

# MICTURITION

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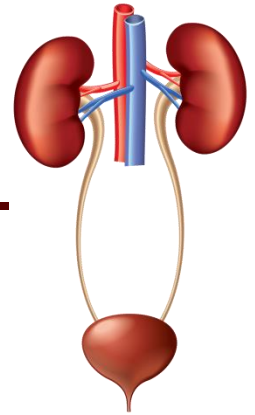
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# Objectives

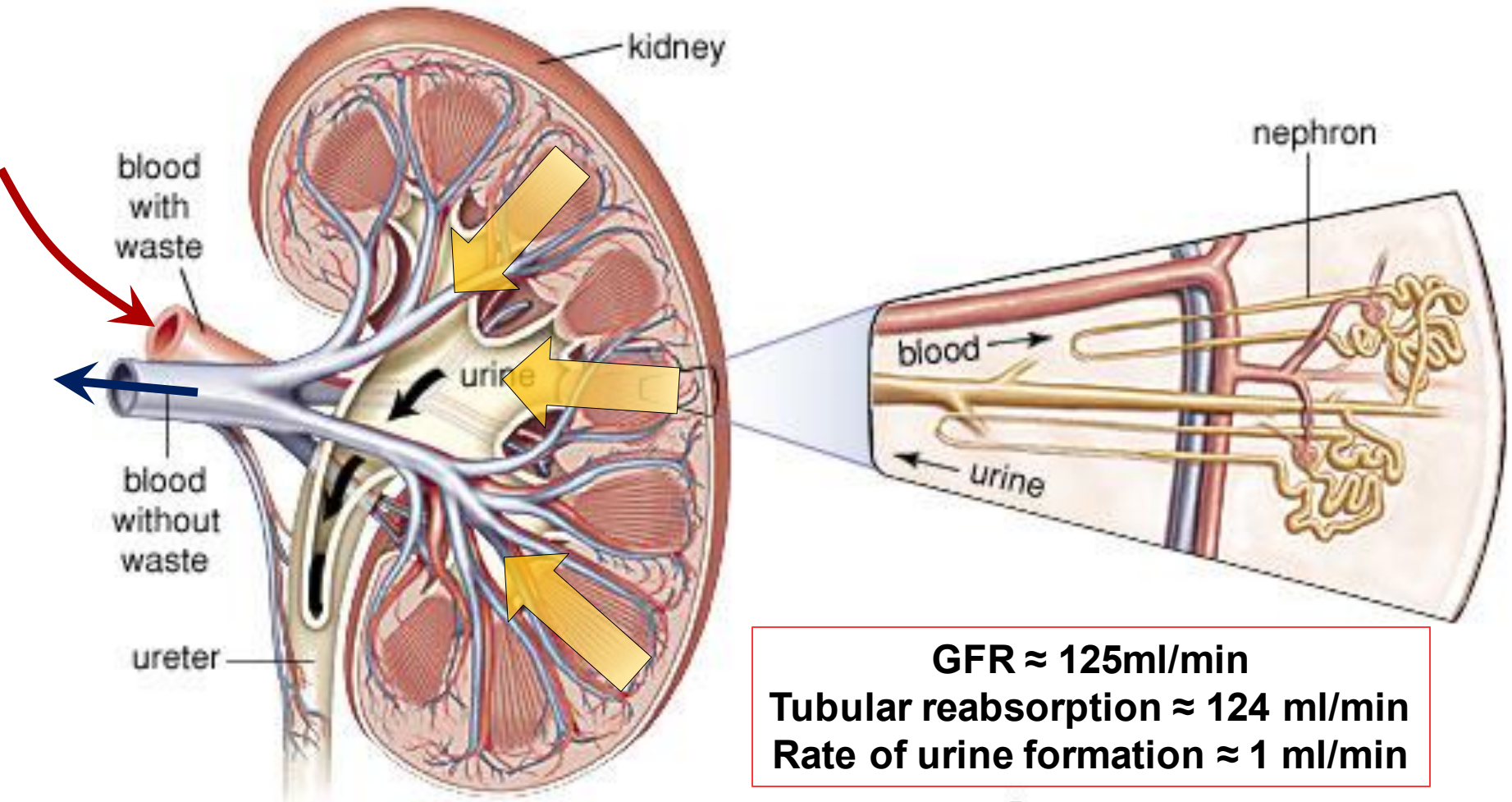
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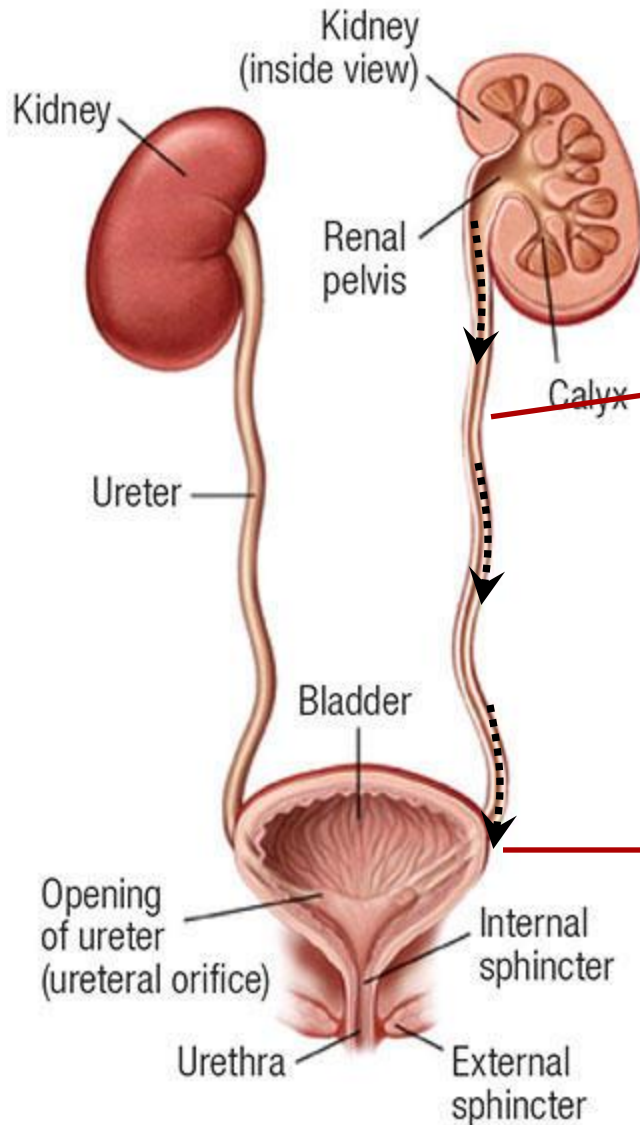
## At the end of this session, students should be able to:

- Define micturition.
- Identify and describe the functional anatomy of the urinary bladder.
- Describe the neural control of the urinary bladder and sphincters.
- Describe the mechanism of filling and emptying of the urinary bladder.
- Cystometrogram.
- Explain the neurogenic control of the micturition reflex and its disorders.

# Introduction



# Introduction



**Ureters conduct urine to bladder**

*How??*

**Urine is stored in the bladder until voiding**

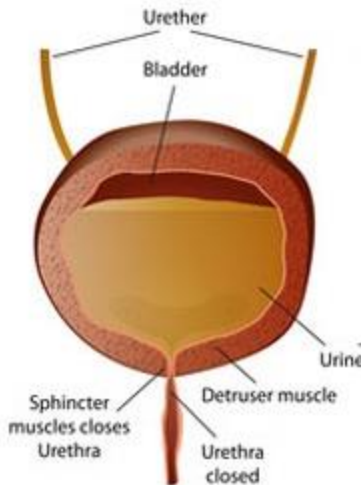
# Functions of the Lower UT

The lower urinary tract = bladder + urethra

Functions of the bladder & urethra

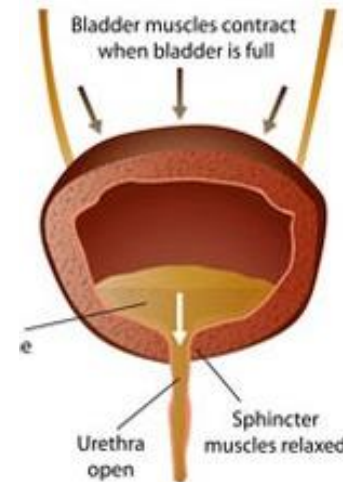
Urine storage

Voiding (Micturition)



Wall relaxed  
with closed  
outlet

Store without leakage



Wall  
contracts  
with open  
outlet

Empty when appropriate

# Introduction

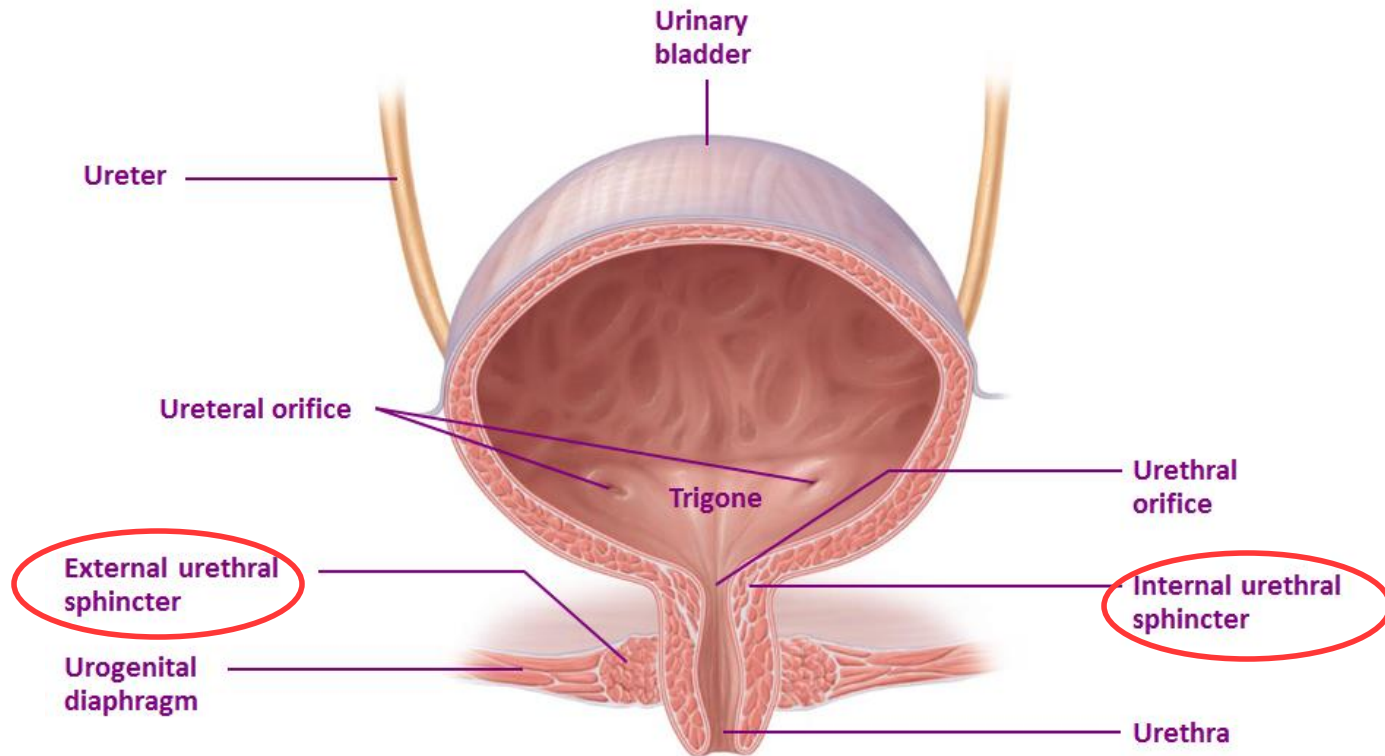
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- To understand how the lower urinary tract performs this function, one must understand:
  1. Functional anatomy of the bladder.
  2. Neural control of the bladder.

# **FUNCTIONAL ANATOMY OF THE BLADDER**

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# Functional Anatomy of the Bladder

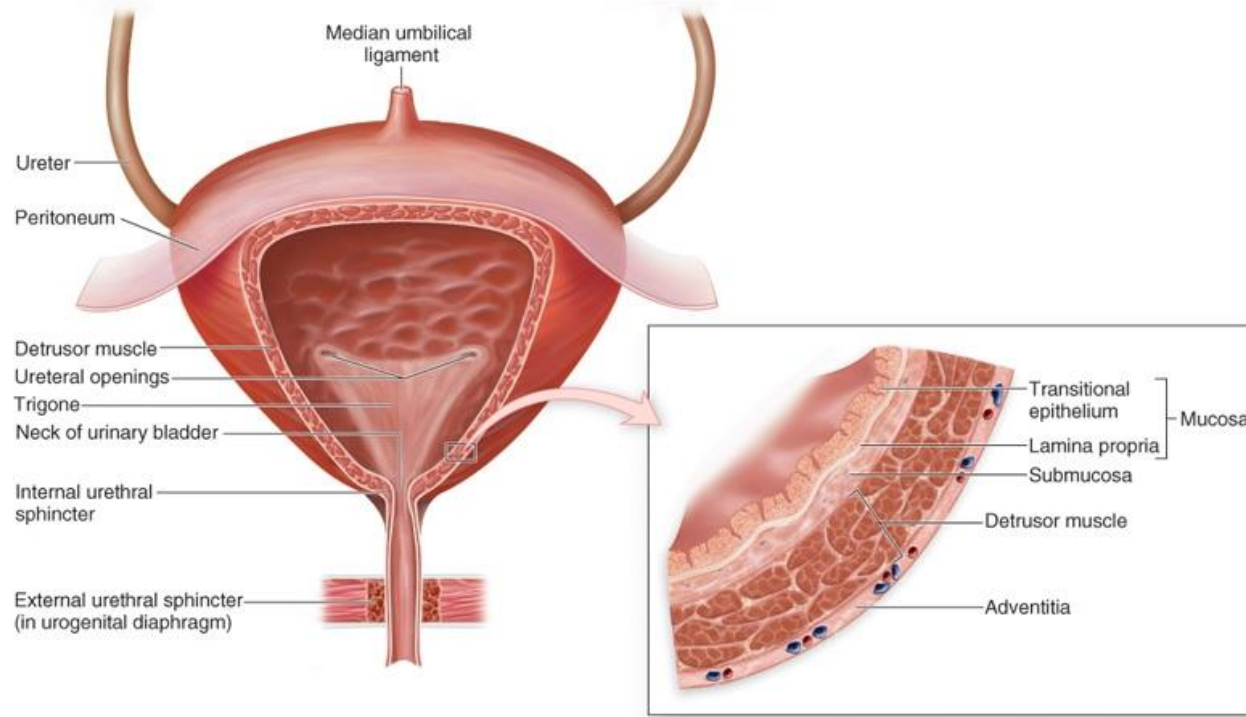


- Bladder has two parts: body & neck.
- What is the trigone?
- How many sphincters are there and how are they different?



# Functional Anatomy of the Bladder

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## **Bladder wall has 4 layers;**

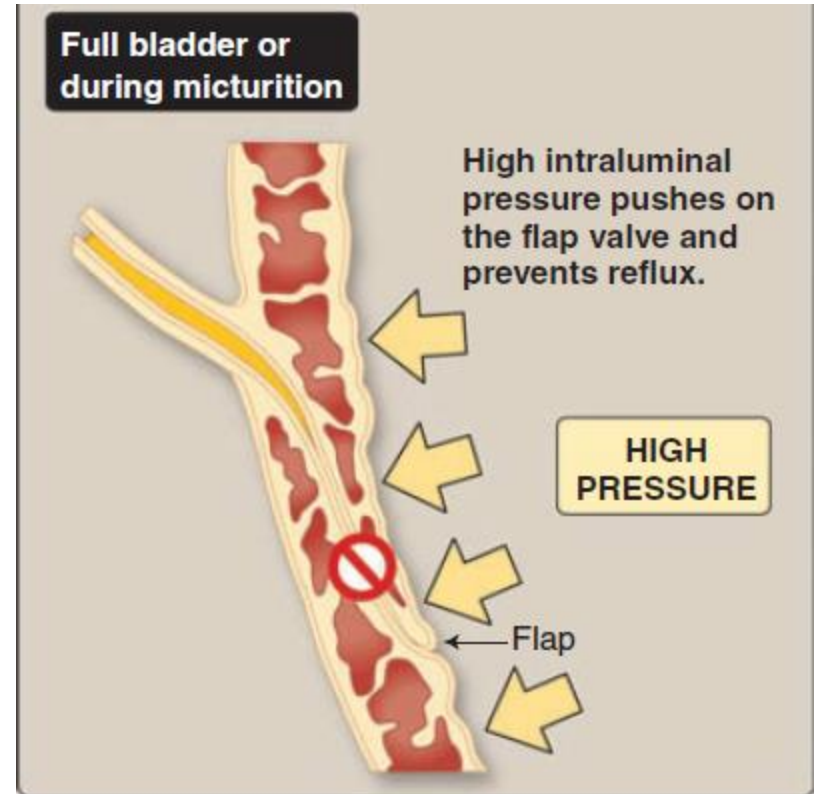
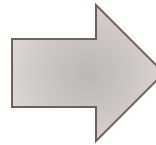
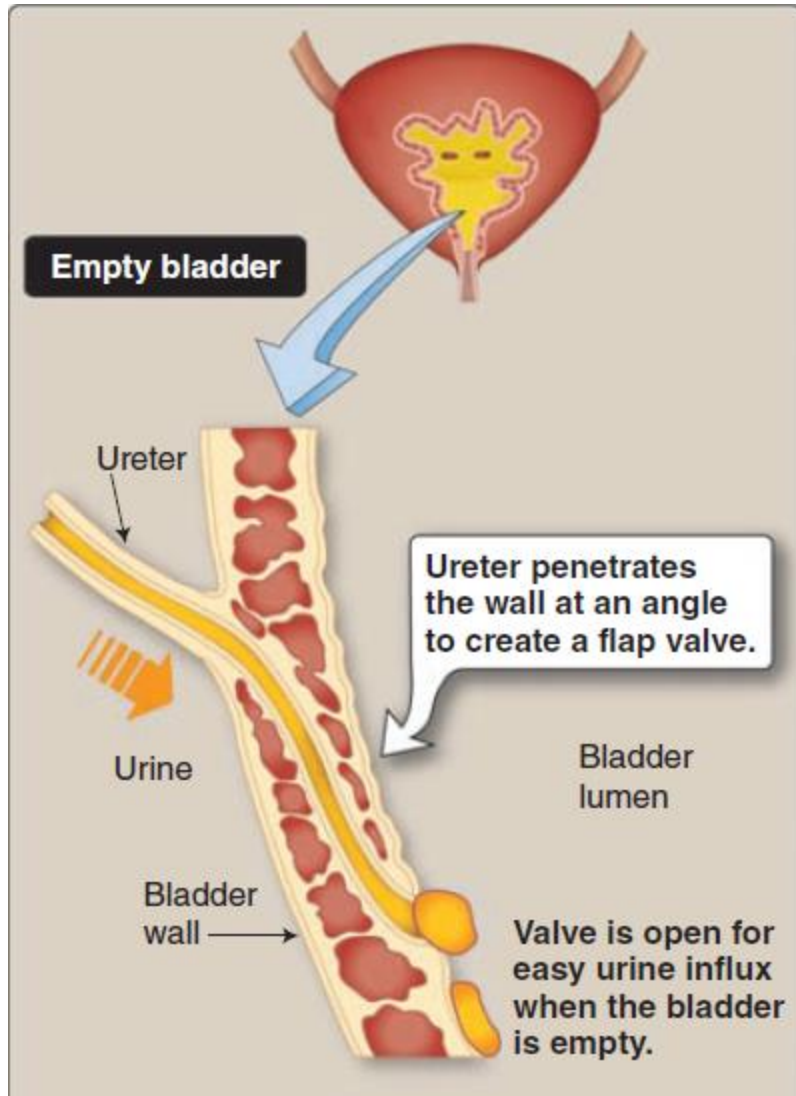
1. Mucosa → transitional epithelium → has folds “rugae”.
2. Submucosa → loose connective tissue.
3. Smooth muscle layer → Detrusor muscle → the main muscle of micturition.
4. Serosa

# Urine Transport from Kidney to Bladder

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- Urine is transported through the ureters.
- Urine is propelled through the ureter and into the bladder by the help of peristalsis.
- Peristalsis is thought to be initiated by pacemaker cells in the renal pelvis.
- **Sympathetic** stimulation → **inhibits** peristalsis.
- **Parasympathetic** stimulation → **enhance** peristalsis.

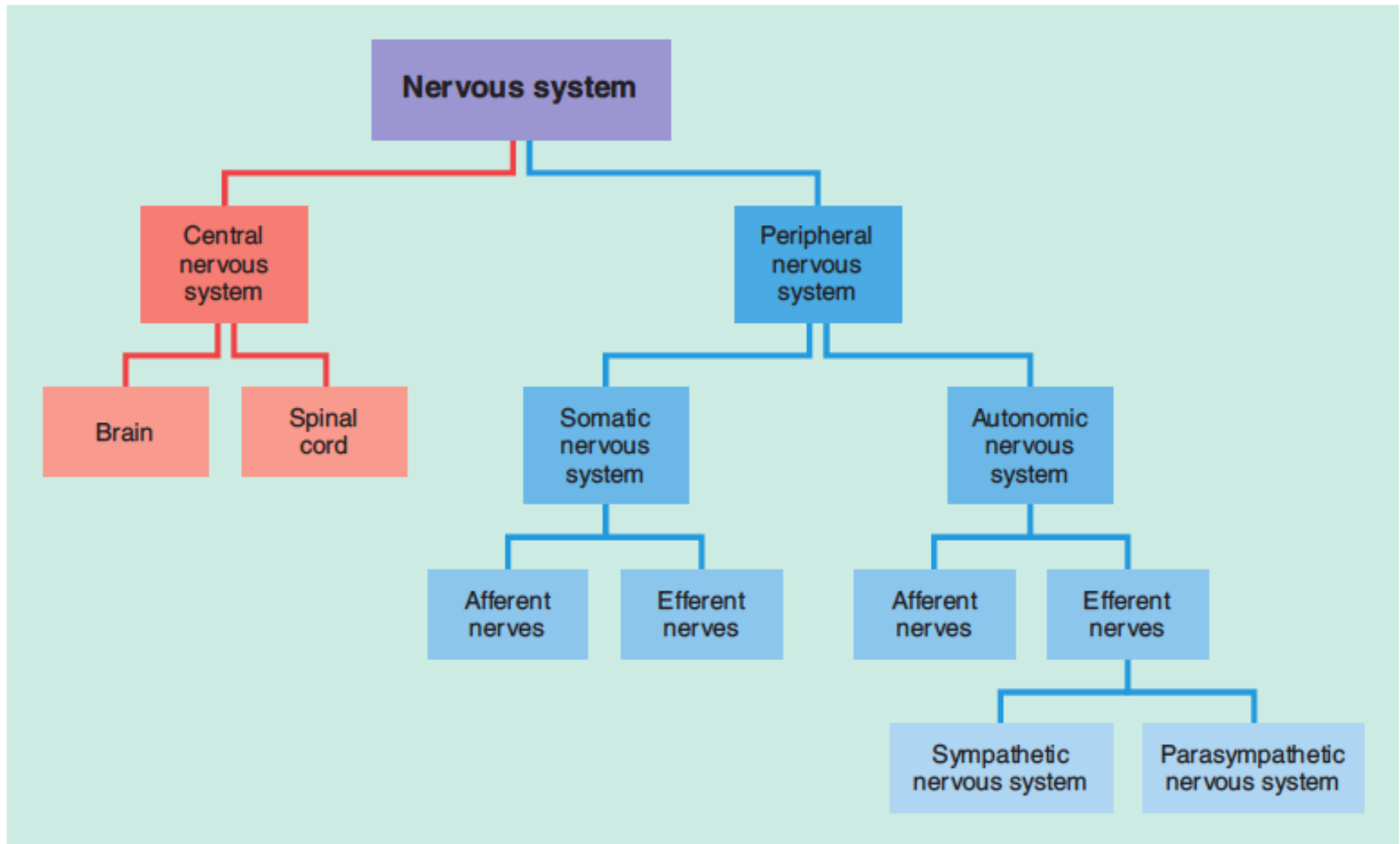
# Ureterovesical Junction



# **INNERVATION OF THE BLADDER & URETHRA**

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# A General Look at the Nervous System

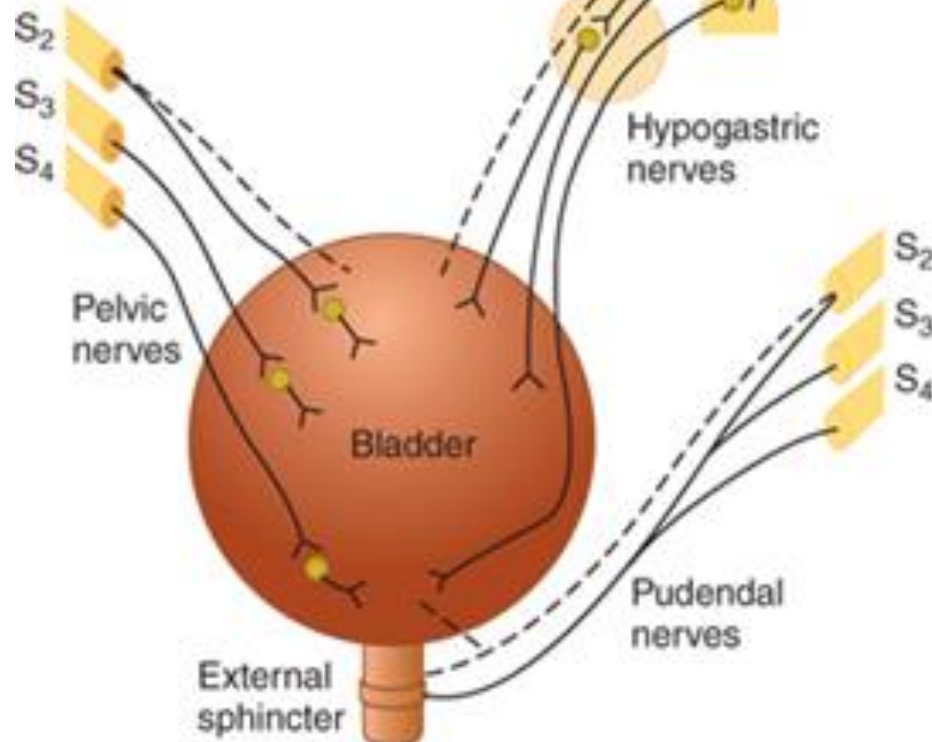


**FIGURE 3.2** The major divisions of the nervous system.

# Neural Innervation of the bladder

Contracts bladder  
Relaxes int. sphincter

## Parasympathetic



## Sympathetic

Relaxes bladder  
Contracts int. sphincter

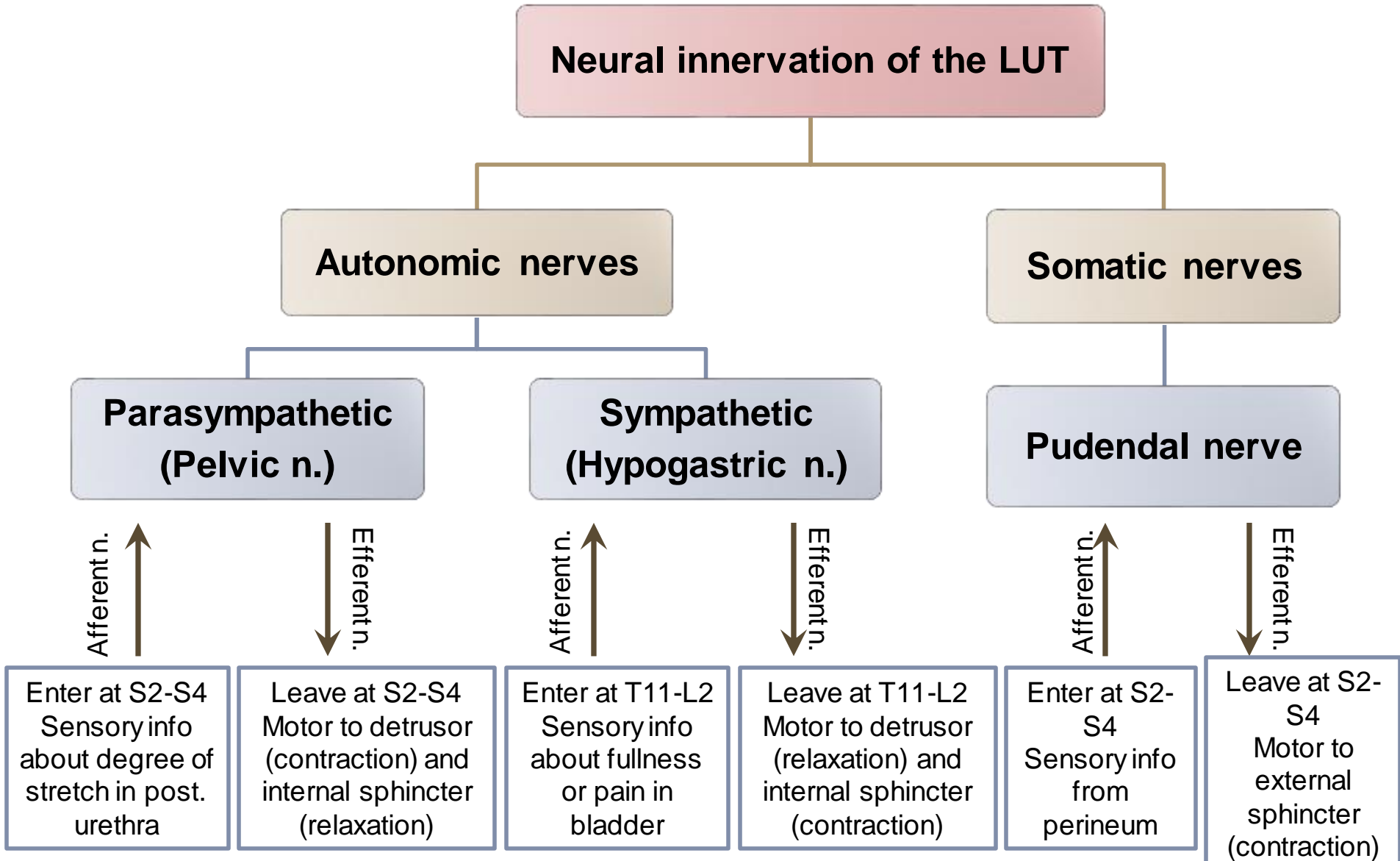
## Nerve supply of the LUT:

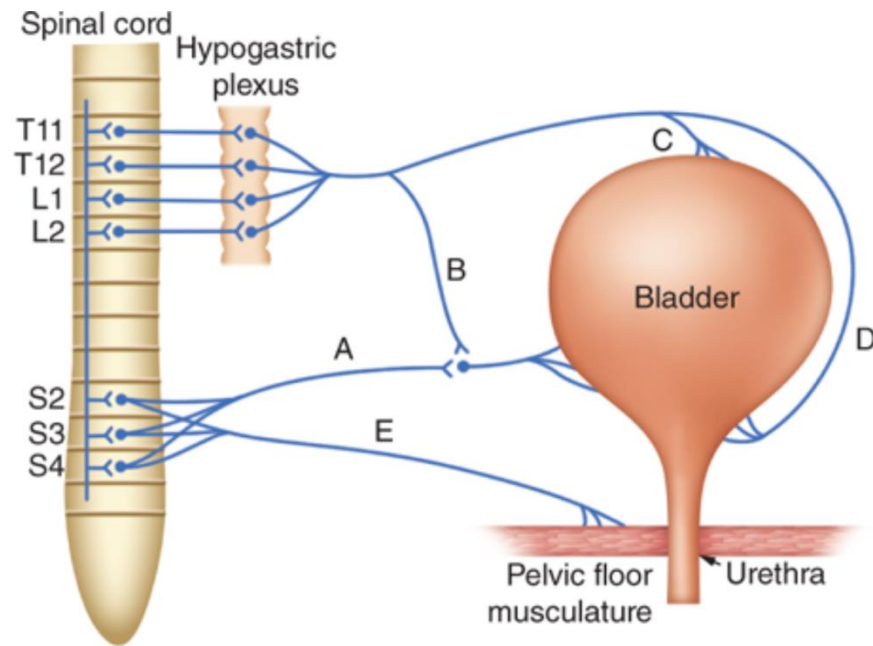
- **Somatic** (S2-S4).
- **Autonomic**
  - Parasympathetic (S2-S4).
  - Sympathetic (T11-L2).

## Somatic

Contracts ext. sphincter

# Neural Innervation of the bladder





TYPE OF NERVE	FUNCTION
A Parasympathetic Cholinergic..... (nervi erigentes)	Bladder contraction
B SYMPATHETIC.....	Bladder relaxation (by inhibition of parasympathetic tone)
C SYMPATHETIC.....	Bladder relaxation ( $\beta$ adrenergic)
D SYMPATHETIC.....	Bladder neck and urethral contraction ( $\alpha$ adrenergic)
E SOMATIC (pudendal nerve).....	Contraction of pelvic floor musculature

Peripheral nerves involved in micturition.

Source: R.L. Kane, J.G. Ouslander, B. Resnick, M.L. Malone:  
 Essentials of Clinical Geriatrics, Eighth Edition  
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Source: Incontinence, *Essentials of Clinical Geriatrics, 8e*

Citation: Kane RL, Ouslander JG, Resnick B, Malone ML. *Essentials of Clinical Geriatrics, 8e*; 2017 Available at: <https://accessmedicine.mhmedical.com/ViewLarge.aspx?figid=178119724> Accessed: April 09, 2018

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# THE MICTURITION REFLEX

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# Micturition

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- Micturition = the process by which the urinary bladder empties when it becomes full.
- Micturition is a visceral function → under control of the autonomic nervous system.
- ***How is micturition different from other visceral functions?***

# The Micturition Reflex

Filling of bladder

Stretches the wall

Stimulate stretch receptors

Excite parasympathetic efferent and inhibit pudendal discharge

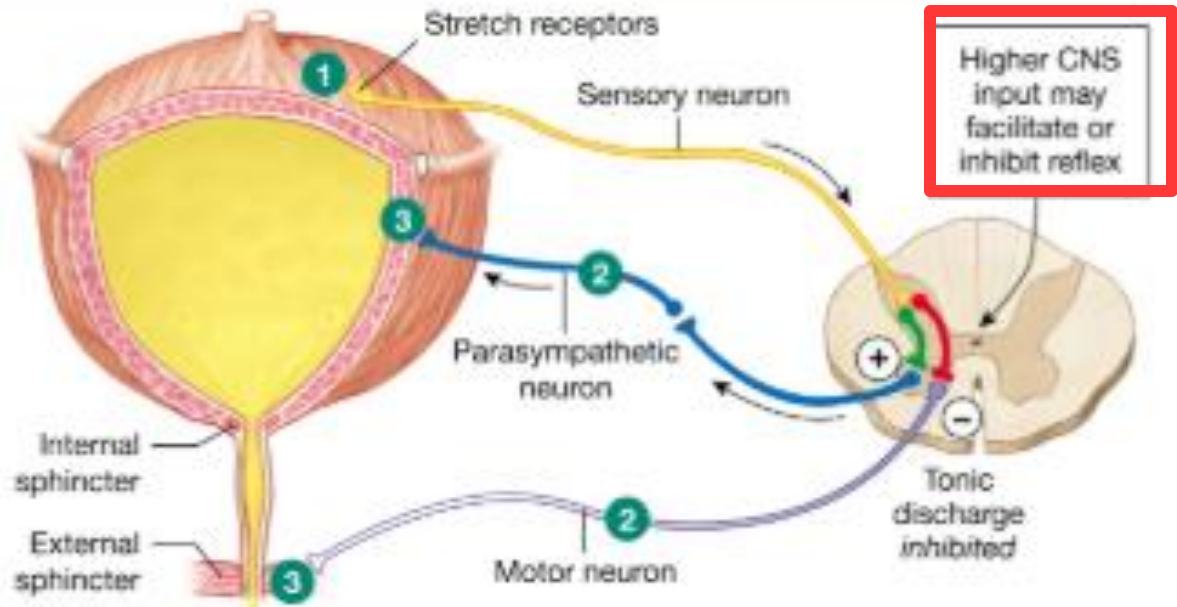
Signals are carried through pelvic nerve to sacral center

## (b) Micturition

1 Stretch receptors fire.

2 Parasympathetic neurons fire. Motor neurons stop firing.

3 Smooth muscle contracts. Internal sphincter is passively pulled open. External sphincter relaxes.



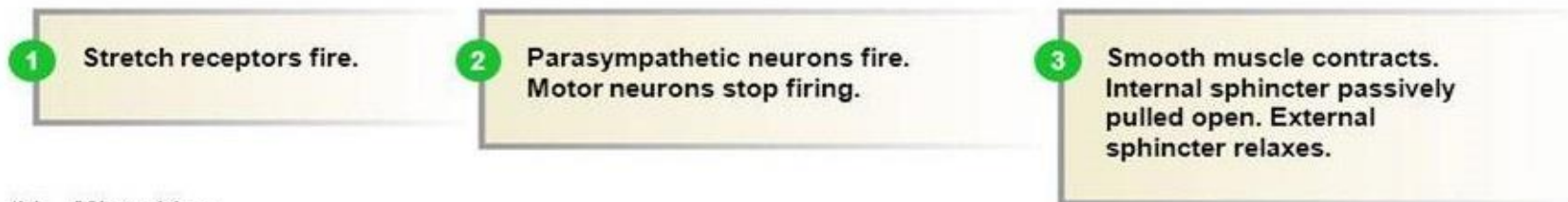
# The Micturition Reflex

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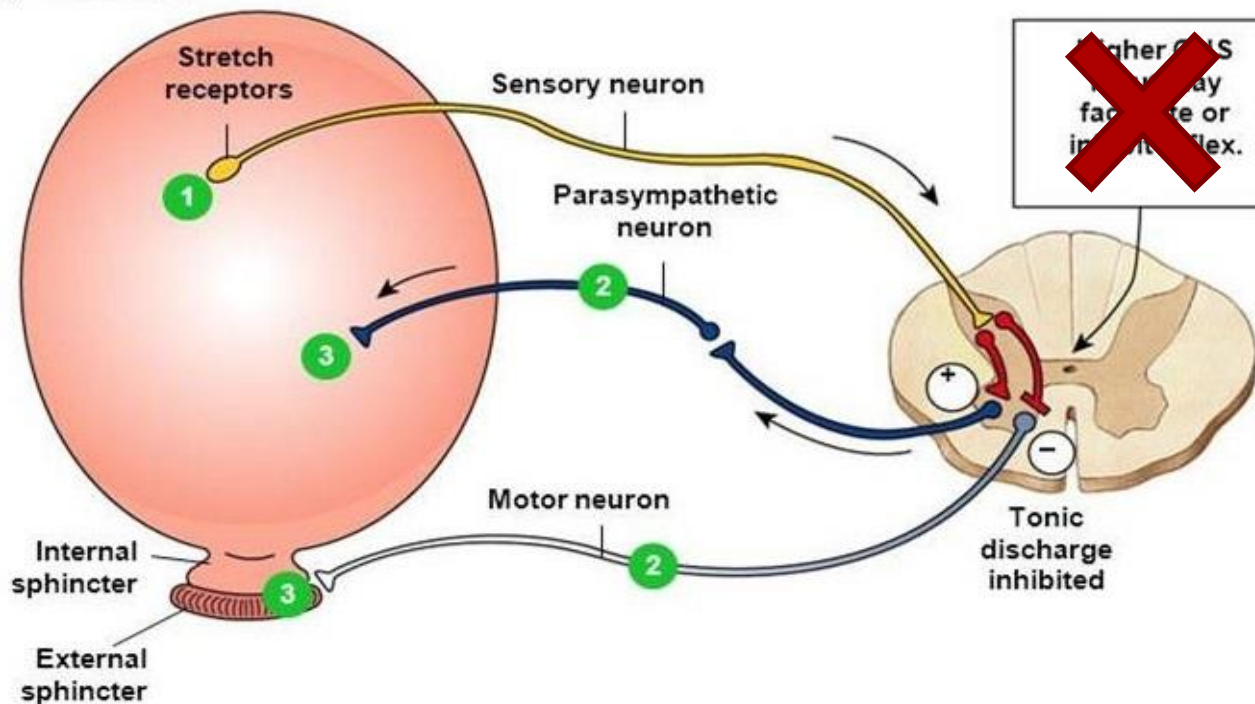
- It is an autonomic reflex that can be facilitated or inhibited by higher centres.
- Occurs in two steps:
  1. Progressive filling of the bladder until a threshold is reached.
  2. At the threshold, a nervous reflex is initiated “micturition reflex” to empty the bladder.
- If the conditions for emptying are favourable → emptying will occur.
- If the conditions for emptying are unfavourable → reflex is inhibited, however, there is the conscious desire to urinate.

# The Micturition Reflex-infants

- An autonomic spinal reflex.
- Involuntary-Not yet under higher CNS control.
- Between 2-3 years of age-they learn to control it and becomes voluntary.

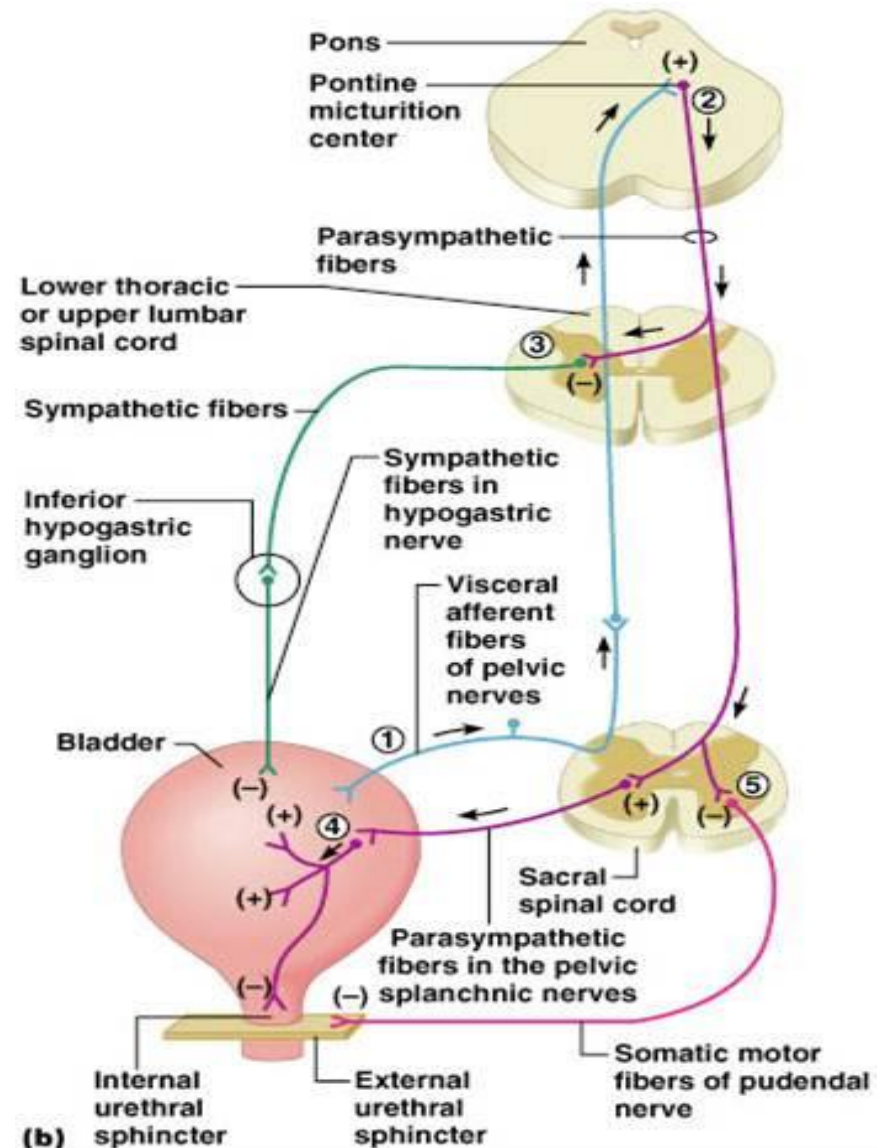


(b) Micturition

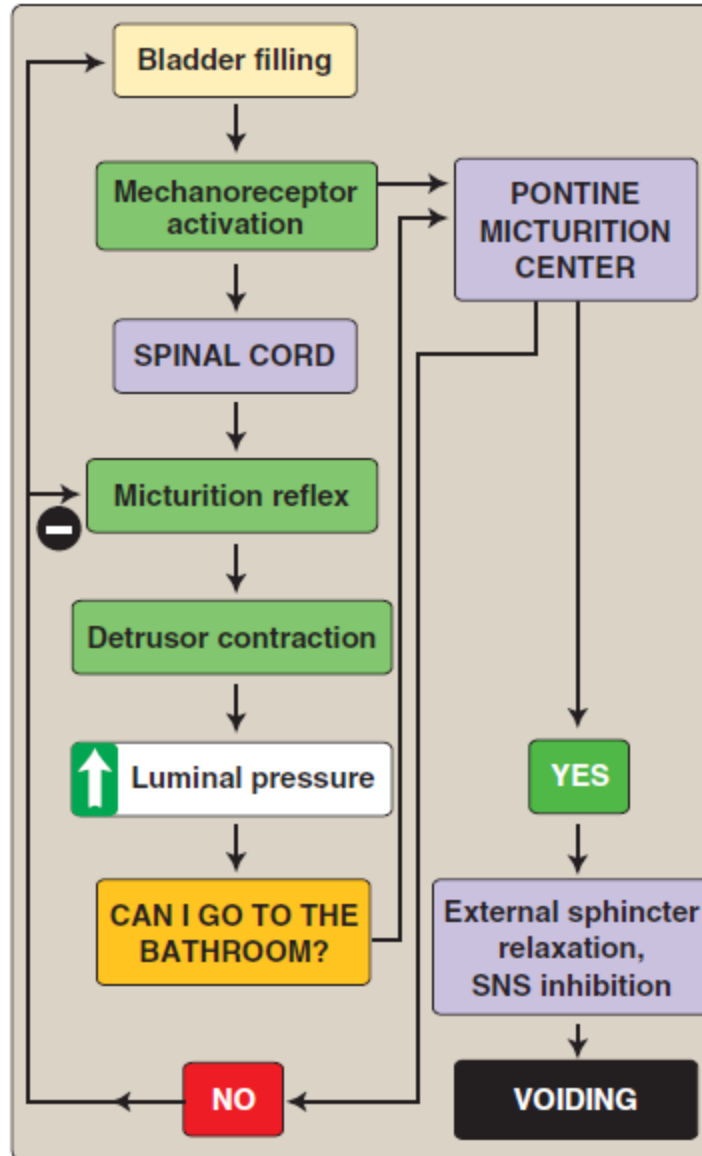


# The Micturition Reflex-Adults

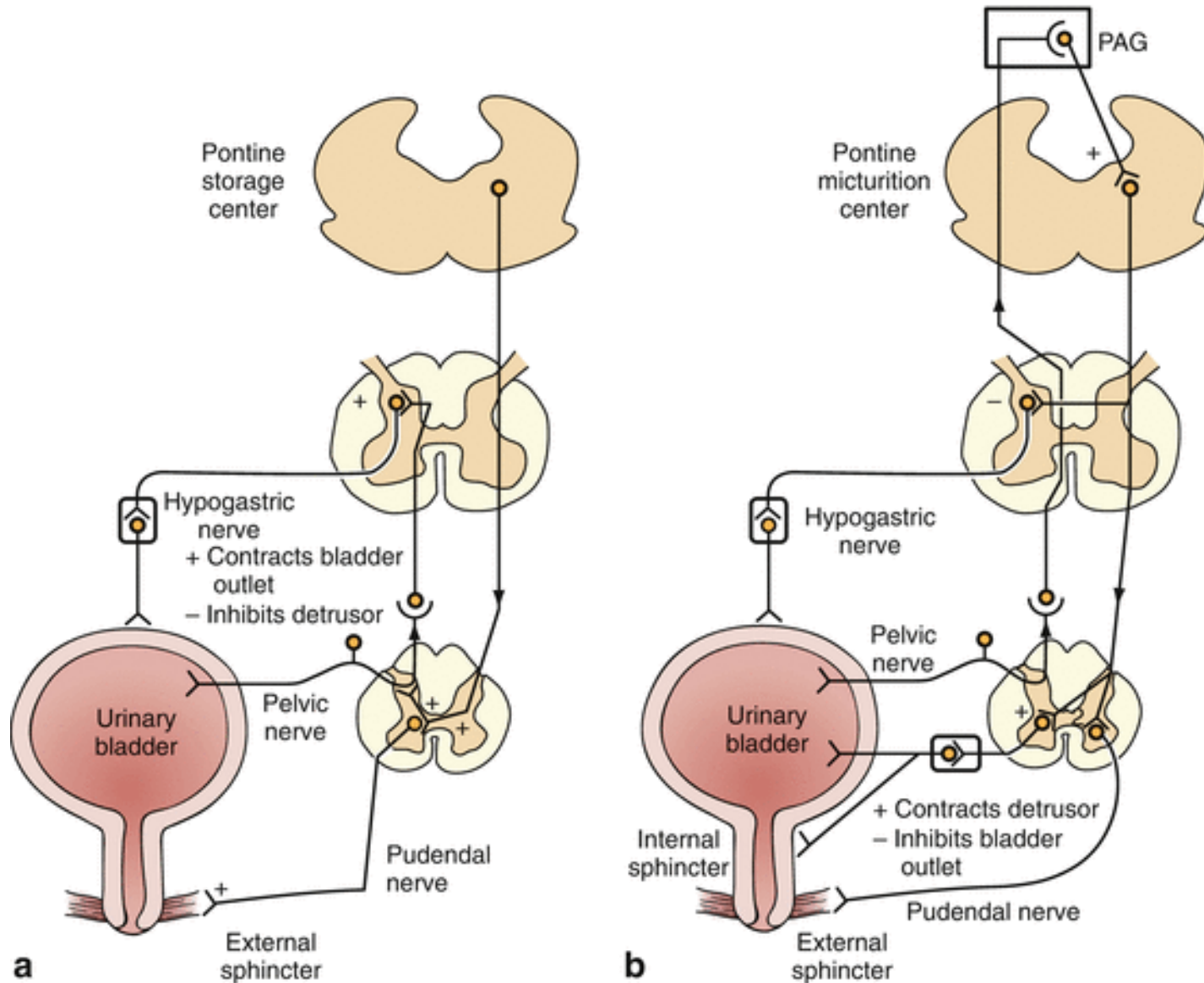
- An autonomic spinal reflex.
- Is controlled by higher CNS centres;
  - Brain stem (Pons).
  - Cerebral cortex.
- Control is either inhibitory or facilitatory.
- Voluntary.



# The Micturition Reflex



# Summary





# THE CYSTOMETROGRAM

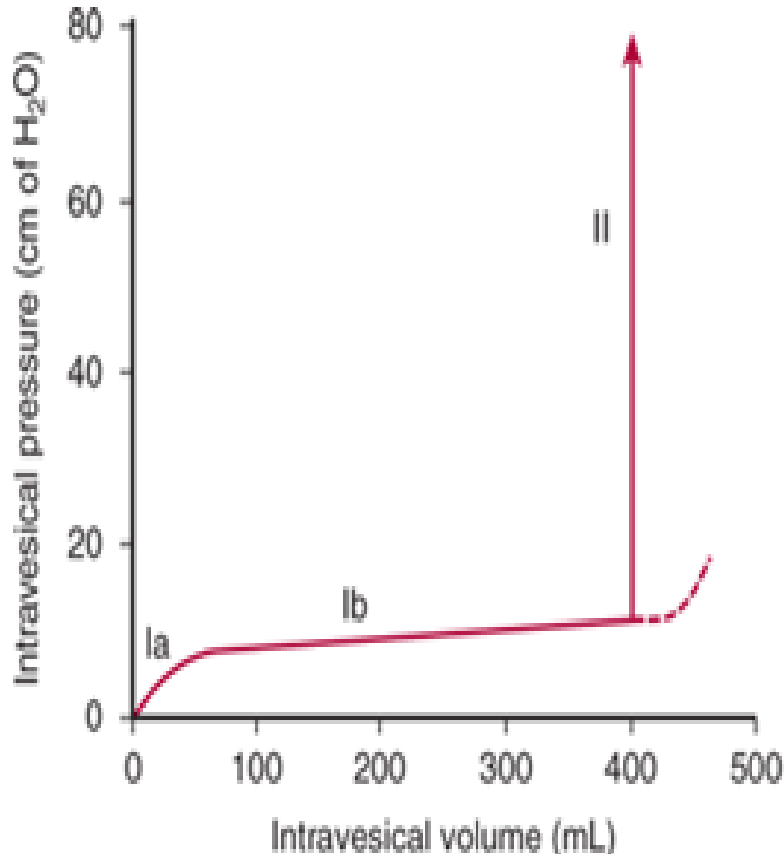
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# Filling of the Bladder-Bladder Tone

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- ***Bladder tone*** = the relationship between bladder volume and pressure (intravesical pr.).
- The relationship between bladder volume and intravesical pressure can be studied using cystometry.
- The volume-pressure record is called a ***cystometrogram***.

# The Cystometrogram



## Three phases:

**Ia** = an increase in IVP (0 to  $\approx 10$  cm H<sub>2</sub>O) at an initial increase in volume from 0 to  $\approx 50$ ml).

**Ib** = filling of bladder from 50 to  $\approx 400$ ml of urine causes no significant increase in IVP.

**Why??**

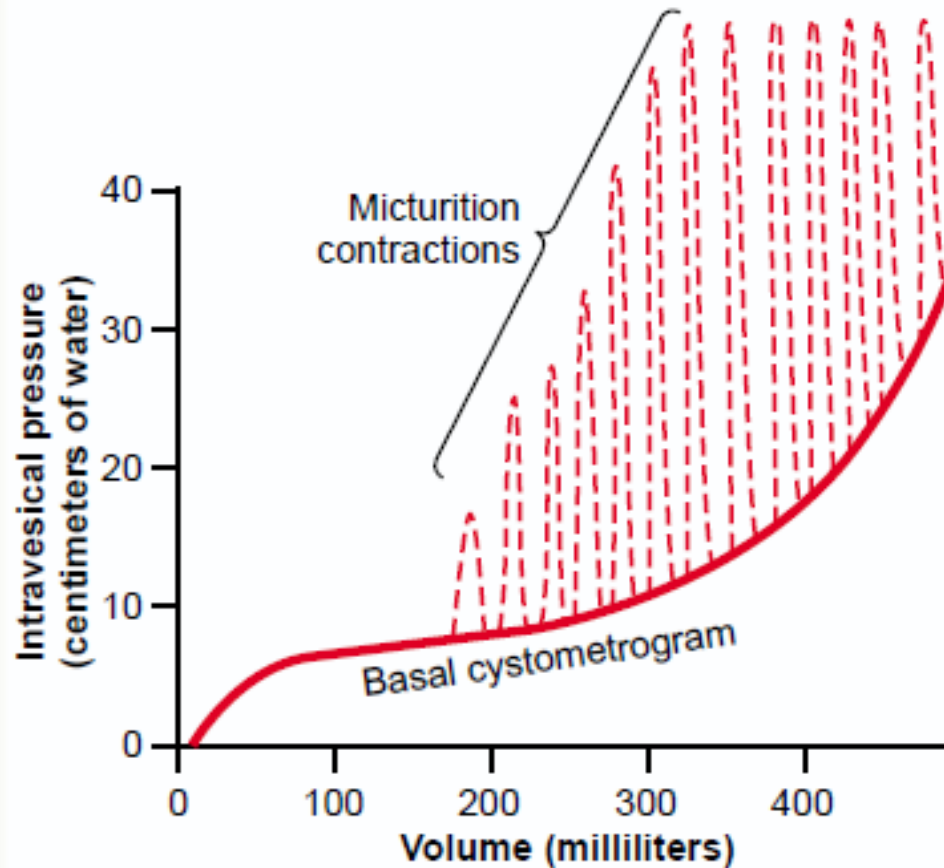
**II** = volumes > 400ml will cause a steep increase in IVP triggering the micturition reflex.

Source: Kim E. Barrett, Susan M. Barman, Scott Boltano, Heddwen L. Brooks: Ganong's Review of Medical Physiology, 25th Ed.

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# The Cystometrogram

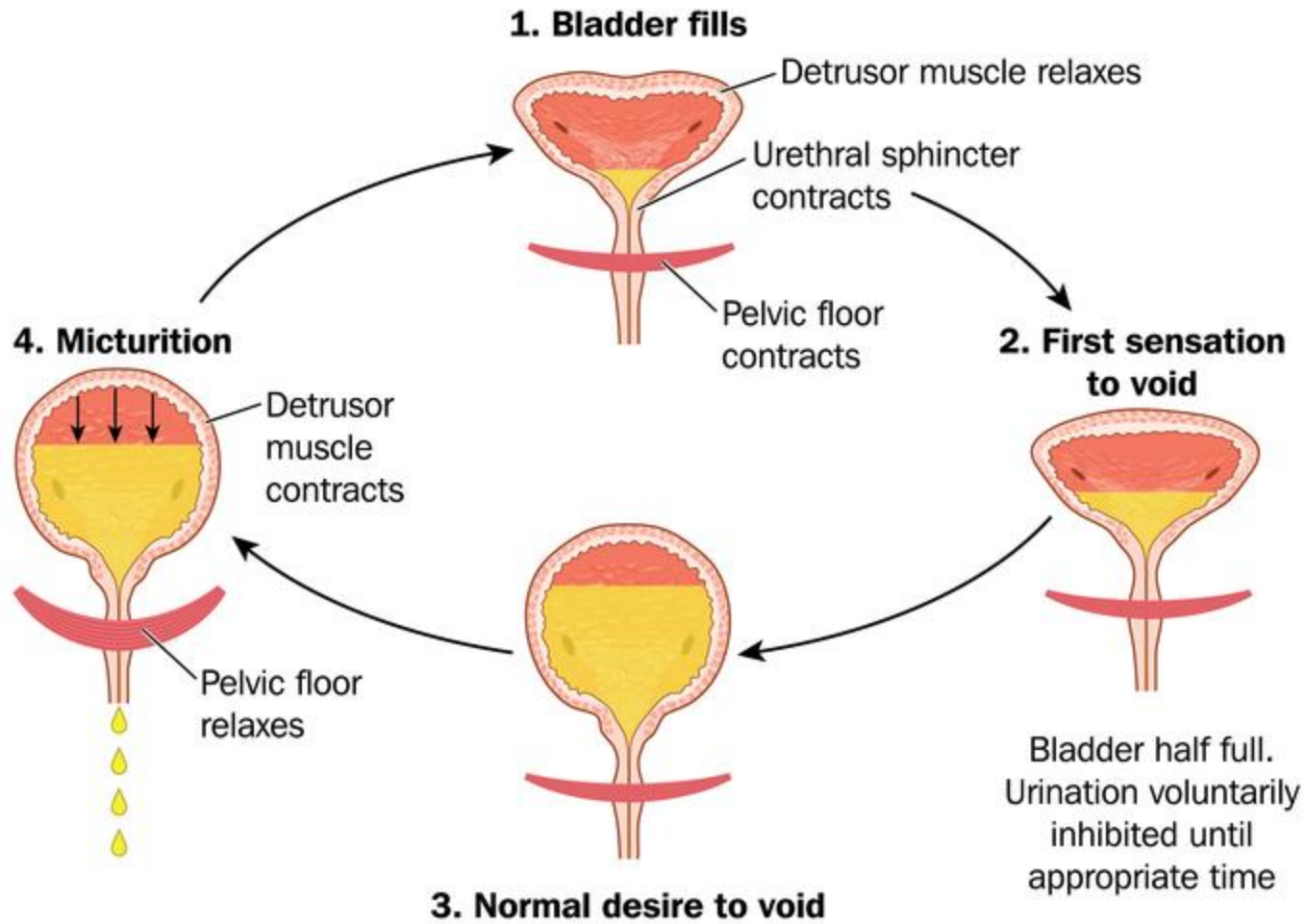


- Superimposed on the basal cystometrogram are periodic sharp increases in IVP that may last a few seconds to more than a minute.
- These peaks are called “micturition waves”.. ***What are they caused by?***

# Bladder Sensations at Different Urine Volumes

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- Urine volume of  $\approx$  **150 –300 ml**  $\Rightarrow$  first urge to void.
- From  $\approx$  **300 –400 ml**  $\Rightarrow$  sense of bladder fullness.
- From  $\approx$  **400 –600 ml**  $\Rightarrow$  sense of discomfort.
- From  $\approx$  **600 –700 ml**  $\Rightarrow$  sense of pain.
- **Micturition reflexes** start to appear at the first stage and progressively increase in intensity as the volume increases. Micturition reflexes can be voluntarily suppressed.
- At  $\approx$  **700 ml**  $\Rightarrow$  break point  $\Rightarrow$  micturition can not be suppressed.



# ABNORMALITIES IN MICTURITION

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# Abnormalities in Micturition

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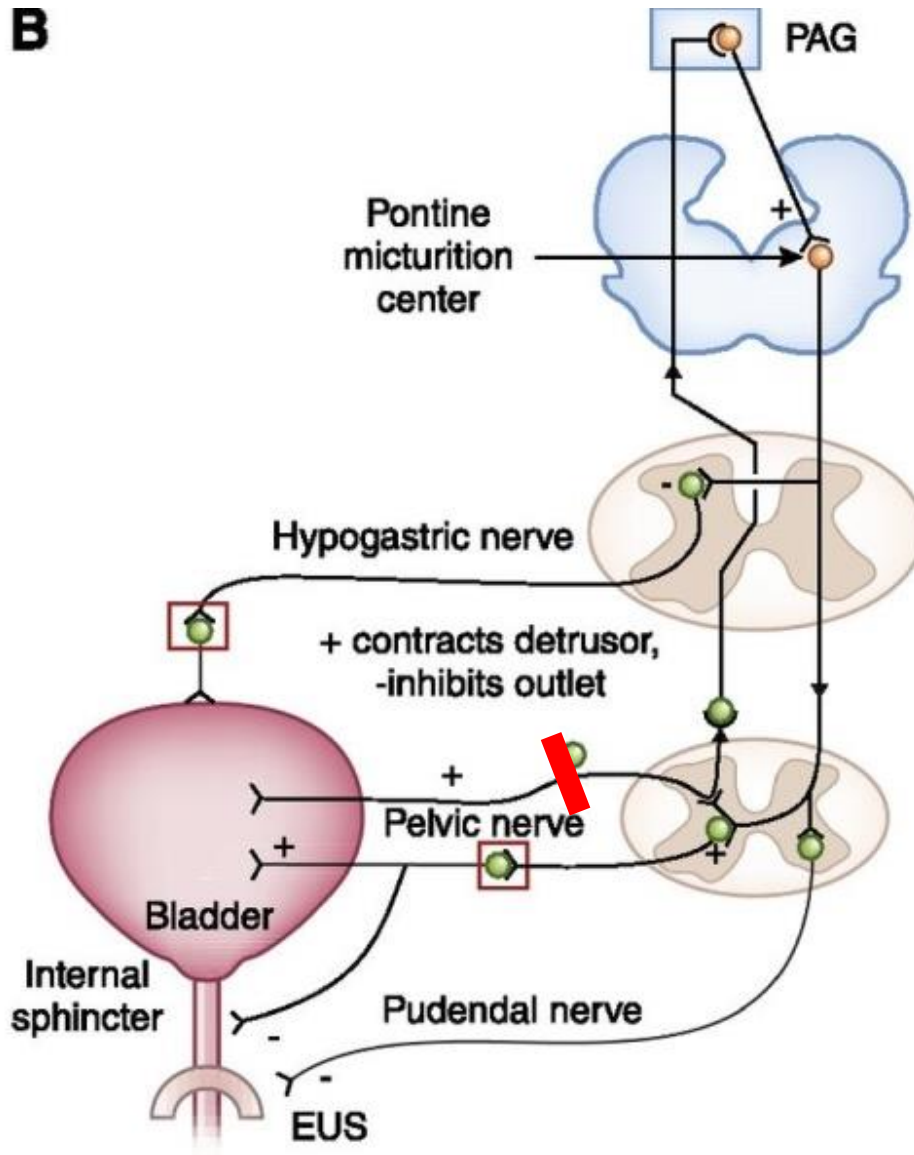
## 1. Lesions affecting the afferent sensory nerves:

- Results in an *atonic (flaccid)* bladder.
- Injury of afferent nerves → loss of perception of bladder fullness + micturition reflex cannot be initiated → bladder overstretching → thinning of the wall and ineffective contractions.
- Retention of urine with overflow.
- Causes e.g. tabes dorsalis (syphilis), diabetes



## Lesions affecting the afferent sensory nerves

**B**



Lesion in the afferent sensory fibers that carry stretch sensation from bladder wall



Feeling of bladder fullness is lost  
Cannot initiate the reflex



The bladder cannot empty urine but urine continues to collect



Urine will collect until pressure in bladder becomes high causing dribbling of urine

***Overflow incontinence***

# Abnormalities in Micturition

## 2. Damage to spinal cord above the sacral region:

- The micturition reflex is intact, but lost higher center control.
- There are several phases:

Acute phase  
(Spinal shock)



Recovery from spinal  
shock

Loss of facilitatory impulses from CNS



Micturition reflex is inhibited



Bladder fills but cannot void  
(overflow incontinence)

Micturition reflex recovers



Not controlled by CNS

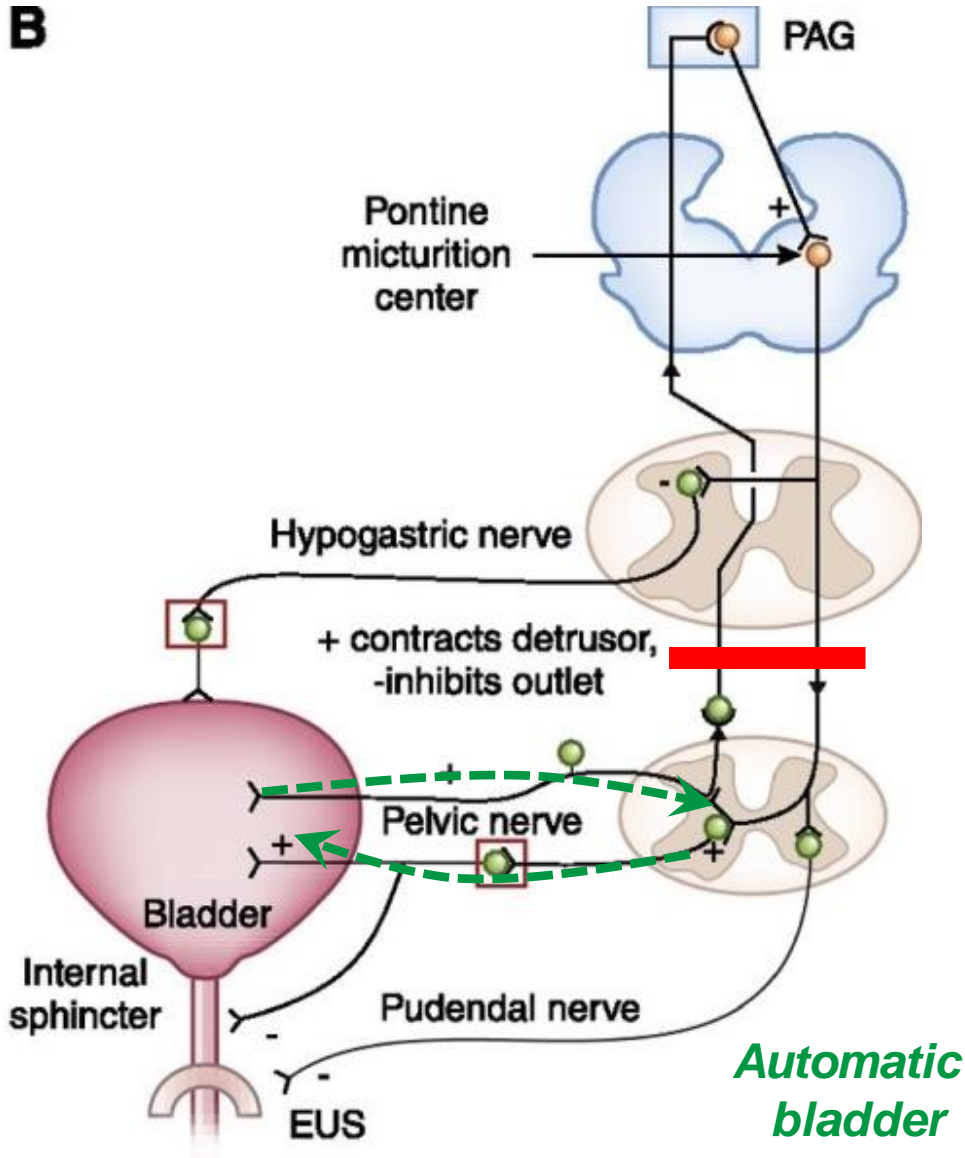


Bladder fills and voids automatically  
(**Automatic bladder**)

*Bladder needs to be emptied periodically by  
catheterization*

# Lesions affecting the spinal cord above the sacral region

B



Lesion in the spinal cord above the sacral center



Loss of facilitatory impulses from higher centers



Micturition reflex is inhibited



Urine will collect until pressure in bladder becomes high causing dribbling of urine

**Overflow incontinence**

Micturition reflex regains function but not under CNS control

Spinal shock phase

Recovery

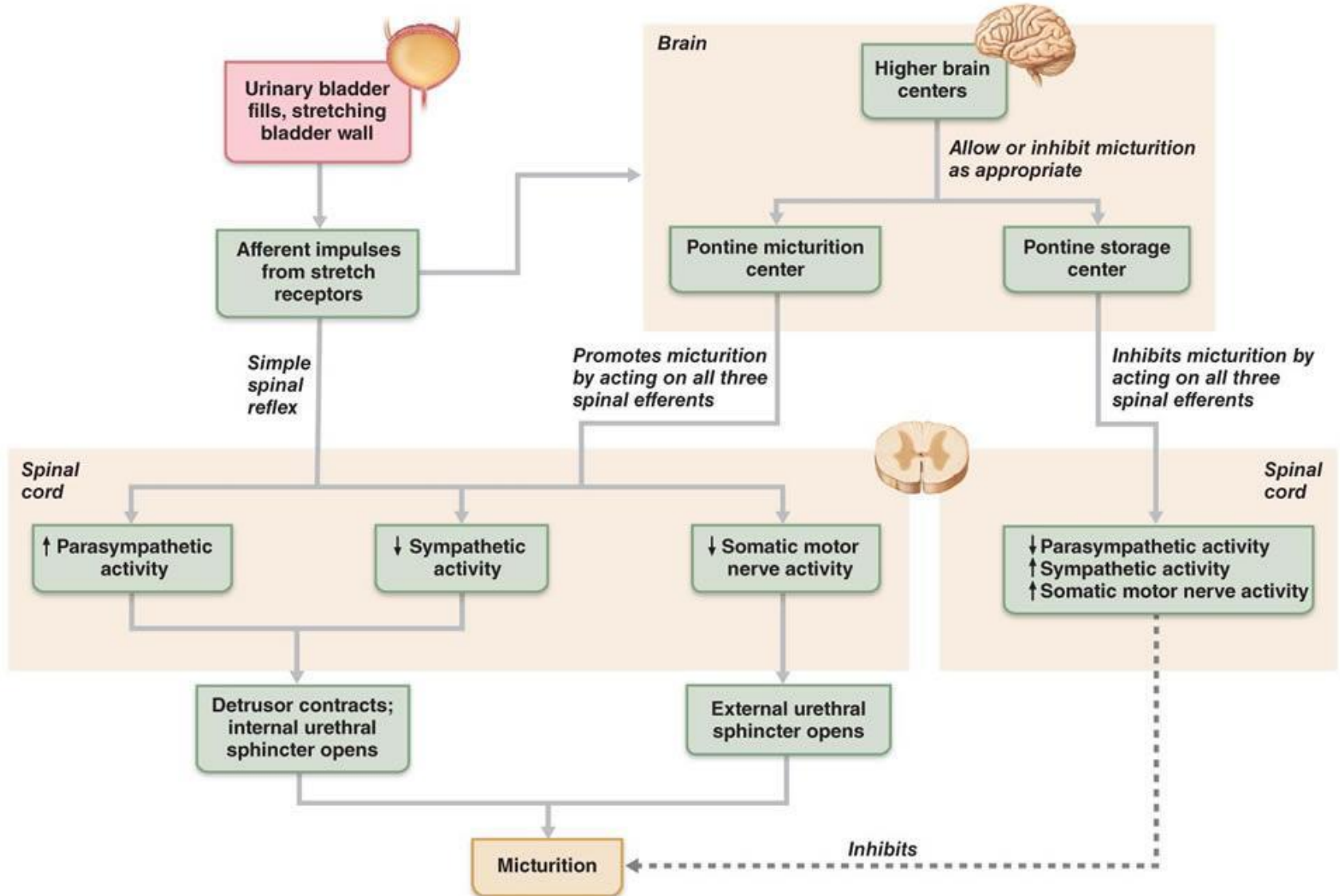
# Abnormalities in Micturition

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## 3. Uninhibited neurogenic bladder:

- Causes frequent relatively uncontrolled micturition.
- Results from lesions to spinal cord or brain stem that mainly affects the inhibitory signals to spinal cord.
- This will cause a hyperactive detrusor muscle that will result in activation of micturition even at small urine volumes.
- Frequent urination of small volume of urine.

# Summary



**Thank you**