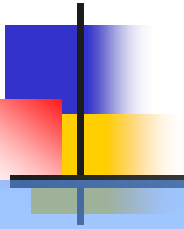


# Renal System



**Professor**

**Ibrahim MH. Alrashid**

**University of Basrah**

**College of Vet. Medicine**



# Renal anatomy

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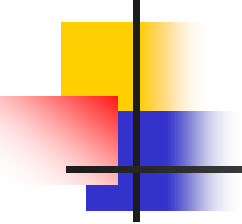
- Kidneys
- Ureters
- Bladder
- Urethra

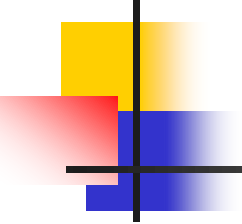
# Kidneys



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- The kidneys of the horse are both enclosed in a fat capsule. Dorsally they rest against the psoas muscle and against the diaphragm. The left kidney is bean-shaped and the right kidney is heart-shaped. The right kidney lies cranial to the left kidney.

- 
- 
- The right kidney is to be found ventrally to, and between, the last 2 ribs and first lumbar transverse process. Cranially it touches the liver and caudally it is attached to the pancreas and the base of caecum. The duodenum winds around its lateral and then ventral surfaces. Medially is the caudal vena cava and adrenal gland.

- 
- 
- The left kidney is between the last rib and 3rd transverse process. Its ventral surface is almost completely covered by the peritoneum and contacts the small intestine and small colon. The spleen contacts it cranioventrally. Medially is the left Adrenal Glands and aorta.



# Anatomy of Kidney

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- Outer fibrous capsule
- Renal Cortex
- Renal Medulla → 1 Outer Medulla  
2 Inner Medulla
- 
- Renal Pelvis
- Blood supply
- Inervation

# Outer fibrous capsule



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- A tough outer capsule surrounds the parenchyma and this prevents the kidney expanding.



# Renal Cortex

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- The renal cortex is the outermost layer of parenchyma, it lies just beneath the renal capsule.
- Composed from
  - 1- Renal corpuscle (nephron)
  - 2- Proximal convoluted tubule
  - 3- Distal convoluted tubule
  - 4- Medullary Rays





# Renal Medulla

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- The renal medulla is the inner layer of renal parenchyma. In the horse, medullary pyramids and their papillae are completely fused to form a renal crest.
- Composed two layers 1- outer RM 2- inner RM



# Inner RM

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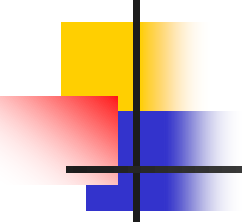
- Loop of henle
- Collecting ducts
- Vasa recta

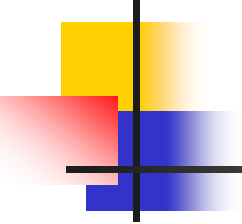


# Renal Pelvis

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- The renal crest opens into the renal pelvis. The renal pelvis is an expansion where the proximal ureter begins. The renal pelvis is located within the renal sinus. The renal sinus is located within an indentation on the medial side of the kidney. The renal sinus is a potential space, which is occupied by the ureter,.

- 
- 
- branches of the renal artery and vein, lymphatics and nerves that enter the kidney at the hilus. In the horse, the renal pelvis consists of a central cavity and two large terminal recesses. The terminal recess is a long tube-like structure that collects urine from the poles of the kidneys into the renal pelvis.

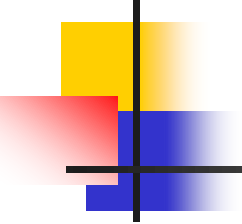
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- Most of the papillary ducts open into the terminal recesses. The renal pelvis is lined with transitional epithelium and contains mucous glands in the horse; giving urine a frothy appearance

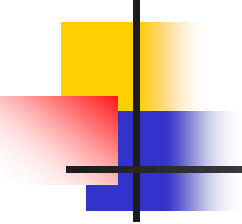


# Blood supply

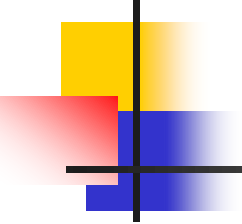
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- The kidney receives approximately 25% of cardiac output. Each kidney is supplied by a renal artery, which is a branch of the abdominal aorta. The renal artery subsequently divides at the hilus of each kidney into interlobar arteries, which run to the corticomedullary junction. Here they branch into arcuate arteries.

- 
- 
- The arcuate arteries then give rise to interlobular arteries which radiate into the renal cortex. The interlobular arteries become the afferent arteriole and subsequently the capillary loops of the glomerulus. These capillary loops then unite to become the efferent arteriole, which supplies a capillary network around the nephrons.

- 
- 
- This capillary network drains blood from the renal cortex into the interlobular veins, arcuate veins, then interlobar veins. The interlobar veins drain into the renal veins, which subsequently drain into the caudal vena cava.



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- The renal capsule is supplied by capillary branches of the interlobular arteries. Venous drainage of the capsule is provided by the stellate veins, which subsequently drain into the interlobular veins.



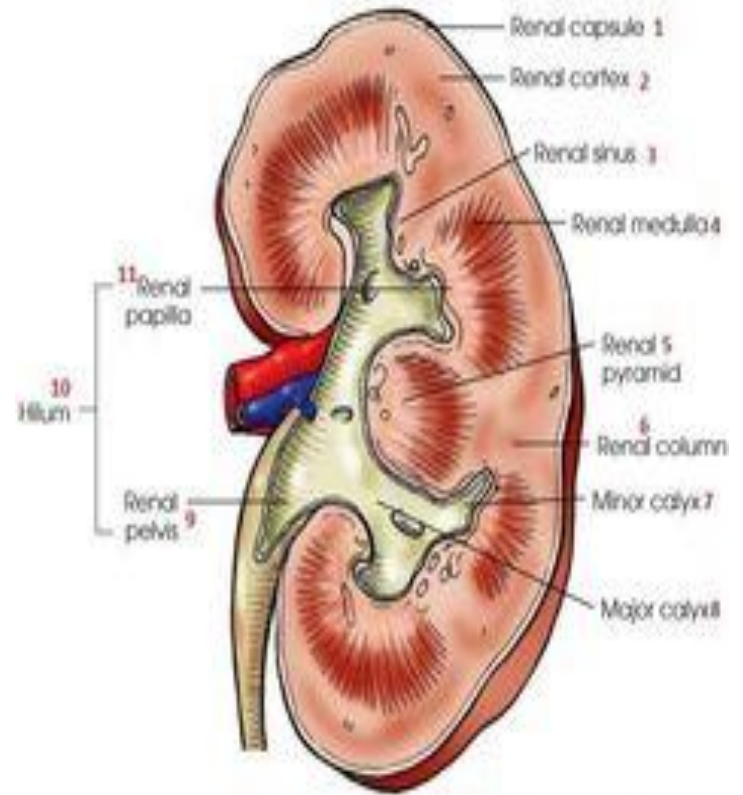
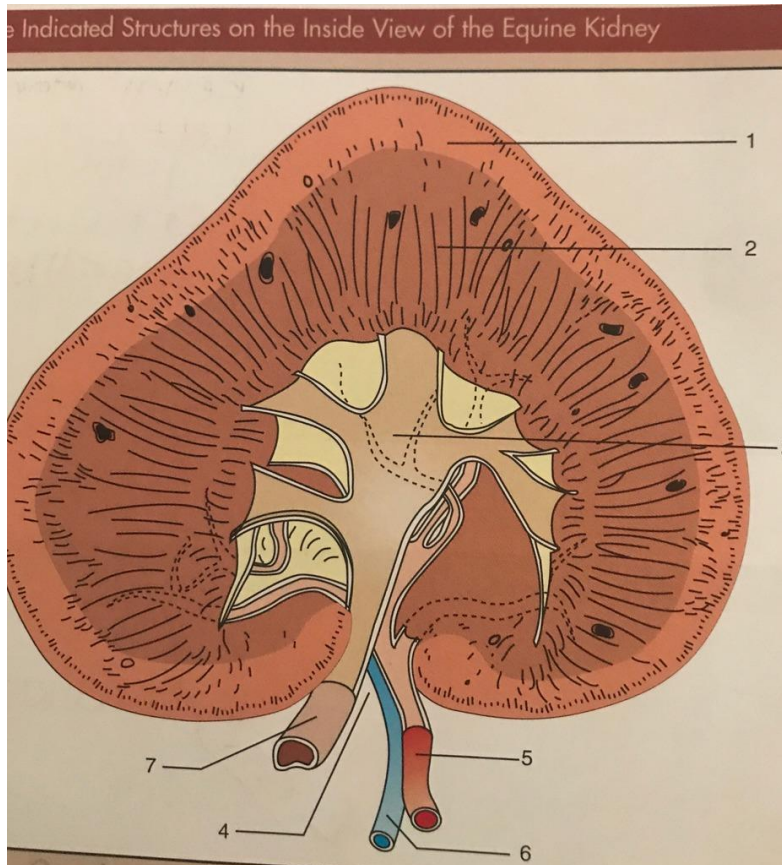
# Innervation

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- The kidney receives sympathetic and parasympathetic fibres from the solar plexus. These fibres travel with renal arteries. Sympathetic fibres synapse in coeliac ganglion and cranial mesenteric ganglion.

# Right

# Left



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# Bovine k.

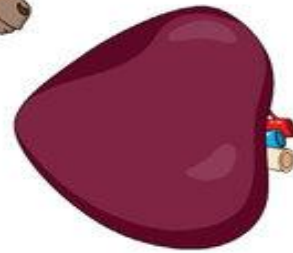
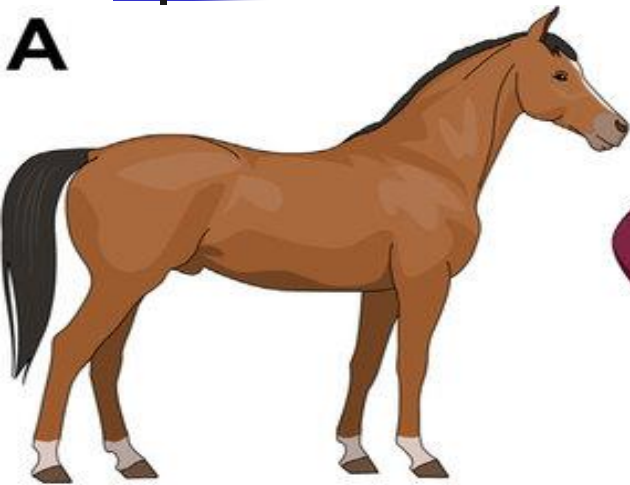


*Section of kidney showing: renal cortex (c), medulla (m), calyx (cx), pelvis (p)*

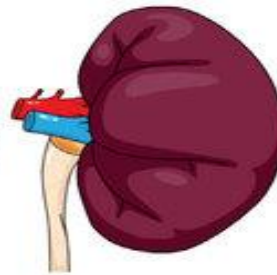


# Different kidneys

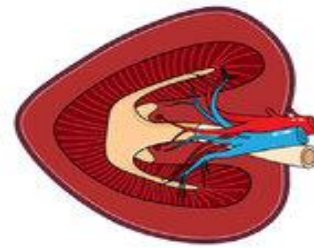
**A**



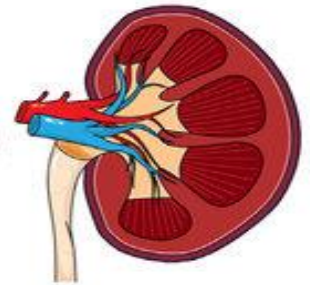
Rt. kidney



Lt. kidney

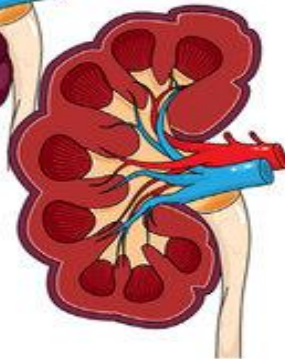
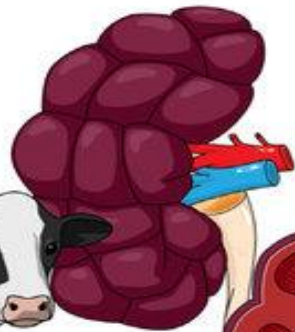
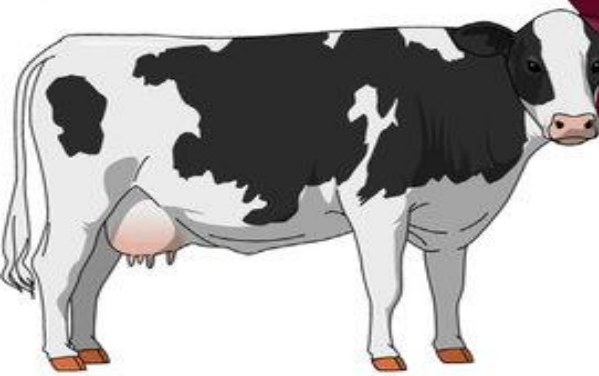


Rt. kidney

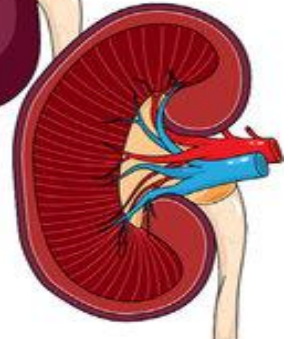


Lt. kidney

**B**



**C**





# Ureters

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- Wall
- Junction with the Bladder
- Movement of Urine
- Vascular Supply
- Innervation



# Wall

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- The wall of the ureters has an internal mucosa layer formed from transitional epithelium. This provides protection against the urine. The middle layer is a muscularis layer. This is well developed for peristalsis, though can enter into spasm on irritation.

# Junction with the Bladder



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- The ureter enters the bladder obliquely near the neck of the bladder and runs between the muscular layers and mucosa. They open through 2 slits on a raised hillock.



# Movement of Urine



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- The movement of urine along the ureters is achieved by peristalsis which is powered by locally regulated smooth muscle. This maintains a low pressure in the renal pelvis.

# Vascular Supply



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- The renal pelvis and proximal ureter is supplied by the renal artery. The distal ureter is supplied by the cranial vesicular artery and the **vaginal artery** (in the female) and **prostatic artery** (in the male).

# Innervation

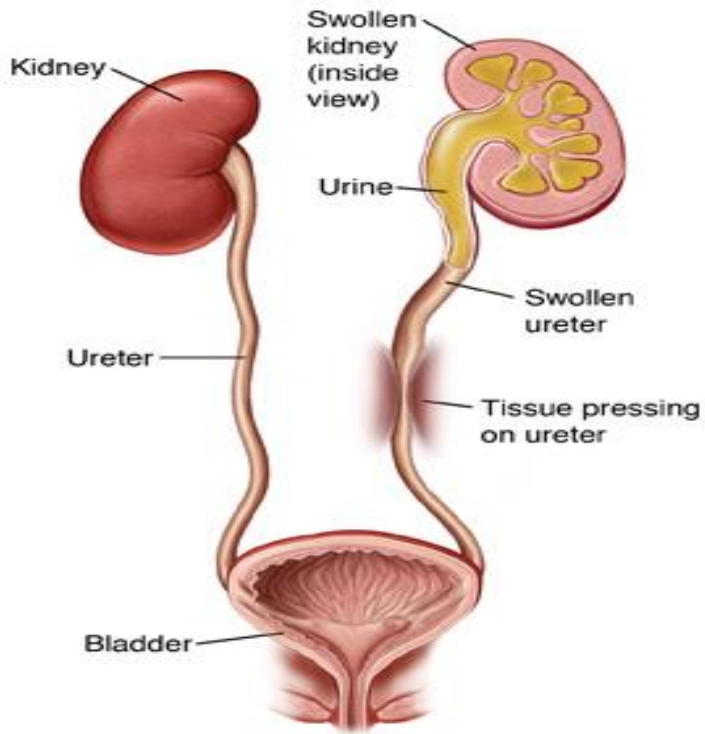


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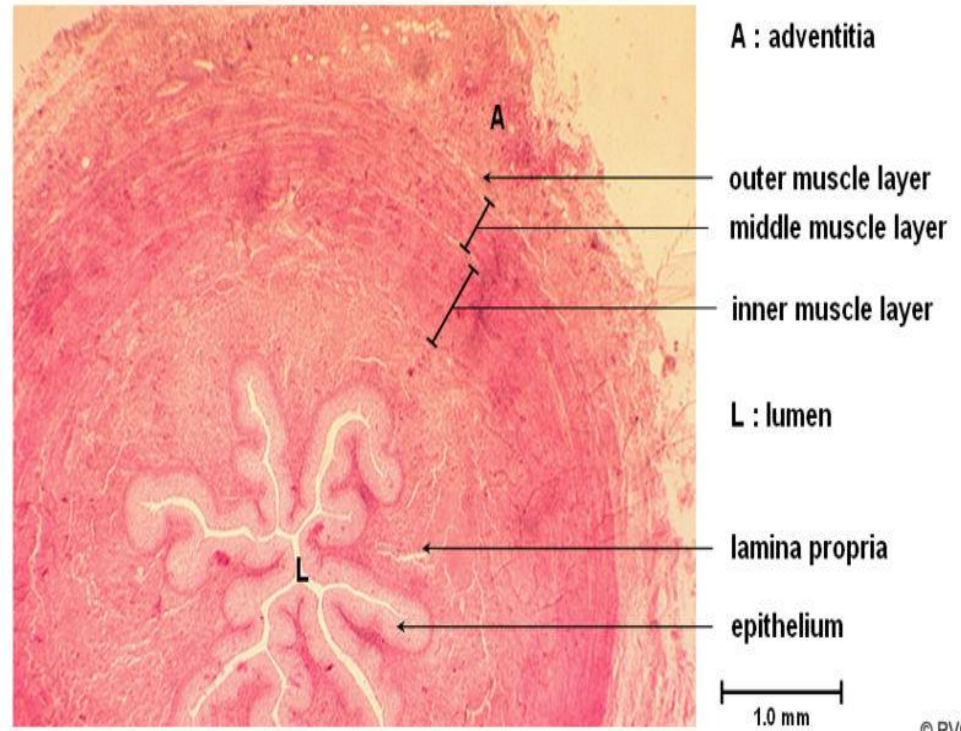
- The ureter receives parasympathetic and sympathetic innervation.

# Ureter

## Ureter



## Wall





# Bladder

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- The bladder is where urine is stored before being expelled by the body through the micturition reflex. Without a bladder urinary continence would be impossible. The bladder is a hollow, muscular organ. It is divided for descriptive purposes into three parts:



# Composition of Bladder

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- Cranial Pole
- Intermediate body
- Caudal neck

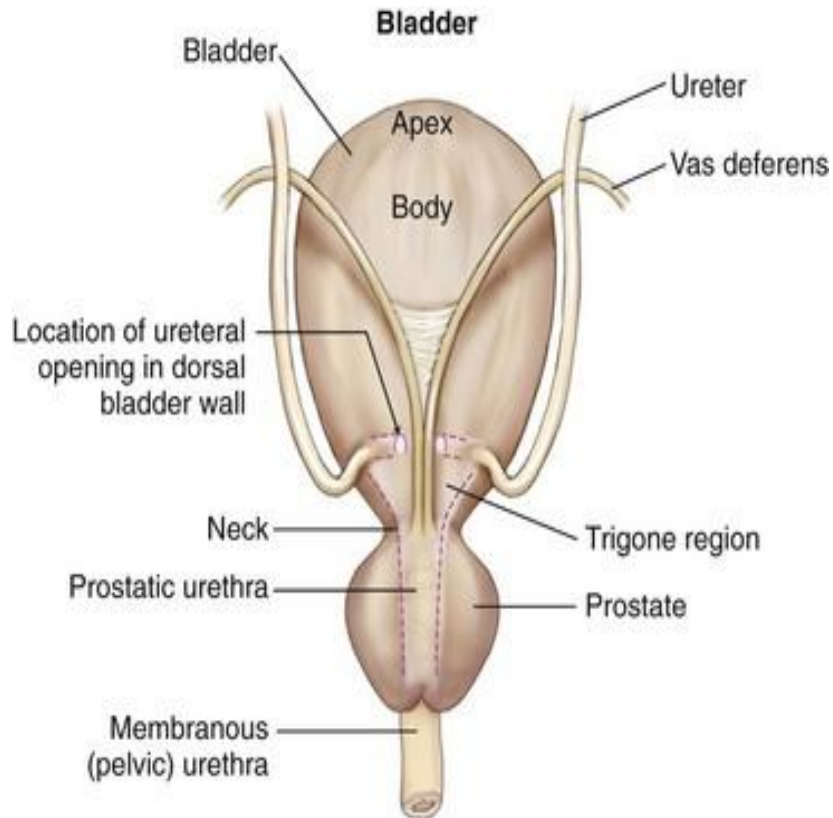


# Trigone

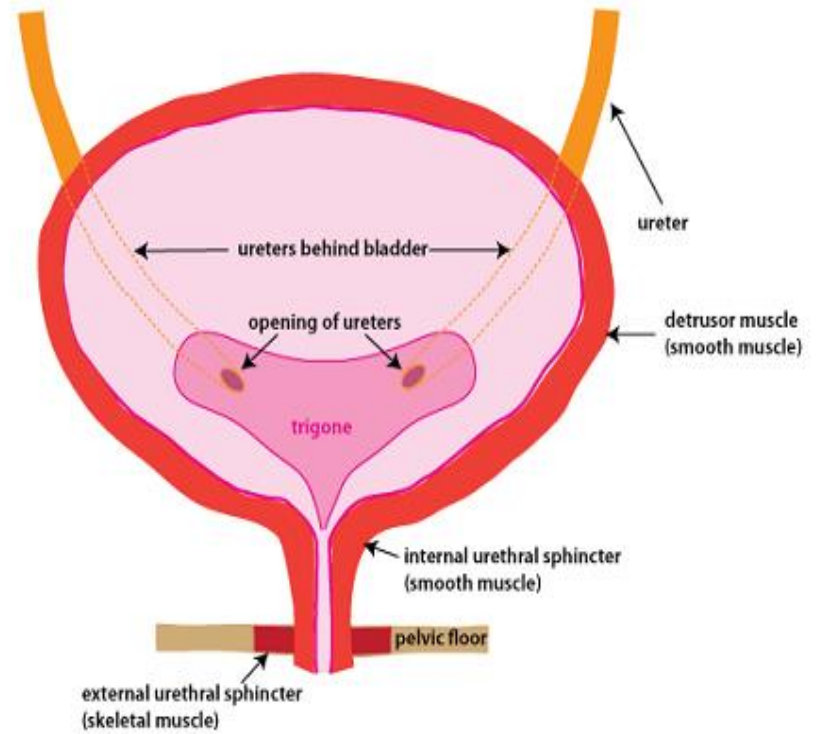
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- The **trigone** of the bladder gets its name as it looks like a triangle without a base. The trigone is bounded by the plicae uretericae. It is believed to have increased sensitivity and is of different embryological origin to the rest of tissue.

# Trigon



# Trigon





# Vascular Supply



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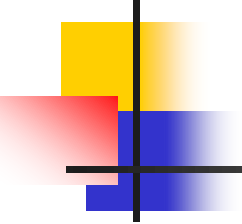
- The main blood supply to the bladder is via the caudal vesical arteries. These are branches of the vaginal artery (in the female) and the prostatic artery (in the male). A minor supply to the cranial bladder is provided by the reduced umbilical arteries.

# innervation



---

- The bladder receives **sympathetic** and **parasympathetic** nerve supply.
- Parasympathetic supply: This comes from S1-S3, synapses within the pelvic plexus, continues as the pudendal nerve and is excitatory to the detrusor muscle via release of Acetylcholine which binds muscarinic acetylcholine receptors. Parasympathetic dominance allows emptying of the bladder.

- 
- 
- Sympathetic Supply: This comes from L1-L4, synapses within the caudal mesenteric ganglion before entering the pelvic plexus. Postganglionic fibres continue as the hypogastric nerves, which terminate on beta 2 receptors within the detrusor muscle. It has inhibitory action on muscular contraction, therefore enabling bladder filling.

# Urethra



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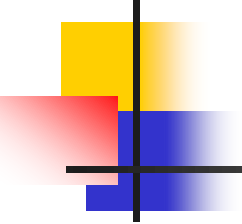
- This muscular tube is the connection between the bladder and the external environment and plays a vital role in conscious urinary continence.

# Male Urethra



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- The urethra empties at tip of penis. The male urethra carries urine, semen and seminal secretions from the accessory sex glands. The urethra is divided into 3 parts:
  - 1-Pre-prostatic - bladder neck to seminal hillock

- 
- 
- 2-Prostatic portion - openings of deferant, vesicular and prostatic ducts
  - 3-Penile portion - ischial arch to penile tip
  - \*\*\*The combination of the pre-prostatic and prostatic portions are called the pelvic portion.



# Female urethra

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- The urethra empties at the external urethral orifice on the ventral wall of the vagina. This is often at the vestibulo-vaginal junction. Only urine passes through the female urethra. In the horse, the urethra is short and wide.

# Muscles of the Urethra



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- The urethralis muscle runs the entire length of the urethra and forms the external urethral sphincter. Unlike the internal sphincter, the external sphincter is composed of striated muscle fibres which are under the voluntary control of the somatic nervous system.





# Innervation of the External Urethral Sphincter

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- The urethralis muscle receives somatic innervation originating from S1-S3 and continuing via the pudendal nerve. This releases the neurotransmitter Acetylcholine, which binds to nicotinic Acetylcholine receptors and mediates skeletal muscle contraction of the external urethral sphincter. This is important in urine retention.

# Vascular Supply



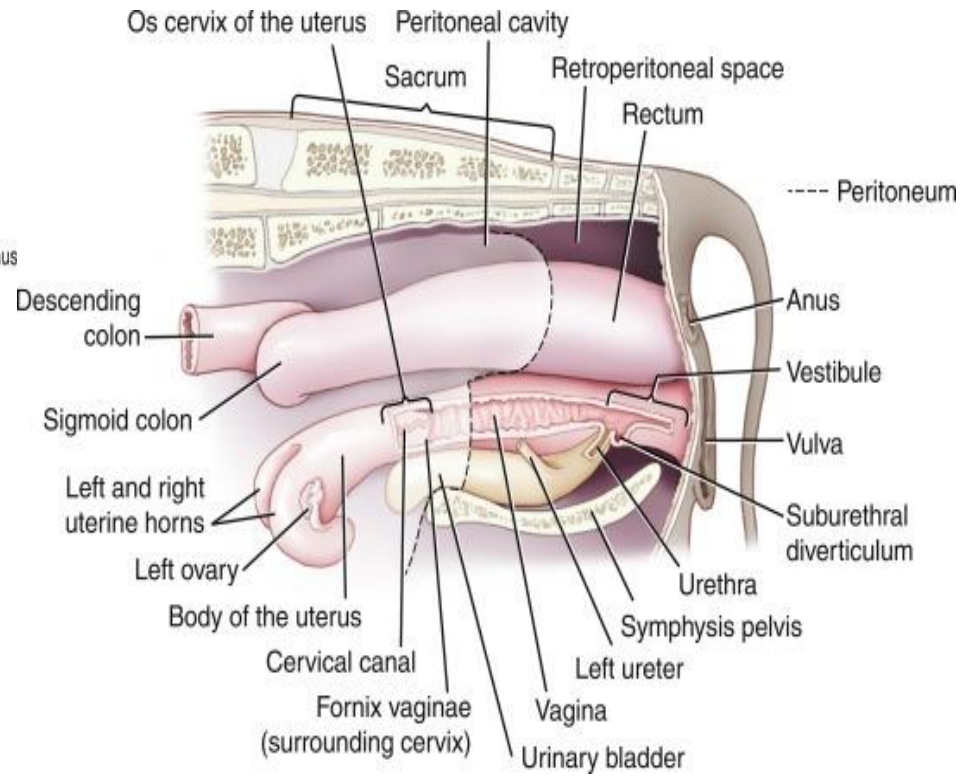
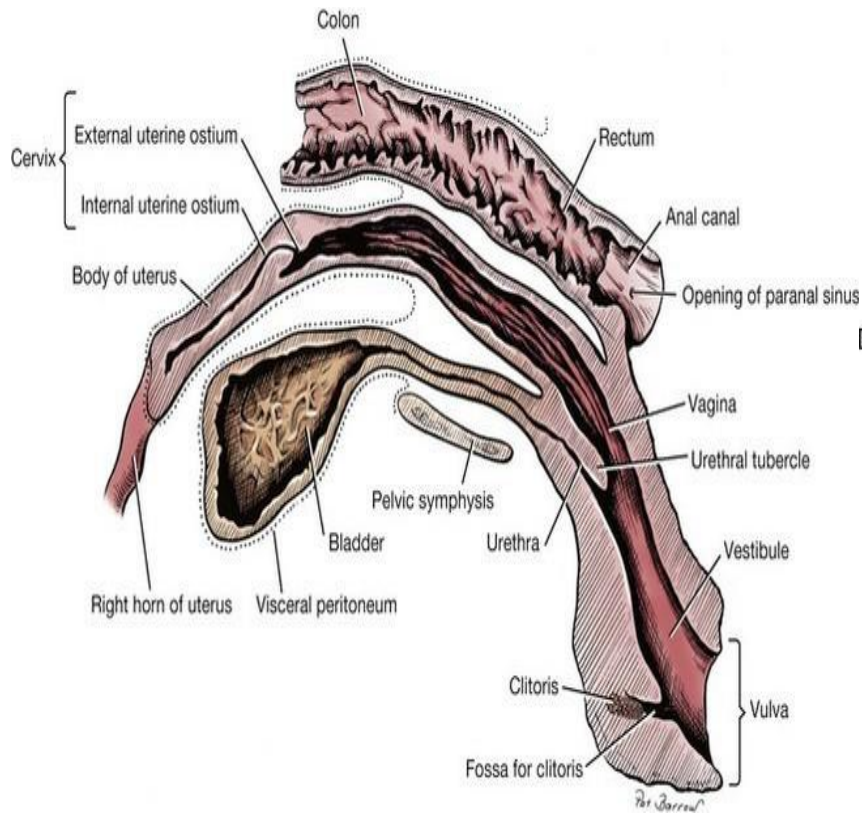
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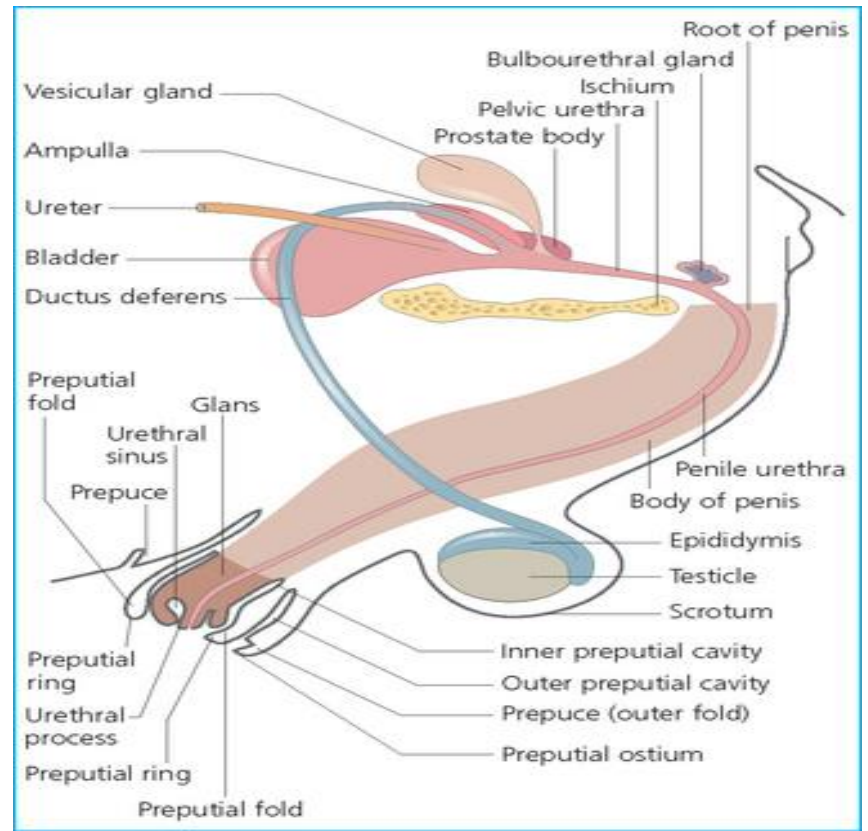
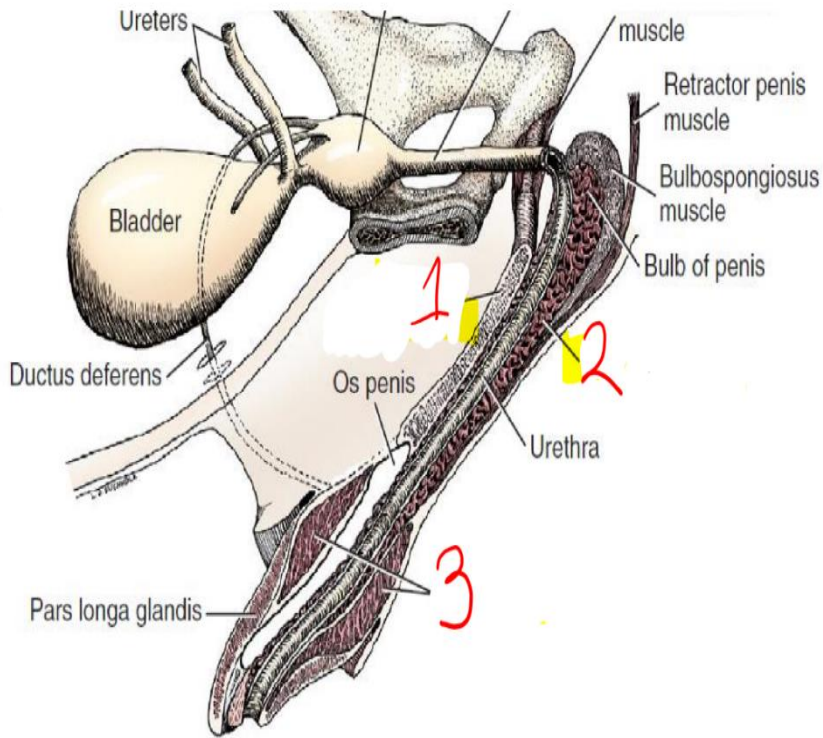
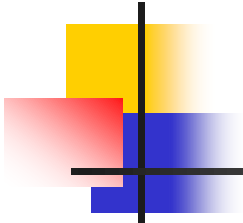
- Blood Supply comes from the Urethral Artery, which is a branch of the vaginal artery which in turn is a branch of the internal pudendal which is a branch of the internal iliac.

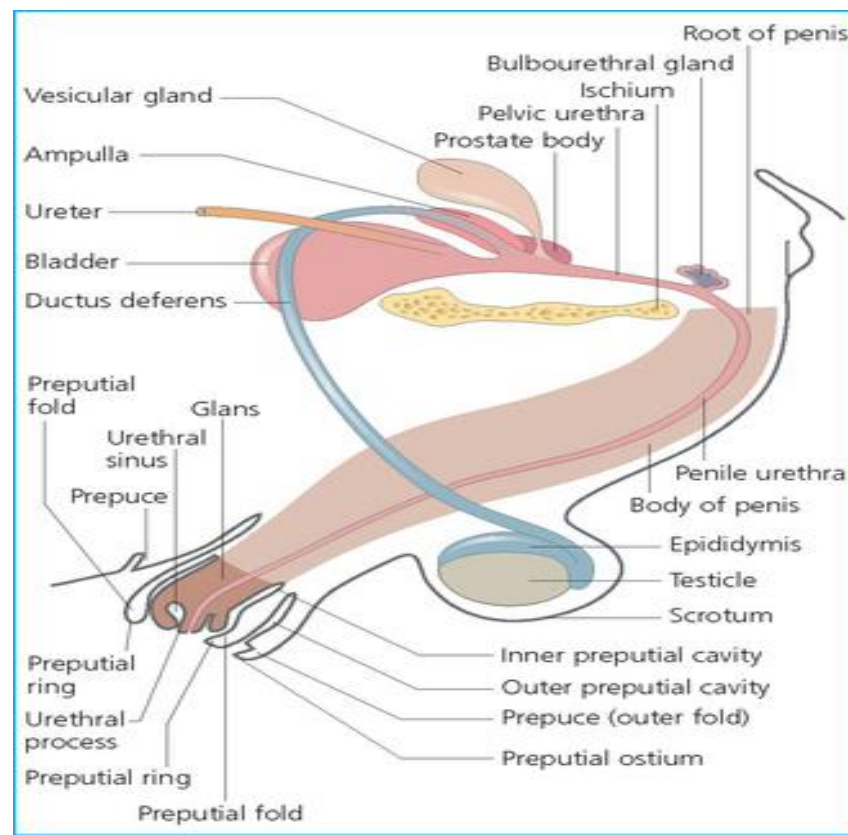
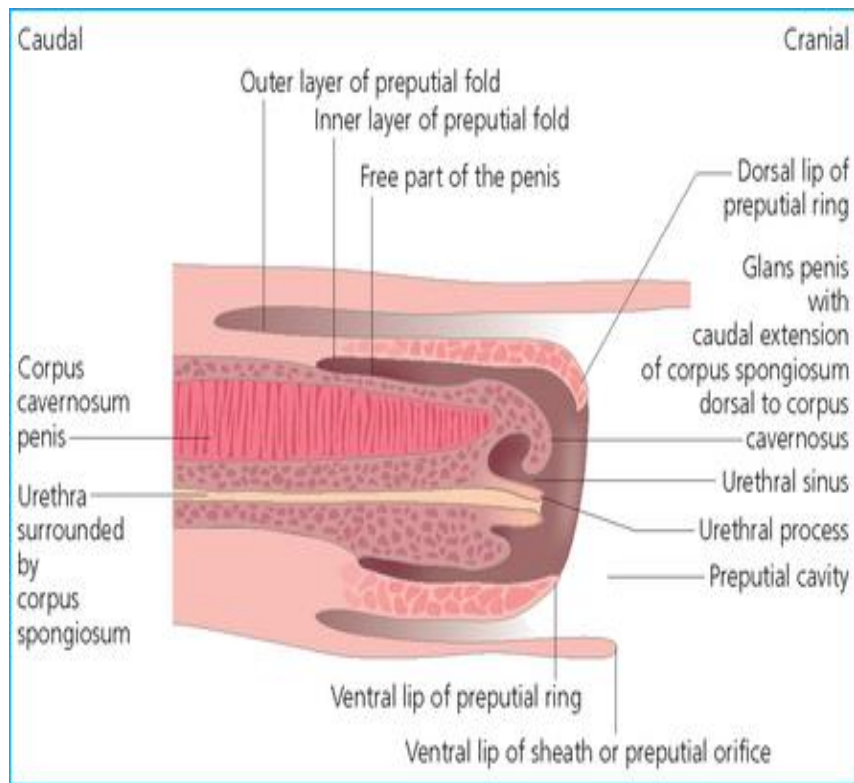


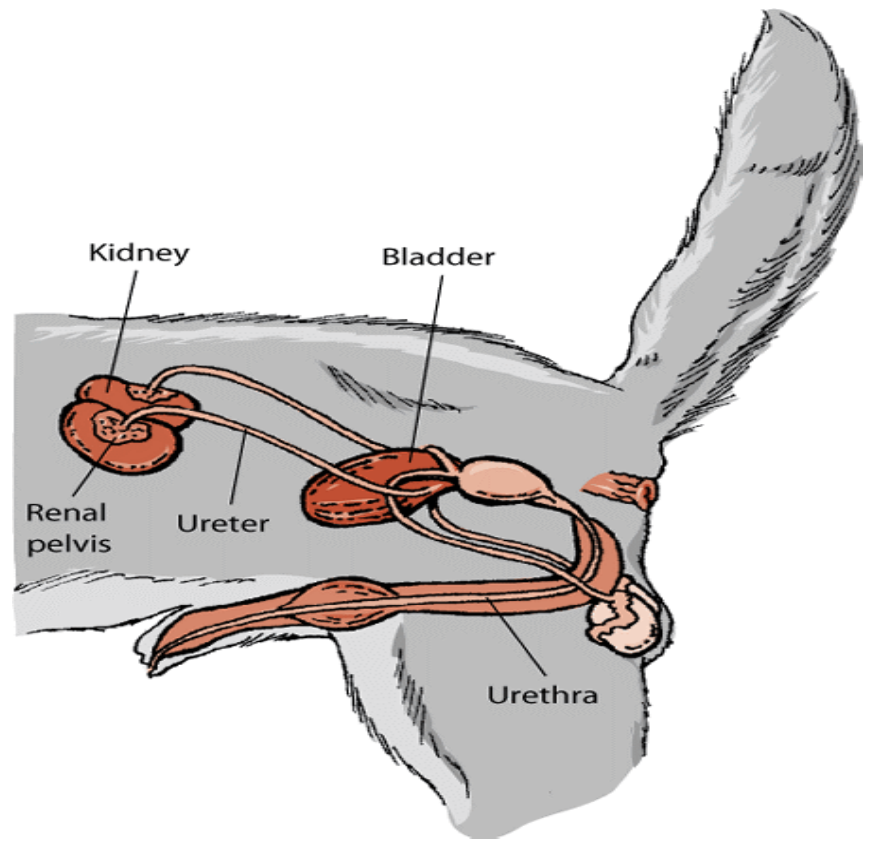
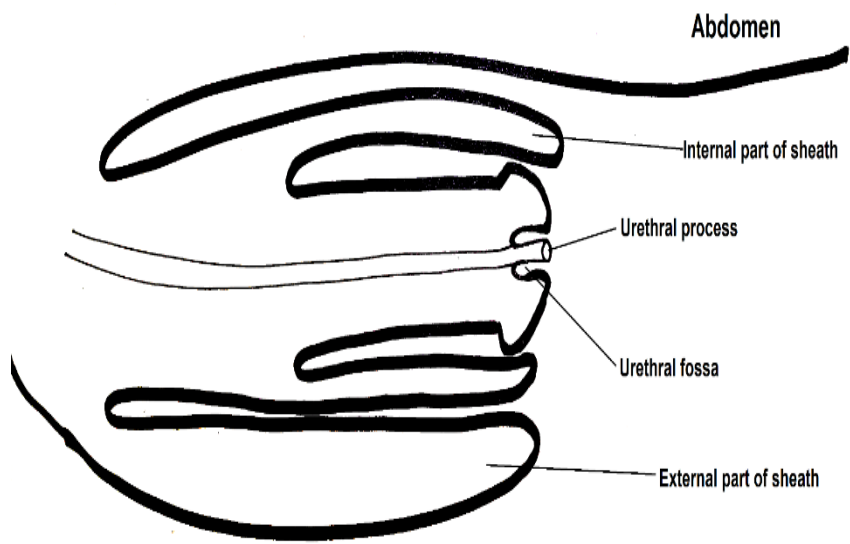
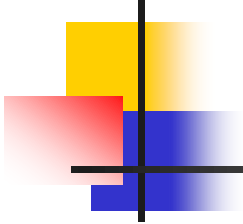
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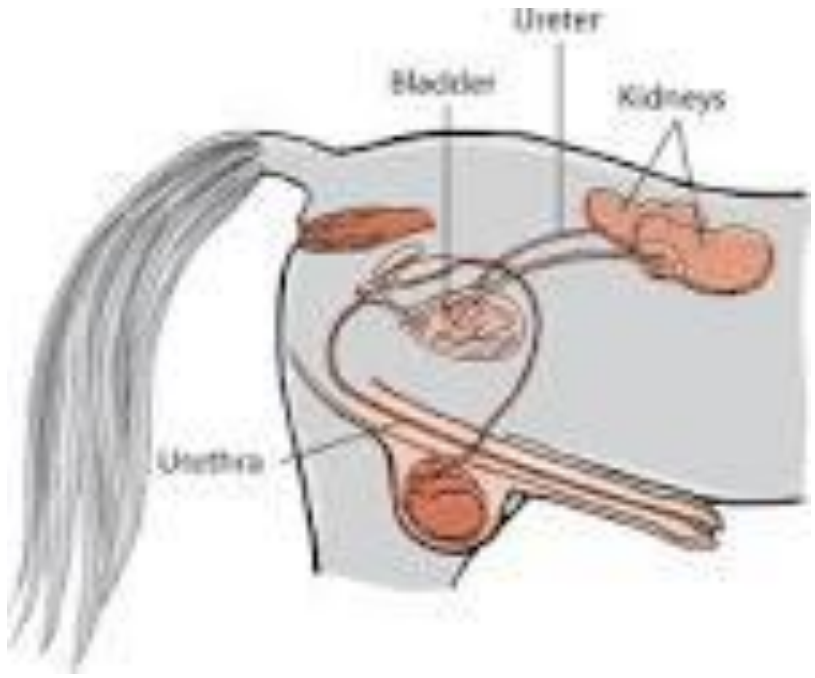
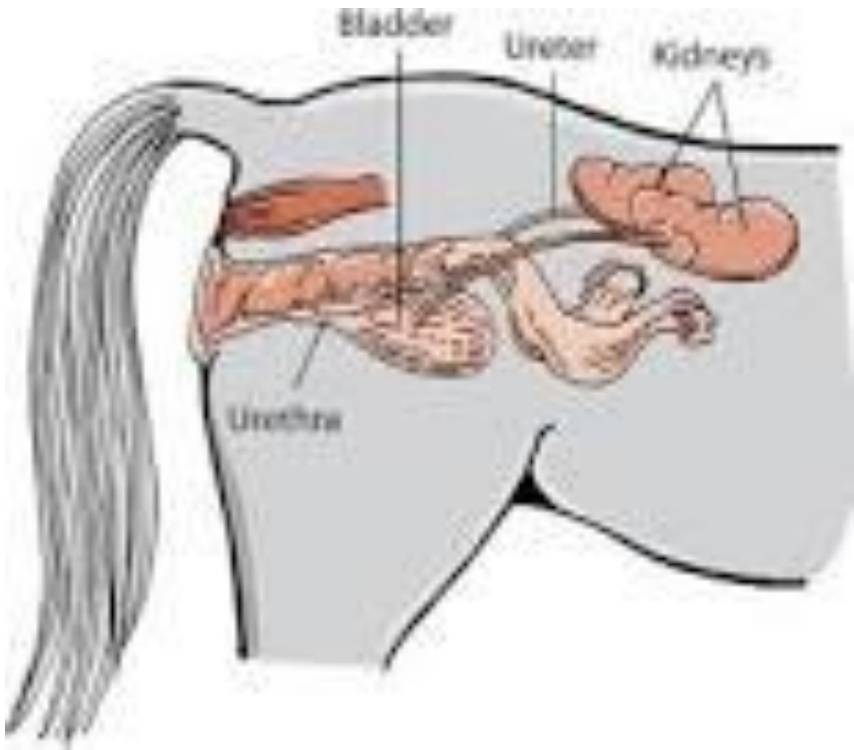






# Topographic

# Topographic



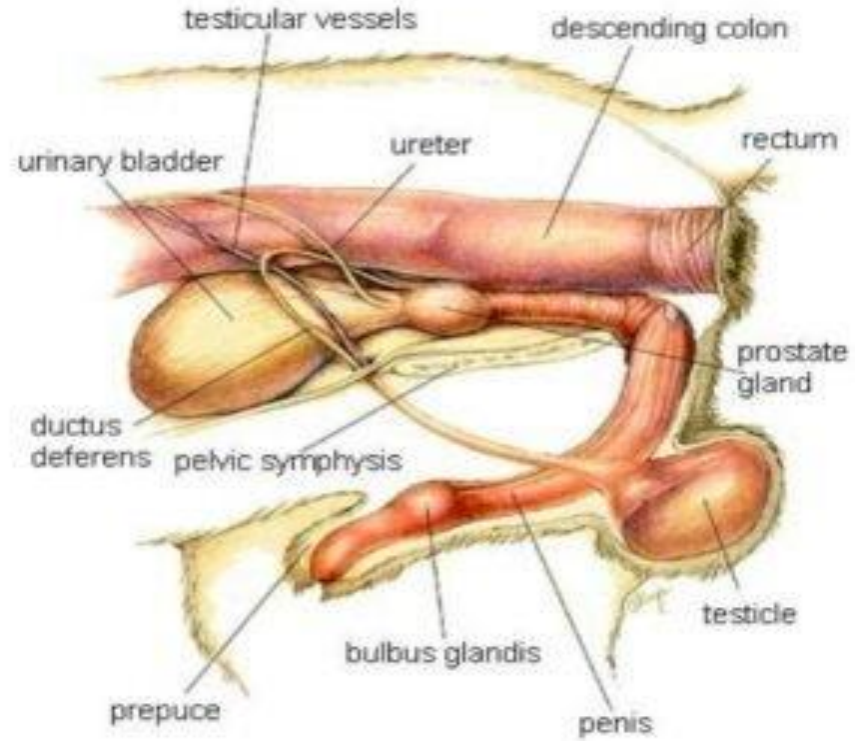
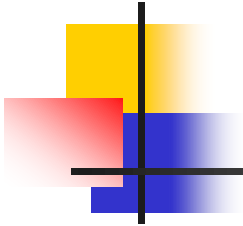


# The Os – penis

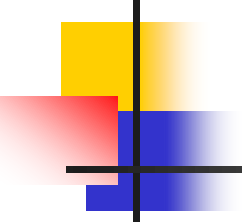
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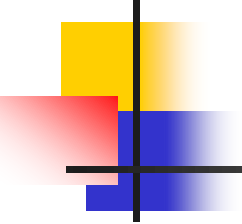
- is a triangular shaped bone and located dorsal to the urethra, and ventral to corpus cavernosum. Its internal space fills with bone marrow. It is composed essentially of spongy bone, on the cross section

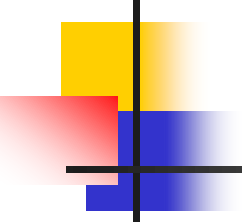




# Penis of cat tom

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- The penis is located ventrally to the testicles and points caudally unless erect. Prior to puberty, the penis is unable to be fully extended due to an adhesion of the balanopreputial fold. Because the breakdown of the fold is dependent on androgen secretion,

- 
- 
- The free portion of the penis of the tom is approximately 5–10 mm in length and 4–5 mm in diameter at the base. Once androgens are present in the postpubertal tom, penile spines become

- 
- 
- The penile spines are dependent on androgens therefore, once the tom is castrated, the penile spines will regress within 5–6 weeks.

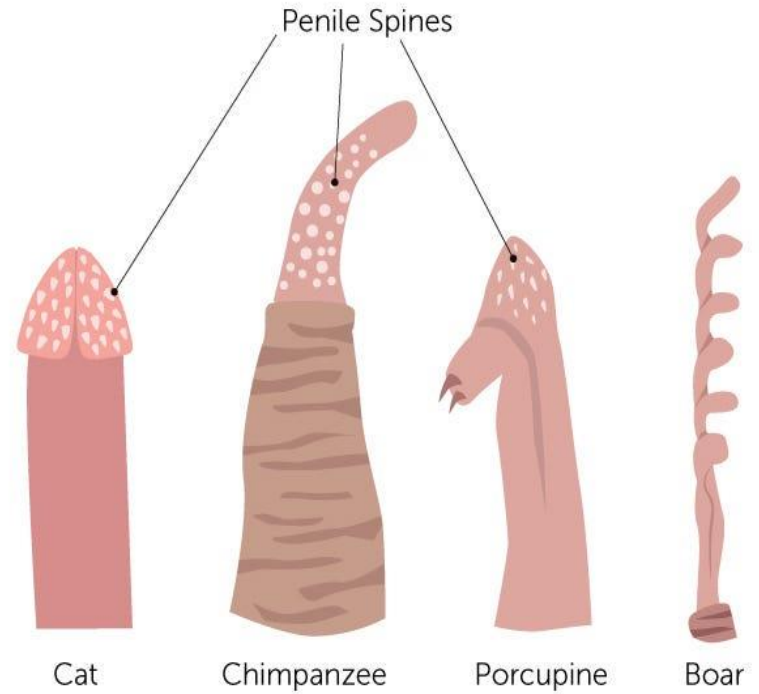


# Spine



# Spine

## EXAMPLES OF PENIS SHAPES



Thank you!