

Lower Urinary Tract Applied Anatomy

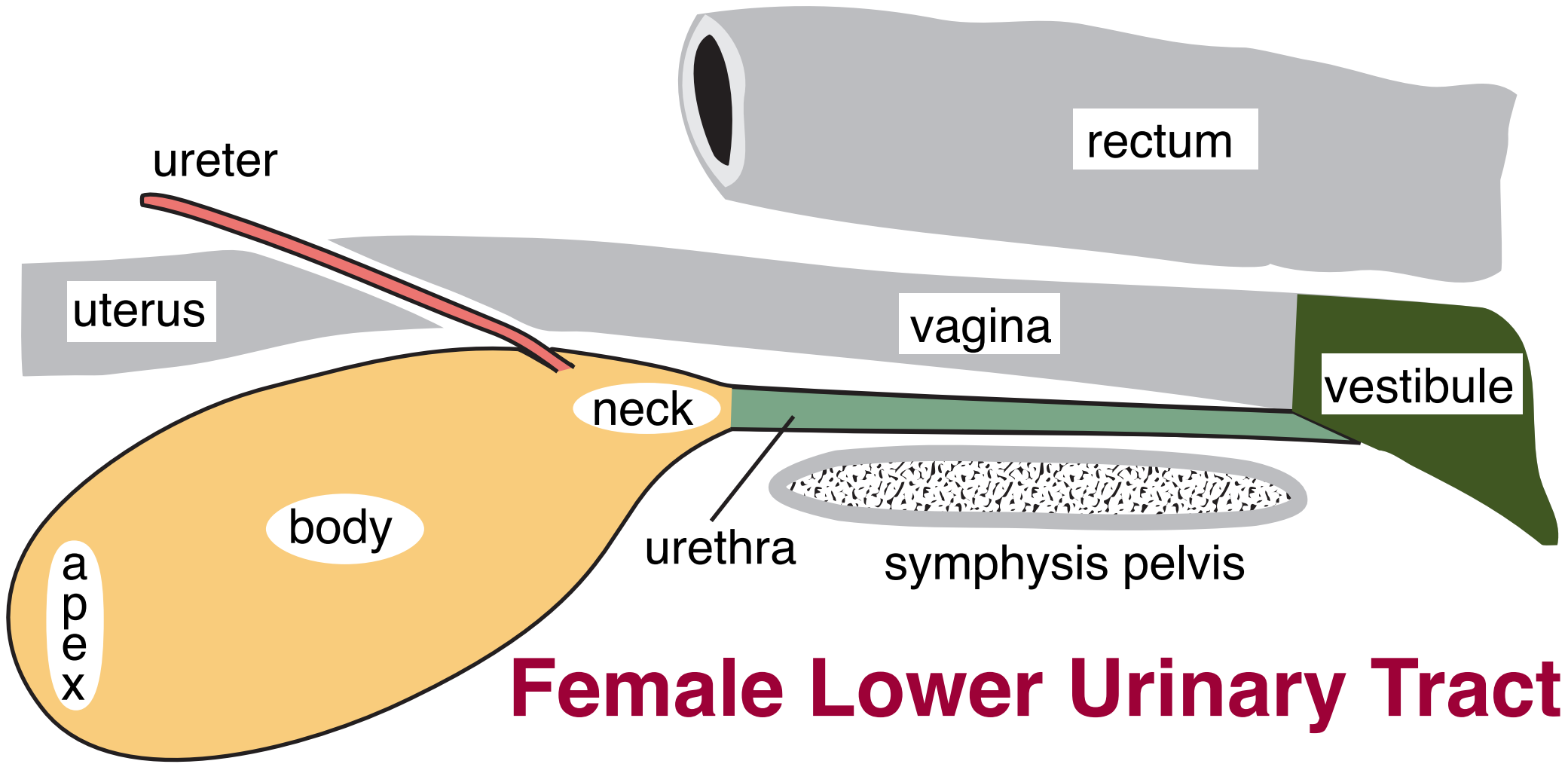
**[http://
vanat.cvm.umn.edu/lutApplAnat/](http://vanat.cvm.umn.edu/lutApplAnat/)**

**T.F. Fletcher, DVM, PhD
fletc003@umn.edu
4-9765**

Definitions:

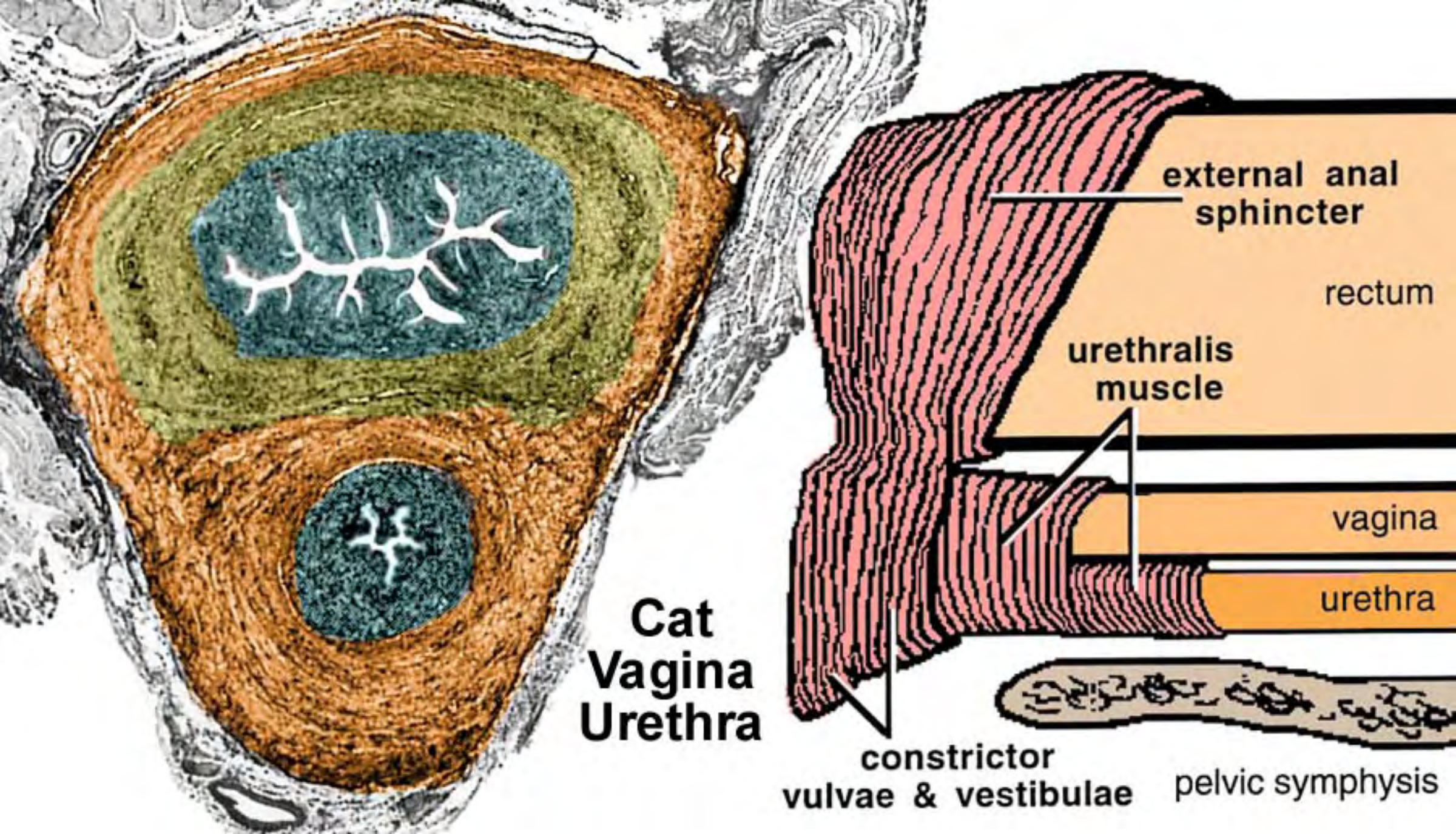
**What constitutes the Lower Urinary
Tract (LUT)?**

— what comprises the *urogenital tract*?



Female Lower Urinary Tract





**Cat
Vagina
Urethra**

**external anal
sphincter**

rectum

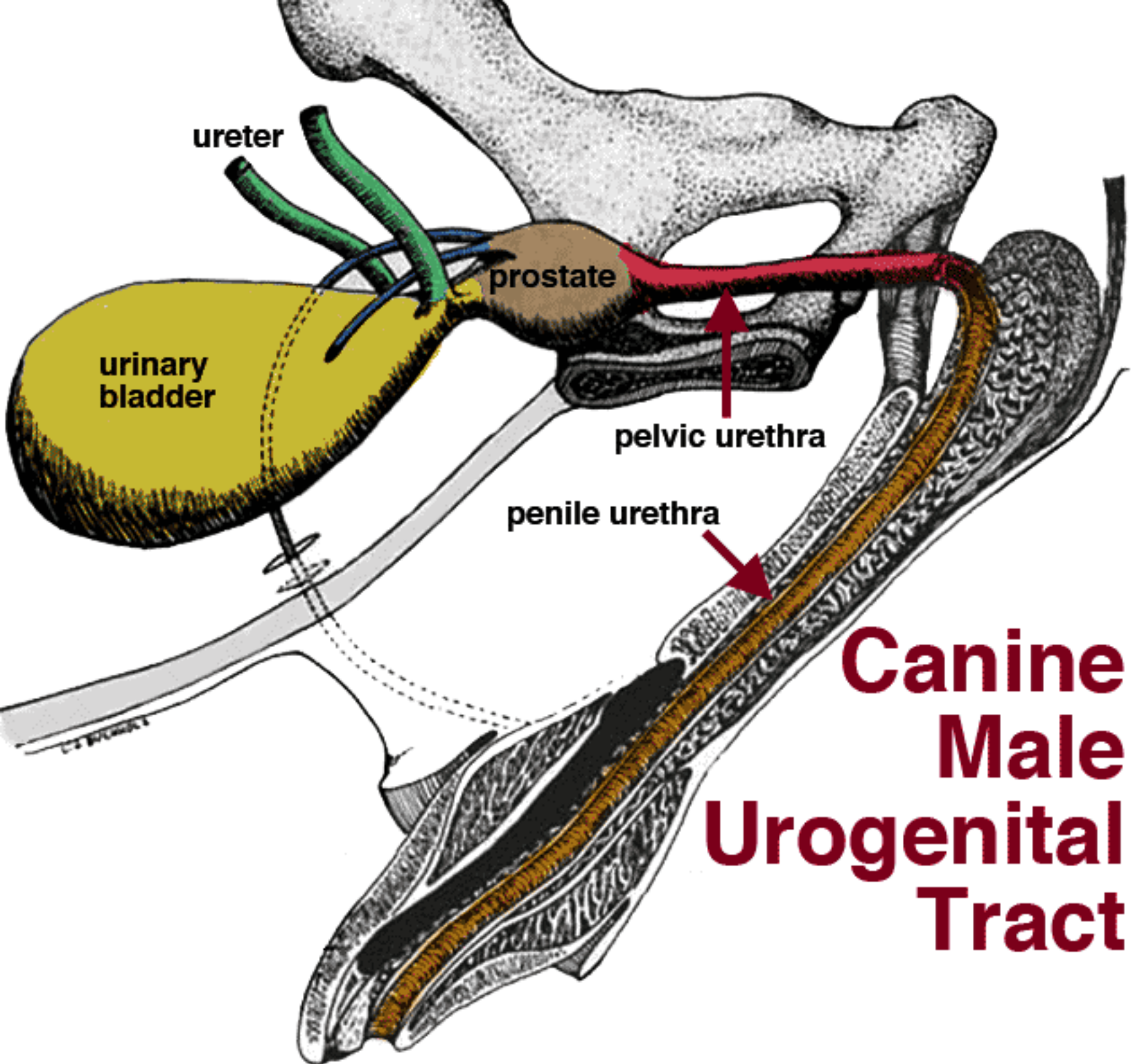
**urethralis
muscle**

vagina

urethra

**constrictor
vulvae & vestibulae**

pelvic symphysis



ureter

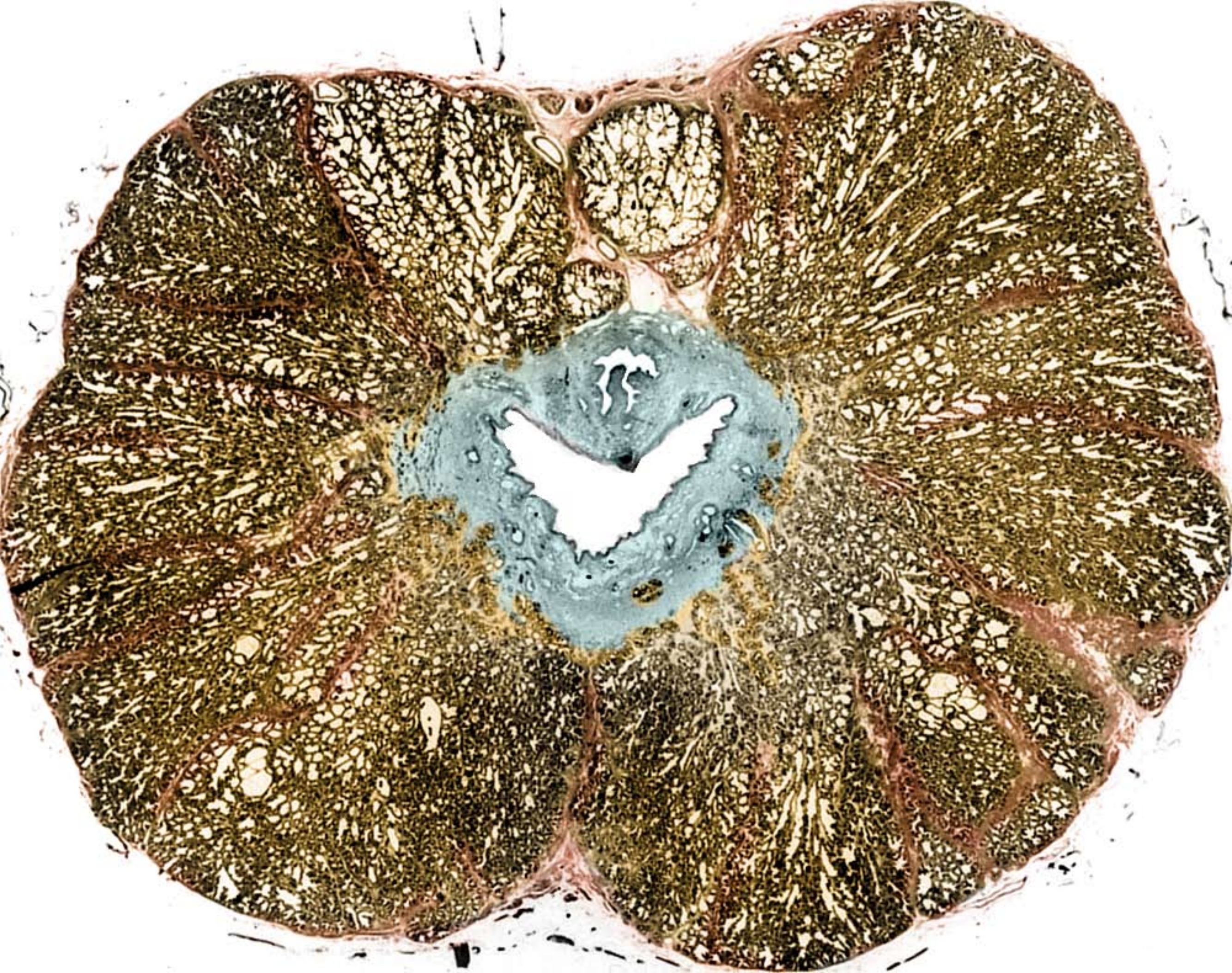
urinary bladder

prostate

pelvic urethra

penile urethra

**Canine
Male
Urogenital
Tract**



Embryonic development of the LUT:

**What is the embryonic origin of the
LUT?**

— what embryonic anomalies can you list?

Embryonic development of the LUT:

What is the embryonic origin of the LUT?

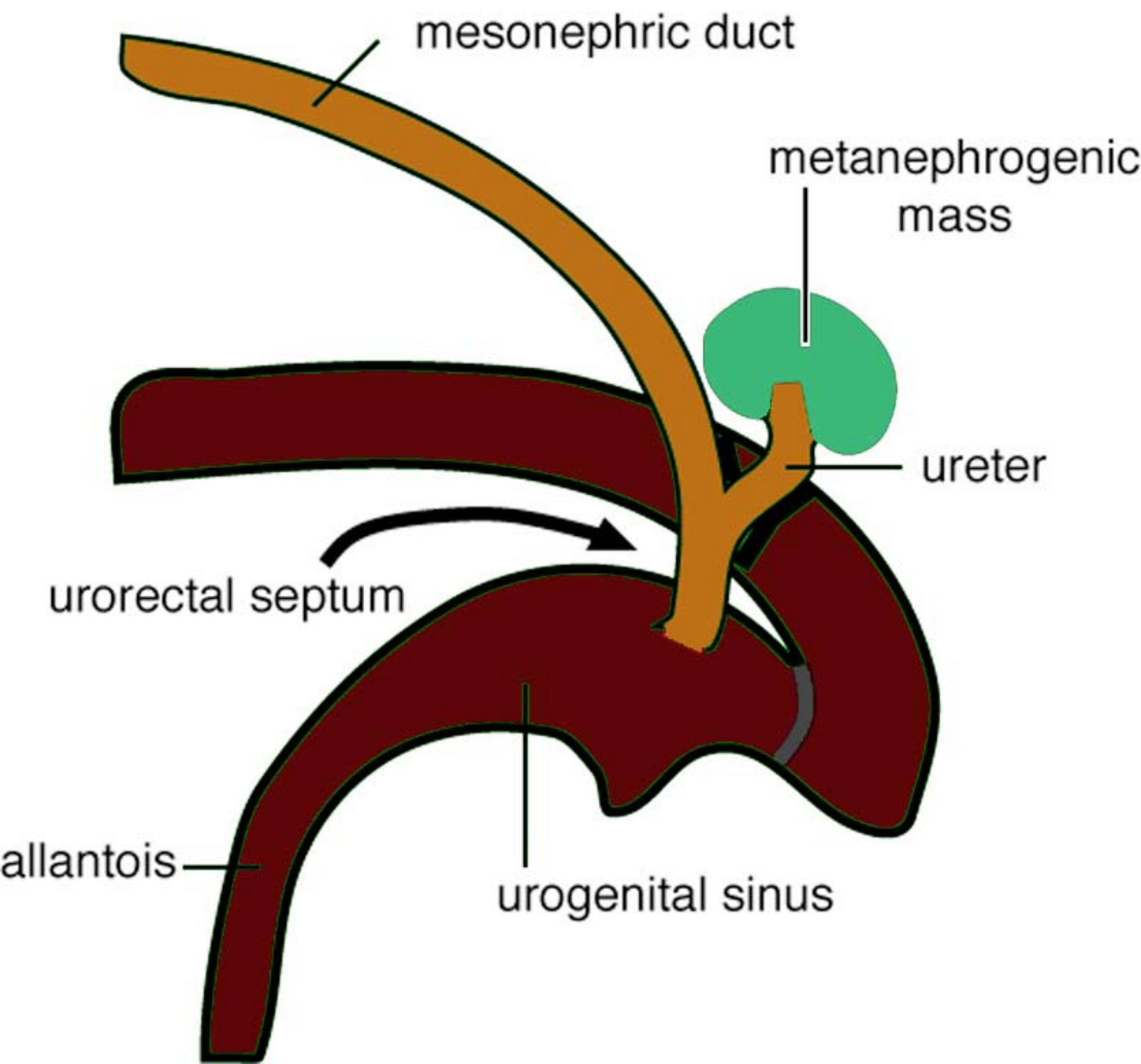
— what embryonic anomalies can you list?

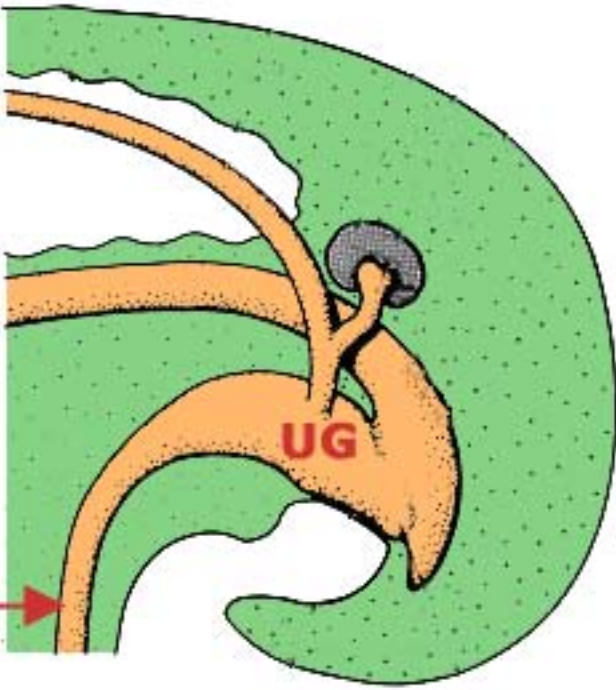
ectopic ureter

patent urachus (urachal fistula; vesico-urachal diverticulum)

hypospadias

urethrorectal fistula





allantois →

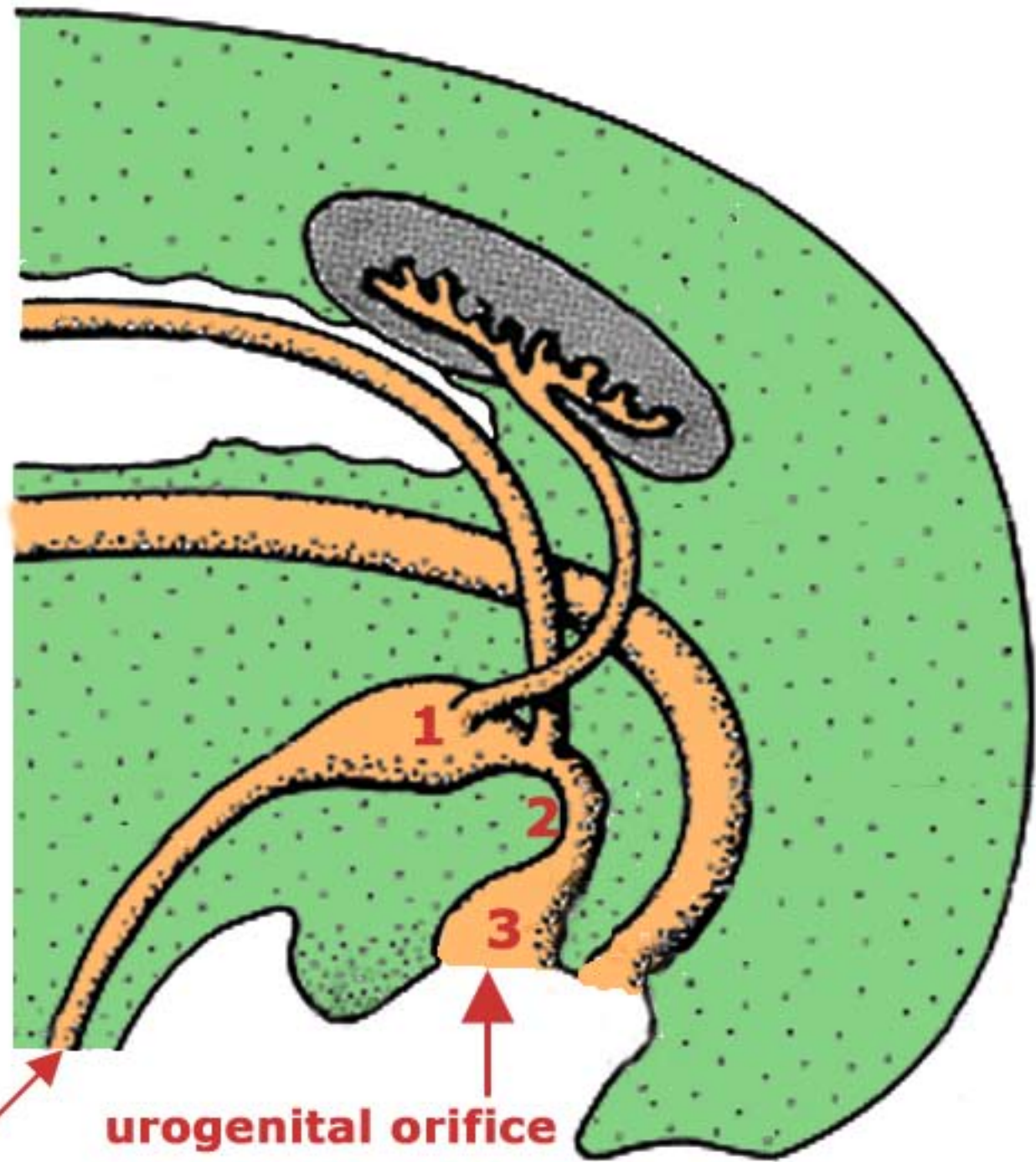
UG

Urogenital Sinus (UG)
Male

- 1. urinary bladder
- 2. pelvic urethra
- 3. penile urethra

Female

- urinary bladder
- urethra
- vestibule



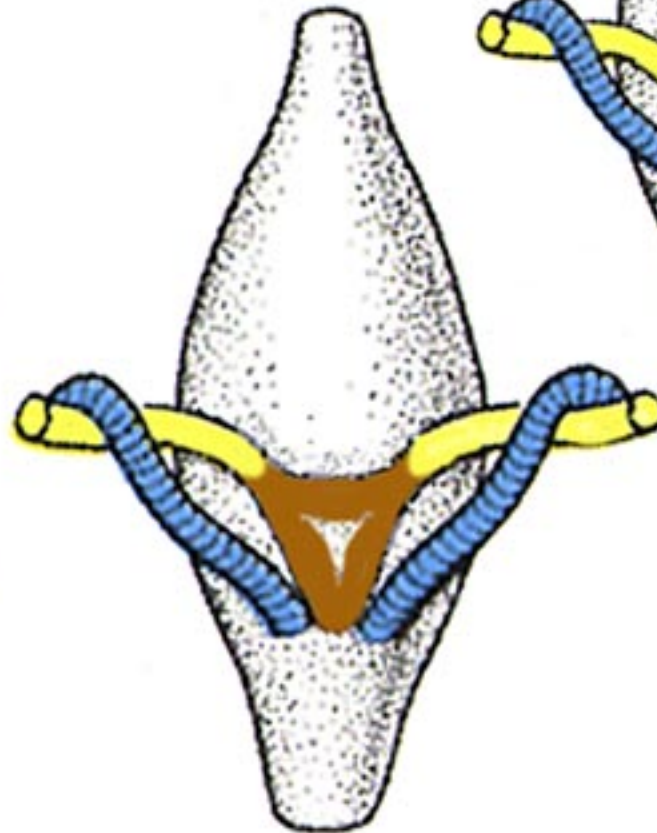
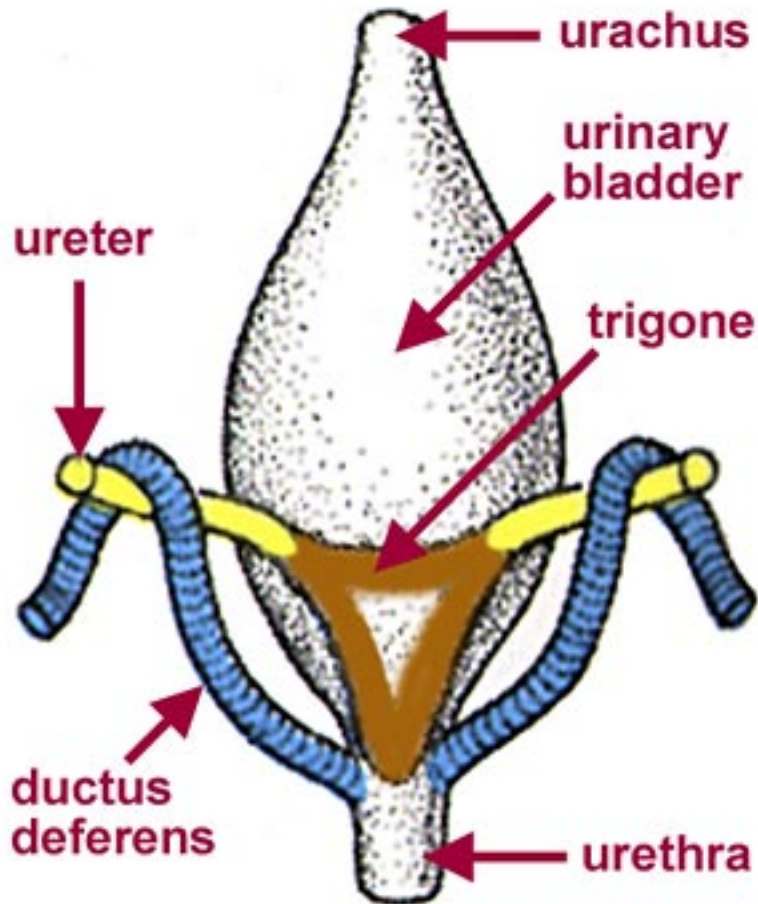
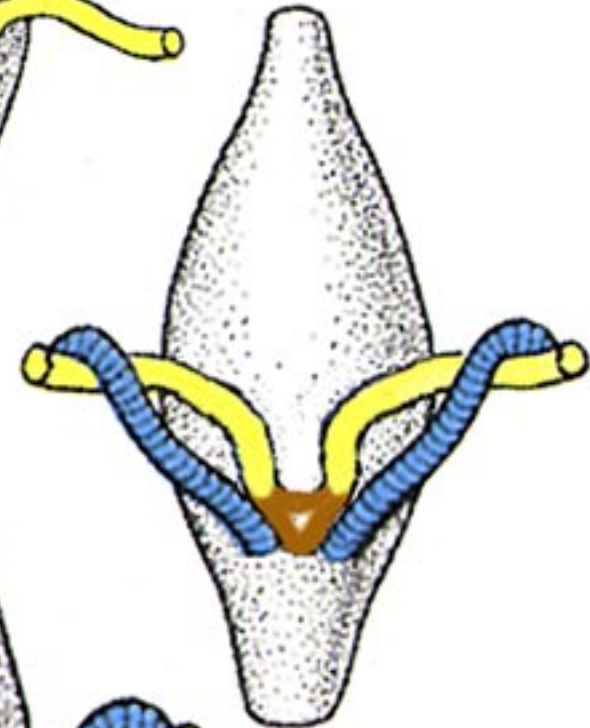
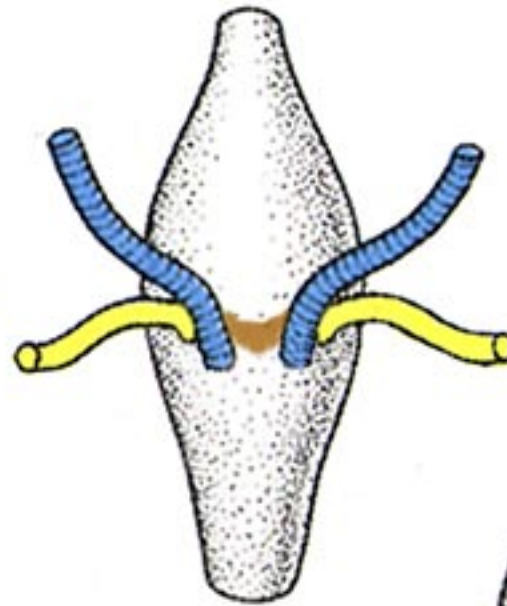
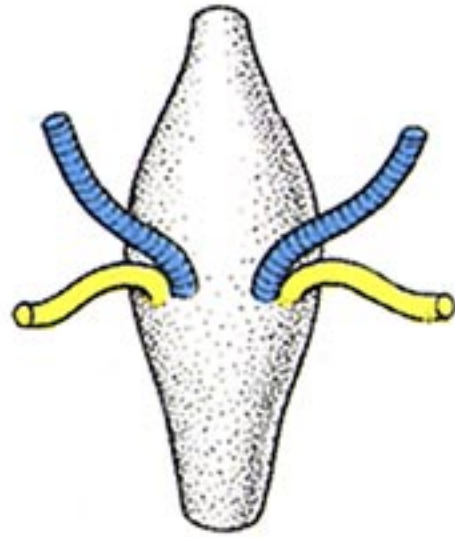
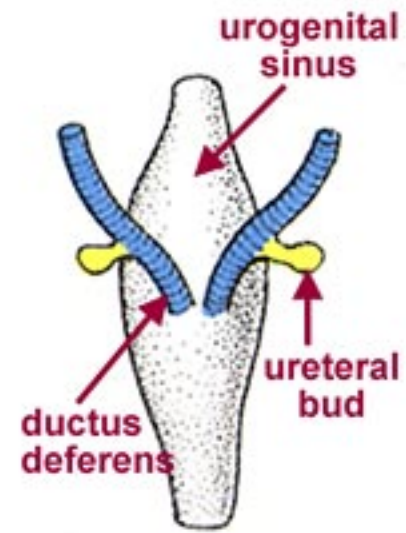
urachus →

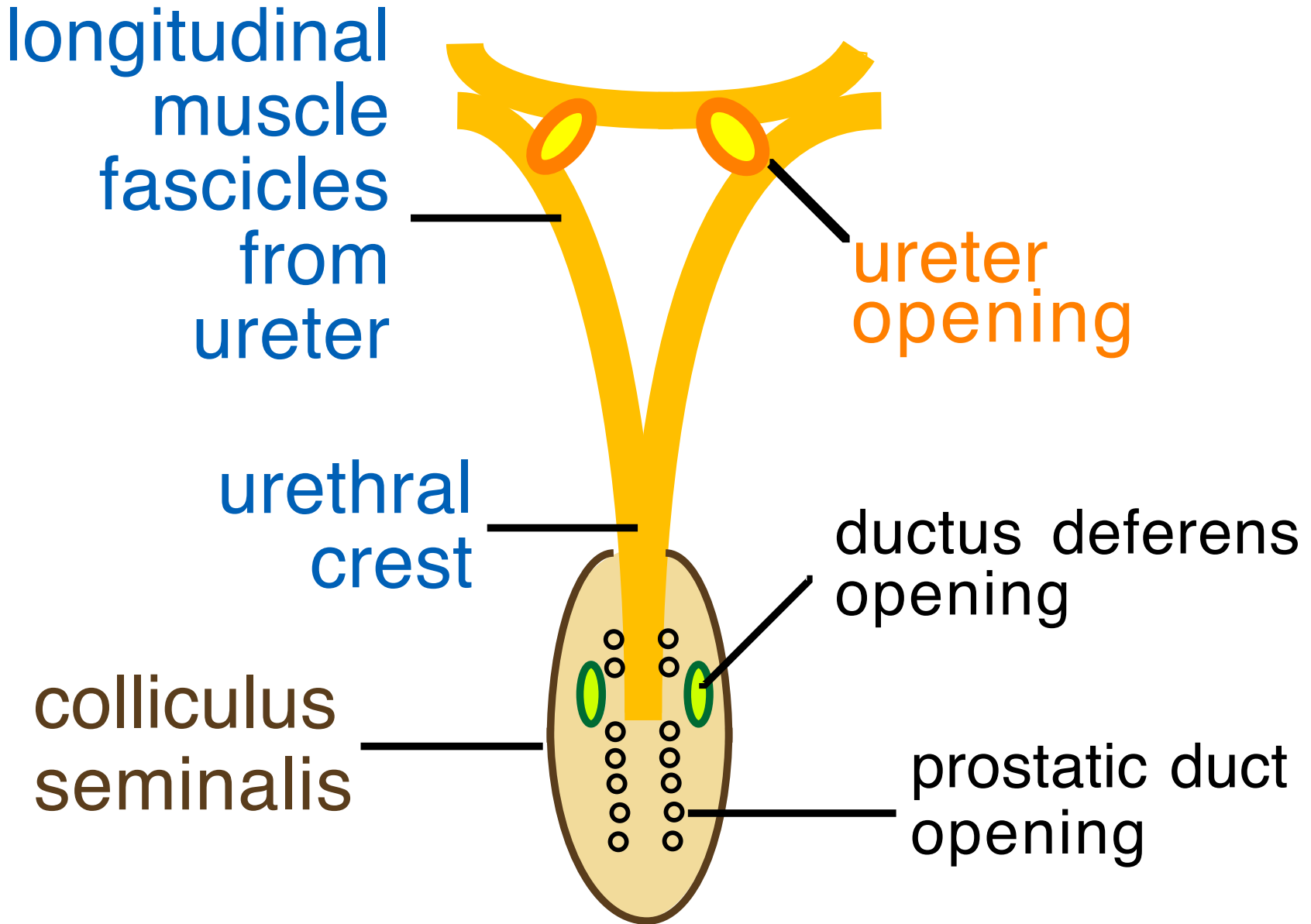
1

2

3

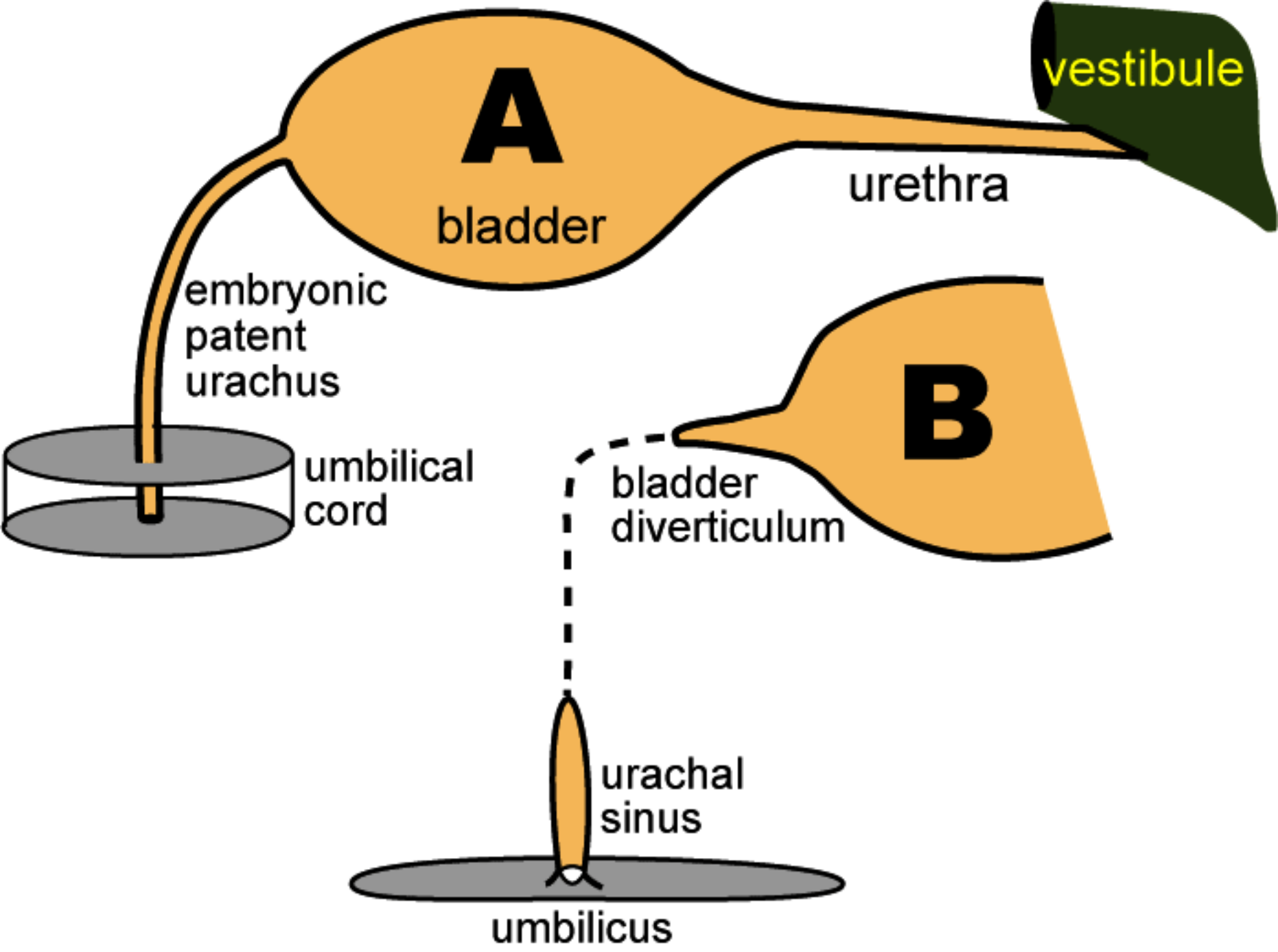
urogenital orifice

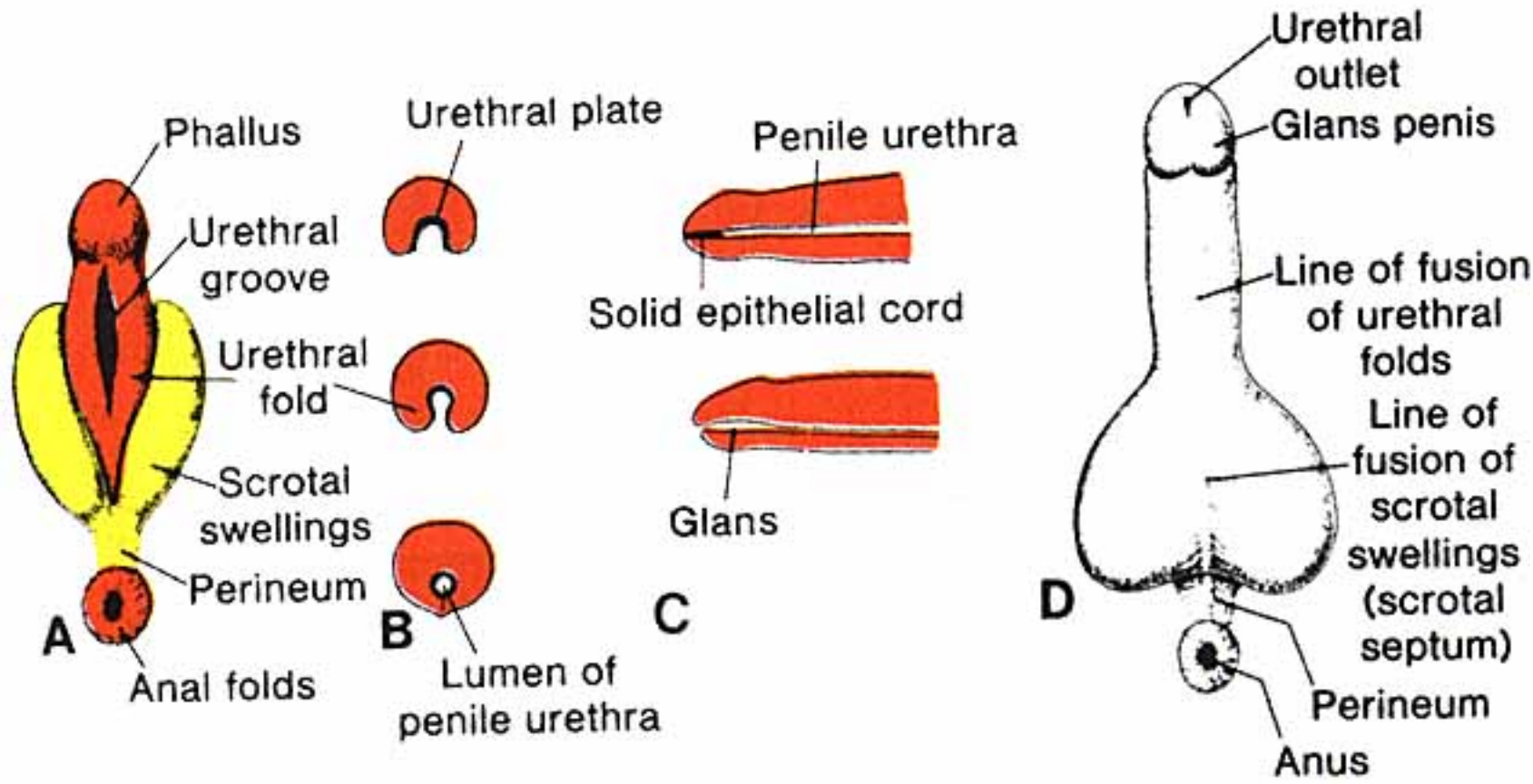
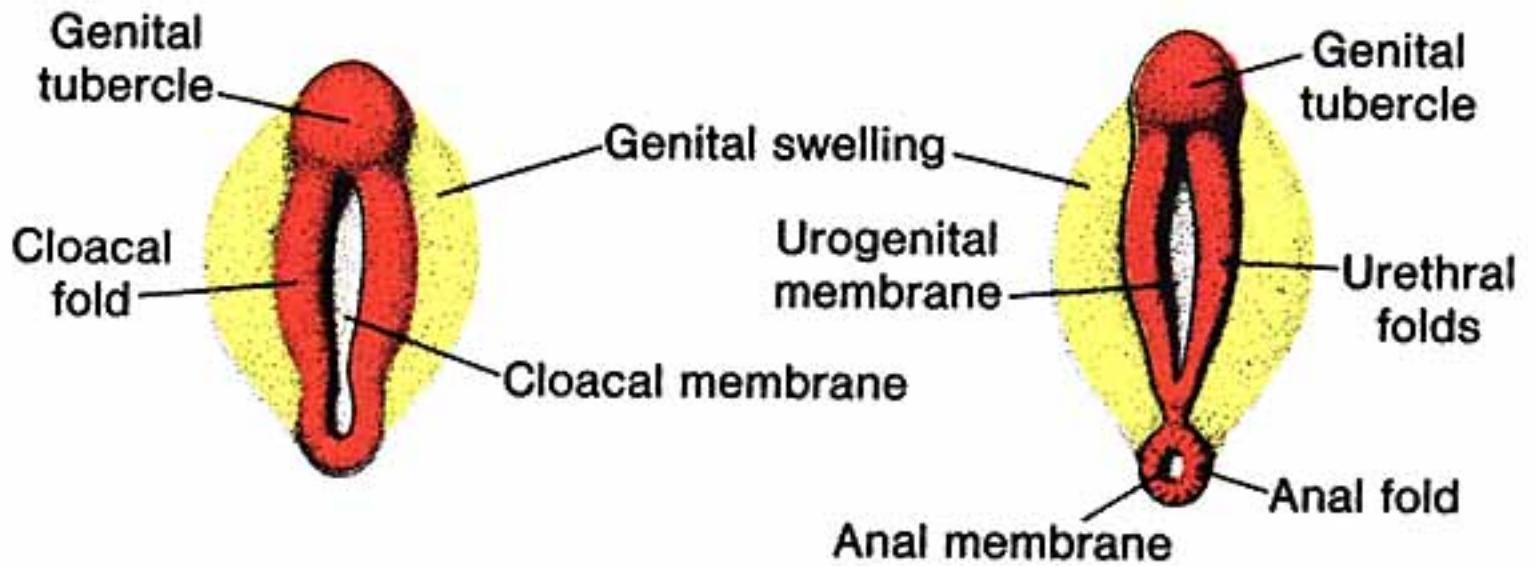


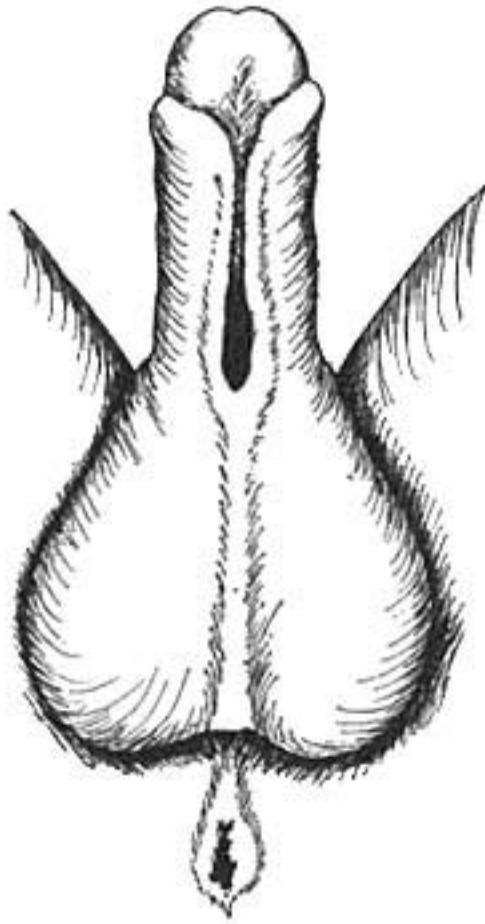
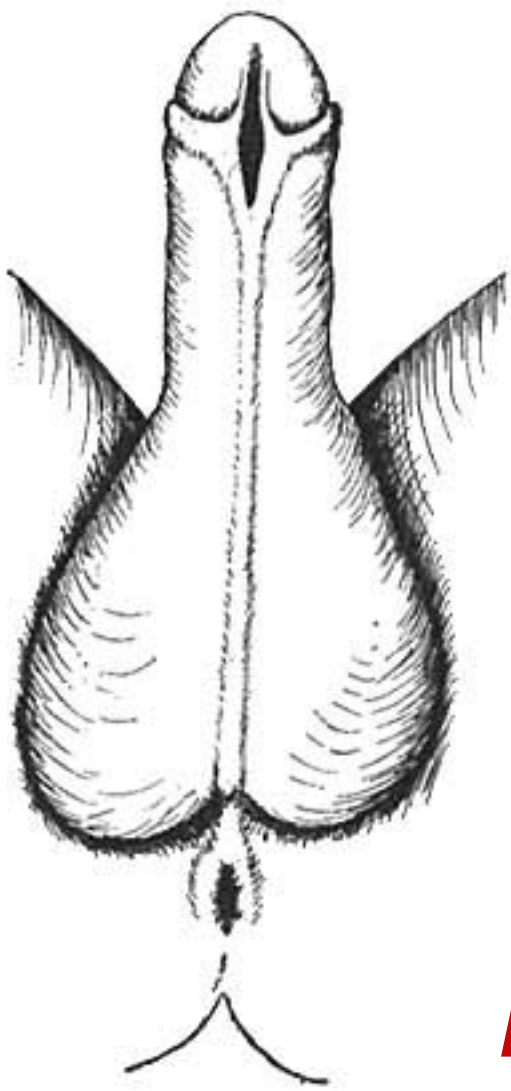


TRIGONE

(internal dorsal wall of bladder neck and prostatic urethra of male dog)







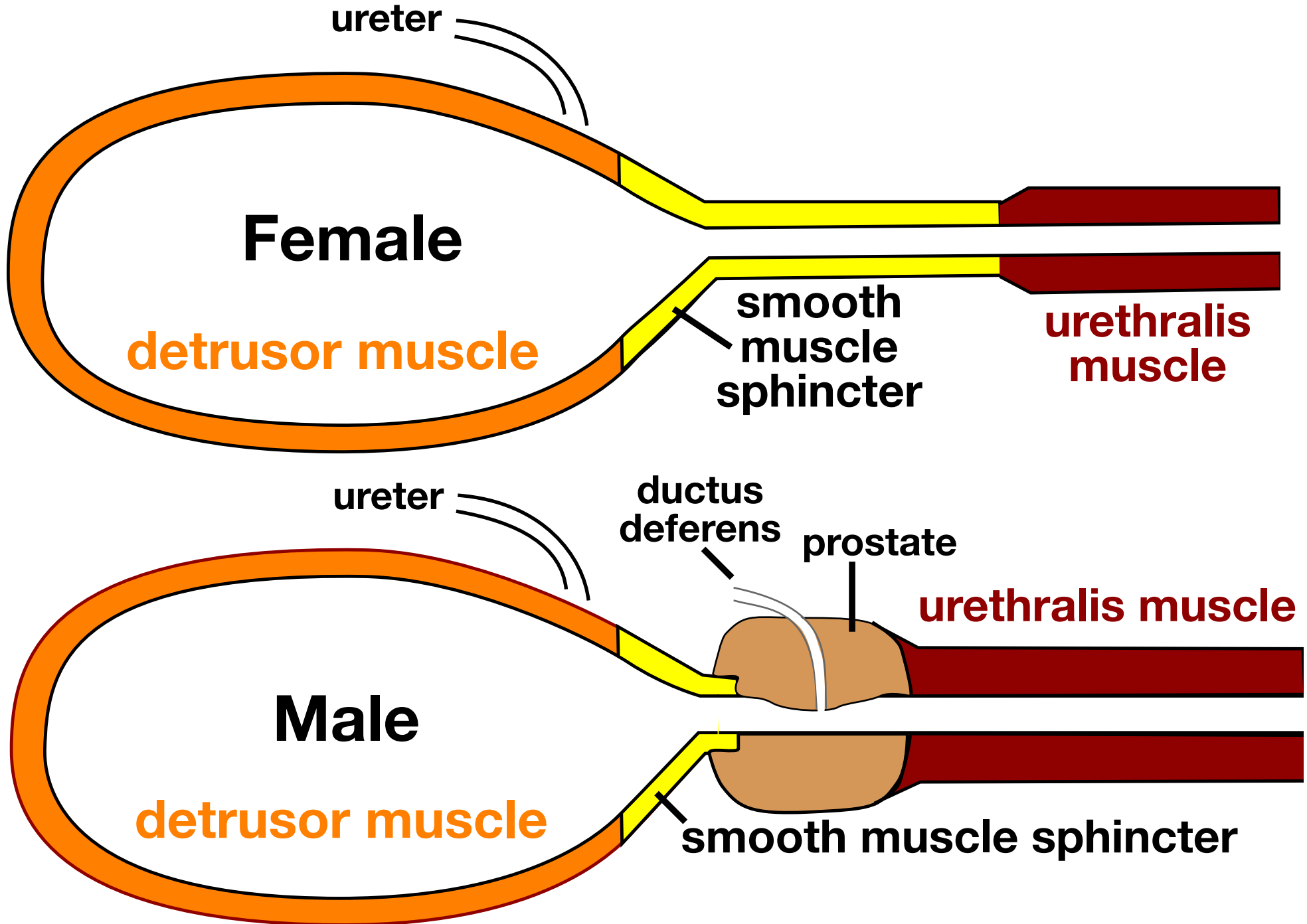
Hypospadias

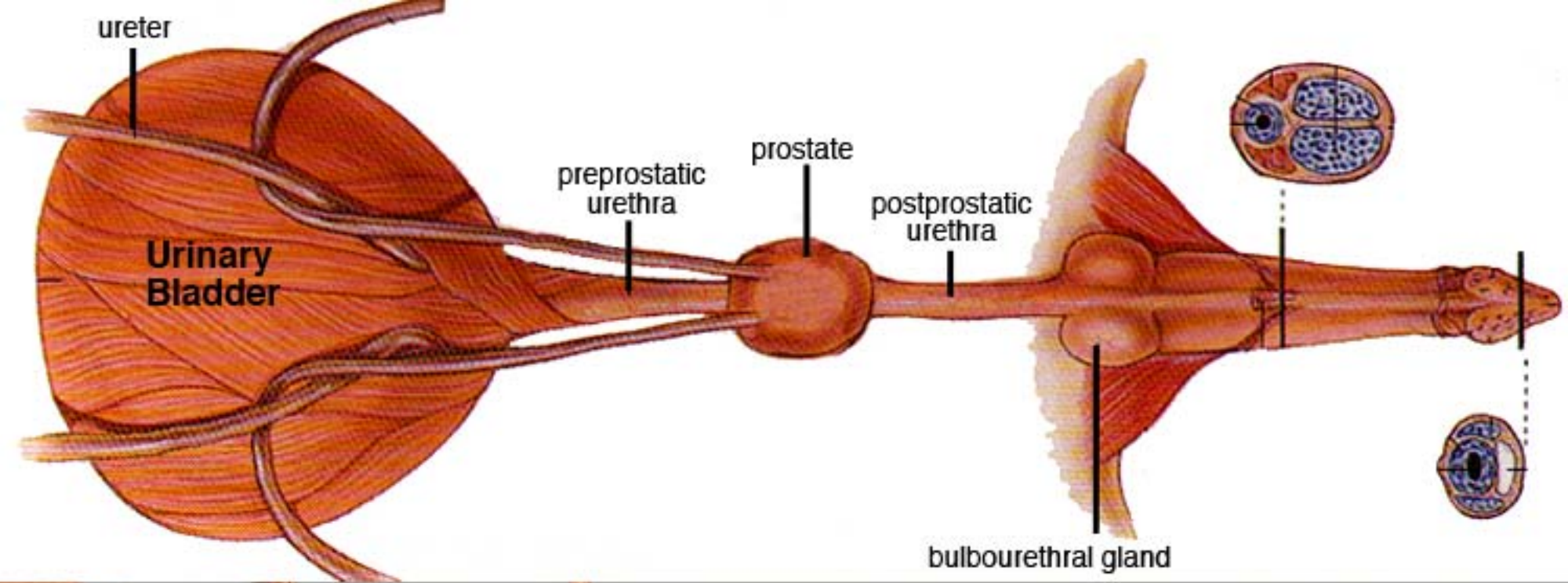
LUT functional units:

**What are the three functionally
distinct components of the LUT?**

— how do functional units relate to LUT anatomy?

Canine Lower Urinary Tract



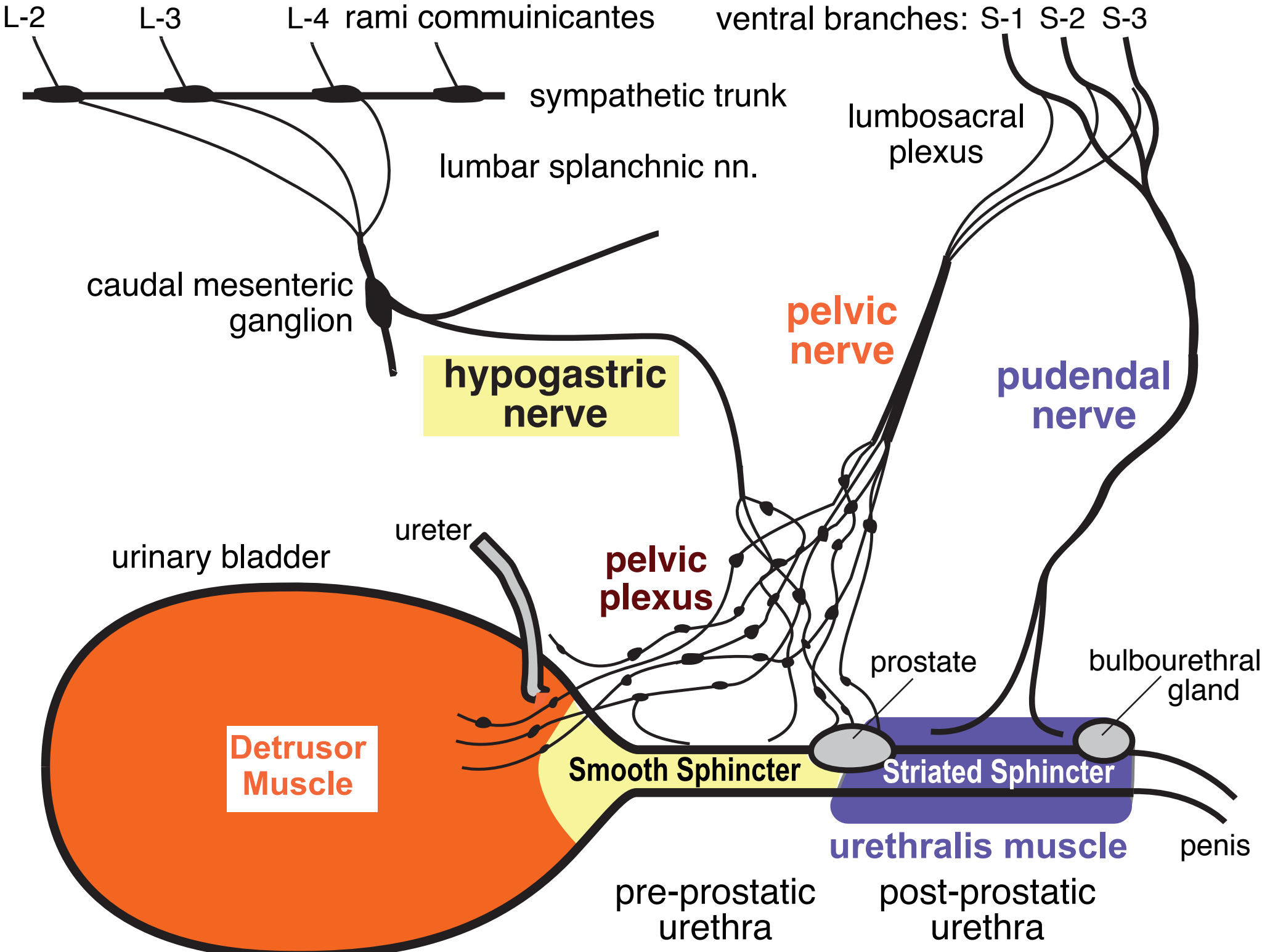


LUT efferent & afferent peripheral innervation:

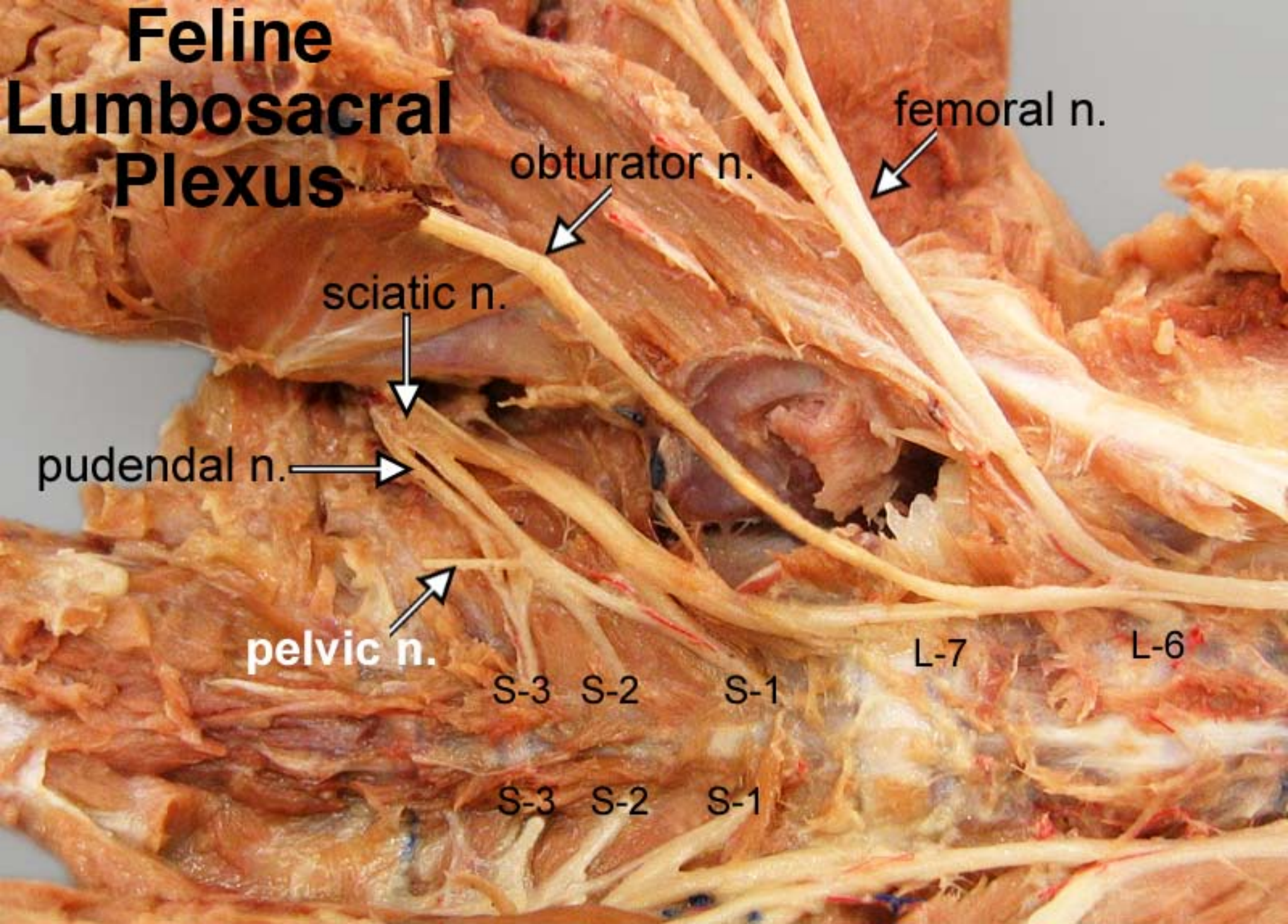
In terms of the spinal origin and the major peripheral nerve, can you describe efferent innervation to each of the three LUT functional units?

— how about the afferent innervation?

Male Cat Lower Urinary Tract Innervation

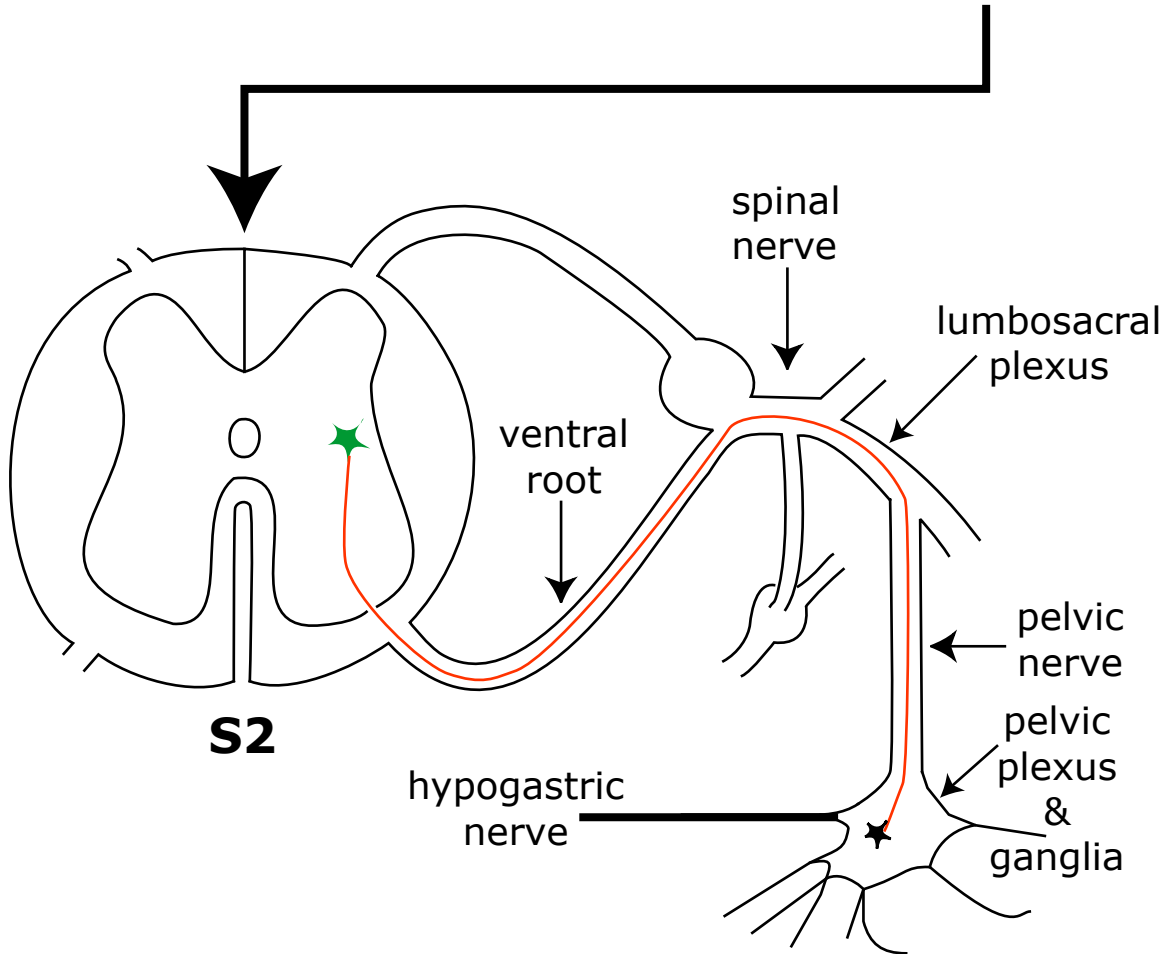


Feline Lumbosacral Plexus



Spinal Cord

S1 – S3



right
hypogastric
nerve

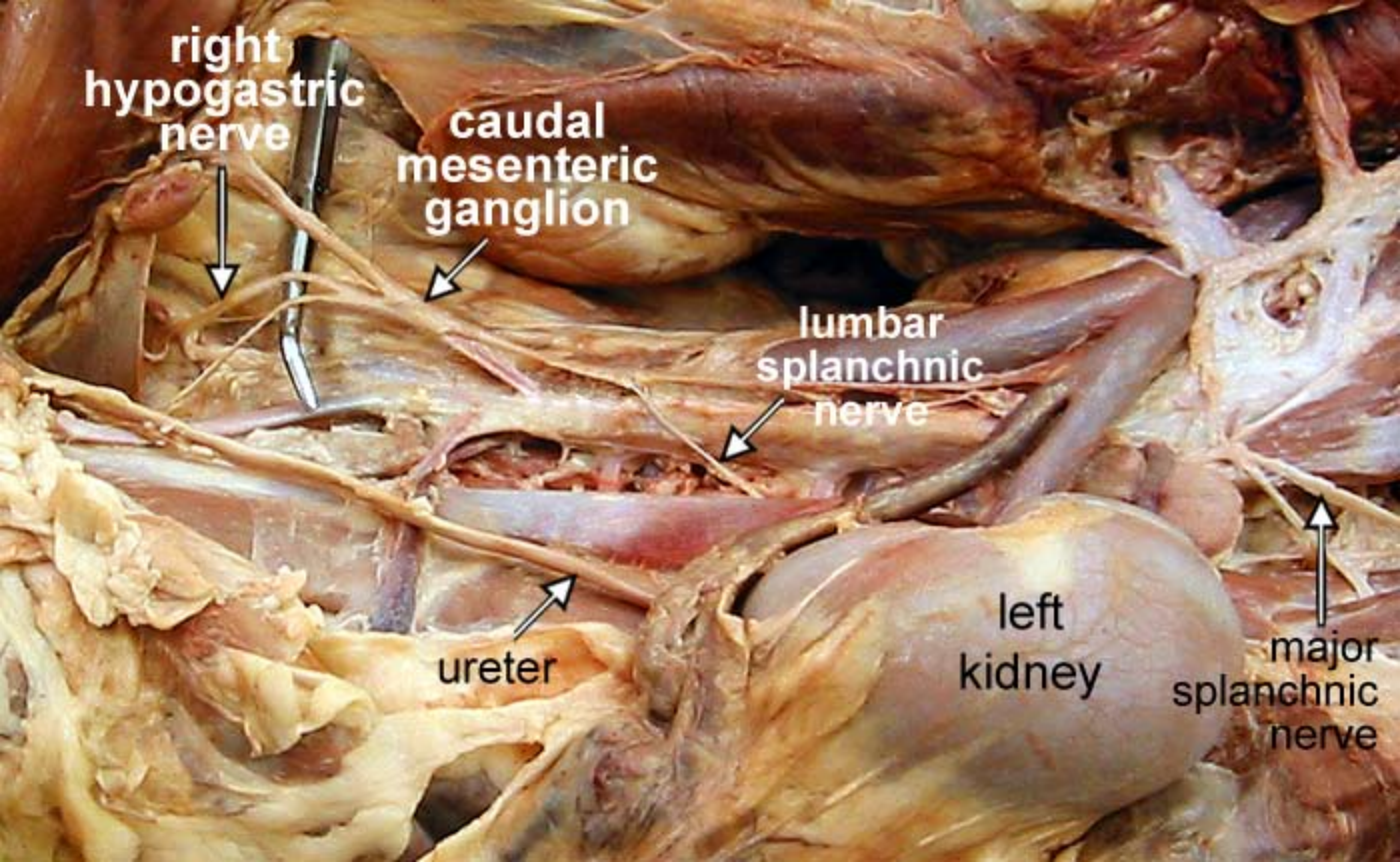
caudal
mesenteric
ganglion

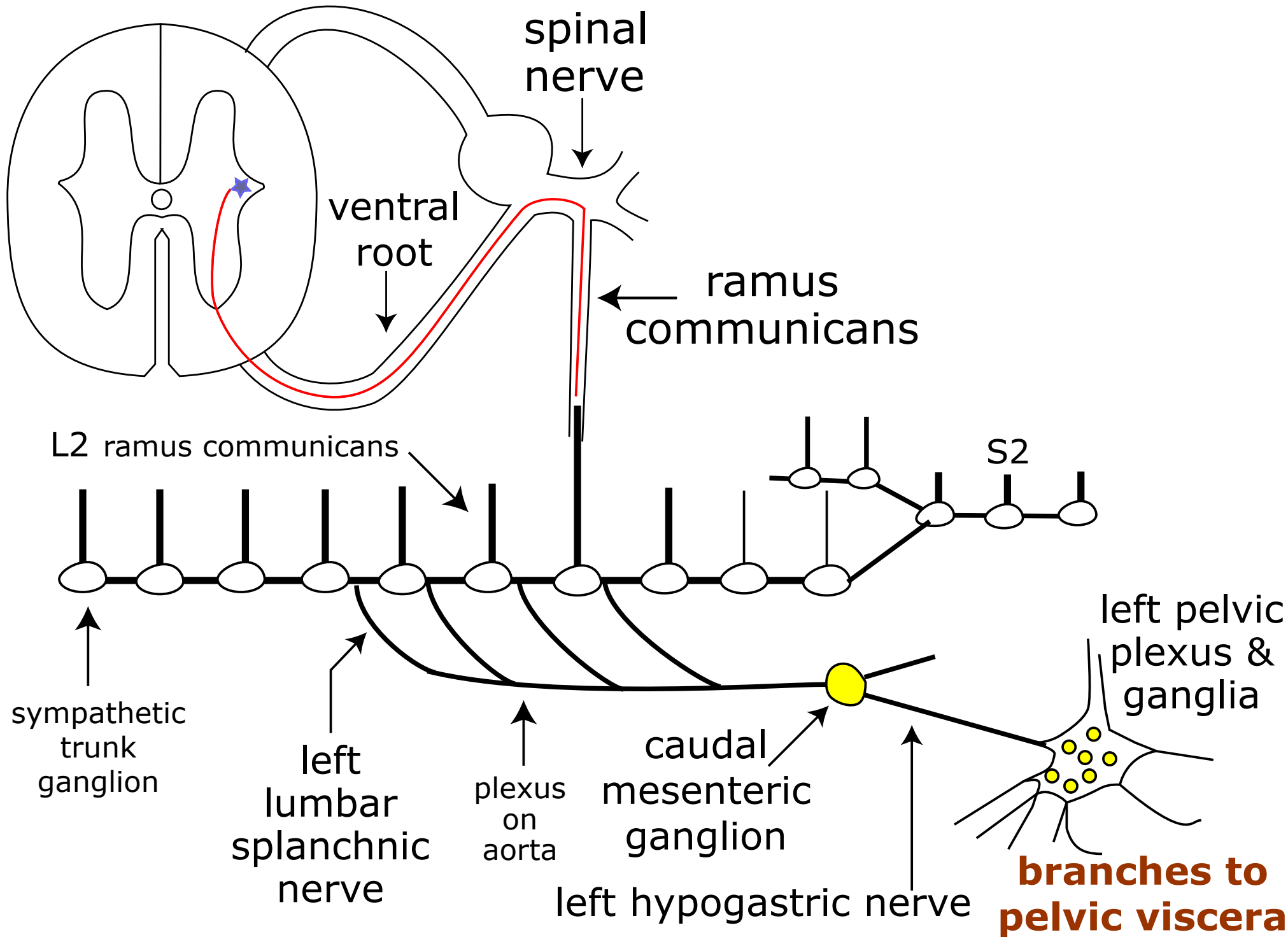
lumbar
splanchnic
nerve

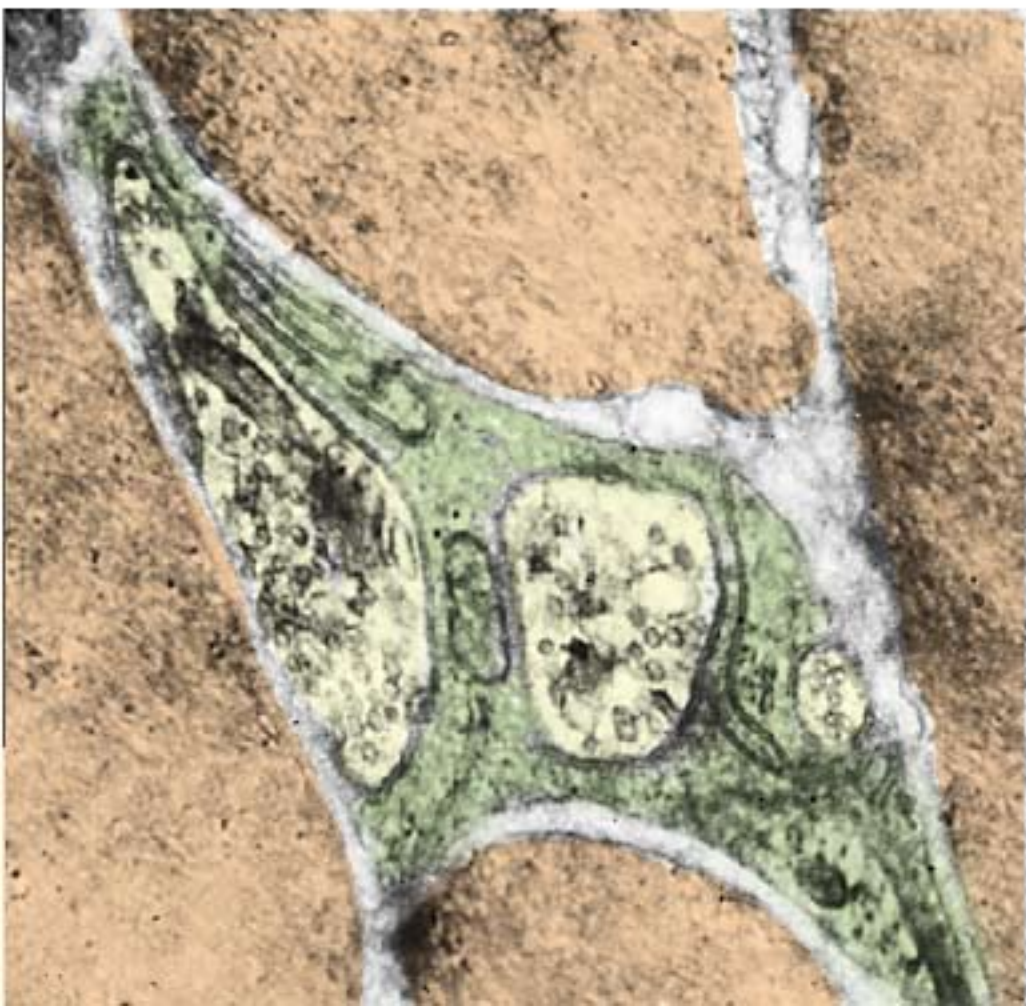
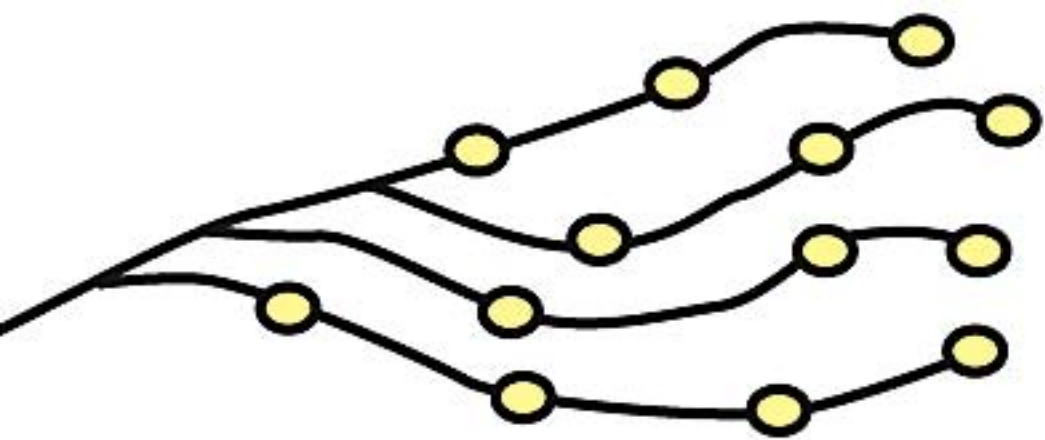
ureter

left
kidney

major
splanchnic
nerve







Brain control of normal micturition:

**What brain components are involved
in normal micturition?**

**— what CNS circuitry is essential to completely
empty the bladder?**

Micturition Schema

Association Cerebral Cortex
(cognitive interpretation of situations)

Bladder Afferents
(mechanoreceptors)

- awareness
- fullness
- urgency

Limbic System
(emotional behavior)

- mating
- defending
- attacking
- etc.

FOREBRAIN
[Medial Frontal Cortex]

*To pee or not to pee !
That is the question.*

Yes

Midbrain

OK to pee

**Micturition
Center**

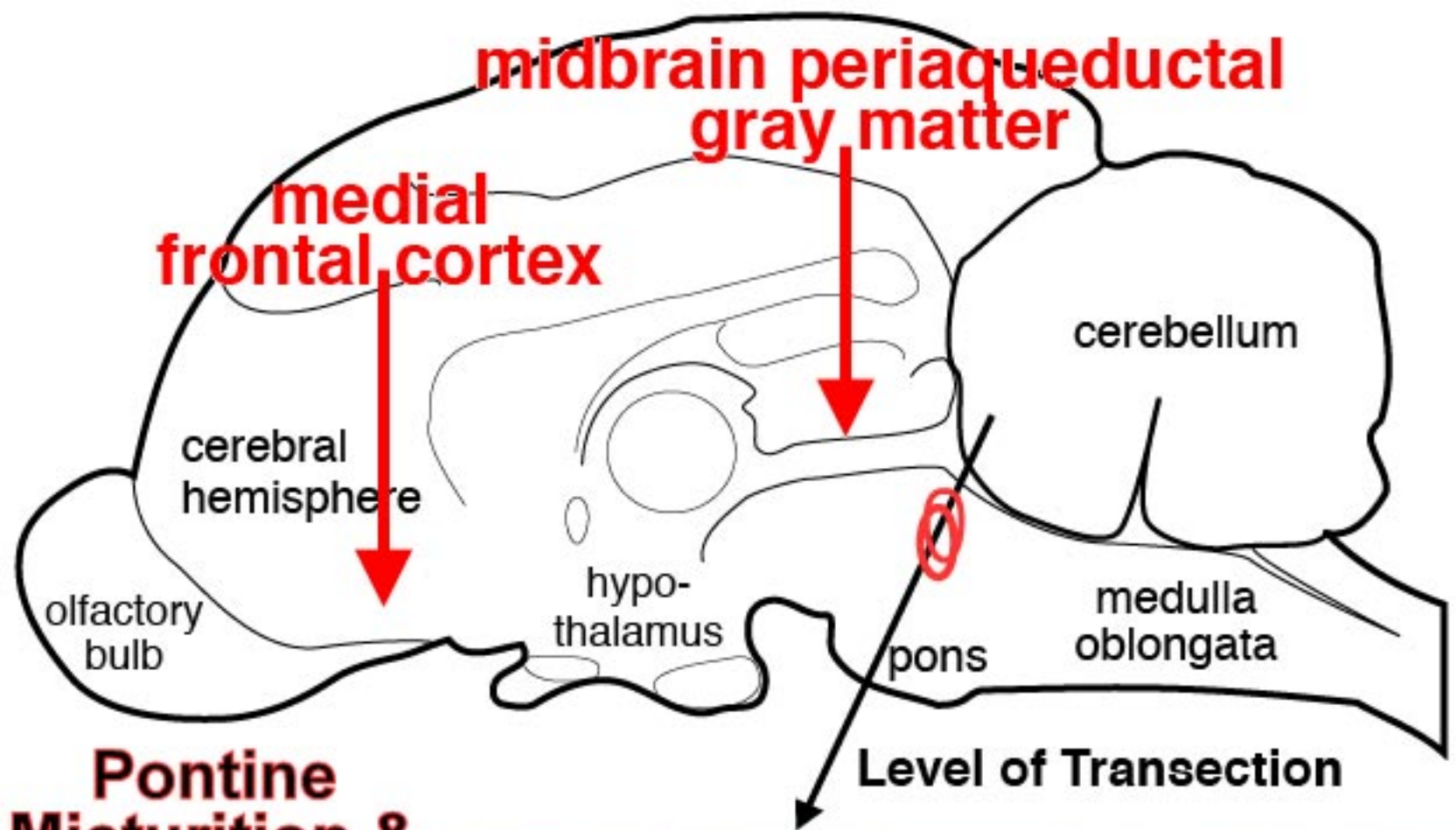
PONS

**Continenence
Center**

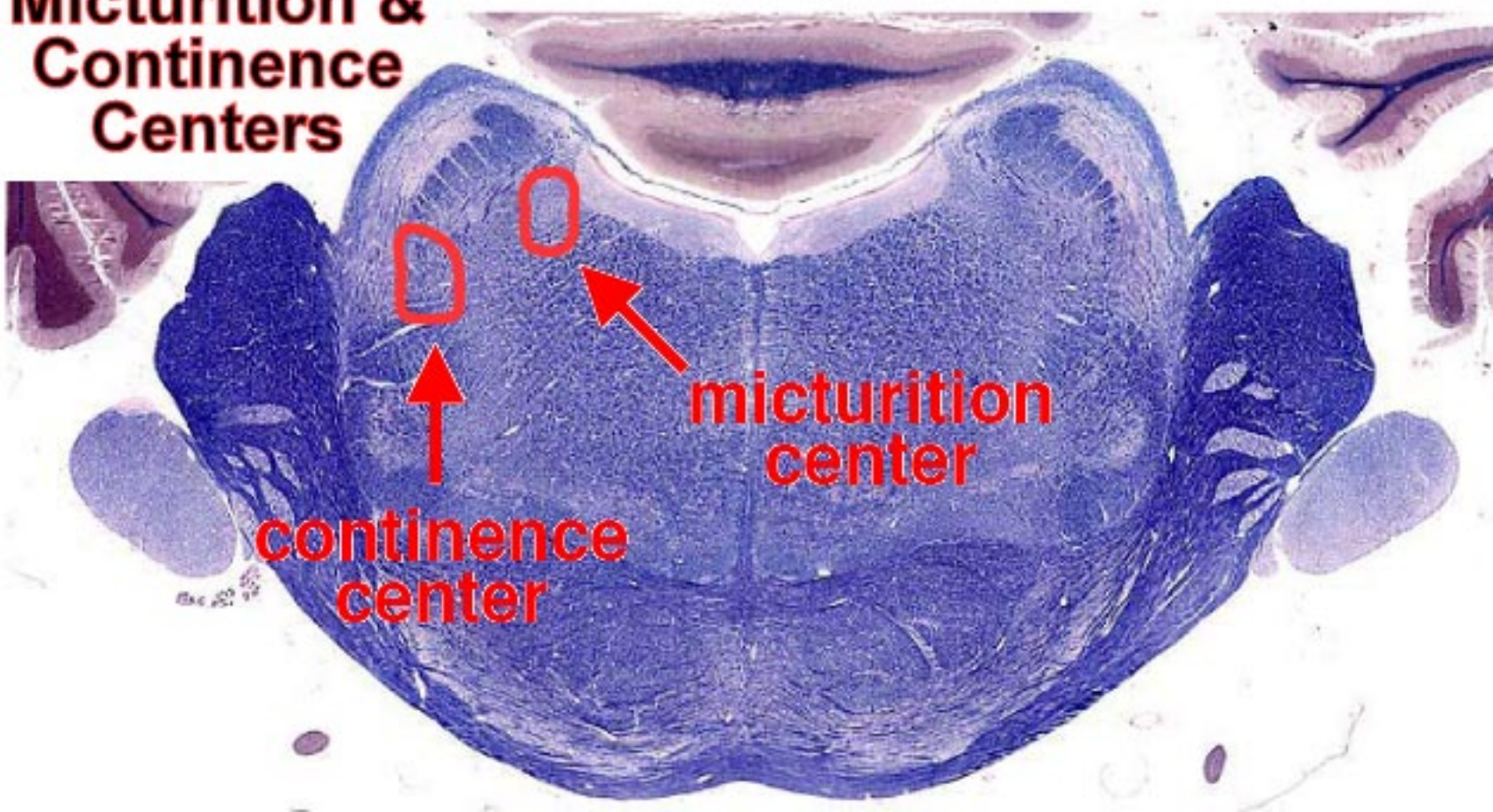
**Excite Detrusor &
Inhibit Sphincters**

Spinal Cord

**Excite Striated
Sphincter**



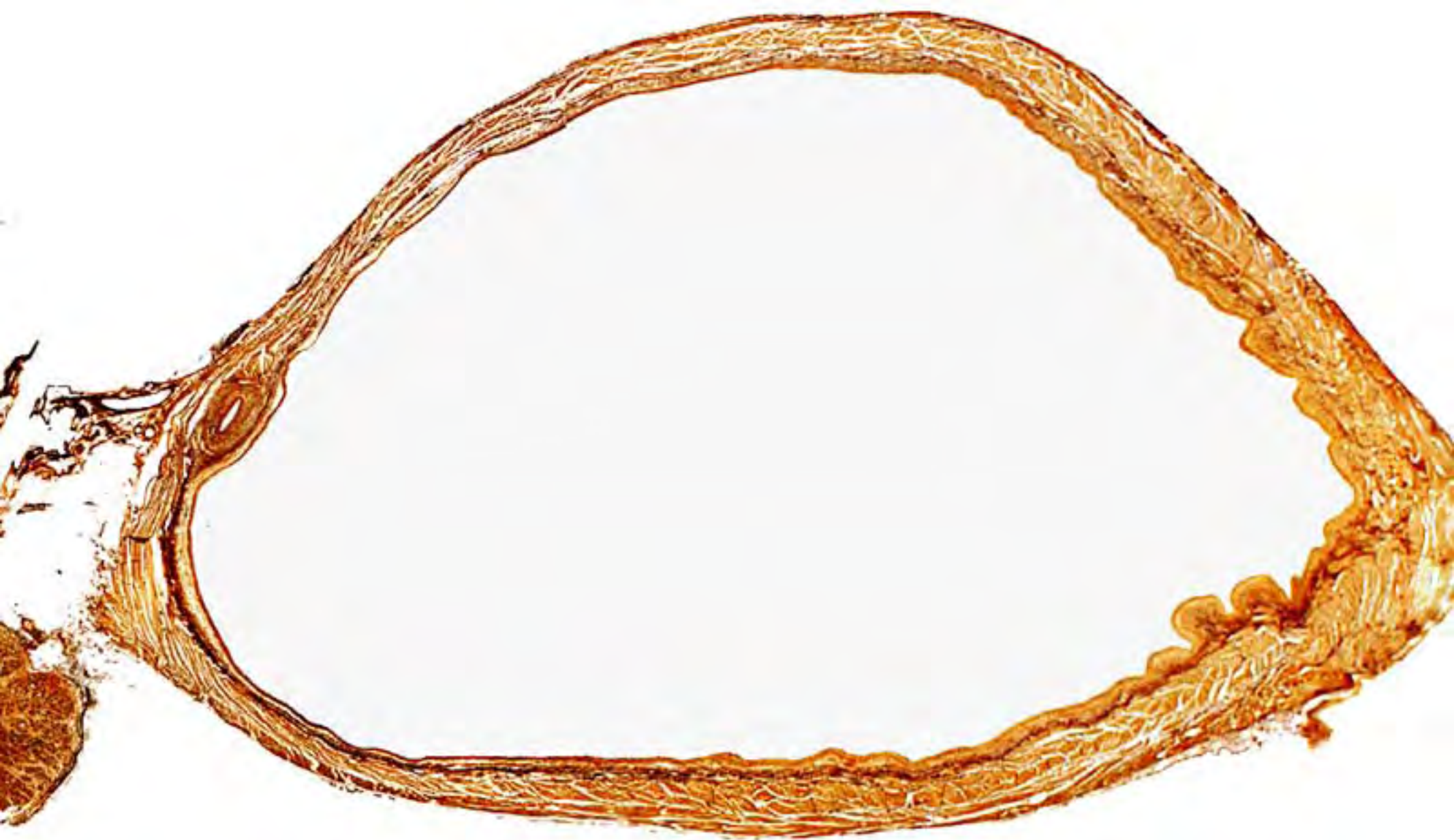
Pontine Micturition & Contenance Centers

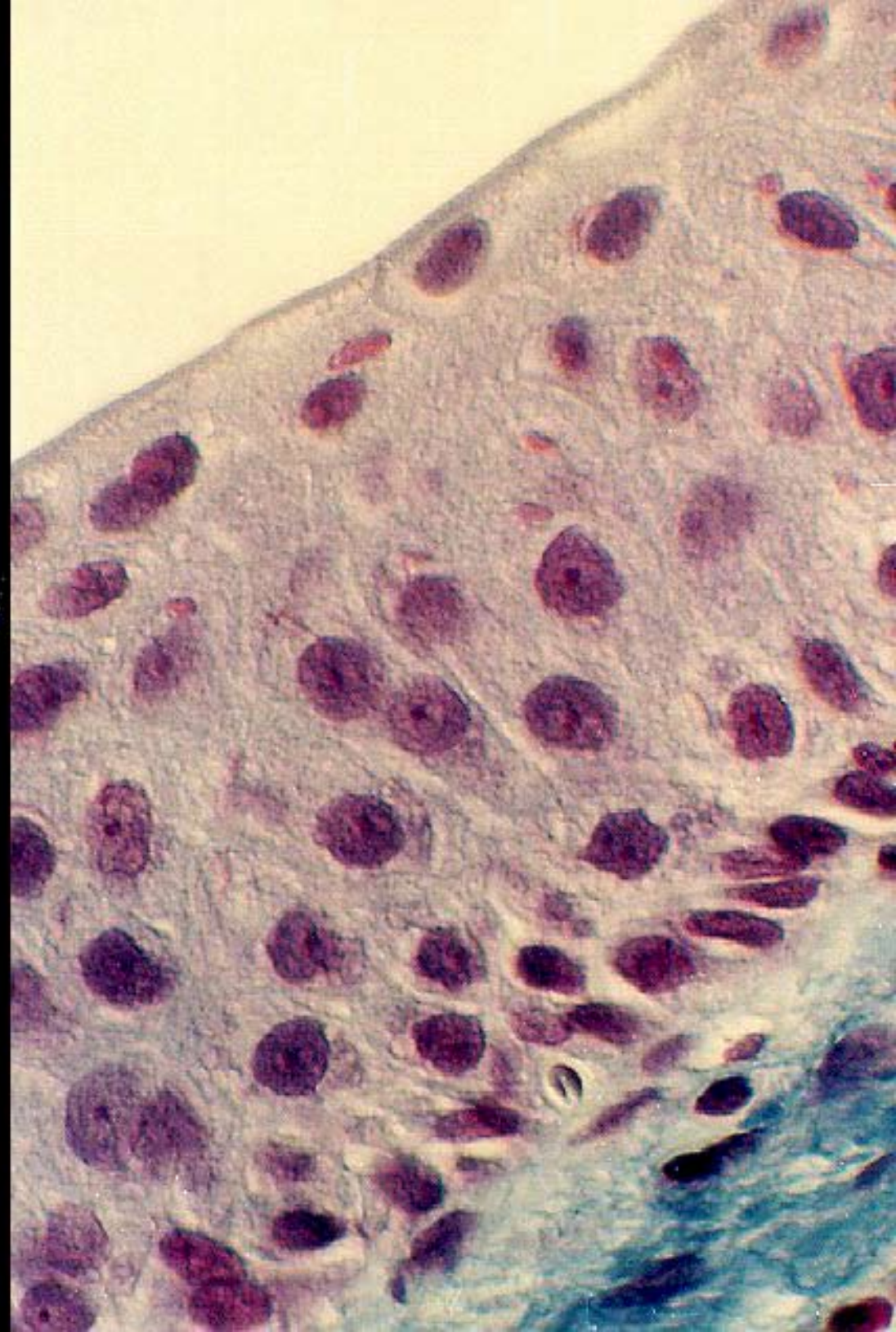
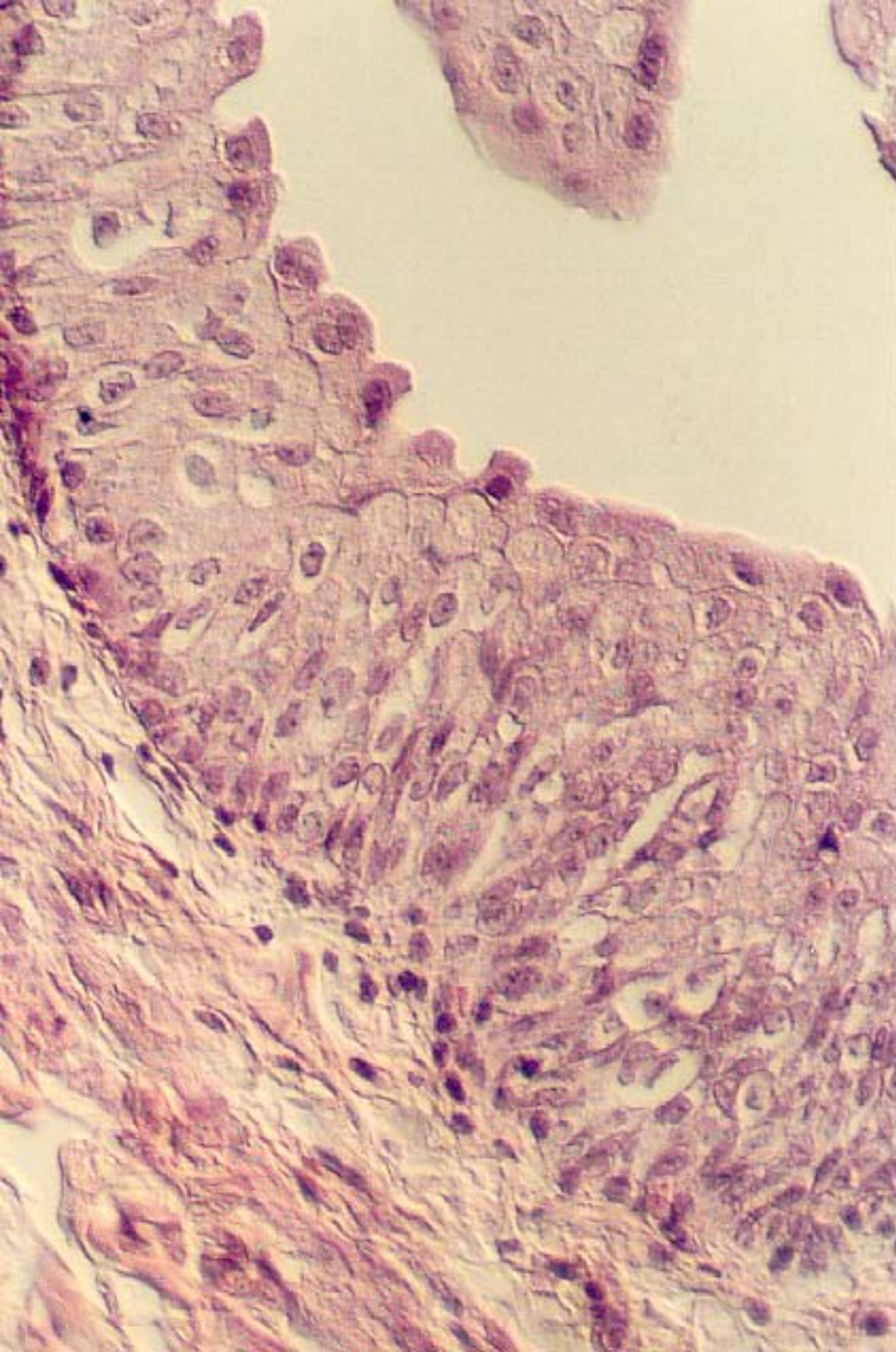


Bladder filling and compliance:

What is bladder compliance and what is the histological explanation for compliance and its limitation?

— how is compliance measured clinically?





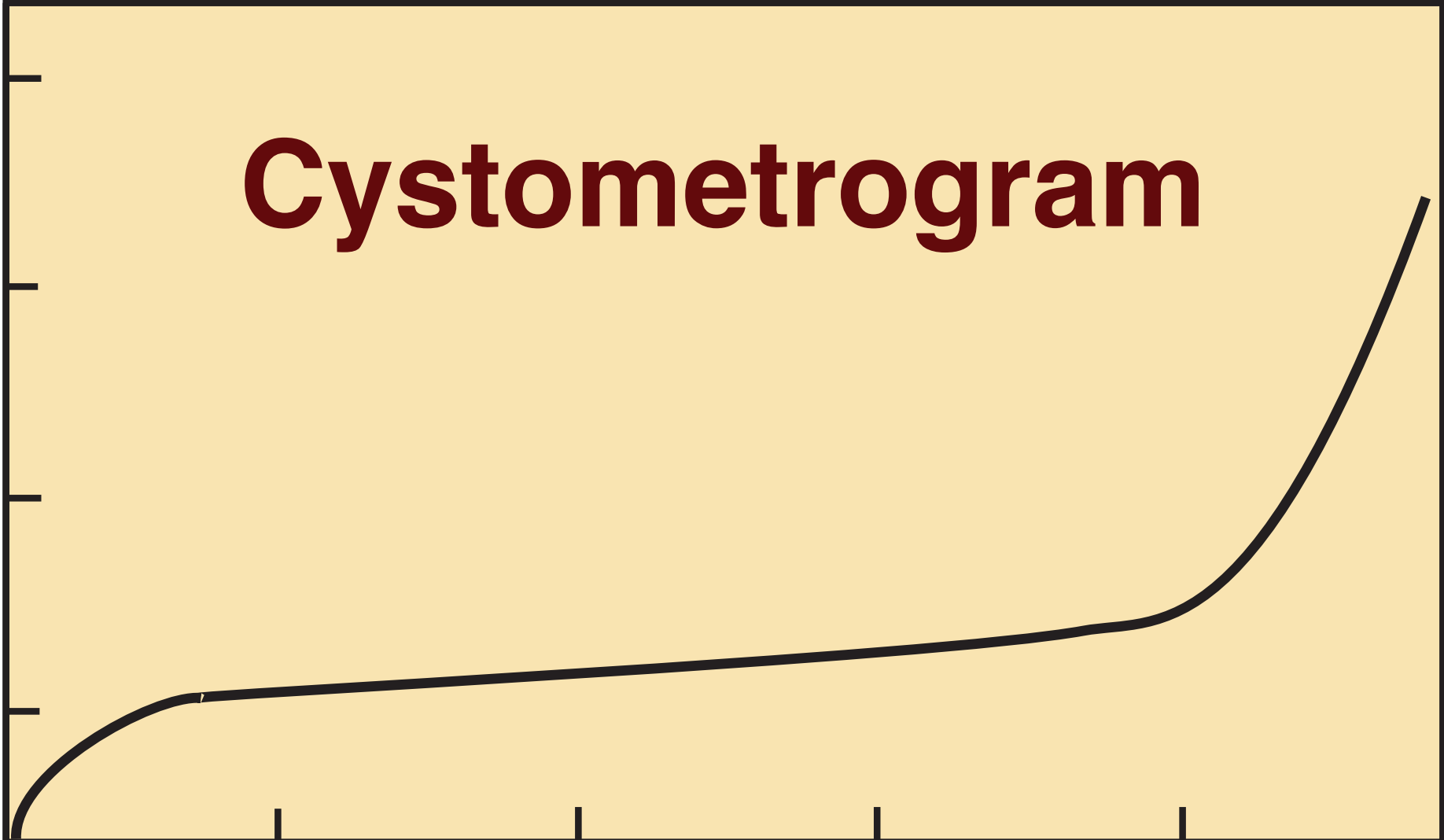
Cystometrogram

Pressure (cm water)

Volume (ml)

20
15
10
5

25 50 75 100



Urine storage and continence:

What mechanisms are involved in maintaining urinary continence?

— how are continence mechanisms related to urine volume?

Continence Schema

**Low
Volume
and
Pressure**

Passive Viscoelastic Urethral Resistance

Viscoelastic properties of :

- *epithelium*
- *elastic fibers*
- *stratum spongiosum*
- *wall connective tissue*
- *muscle fascicle arrangement*
- *myocyte length*

**Volume
Near
Half-Full**

Sympathetic Spinal Reflexes:

- **Tonic contraction of smooth muscle sphincter**
- **Sympathetic inhibition of detrusor**
(triggered by mechanoreceptors in bladder wall)

**Sudden
Increased
Pressure**

Somatic Spinal Reflex: Urethralis M. Contraction

Quick contraction of striated urethral sphincter
(triggered by urine flow into the urethra)

Also, levator ani muscle contracts along with abdominal wall mm.

**Voluntary
Continence**

Voluntary Contraction of Urethralis Muscle

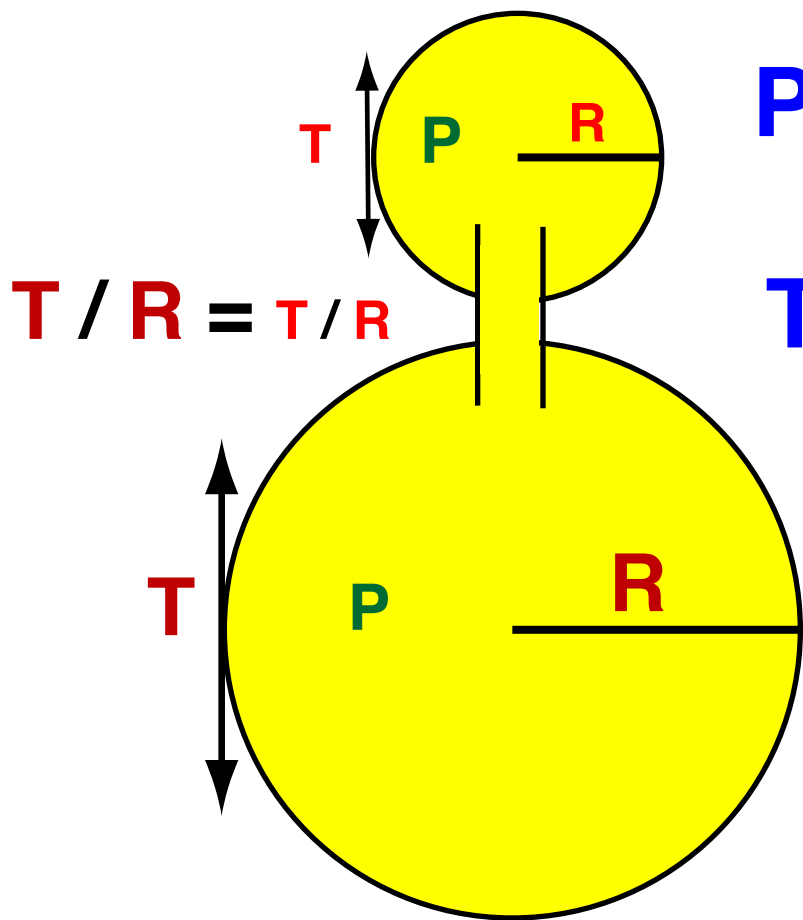
Conscious decision by the forebrain

(in response to a sense of bladder fullness,
or to abruptly stop urine flow when desired)

Physics of elastic containers:

How are wall tension, lumen volume and internal pressure related to one another for elastic spherical containers (Law of Laplace)?

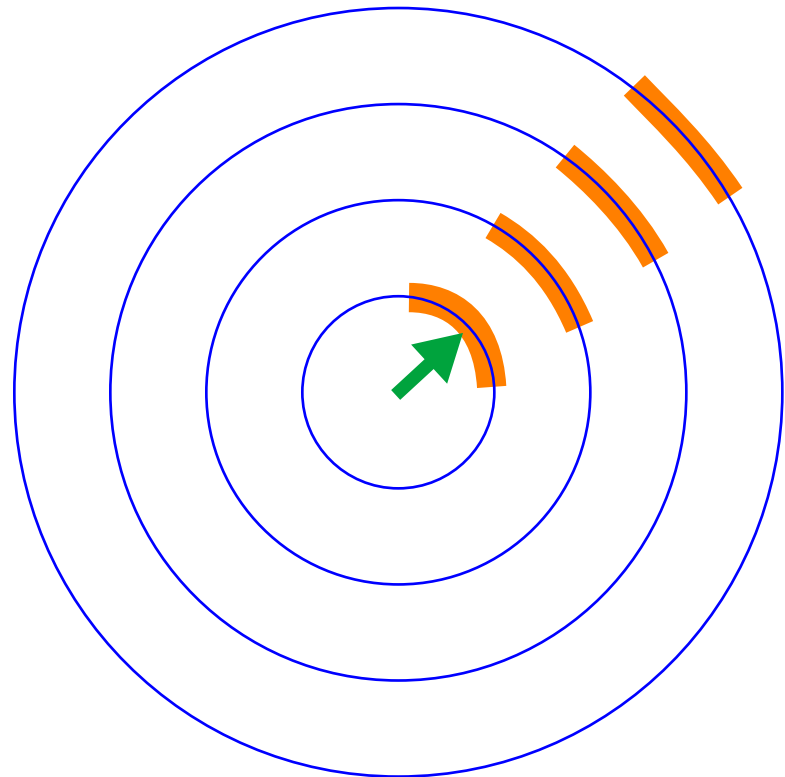
— what are the clinical implications for the urinary bladder?



$$P = T/R$$

&

$$T = P R$$

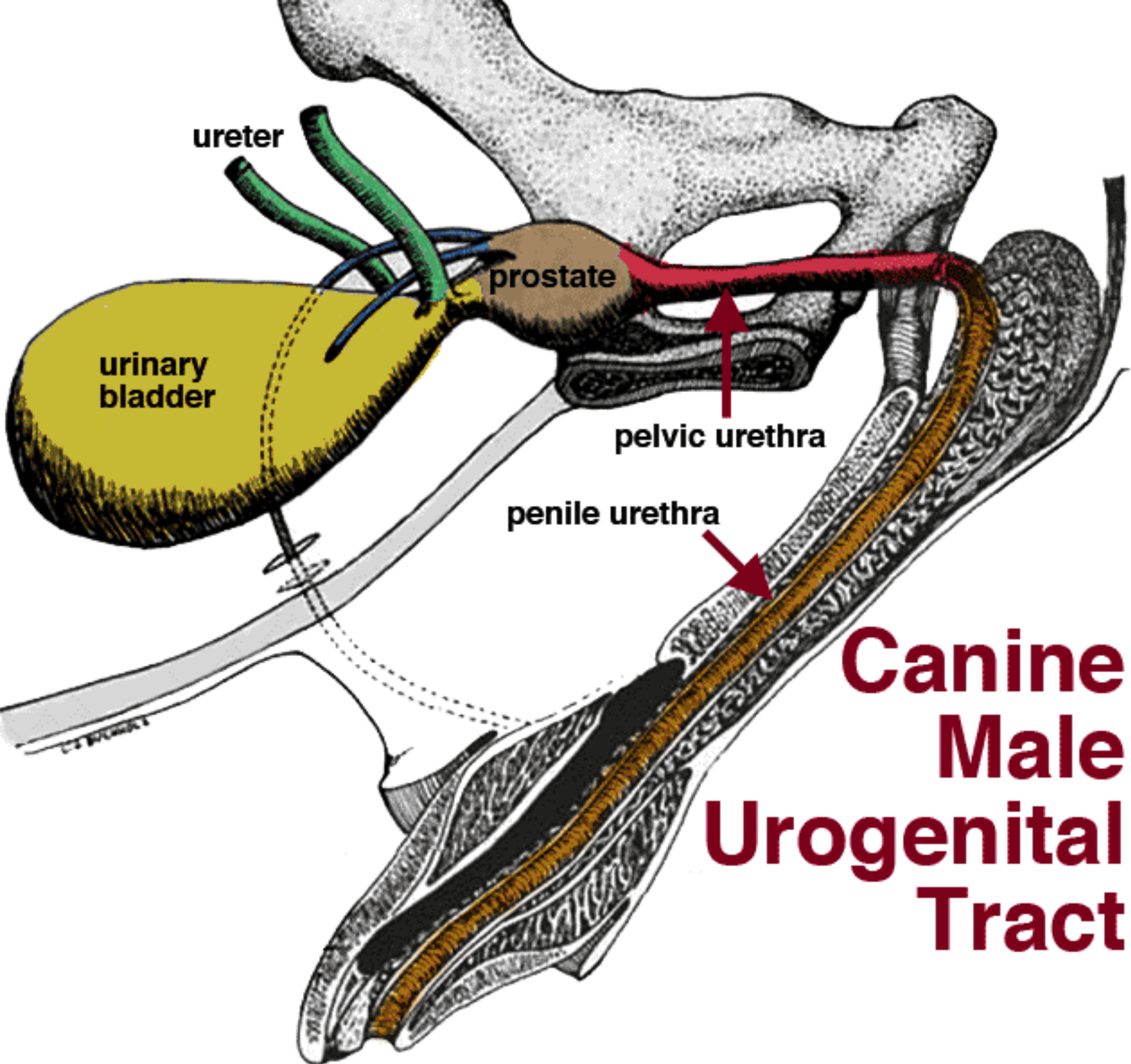


Encircling > Tangential

Male urogenital tract adaptations:

**How is the male urogenital tract
designed to accommodate
ejaculation?**

**— what is the probable sequence of events during
ejaculation?**



ureter

urinary bladder

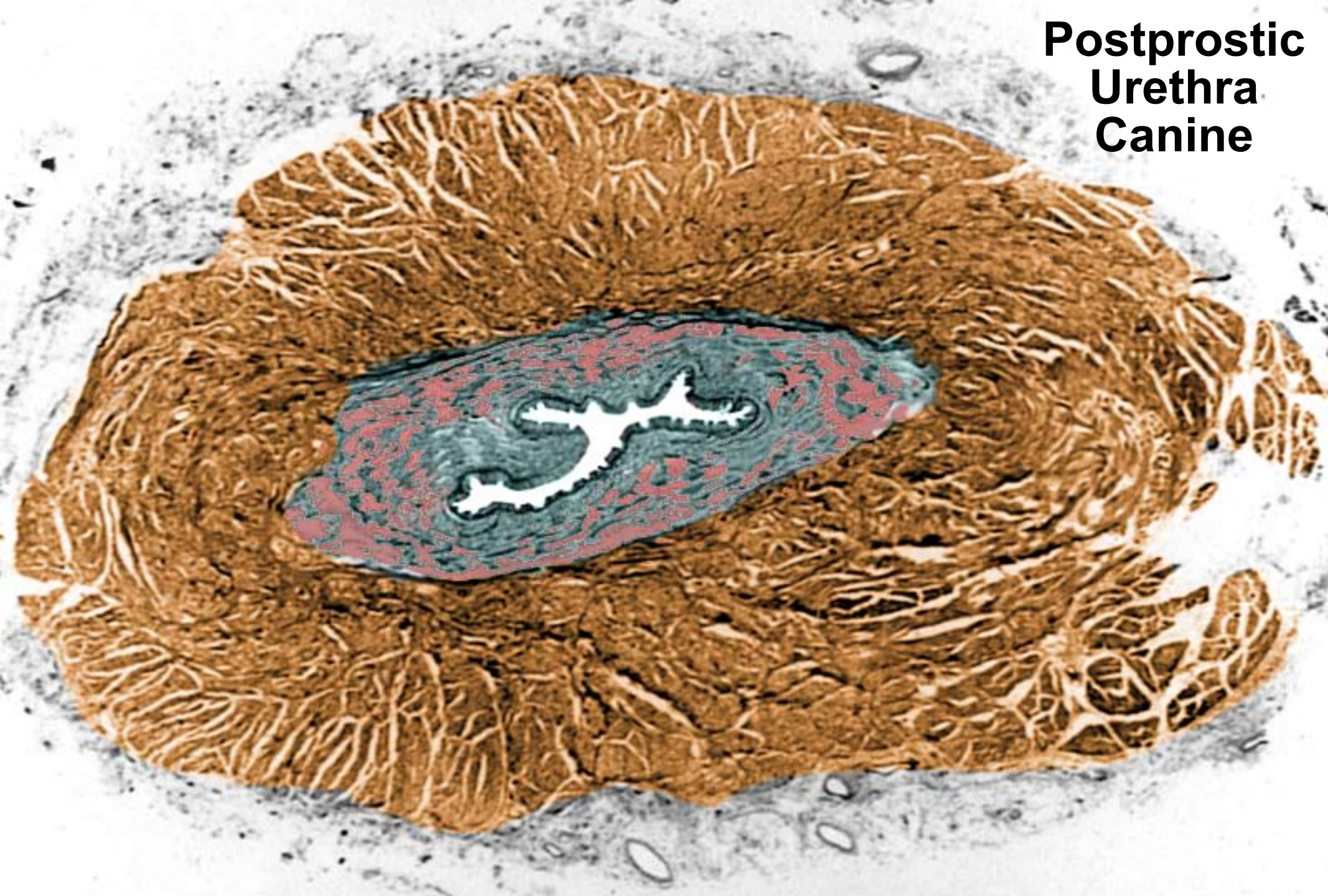
prostate

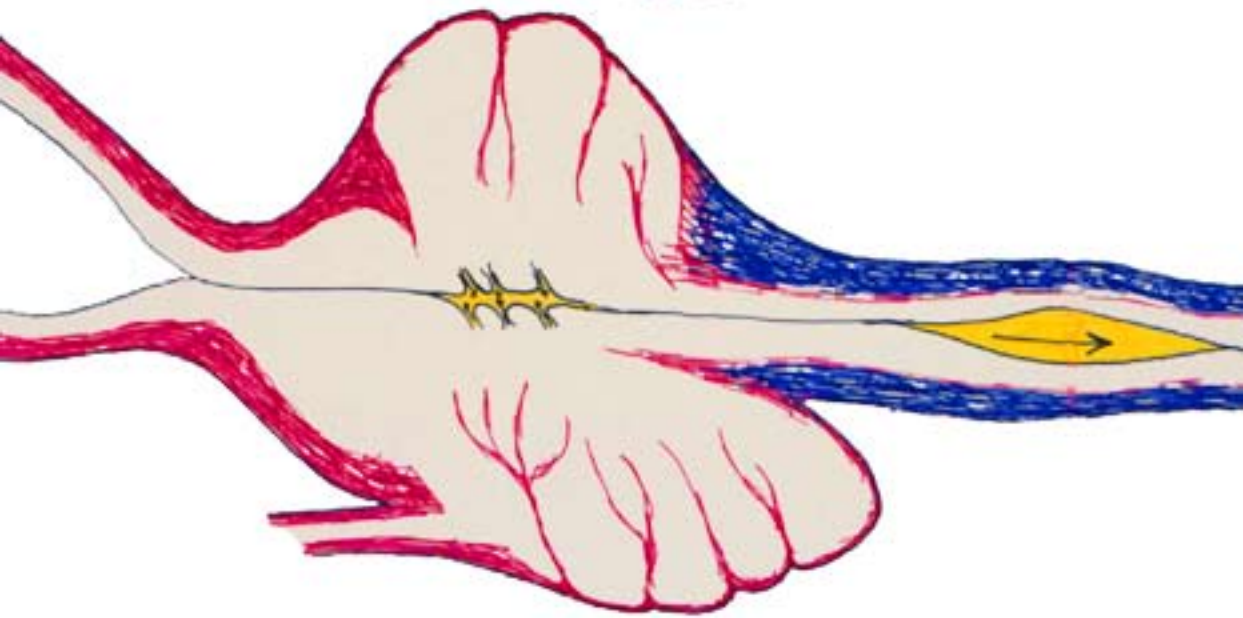
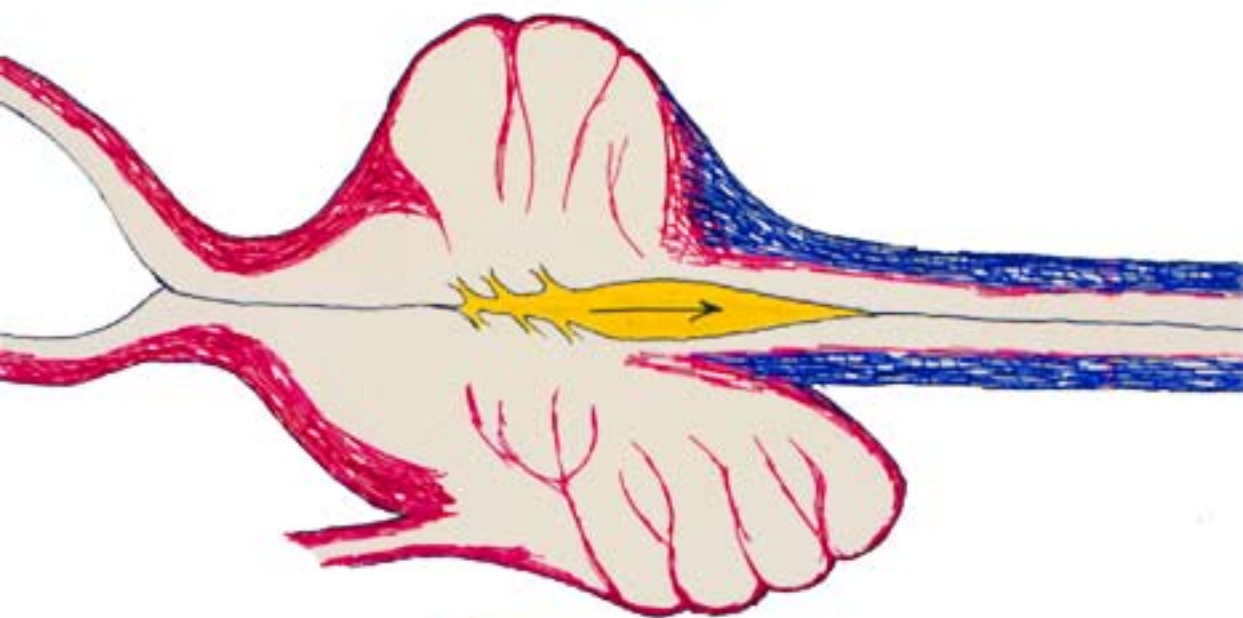
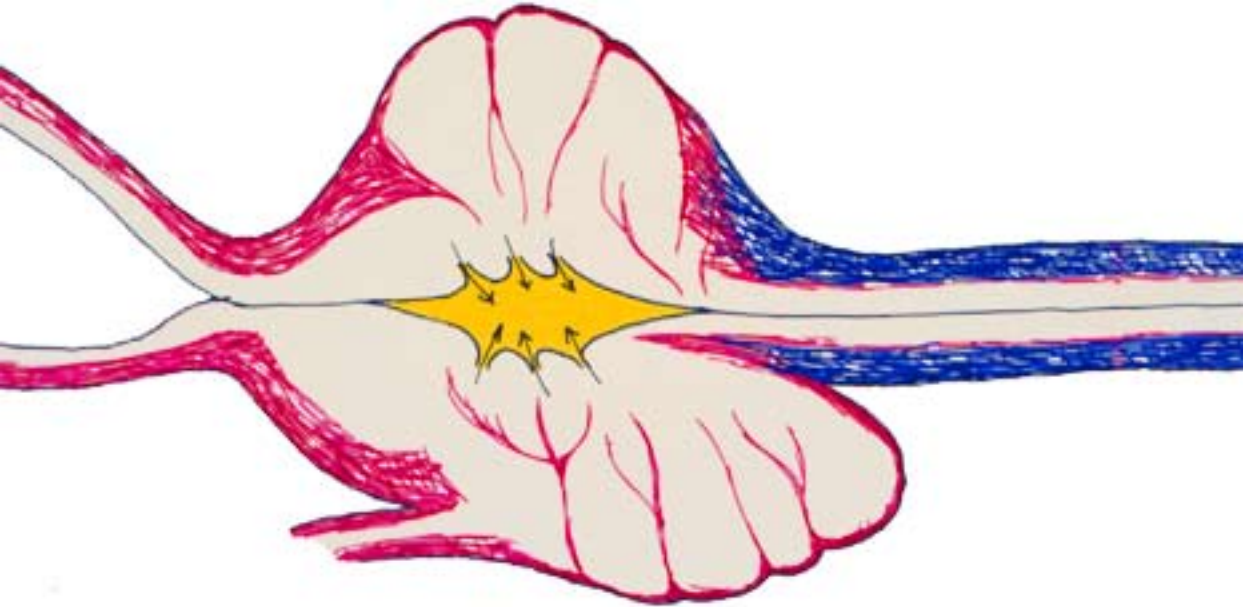
pelvic urethra

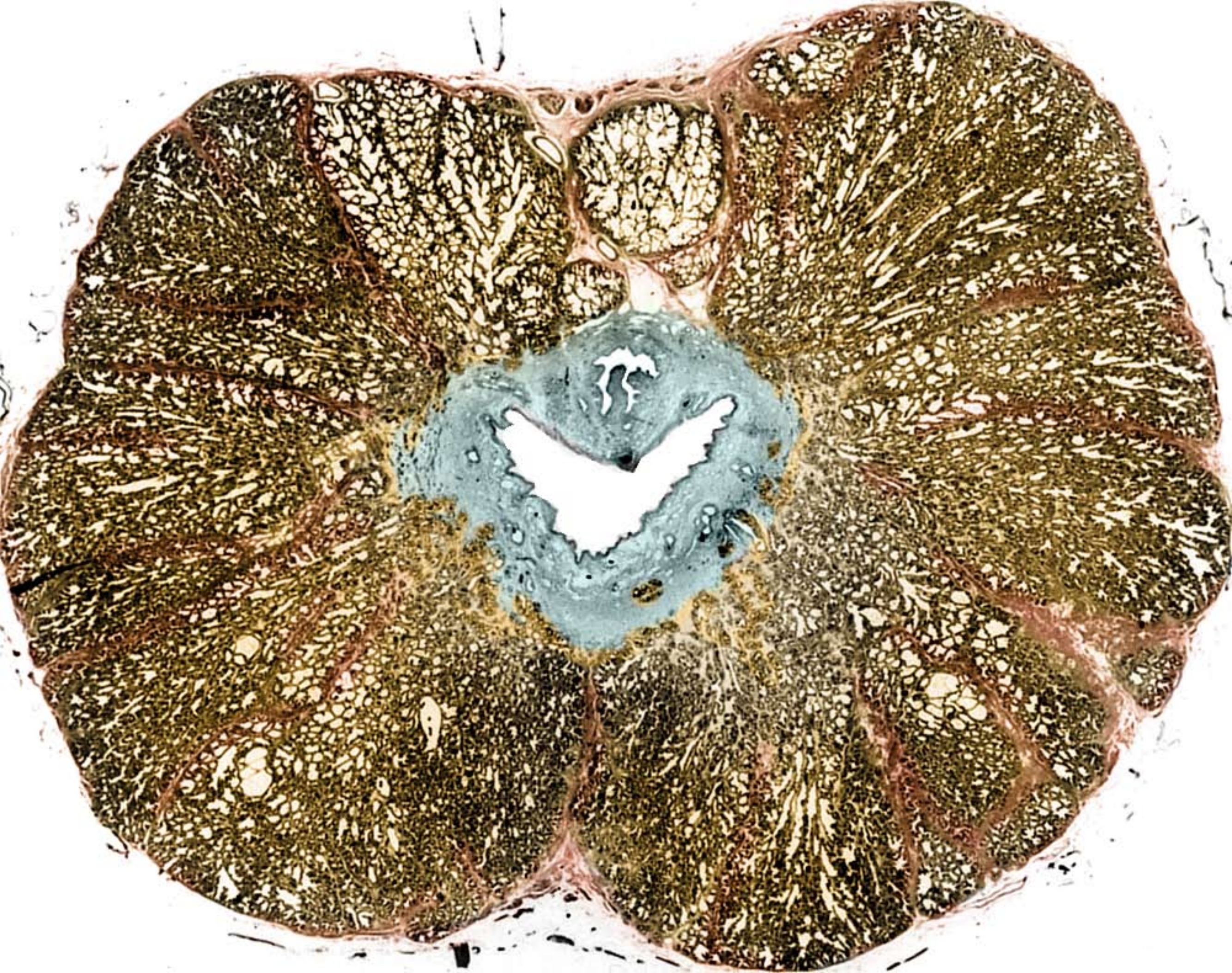
penile urethra

Canine Male Urogenital Tract

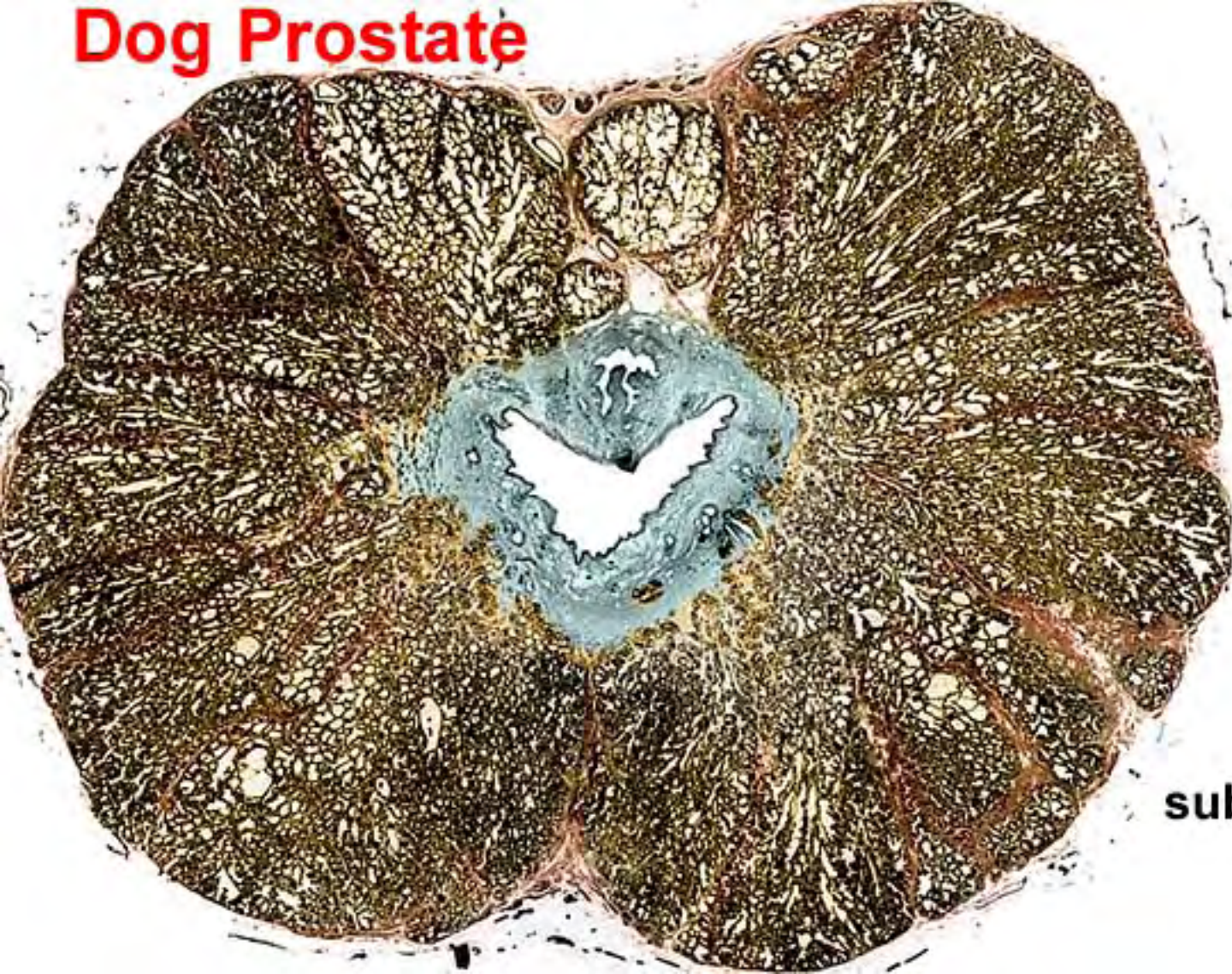
**Postprostatic
Urethra
Canine**



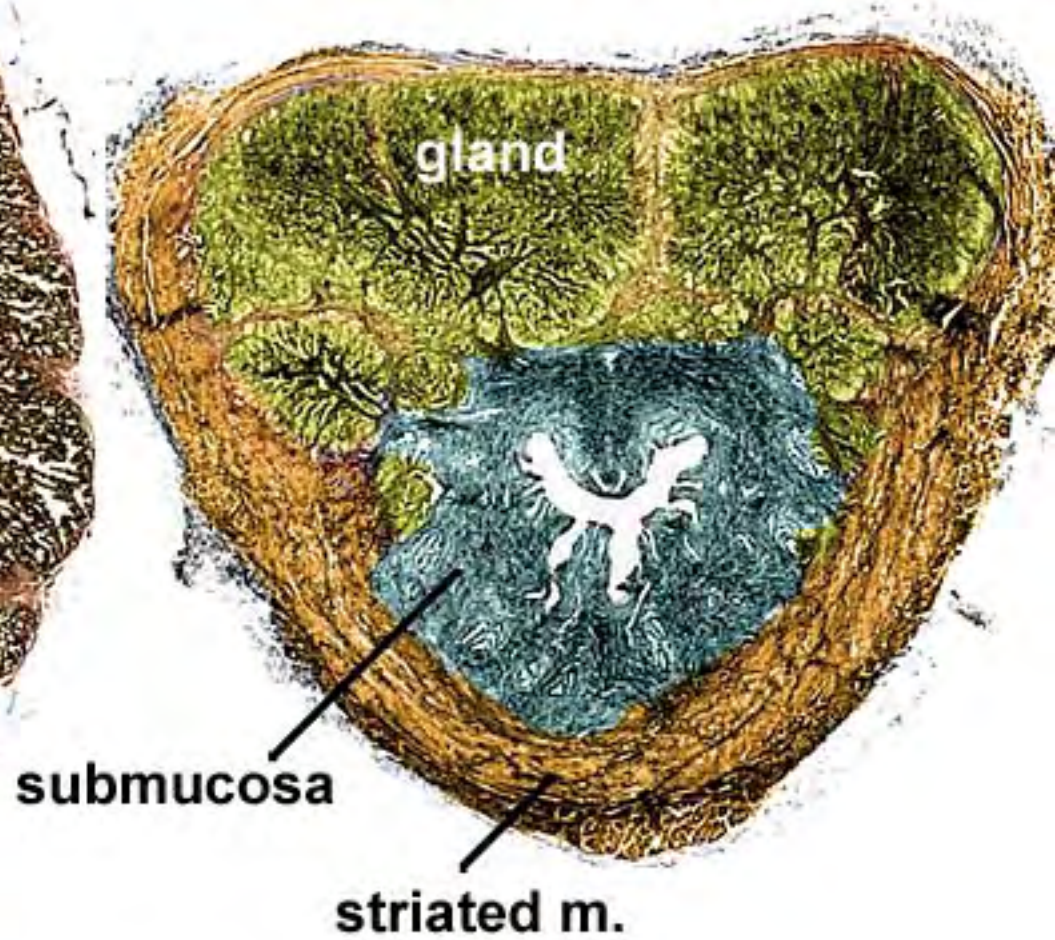




Dog Prostate



Cat Prostate



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