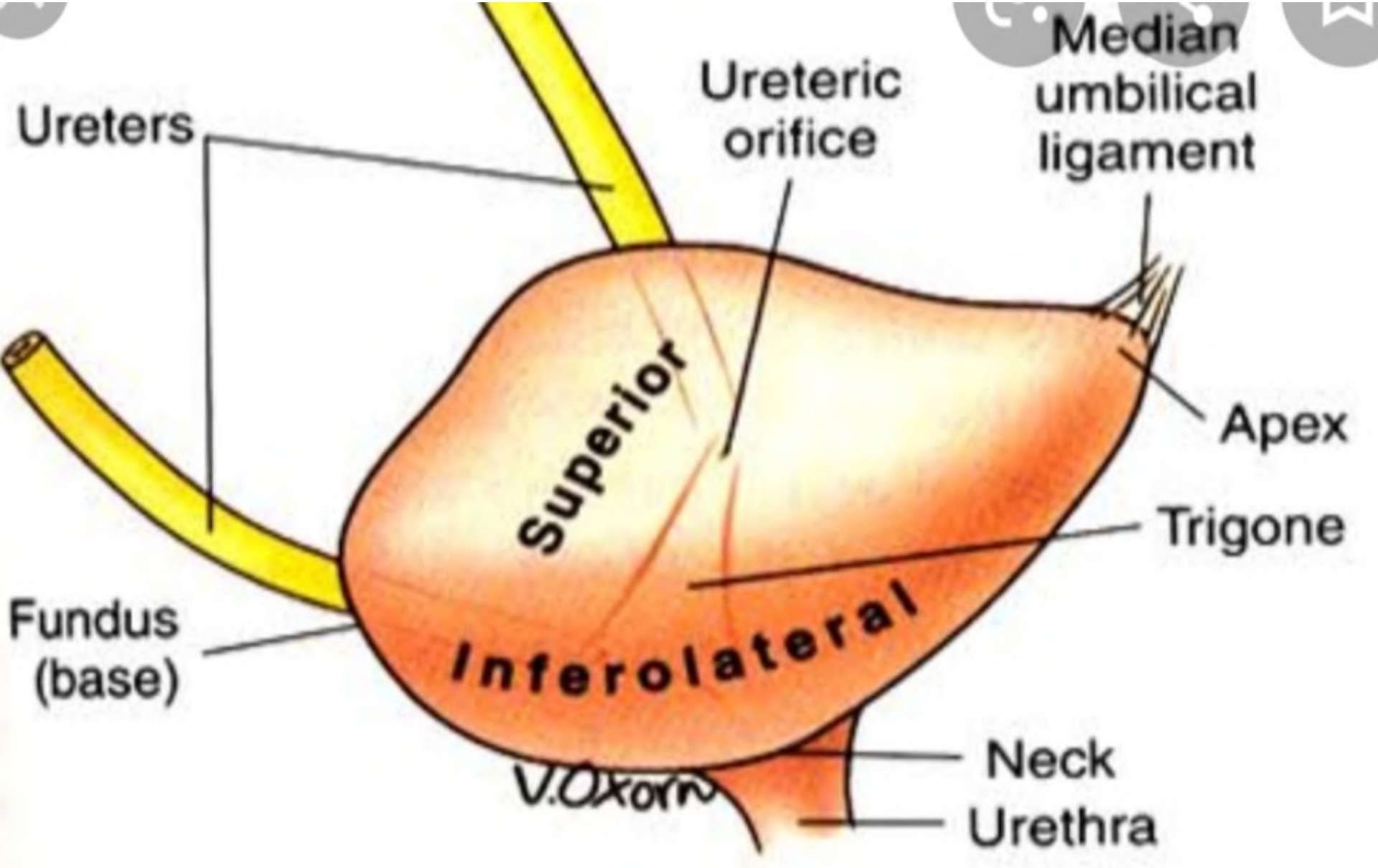
Physiology Of Micturition And Bladder Dysfunctions

Gross Anatomy

- External features :Bladder is a hollow muscular viscous organ .
- ➢ pyramidal in shape having apex base & 3 surfaces.
- ➢ Neck- lowest part, continues as urethra.
- Interior of bladder : mucosa shows irregular folds, & smooth trigone.



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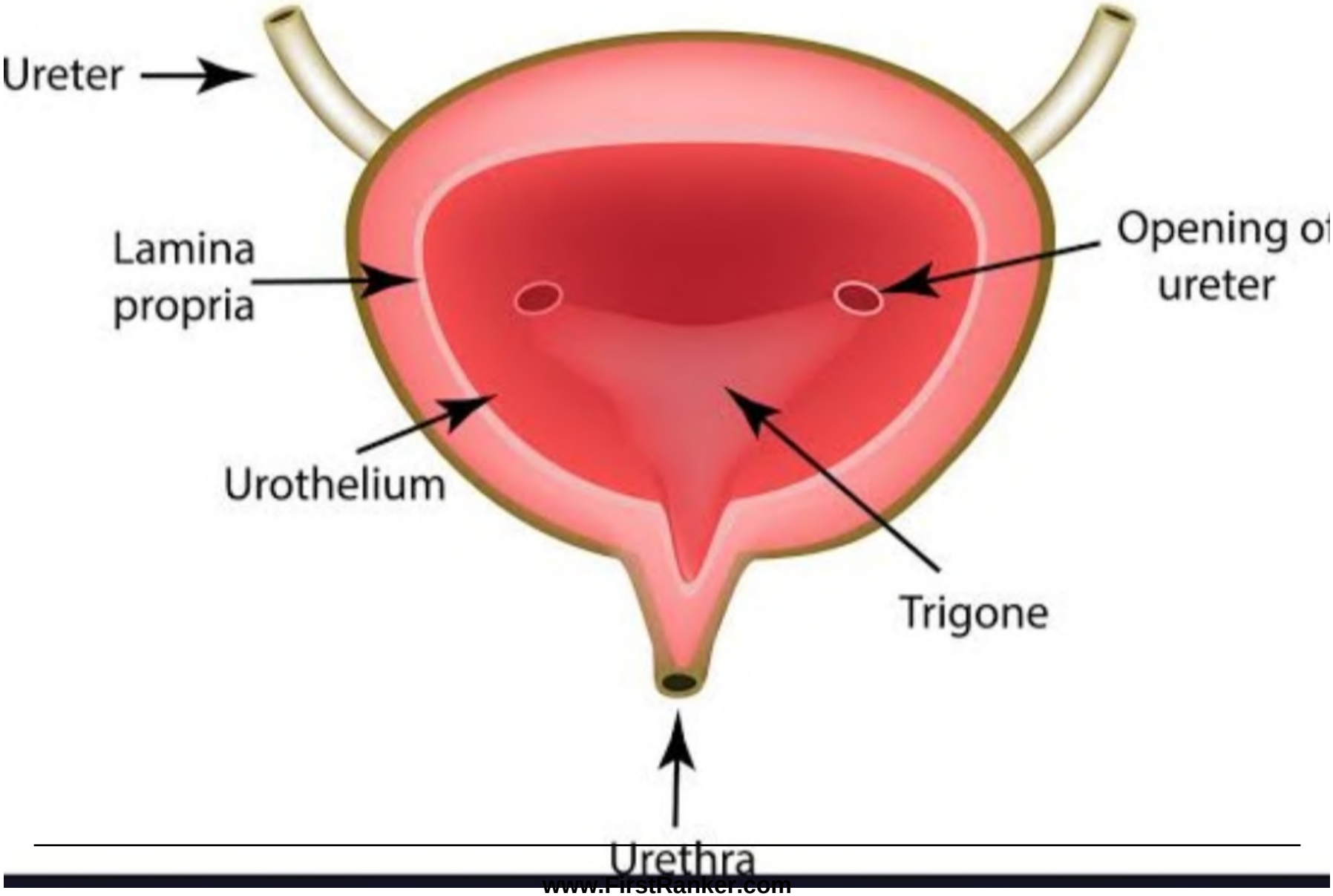
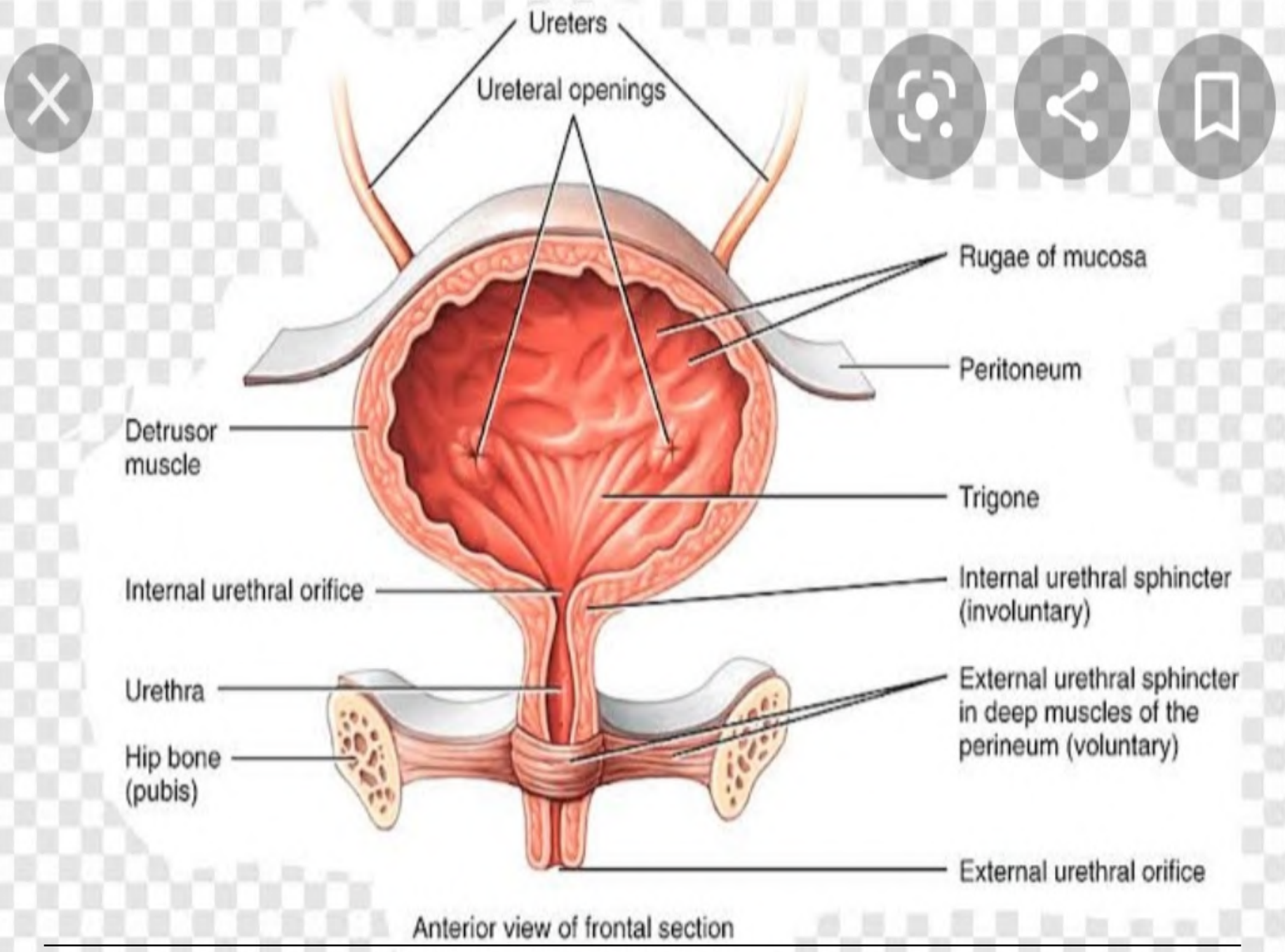


Urinary Bladder

- Urinary bladder is a sac like structure in the pelvic cavity.
- It is a **distensible organ** made up of smooth muscle called **detrusor muscle** , depicting the Latin word “pushes down”.
- Smooth muscles are arranged **in three** bundles: spiral, longitudnal, and circular.
- The bladder epithelium **has superficial layer of flat cells** and **deep layer of cuboidal cells**.



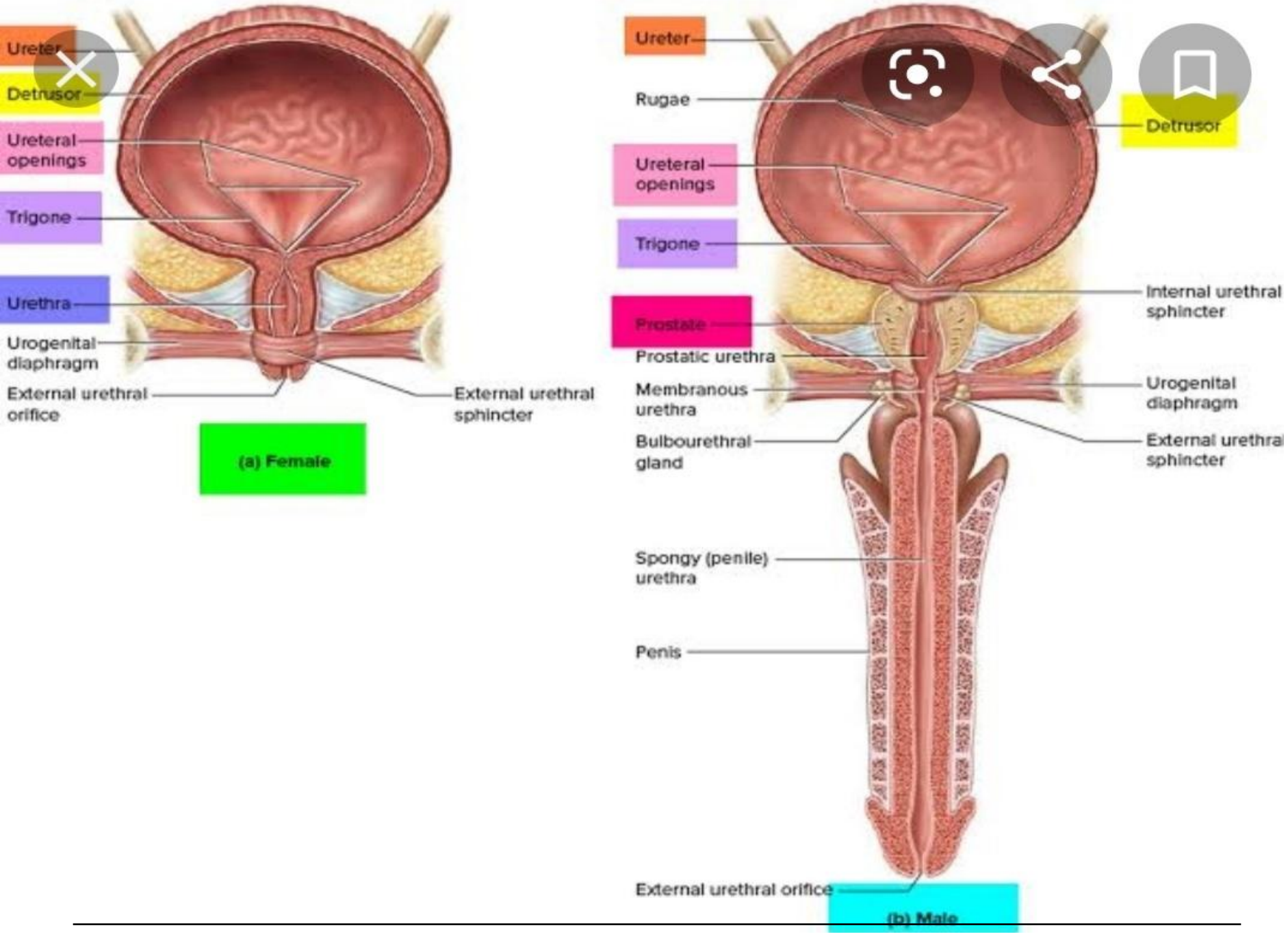
Anterior view of frontal section

Urethral Sphincters

- There are 2 sphincters

➢ Internal sphincter :located at the neck of the bladder ,made up of bundle of smooth muscle (**sphincter vesicae**) ,and **innervated by sympathetic (hypogastric) and parasympathetic(pelvic) nerves.** Therefore, it is under **autonomic control**.

➢ External sphincter : present around urethra in its proximal part ,made up **of skeletal muscle(sphincter urethrae) ,innervated by somatic (pudendal) nerves** . Therefore under voluntary control.



- Male urethra -20cm,3 parts ?
- Female urethra -4cm ,traverses external sphincter, lies in front of vagina.

INNERVATION OF URINARY BLADDER

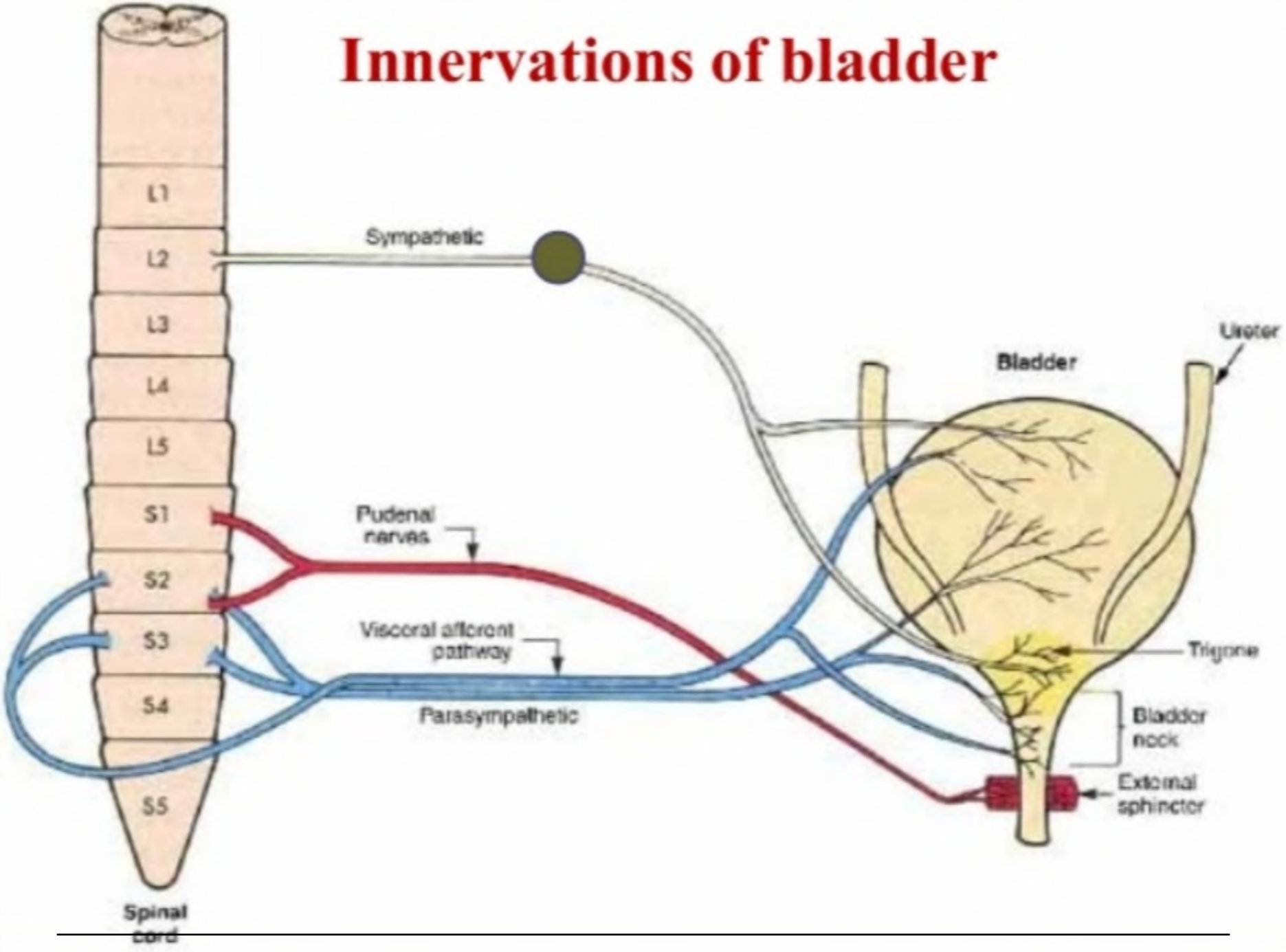
Parasympathetic(S2,3,4) via pelvic nerves

Sympathetic T11-L2 via hypogastric nerves

Somatic fibres(S2,3,4)

- Via pudendal nerves
- Innervates external sphincter

Innervations of bladder



INNERVATIONS OF BLADDER - FUNCTION

Nerve	On detrusor muscle	On internal sphincter	On external sphincter	Function
Sympathetic nerve	Relaxation	Constriction		Filling of urinary bladder
Parasympathetic nerve	Constriction	Relaxation		Emptying of urinary bladder
Somatic nerve			Constriction	Voluntary control of micturition

Transport of urine from kidney

Urine from collecting ducts flows into renal calyces

Stretches calyces & ↑es pacemaker activity

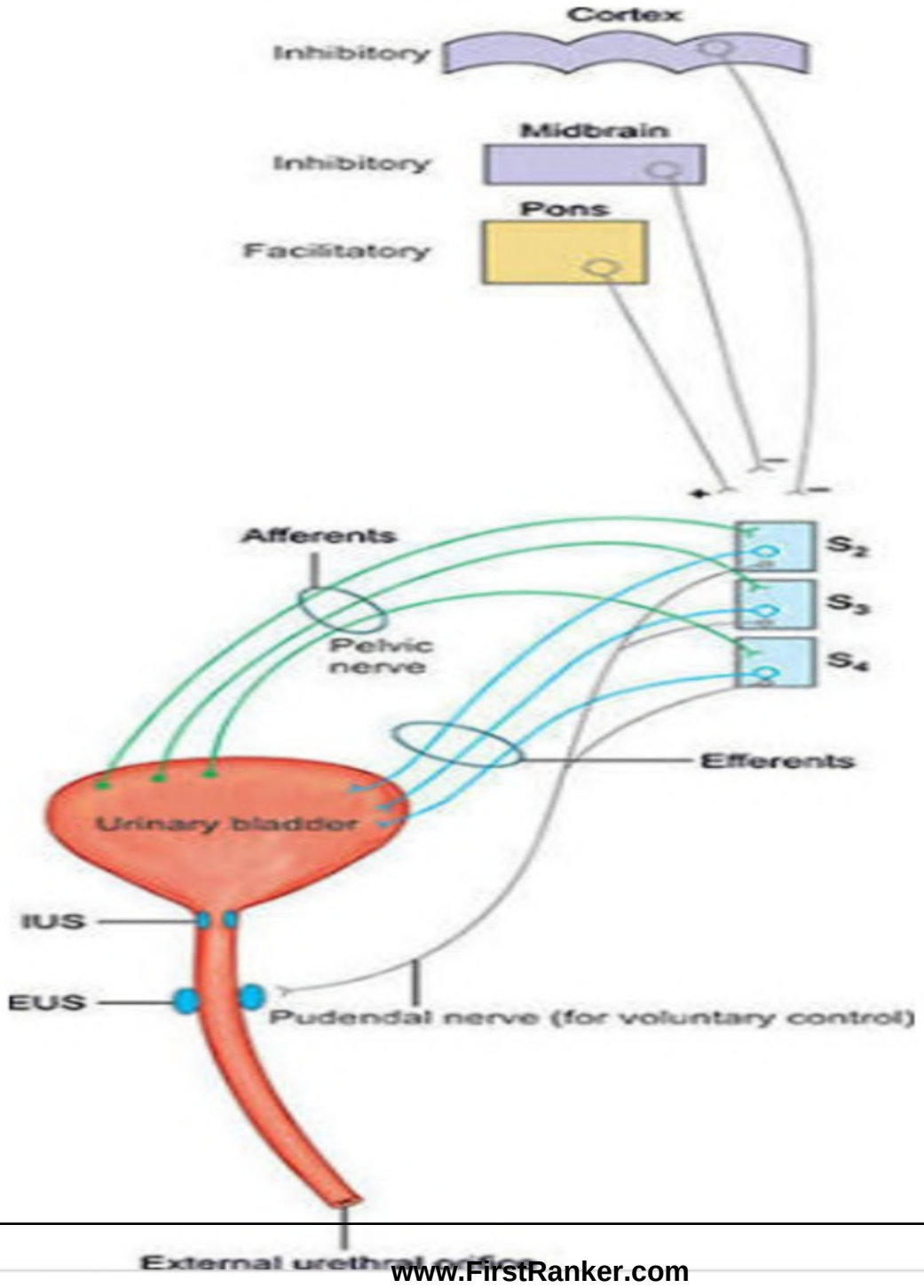
Initiates peristaltic contraction in renal pelvis & along the length of ureter

Urine enters bladder

- In adults ureter is 25-35cm long.
- Peristaltic activity in ureter are enhanced by parasympathetic stimulation and inhibited by sympathetic stimulation.
- There is no significant change in composition of urine as it flows from renal calyces and ureter to the bladder.
- Trigone of bladder
- **Vesicouretric reflux ??**
- **Uretrorenal** reflex (explain)

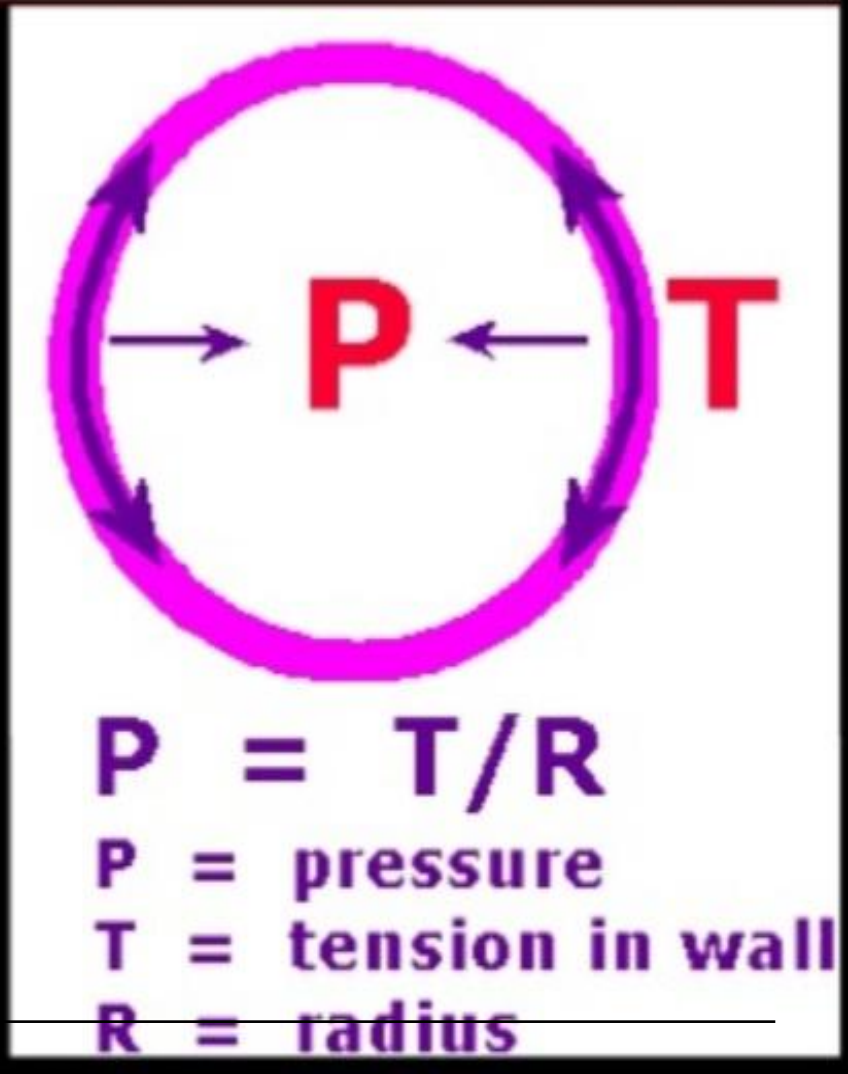
Micturition reflex

- Micturition is the process by which urinary bladder empties when it becomes filled.
- It is a reflex phenomenon, integrated in spinal cord.
- This spinal reflex is influenced by activities of the higher center.
- Urine enters the bladder without producing much increase in intravesical pressure untill well filled, because **smooth muscle exhibit property of plasticity**



PRESURE & VOLUME CHANGES IN BLADDER DURING FILLING.

- **When complete empty** – intra-vesical pressure = intra-abdominal pressure.
- As it fills – causes adaptation due to inherent property of plasticity.
- **Law of Laplace** – P α 1/R



CYSTOMETROGRAM

- **Cystometry**
  - It is the technique used to demonstrate the relationship between the intravesical pressure and the volume of urine in the bladder.
- **Cystometrogram** It is the graphical recording of pressure changes in urinary bladder in relation to rise in the volume of urine.

NORMAL CYSTOMETROGRAM

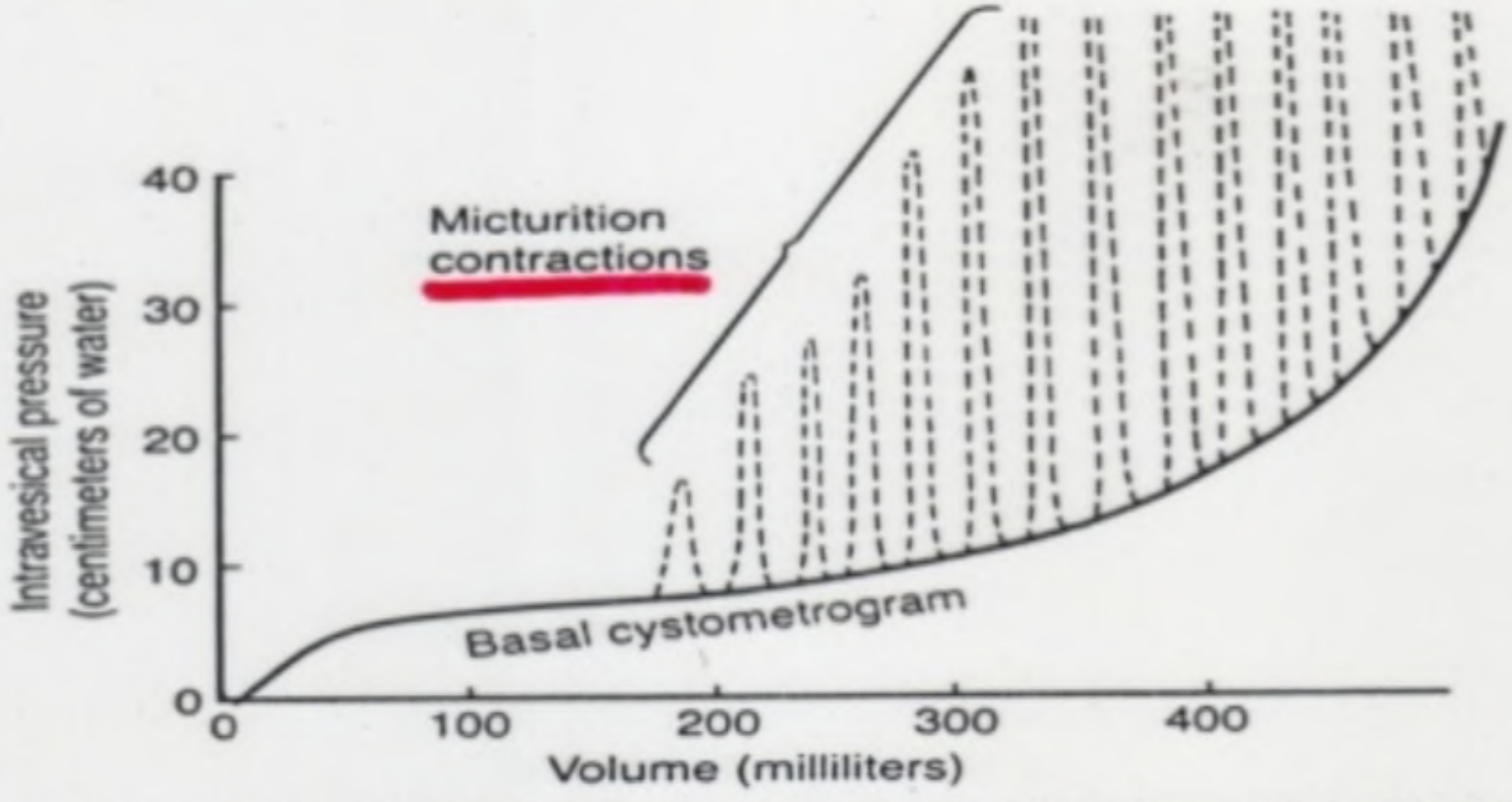
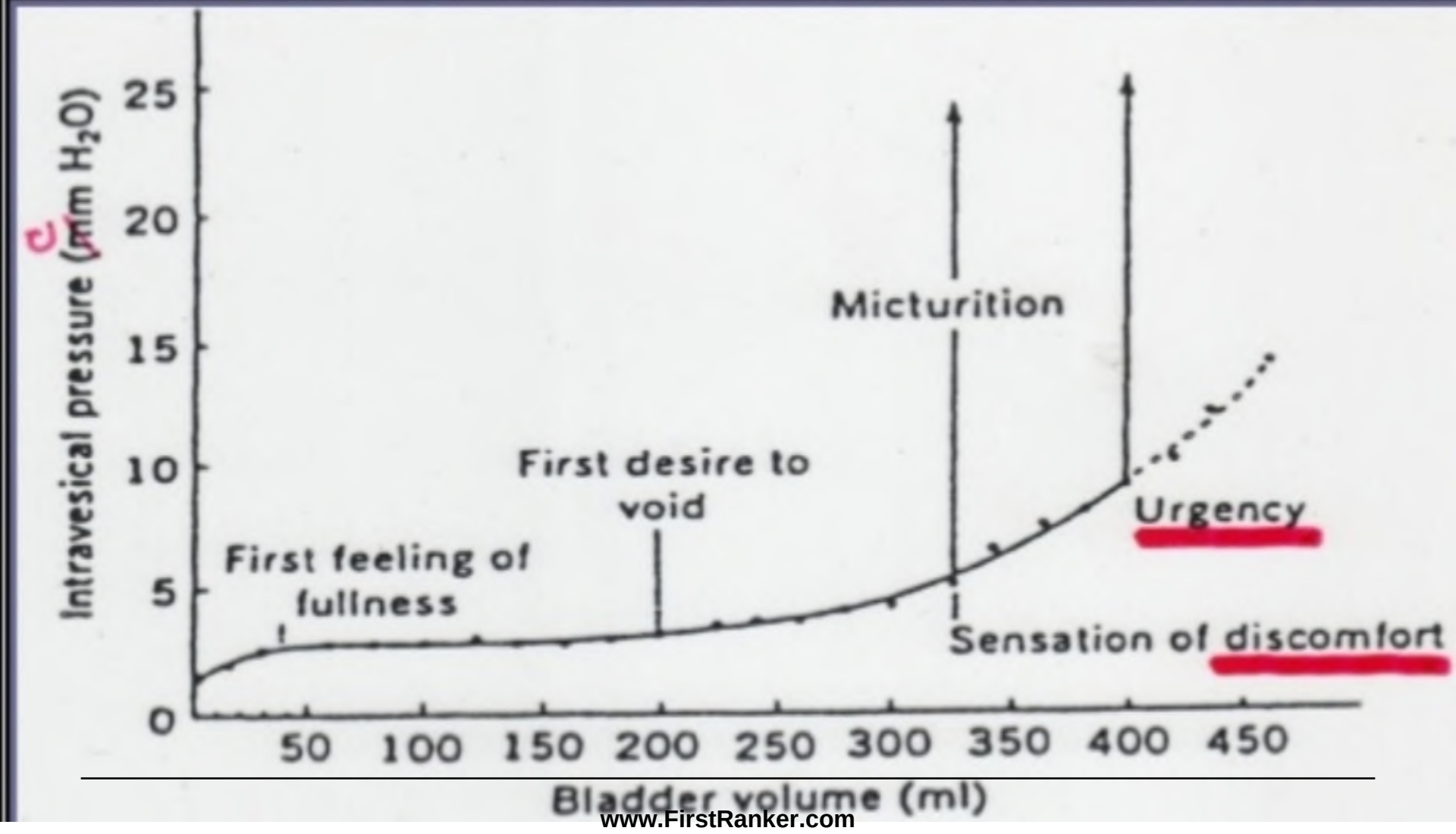


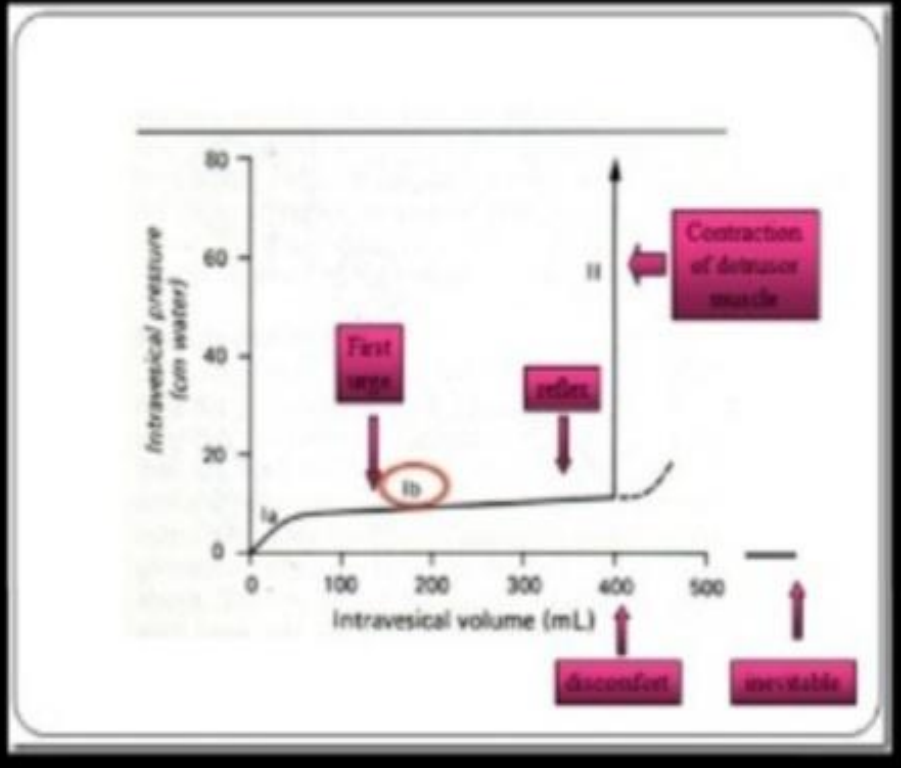
Figure 31–2. Normal cystometrogram, showing also acute pressure waves (dashed spikes) caused by micturition reflexes.

BLADDER FILLING



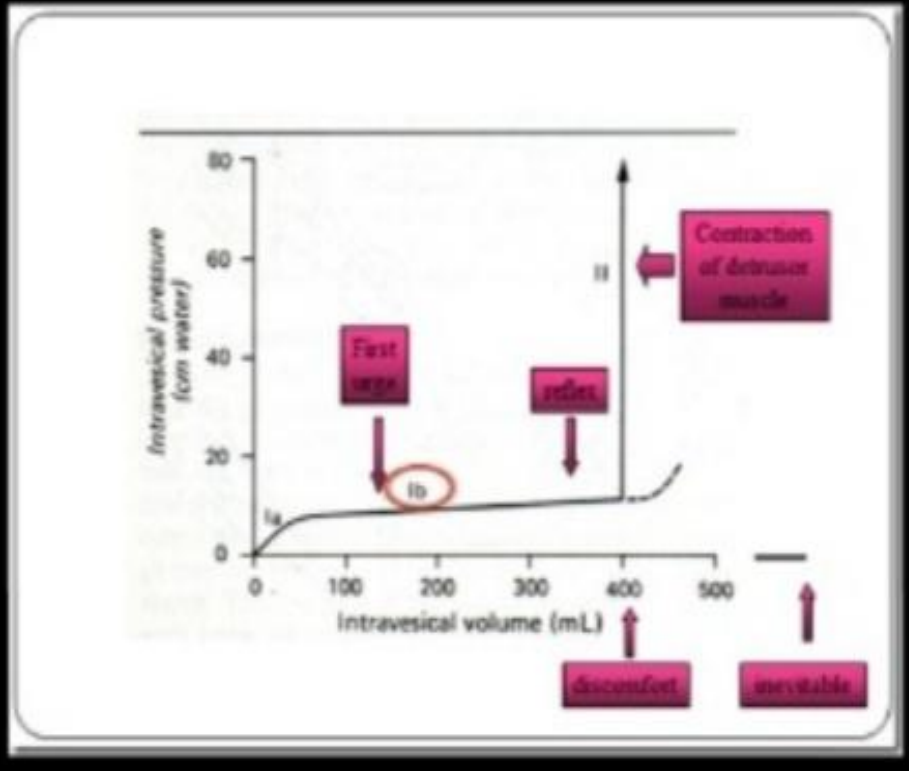
NORMAL CYSTOMETROGRAM

- **3 PHASES.**
- **Phase Ia** – upto 50 ml – pressure changes to 0-10
- **Phase Ib** – from 50 ml -400 ml, pressure does not change much, remains 10 cm of H2O, due to adaptation By Relaxation.



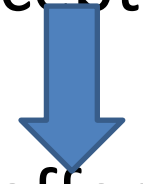
NORMAL CYSTOMETROGRAM

- **Phase II** – starts beyond 400 ml, pressure changes markedly triggering Micturition Reflex
  - Voiding contractions raises pressure more by 20-40 cm of H2O
  - After 600 ml , urge becomes unbearable.



Mechanism Of Micturition

Filling of the bladder stimulates its stretch receptors



Impulses travel in afferent(pelvic) nerve

Reaches S2,3,4 spinal segment (center)

Parasympathetic fibers form efferent limb which travel in pelvic nerves

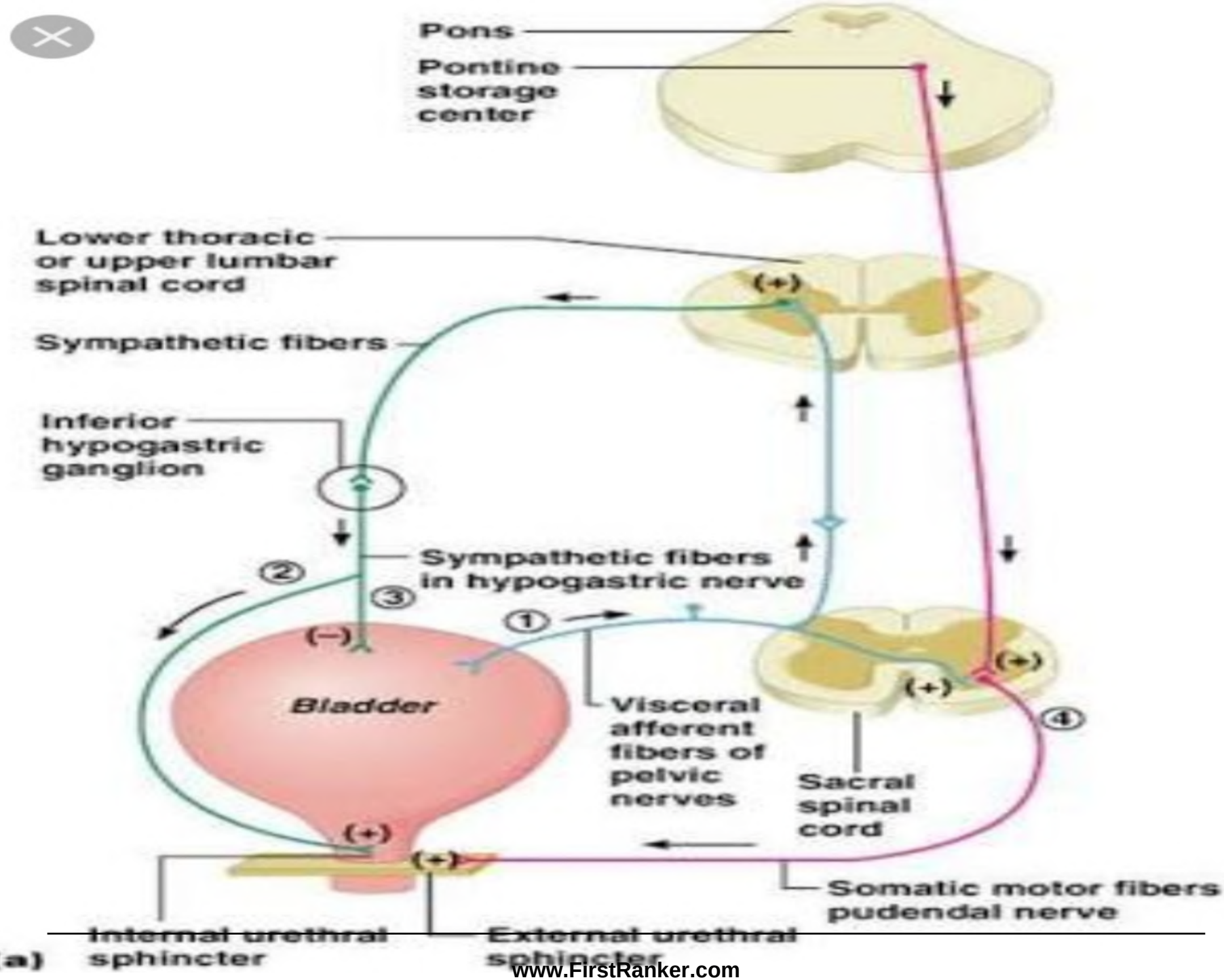
Parasympathetic stimulation causes **contraction of detrusor** and **relaxation of internal sphincter**

Urine passes into the urethra

Also external sphincter relaxes due to cortical influences

Urine finally comes out of urethra and is **completely emptied by effect of gravity in females**

And by contraction of bulbocavernous muscle in males



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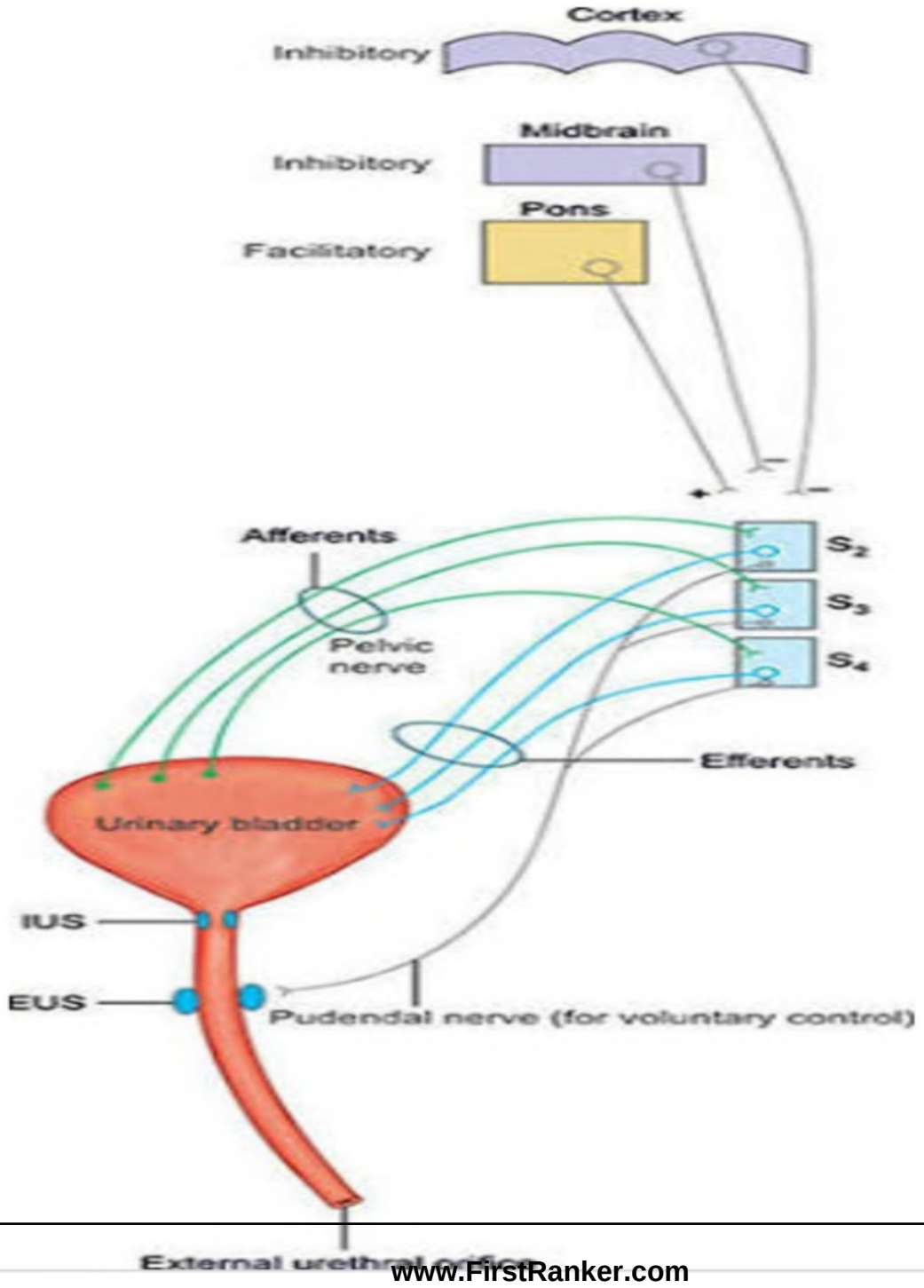
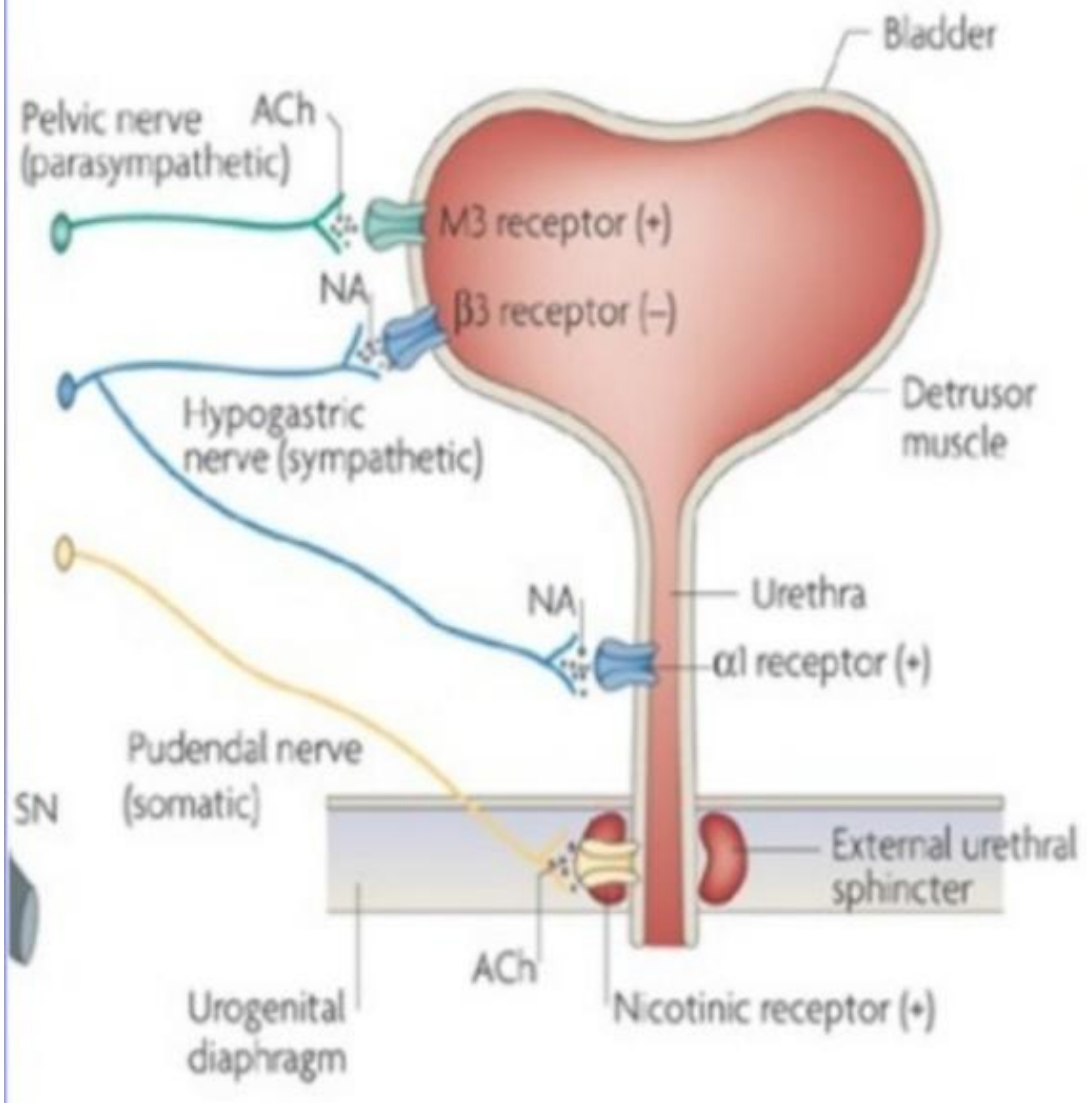


BLADDER INNERVATION – Mode of Action



Lumbar cord

Sacral cord S 2,3,4

Pudendal N.

- Contraction of abdominal muscle and descent of diaphragm ↑es intra-abdominal pressure which helps in expulsion if urine.
- Pelvic , perineal, and levator ani muscle relaxes which causes downward pull of detrusor muscle and aids in initiation of contraction.
- Voluntary control of micturition is influenced by cortical activities and by learning to contract the external sphincter.

Control Of Micturition

- Micturition reflex is controlled by centers in the brainstem.
- Facilitatory area is present pons and inhibitory area is in midbrain.
- What is the effect of neurexis above 1. pons 2.midbrain on micturition ?
- Posterior hypothalamus also contain facilitatory area for micturition.
- Cortex has voluntary inhibitory control on micturition.
- Control of urination starts to develop at about 2yrs

HIGHER CENTRE INFLUENCE ON MICTURITION

This is completely autonomic spinal reflex

Inhibitory Centers for Micturition

- In **midbrain and cerebral cortex** inhibit the micturition by suppressing spinal micturition centers.

Facilitatory Centers for Micturition

- In **pons and posterior hypothalamus** facilitate micturition via spinal centers.

Bladder Dysfunctions

- 3 major types of bladder dysfunctions are due to neural lesions:
  1. Interruption of the afferent nerve.
  2. Interruption of both afferent & efferent nerves.
  3. Interruption of facilitatory & inhibitory pathways descending from brain.

➢ In all 3 types the bladder contracts , but **contractions are not sufficient** so **residual urine is left .**

Deafferentation

When **sacral dorsal roots are cut** in experimental animals or interrupted by disease of dorsal root , such as **tabes dorsalis .**

- All reflex contraction of bladder are abolished.
- Bladder is **distended, thin walled,and hypotonic.**
- Some contractions occurs because of intrinsic response of smooth muscle to stretch.
- **Overflow incontinence** occurs.

Denervation

When **both afferent and efferent fibers are destroyed** as in tumor of cauda equina or filum terminale.

- Bladder is **flaccid** and **distended** for a while.
- Gradually the muscle of '**decentralised bladder**' become active ,with many contraction waves that expel dribbles of urine.
- Bladder is **shrunken** and **its wall is hypertrophied** .
- This hyperactive bladder is due to **denervation hypersensitivity.**

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Spinal cord transection

- During spinal shock bladder is flaccid and unresponsive , there is overflow incontinence .
- In recovery phase , voiding reflex returns but there is no voluntary control and no inhibition or facilitation from higher center.
- How **Mass reflex** helps paraplegic patients ?
- Sometimes voiding reflex is hyperactive leading to **spastic neurogenic bladder**
- Reflex hyperactivity is worsen by infection .

- Nocturnal enuresis/Bed wetting : Involuntary micturition during sleep, normal phenomenon in children below 3yrs ,due to incomplete myelination of motor nerve fiber of bladder.
- It may be primary or secondary type .
- If present beyond 5yrs need proper evaluation and treatment.

Urinary incontinence : is any involuntary leakage of urine