solid until just before puberty.
- Initial appearance of tunica albuginea → 1<sup>st</sup> histological evidence of testicular development (7<sup>th</sup> week)

# Mesonephric duct (Wolffian duct) = Male

- Epididymis
- Ductus deferens or vas deferens
- Ampulla
- Seminal vesicle

# Paramesonephric duct (Mullerian duct) = Female

- Oviduct
- Uterine horn
- Uterine body
- Cervix
- Cranial 2/3 Vagina
- Rest part of vagina formed by **Urogenital sinus**

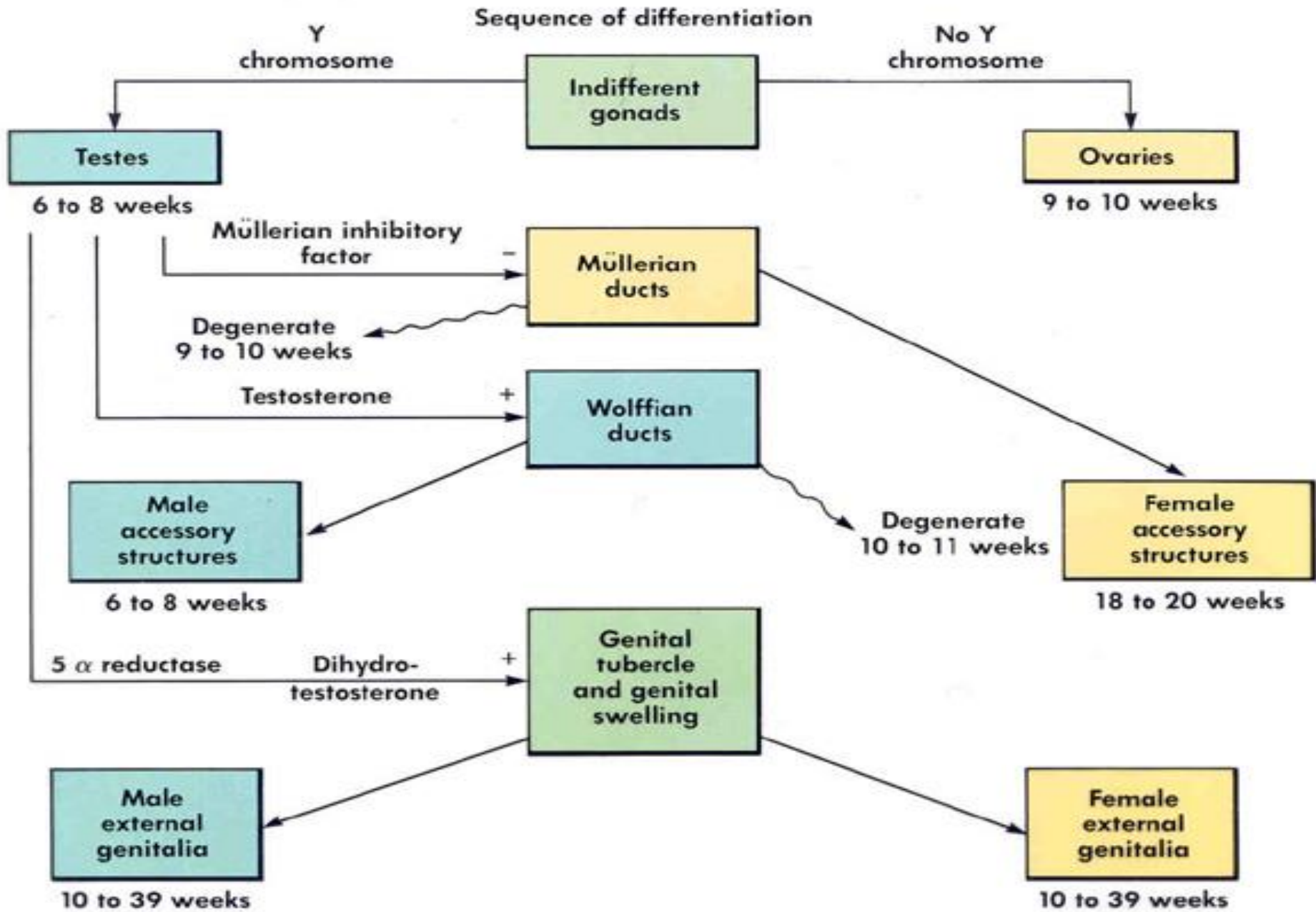


**Prostate & bulbourethral gland**

# Origin of external genitalia

Embryonic structure	Adult male	Adult Female
Genital swelling	Scrotal Pouch	Labia majora
Genital tubercle	Penis	Clitoris
Genital fold	Prepuce	Labia minora

- Genetic sex → Gonadal sex → Phenotypic sex  
→ Behavioral sex
- Sex of the foetus is determined at the time of fertilization (**Genetic sex**)



# **Reproductive Organs of Male domestic animals**



# Male Reproductive Organs:

**Scrotum**



**Two testes or testicle**



**Duct System**

(Epididymis, Vas deference, Ampulla)

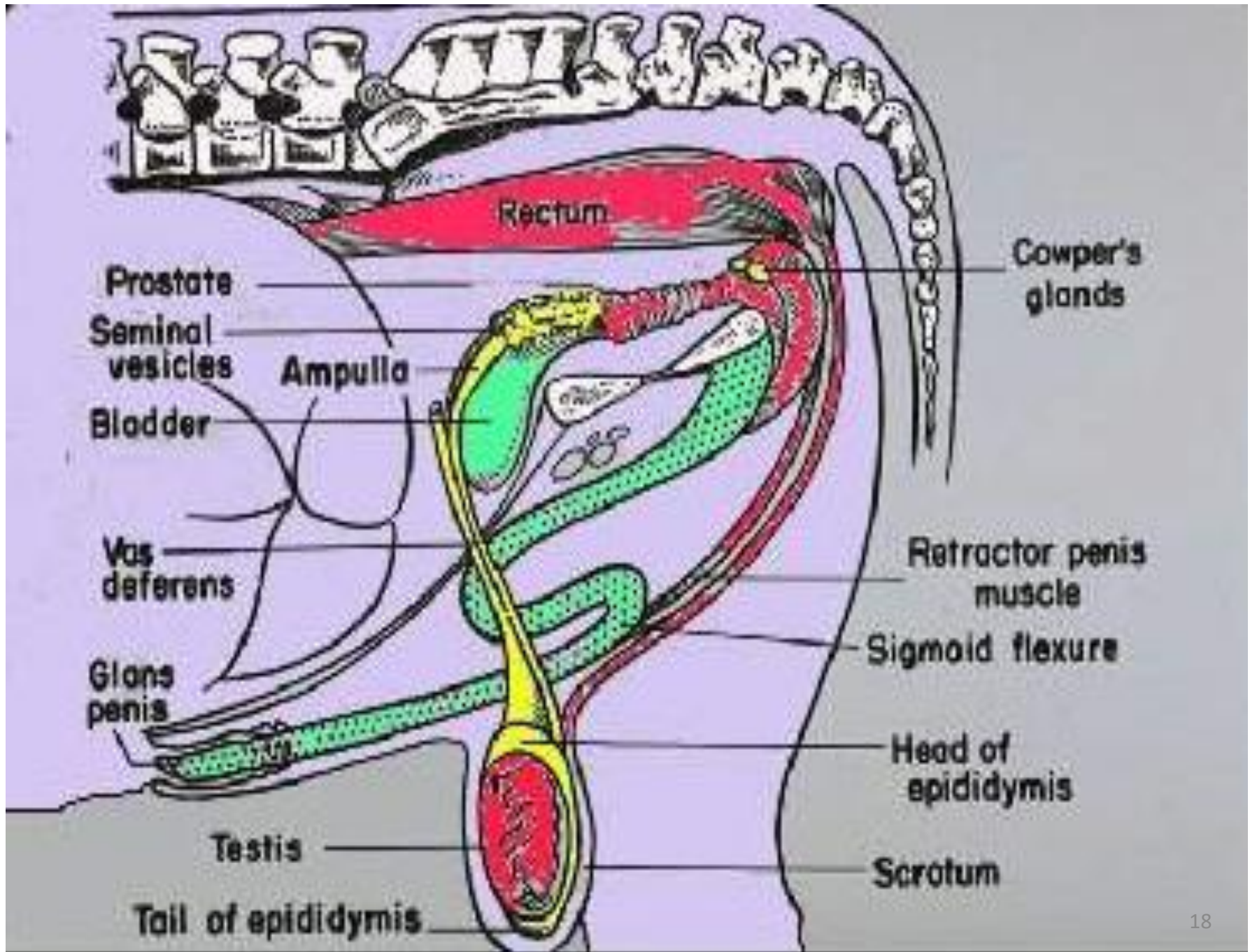


**Accessory sex glands**

(Seminal Vesicle, Prostate and Bulbo-urethral Gland)



**Penis and prepuce**



# SCROTUM AND TESTES

- Scrotum-
- Cutaneous pouch derived from skin and fascia
- House of testicle.
- **Location:-**
- In between thigh or inguinal region in all domestic animals except boar and cat.
- Boar and Cat → caudal to thigh or perineal region.
- Testis fixed to the scrotum → scrotal ligament attached to caudal end

# Scrotal Images



**Testes of Bull**



**Boar testicles**



**Cat  
testicles**



**Tiger Testicle**

# Scrotal Layers

**Stratum  
Subdarticum**

**Tunica Vaginalis  
(parietal layer)**

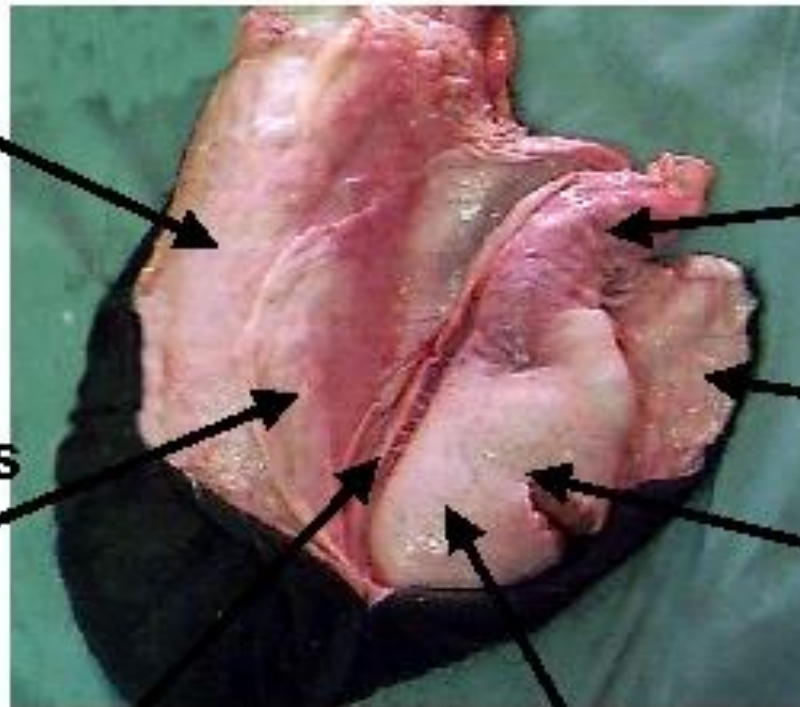
**Vas Deferens**

**Tunica Vaginalis  
(visceral layer)**

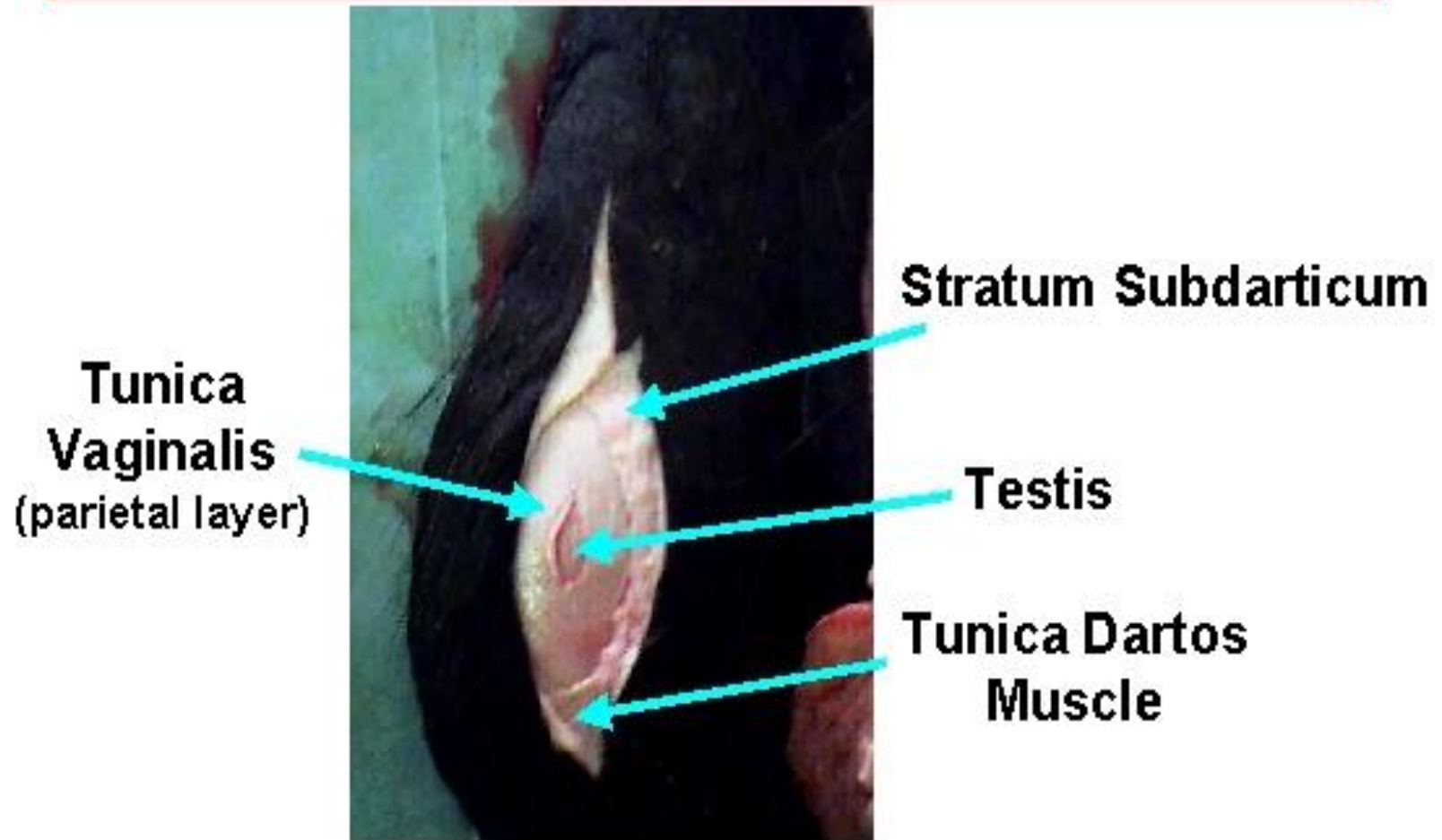
**Pampiniform  
Plexus**

**Tunica Dartos  
Muscle**

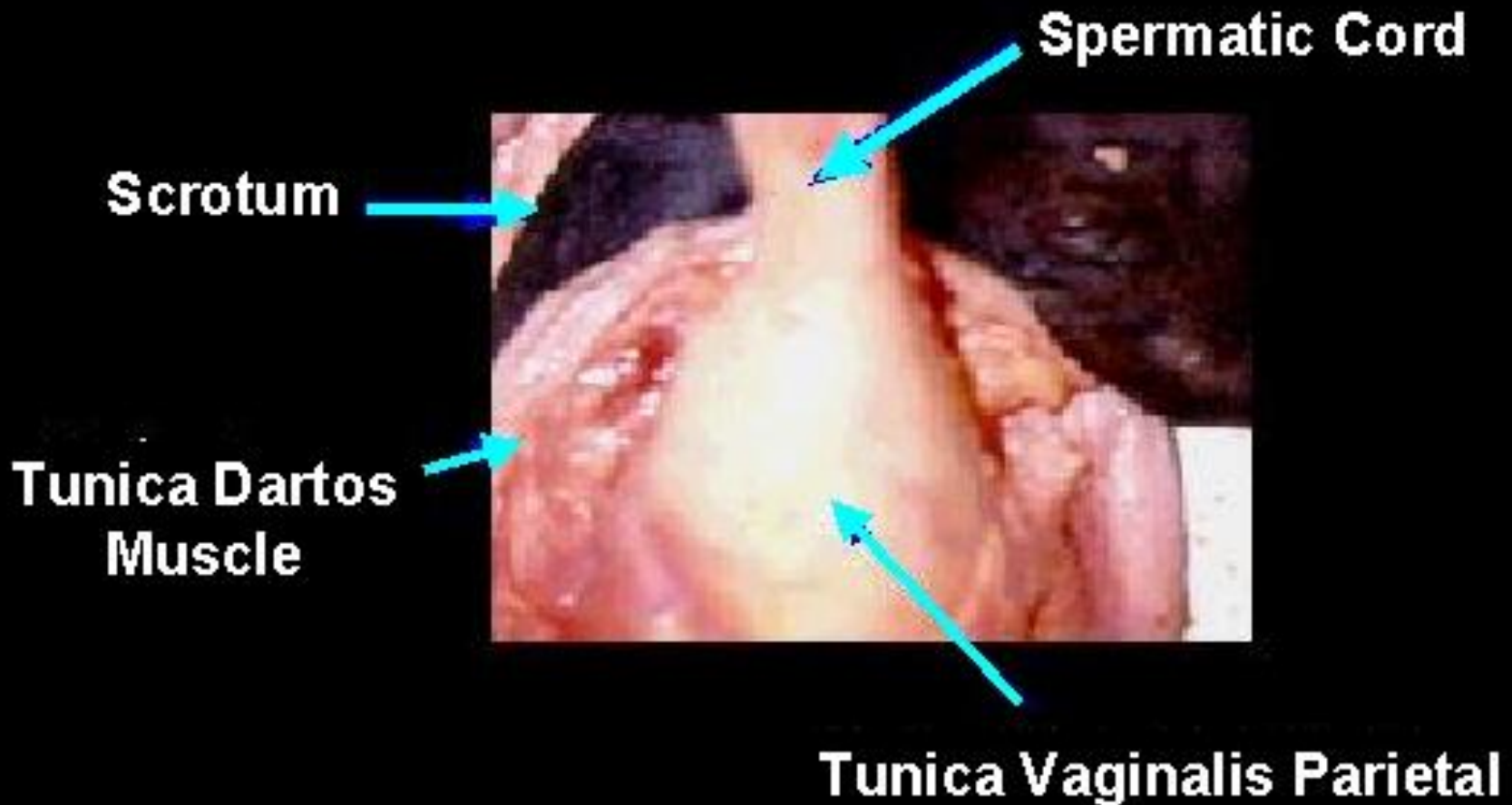
**Testis**



# Scrotum



# Spermatic Cord and Scrotum





# Layers of tissues between scrotal skin and testis proper

## 1. Tunica dartos layer:

- Present under the scrotal skin
- Composed of smooth muscle fibres, fibrous and elastic connective tissue.
- Surrounds both the testes.
- Forms **medial septum** w/n two testes

## 2. Loose connective tissue layer

- Present under tunica dartos layer


### 3. Vaginal process layer:

- Present under loose connective tissue layer
- It is an extension of peritoneum passing through abdominal wall at the inguinal canal.
- Composed of a) **Tunica vaginalis communis** : corresponds to parietal peritoneum of abdominal cavity.
- b) **Tunica vaginalis propria**: corresponds to visceral layer of peritoneum of abdominal cavity

- **4. Tunica albuginea layer:**

- Present beneath the visceral layer of the vaginal process (tunica vaginalis propria)
- Tough layer composed of fibromuscular tissue.
- Extensions of tunica albuginea penetrate the testicular parenchyma to join at medistinum.
- Fibrous septa divides parenchyma into → lobules
- Lobules contains → seminiferous tubules (75% of testicular mass)

# DESCENT OF THE TESTICLE

- **TESTIS** originates near caudal pole of kidney
- Sink through  **inguinal canal**

**Scrotum**

**Inguinal ligament, diaphragmatic ligament & mesorchium → Suspend the testicle**

**Testicular descend → passive**

**Testis governs its own descends**

**Hormonally controlled from testis or adrenals**

- Testicular descent → gubernaculum testis



- **Regressed & Decrease in size after descend**



- **Forms Ligamentum testis & scrotal ligament**

**→ descend of testis completed by birth or soon after**

# Period of testicular descend

- **Bull= 106 days of GP**
- **Ram & Boar = 70 days of GP**
- **Horse = at or near birth**
- **Dog = 3-4 days postnatally**

# Cryptorchidism

- One or both testes are retained either in the abdominal cavity or in the inguinal canal.
- **High flanker:** the animal in which the testicle descends in to the inguinal canal but not into the scrotum is called “**high flanker**”.
- **Unilateral or bilateral cryptorchidism**
- **Unilateral → spermatogenesis from one normal testis**
- **Bilateral → no spermatogenesis, sterile.**

# Length of the seminiferous tubules in different species

- Bull = 5 km
- Ram = 4 km
- Boar = 6 km
- Dog = 150 m
- Cat = 25 m



# Passage of spermatozoa

- Seminiferous tubules → Tubuli recti (straight tubule) → Rete testes Efferent tubules (**6-24 in number**) → Epididymis → Vas deferens → Ampulla → Urethra

# Component of spermatic cord

1. Internal spermatic artery
2. Internal spermatic vein
3. Vas deferens
4. Autonomic nerve from renal and caudal mesenteric plexus.
5. Lymphatic vessels
6. Internal cremaster muscles
7. Tunica vaginalis propria.

# Shape, colour of parenchyma and measurement of testis

	Horse	Bull	Ram	Boar	Dog	Cat
shape	Oval	Elongated /Oval	Elongated / Oval	Elliptical	Round to Oval	Round to Oval
parenchyma	Reddish gray	Yellow	Creamy white	Grayish to dark red	Reddish	Reddish
Measurement (cm)	11 x 6 x 4	14 x 7 x 7	10 x 6 x 6	13 x 7 x 7	1 x 1.2 to 4x 2.5	1.2 x 0.7 to 2 x 1.5
Weight (gm)	200-300	200-300	200-300	150-200	7-15	-----
Plane	Horizontal	Vertical	Vertical	Oblique	Oblique	Oblique

# Thermoregulation of testes

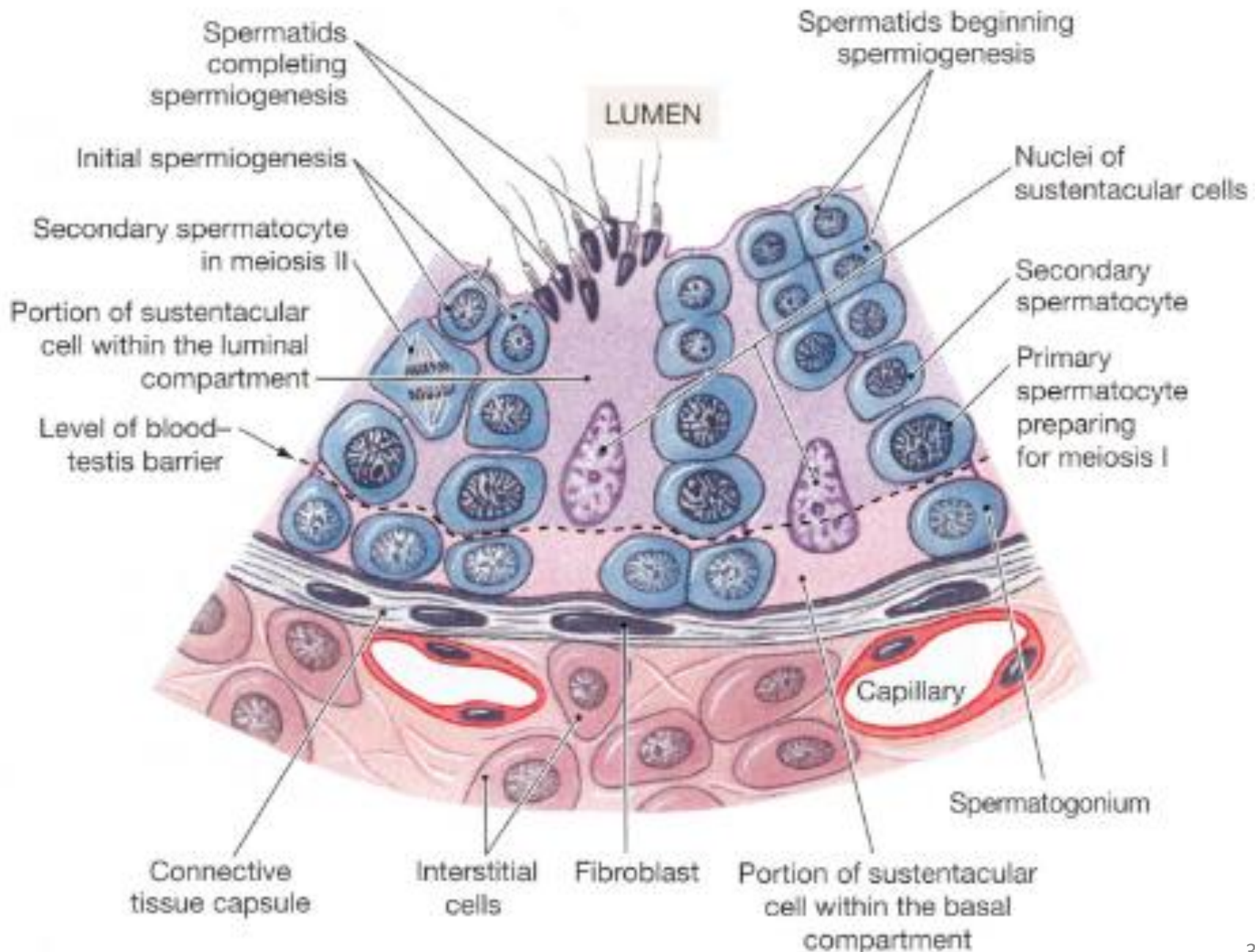
1. Lack of **subcutaneous fat** in scrotal skin.
2. Rich supply of **sweat gland** in scrotal skin.
3. **Cremaster and Dartos muscle :-**  
Contract – during cold weather (close to body)  
Relax – during summer (away from body)
4. **Pampiniform plexus of the testicular vein –**  
arterial blood supply of the testis is cooled down by pampiniform plexus of the testicular vein

# Functions of the testes

1. Production of testosterone (endocrine function)
  2. Production of the spermatozoa (exocrine function)
  3. Blood testes barrier protect the germinal epithelium from immunological damages.
- \*\* Bull produces 12-17 million spermatozoa per gram of testicular tissue daily**

# Blood testes barrier (BTB)

- Blood testes barrier is a physical barrier between blood or lymph vessels and the lumen of the seminiferous tubule of the testes.
- Adjacent **Sertoli cells (or sustentacular cells)** joined together by tight junction through basal cytoplasmic processes over spermatogonia.
- These tight junction form blood testes barrier.



- It divides the seminiferous epithelium into the basal and the apical (adluminal) compartments.
- The blood-testis barrier is one of the tightest tissue barriers in the mammalian body.
- Blood testes barrier prevent entry of harmful substances from blood affecting developing sperms.
- It also prevents sperm related proteins to enter circulation.



- **Basal compartment:-** spermatogonial renewal and differentiation and cell cycle progression up to the preleptotene spermatocyte stage take place outside of the BTB.
- **Apical compartment:-** Meiosis I and II, spermiogenesis, and spermiation all take place in a specialized microenvironment behind the BTB

# EPIDIDYMIS

- Coiled tube closely attached to the testis
- More firm in consistency than testis

## 3 different parts:

1. **Head (caput)** → broad, covers 1/3<sup>rd</sup> proximal end of testis
2. **Body (Corpus)** → narrow, running towards distal end of testis
3. **Tail (Cauda)** → enlarged end at distal pole of the testis.  
→ continue with the vas deferens.

# Length of epididymis:

Bull = 30-33 m

Ram = 50 m

Boar = 50 m

Horse = 20 m

- Histologically two prominent layers
  - 1. circular muscle fibers layer
  - 2. Pseudostratified columnar cell layer
  - Based on histology -- 3 Segment
- 1. Proximal segment** → ciliated cells (kinocilia), beating outward
    - almost no lumen
    - medusa (deattached ciliated cells) formation
  - 2. Middle segment** → wide lumen, cilia are not so straight
  - 3. Terminal segment** → lumen very wide, short cilia
    - packed with spermatozoa

# Functions of the epididymis

## 1. Absorption:

→ testicular fluids >>> semen ejaculates

Ex. Ram's testicular fluid 60 ml, semen ejaculate 1 ml

**Epithelial cells of cauda epididymis**



**Active absorption of fluid**



**highly concentrated spermatozoa**

## 2. Secretion:

- Epididymal cells,
- Maintain viability of spermatozoa.

## 3. Maturation:

- Occurs during storage period
- migration of the cytoplasmic droplet from the neck of spermatozoa to the distal end of middle piece.
- increased capacity for motility & fertilizing ability.

**Proximal protoplasmic droplet**



**Immature**

**Distal protoplasmic droplet**



**Mature**

## 4. Transportation:

- Due to ciliated epithelium.
- Action of peristaltic waves of muscles fibers.
- **Duration of epididymal journey:**
  - Bull = 10 days**                      **Ram = 13-15 days**
  - Boar = 9-12 days**                **stallion = 8-11 days**

## 5. Storage:

- **Cauda epididymis stores approx. 50% sperms**
- **Two epididymis stores up to 3-4 days production of spermatozoa.**
- **Spermatozoa remains in quiescent metabolic stage in epididymis**



# VAS DEFERENS OR DUCTUS DEFERENS

- Cauda epididymis →→→→ pelvic urethra.
- Thick muscular walls and small lumen.
- Convoluted near cauda epididymis and run parallel to corpus epididymis.
- Pass through inguinal canal into abdominal cavity along with components of spermatic cord.
- Then open into pelvic urethra

- Vas deferens → 3 mm thick in bull
- → 6 mm in stallion
- Elongated terminal part of vas deferens is called **Ampulla**.
- **Length = 10-12 cm, diameter = 1 to 1.5 cm**
- **Dog & cat ampulla absent**
- **The opening of ampulla in the cranial portion of the pelvic urethra through a rounded prominence is k/a “Colliculus seminalis”.**

# ACCESSORY SEX GLANDS

## 1. Vasicular glands or Seminal vesicles :

- Paired gland with lobulations
- Located on the pelvic floor cranial & lateral to the ampullae.
- Open in the pelvic urethra near opening of ampullae (colliculus seminalis) or both shares common ejaculatory duct
- Branched tubular secretory glands
- Add volume, nutrition and buffers

- ✓ **Secretion of about 50% of total semen ejaculate**
- ✓ **Secretions Alkaline in nature.**
- ✓ **Contains Protein, fructose, ascorbic acid, citric acid, potassium bicarbonate and enzymes.**
- ✓ **Stallion – vasicular gland (elongated Pear shaped sacs) → gel to ejaculates.**
- ✓ **Boar – large bag like → milky and viscous fluid secretions → high Inositol & ergothionine content.**
- ✓ **Bull – secretion yellow → high riboflavin**
- ✓ **Absent in Dog & Cat.**

## 2. Prostate Gland :

- **Bull : Location** → pelvic floor on or around neck of bladder or cranial portion of pelvic urethra.
- Opens into pelvic urethra lateral to the “**colliculus seminalis**” through many ducts.
- Two parts a) pars propria (body)
- b) pars disseminata
- Ram → no body
- Dog → Larger in older dogs

- Prostatic secretions → rich in enzymes
- Ex. Glycolytic enzymes, proteinases, phosphatases, glycosidases, nucleases, nucleotidases.
- Dog : pH = 6.5
- Secretions : citric acid phosphatase, high Zinc conc.
- Zn conc. In seminal plasma → prostatic secretion

# 3. Bulbourethral gland or Cowper's gland

- Paired gland
- Either side of pelvic urethra near the ischial arch.
- Bull : embedded under **bulbospongiosus muscles.**
- Bull/Ram/Stallion = Ovoid
- Boar = cylindrical
- Absent = Dog

- Bull: dribbling before ejaculation → secretions of **prostate & bulbourethral glands**.
- Cleans urethra prior to semen ejaculations.
- Gel (rubber like white substance) formation in boar semen



# PENIS

- Copulatory organ of male
- Dorsal part made of corpus cavernosum penis
- Corpus cavernosum penis enclosed by thick layer of tunica albuginea layer
- Ventral part surrounding the urethra → corpus spongiosum penis
- Bull /ram /boar → **sigmoid flexure** (S –shaped curve)
- **Sigmoid flexure :**
- Post scrotal → Bull , Ram
- Pre-scrotal → boar
- Absent → horse

- Retractor penis muscles attached to the distal end of sigmoid flexure.
- Help in penile erection by compression and pumping action
- **Bull:** penis length = 90 cm, diameter = 4-5 cm
- Glans penis = 7.5-12.5 cm long → pointed and twisted
- Penis of bull = Fibroelastic (less erectile tissue)

- **Stallion:**
- Penis length = 50 cm, diameter = 2.5-6.0 cm (non-erected)
- Length = 2x on erection, glans penis 3x
- Urethral process in glans
- Shallow groove in glans called fossa glandis → urethral sinus or diverticulum

- **Ram:**
- 30 cm , 1.5-2.0 cm
- Characterized by urethral process → extends 4-5cm beyond glans penis
- **Boar:**
- 45-55cm,
- No glans
- Terminal part twisted counter clockwise

## **Dog:**

- Penile Length = 6.5-24 cm
- Two separate corpora cavernosa
- Cranial free portion of penis contains a bone →  
“Os penis” or Bacculum
- **Glans penis : two parts**
  1. Bulbus glandis: proximal 1/3 part
  2. pars longa glandis : distal 2/3 part

Bulbus glandis engorged with blood during copulation

## Cat:

- Short and directed caudally & ventrally
- **Urethra lies dorsally in the penis**
- Os penis absent or short
- Bulbus glandis → absent
- Glans penis absent
- Terminal part contains **numerous spines**  
(**about 120**) pointing backward → reason for  
cat cry during copulation

# Number of chromosomes

- Cattle = 60
  - Goat = 60
  - Sheep = 54
  - Horse = 64
  - donkey = 62
  - Swine = 38
  - Cat = 38
- River buffalo = 50  
Swamp Buffalo = 48  
Dog = 78  
Fowl = 78



*THANK YOU*