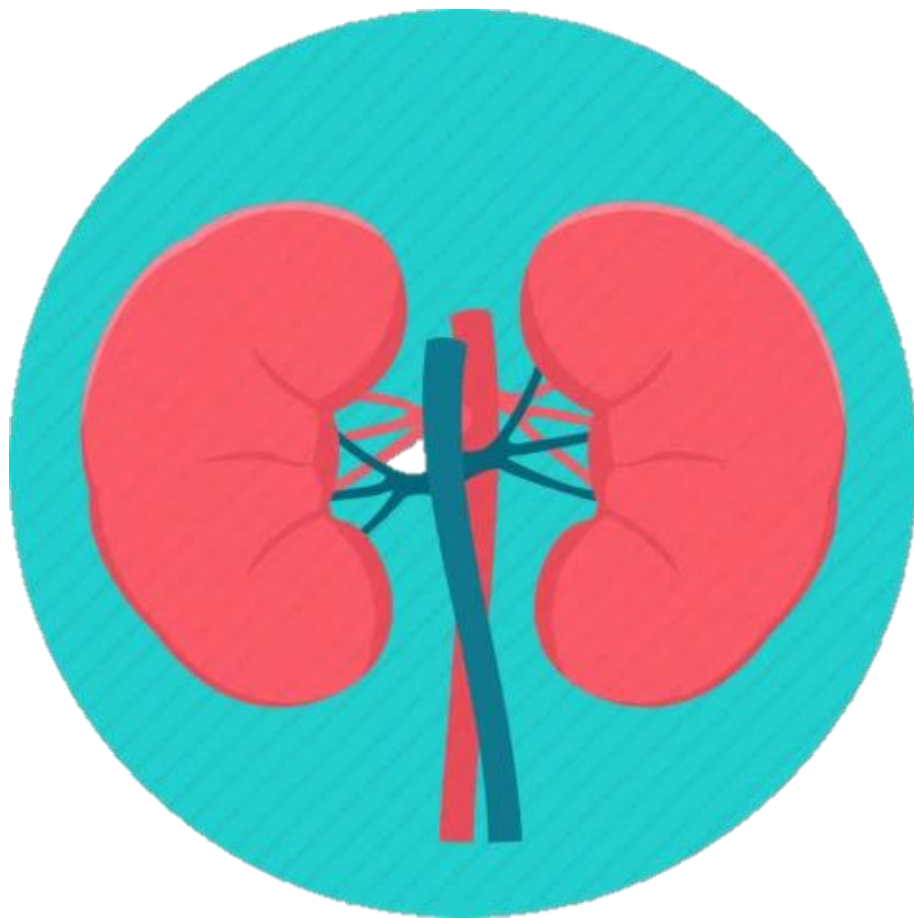


# Lecture (4)

# Micturition

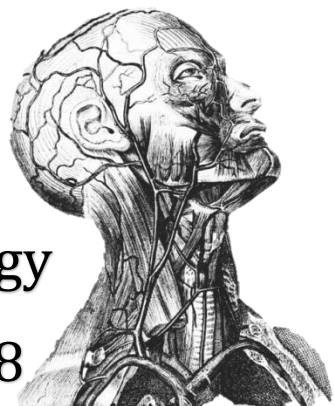


## Index:

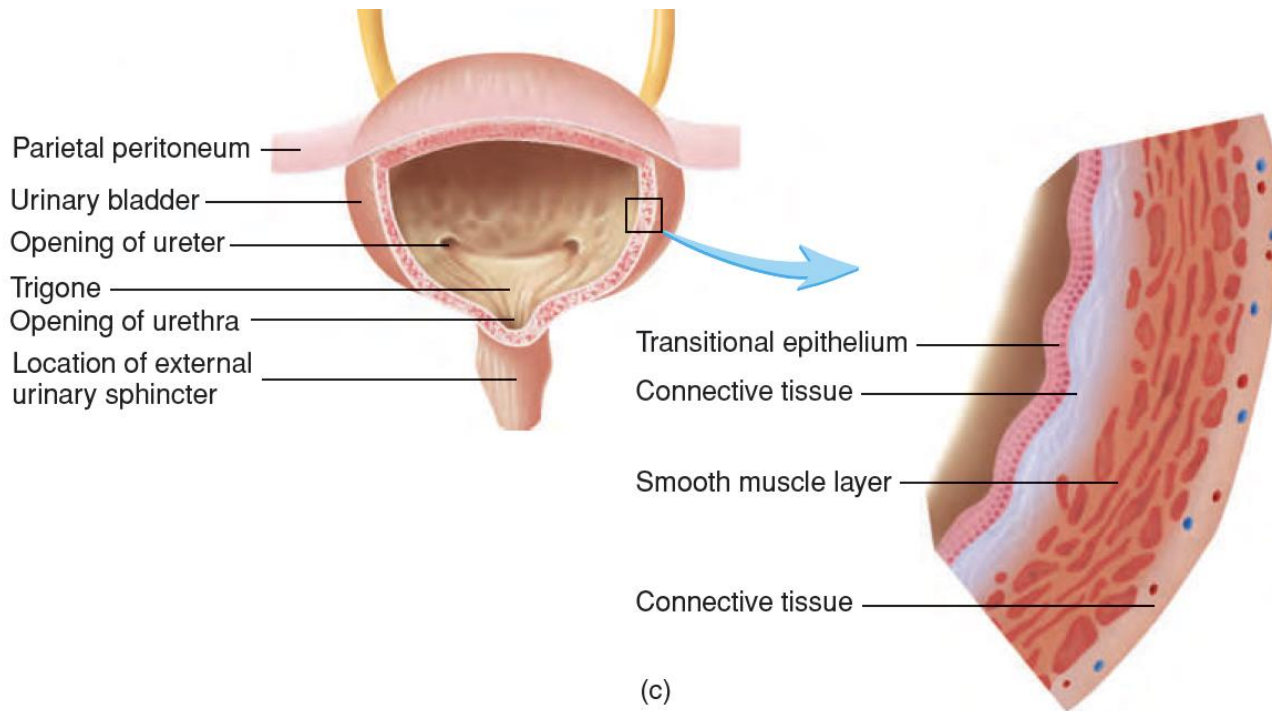
- Text
- **Important**
- Extra

Physiology

MED438



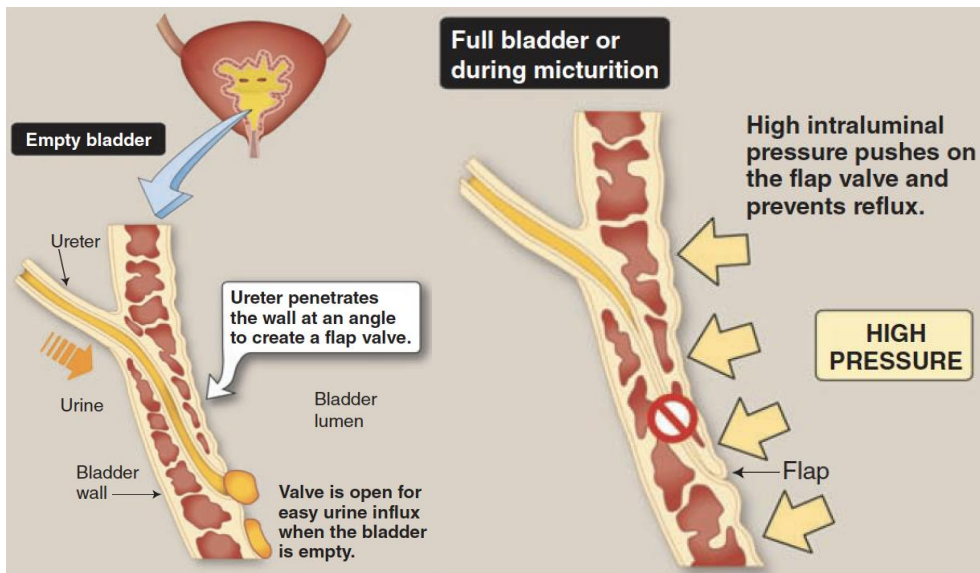
# Anatomy of the Urinary Bladder:



- The bladder has a body and a neck, with two sphincters, internal and external.
- Internal sphincter is made up of smooth muscles (involuntary by autonomic nerves)
- External sphincter is made up of skeletal muscle (voluntary by somatic nerves)
- The bladder is made up of **4 layers**:
  1. Mucosa: transitional epithelium
    - Has “rugae”, or folds, that will flatten out as the bladder fills in.
    - These foldings allow the capacity to extend from 10 ml to 400 ml with a very minimal pressure change of 10 cmH<sub>2</sub>O
  2. Submucosa: loose connective tissue
  3. Detrusor muscle: **smooth** muscle used to empty the bladder. (involuntary)
  4. Serosa: connective tissue

Functions	Abnormalities
Storage of urine	Incontinence (leakage)
Emptying (voiding)	Obstruction

# Ureterovesical Junction



- The ureter penetrates the bladder through the ureteric orifice
- When the bladder gets full, the opened junction will close due to the increase in the intravesical pressure (pressure inside the bladder) to prevent more urine from filling it
- If the distance of the ureter entering through the bladder is **short** (runs horizontally), **reflux** will happen

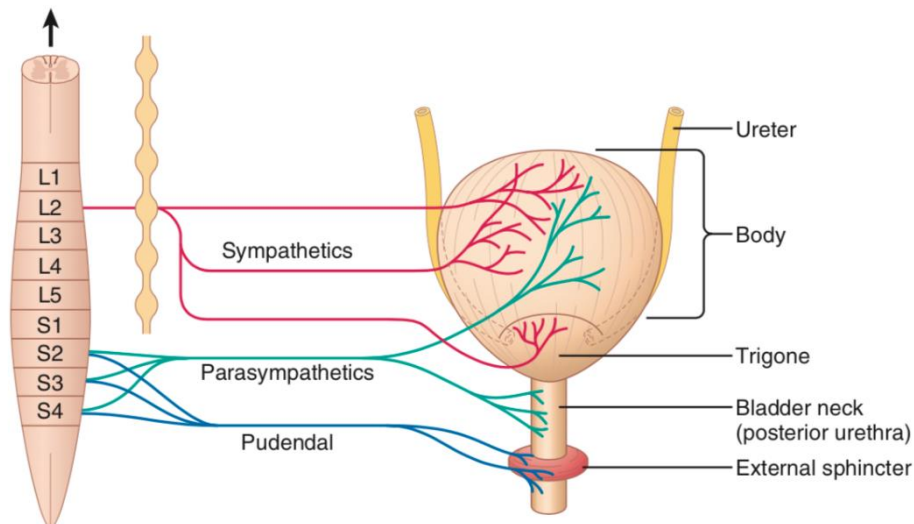
# Urine Transport

- Urine is transported from the kidneys to the bladder through the ureters
- Urine is propelled (moved) to the bladder using peristalsis (smooth muscle contractions)
- Peristalsis is thought to be initiated by pacemaker cells in the renal pelvis

**Sympathetic** → ↓ **peristalsis**

**Parasympathetic** → ↑ **peristalsis**

# Innervation of the Urinary Bladder



	Nerves	Functions
Autonomic	<b>Hypogastric Sympathetic</b> (L1-L3) (T11-L2)	<b>Afferent</b> (via dorsal lumbar roots to L1-L3) <ul style="list-style-type: none"> <li>Sensation of <b>pain</b> when bladder is distended (enlarged) or inflamed</li> </ul> <b>Efferent</b> (to the bladder): <ul style="list-style-type: none"> <li>-Motor- Inhibitory (relaxation) to the detrusor muscle</li> <li>Motor (contraction) to the internal urethral sphincter</li> <li>Motor to the seminal vesicle and ejaculatory duct</li> </ul>
	<b>Pelvic (Parasympathetic)</b> (S2-S4)	<b>Afferent</b> (via dorsal sacral roots to S2-S4) <ul style="list-style-type: none"> <li>Sensation of bladder fullness, pain &amp; reflex micturition (desire to pee)</li> </ul> <b>Efferent</b> (to the bladder): <ul style="list-style-type: none"> <li>Motor to the detrusor muscle</li> <li>Inhibitory to the internal urethral sphincter</li> </ul>
Somatic	<b>Pudendal</b> (S2-S4)	<b>Afferent</b> -Sensory info from external sphincter- Sensation when urethra is distended and when urine passes it <b>Efferent</b> (to the bladder): <ul style="list-style-type: none"> <li>Motor (contraction) to the external urethral sphincter</li> </ul>

[more about innervation](#)

# Micturition & the Micturition Reflex [Extra explanation](#)

- **Micturition:** is the process by which the bladder empties itself when it becomes filled
- It is a nervous reflex that can be **facilitated** or **inhibited by higher center**
- Emptying is favorable → micturition reflex is facilitated (will occur)
- Emptying is NOT favorable → micturition is inhibited (but the need to urinate is still felt)

**It occurs in two steps:**

## Filling:

distention of the bladder -until the threshold is reached- **due to the increase in I.V.P.\*\*** will send a nerve signal to the higher centers of the brain to initiate the reflex.



## Emptying:

at the threshold, contraction of detrusor muscle and relaxation of both sphincters  
**"micturition reflex"**

\*\* I.V.P. (intravesicular pressure) is responsible for micturition **NOT** the urine volume

## Stages of Sensation of Urine Volume:

**Stage 1:** 150-300 ml → first urge to void

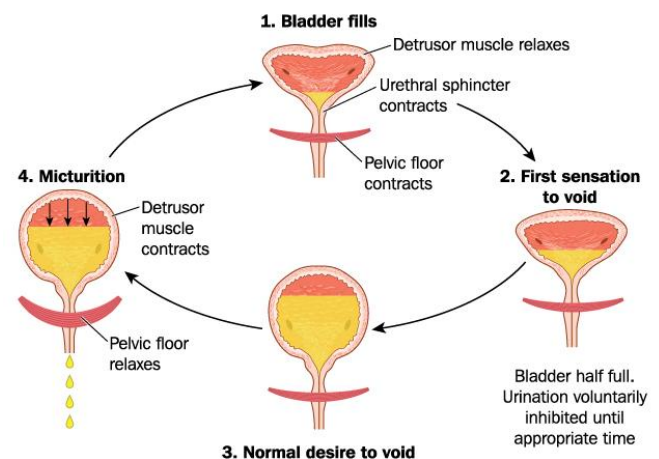
**Stage 2:** 300-400 ml → sensation of bladder fullness (parasympathetic afferent supply)

**Stage 3:** 400-600 ml → sensation of discomfort

**Stage 4:** 600- 700 ml → sensation of pain (sympathetic afferent supply)

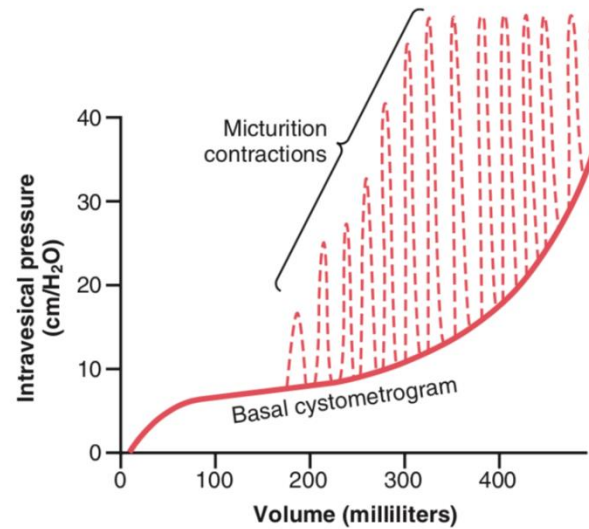
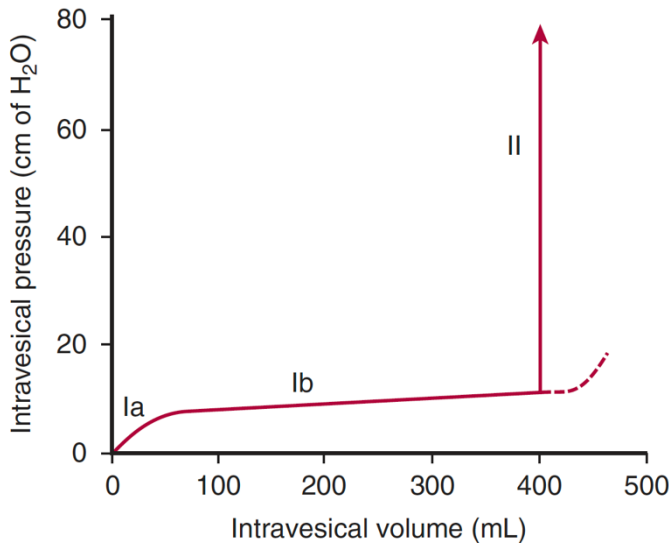
**Stage 5:** at about 700 ml → break point (micturition can't be suppressed)

- Micturition reflex start to appear at the first stage and can be suppressed voluntarily except in stage 5



# Cystometrogram

- **Bladder tone:** the relationship between bladder volume and intravesical pressure (I.V.P.)
- Cystometry is the study of the relationship between bladder volume and the intravesical pressure.
- The vesical-pressure record is called **cystometrogram**



SEGMENTS	PROCESS
<b>IA</b>	Represents the initial rise in I.V.P. by about <b>10 cmH<sub>2</sub>O</b> Due to the increase in volume by about <b>50 ml</b>
<b>IB</b> (LONGEST PHASE)	Represents the increase of volume to <b>50-400 ml</b> There's <b>NO change</b> in pressure due to the ability to stretch
<b>II</b>	Represents the sudden increase in pressure when volume reaches <b>400 ml</b> which will trigger the micturition reflex

- In the right graph, pressure waves (peak) shown are called **micturition waves** that occurs during voluntary voiding due to the micturition reflex which may last from a **few seconds** to more than a **minute**

## Micturition reflex in infants & adults:

Unconditioned/involuntary	Conditioned/voluntary
<p style="text-align: center;"><b>Infants</b></p> <ul style="list-style-type: none"> <li>• Micturition in infants is an autonomic reflex that is involuntary due to the underdeveloped pudendal nerves (unmyelinated)</li> <li>• Between 2-3 years the child begins to learn how to control it.</li> </ul>	<p style="text-align: center;"><b>Adults</b></p> <ul style="list-style-type: none"> <li>• Micturition in adults is also a reflex but can be controlled (voluntary)</li> <li>• An autonomic spinal reflex</li> <li>• It can be facilitated or inhibited by the supraspinal centers in the brain.               <ol style="list-style-type: none"> <li>1. <b>Facilitated:</b> pontine center -brain stem(pons)-, posterior hypothalamus &amp; cerebral cortex</li> <li>2. <b>Inhibited:</b> pontine storage center and the mid brain</li> </ol> </li> </ul>

## Micturition in Adults

Filling and stretch of the bladder (400 ml)

Stretching will send sensory signals to the sacral segment through the pudendal nerve

Signal will go to the pontine center in the brain  
Pontine center will send a signal back based on the condition

### Conditions are favorable

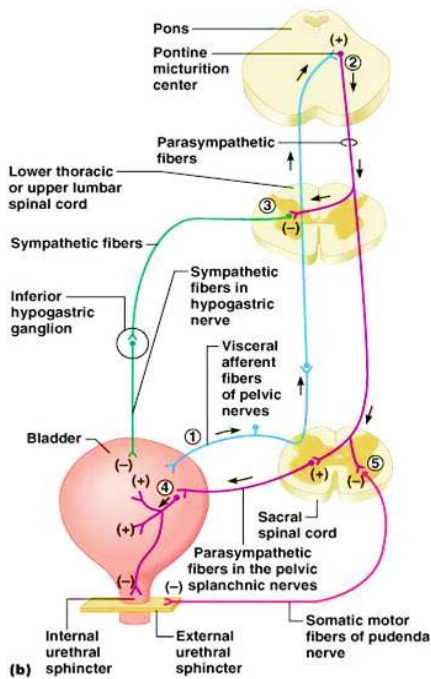
- Stimulation of micturition center
- Inhibition of pudendal nerves
- Relaxation of external sphincters
- Contraction of abdominal muscles and diaphragm (increase I.V.P)

### Conditions are unfavorable

- Inhibition of micturition center
- Stimulation of pudendal nerves
- Contraction of external sphincter
- Urine is retained in the bladder

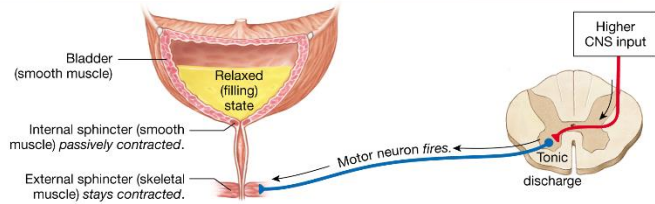
# Micturition reflex

## In Adults

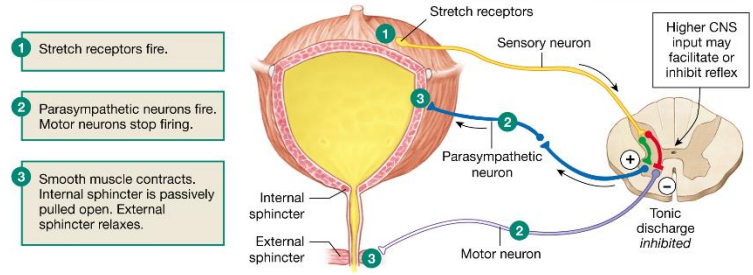


## In Infants

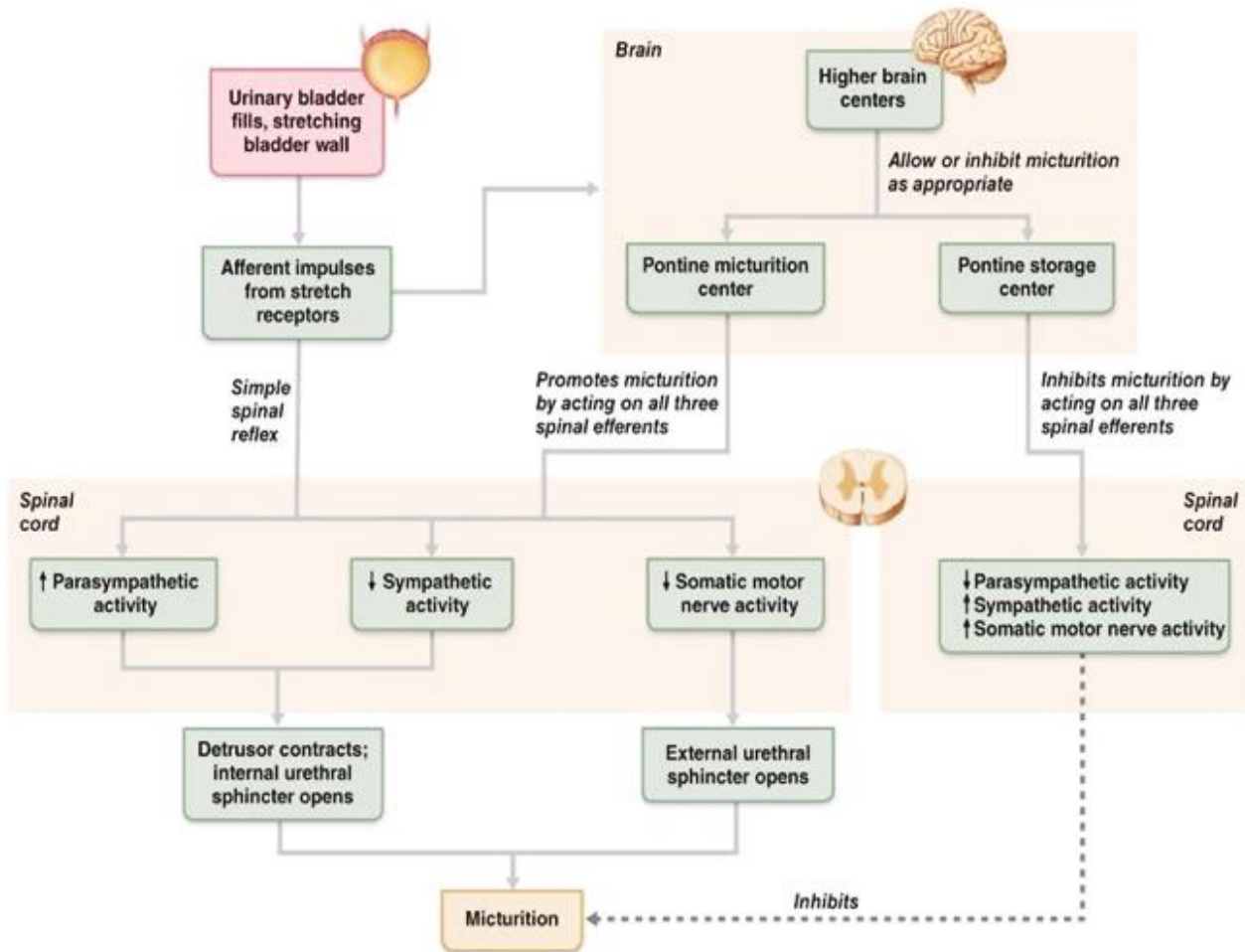
(a) Bladder at Rest



(b) Micturition



## Micturition reflex Summary





# Abnormalities in Micturition

## 2. Denervated afferent supply (sensory)

<b>Causes</b>	Tabes dorsalis/ Tabetic bladder (syphilis)
<b>Characteristics</b>	<ul style="list-style-type: none"> <li>• Flaccid (atonic), overstretched and hypotonic bladder</li> <li>• Loss of sensation of bladder fullness &amp; reflex micturition</li> <li>• Bladder over stretching → thinning of the wall &amp; ineffective contractions</li> <li>• Urine retention with overflow (dribbling when full)</li> </ul>

## 3. Denervation of afferent and efferent supply

<b>Causes</b>	Tumor or cauda equina syndrome
<b>Characteristics</b>	<ul style="list-style-type: none"> <li>• Hypertonic bladder due to:             <ul style="list-style-type: none"> <li>- Reuptake of Ach decreases its degradation</li> <li>- Decrease in cholinesterase (enzyme that degrades Ach)</li> <li>- Increase in Ach receptors</li> </ul> </li> <li>• Reflexes are abolished</li> <li>• Increase in SM intrinsic response</li> <li>• Uncontrolled periodic micturition (25-100ml at a time)</li> </ul>

## 4. Spinal cord transection (damage) **above sacral region**

<b>Characteristics</b>	<ul style="list-style-type: none"> <li>• Micturition reflex is intact, but lost higher center control</li> <li>• Divided into 3 stages:             <ul style="list-style-type: none"> <li>- <b>-Acute- Spinal shock stage (2-6 wks):</b> retention with overflow                → Occurs due to the separation of the spinal centers from the brain                → Loss of facilitatory impulses from CNS → micturition reflex is inhibited → bladder fills but can't void (over flow incontinence)-we protect them by catheterization-</li> <li>- <b>Recovery stage:</b> involuntary reflex micturition                → Not controlled by CNS → bladder fills &amp; void automatically (automatic bladder)                -like infant-                → This stage will occur as soon as the I.V.P. rises to 15-20 cmH<sub>2</sub>O</li> <li>- <b>Failure stage:</b> retention with overflow                → In case of bacterial damage by toxins to spinal cord</li> </ul> </li> </ul>
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## 5. Uninhibited neurogenic bladder

<b>Causes</b>	Lesions to spinal cord or brain stem that affects inhibitory signals
<b>Characteristics</b>	<ul style="list-style-type: none"> <li>• Hyperactive detrusor muscle</li> <li>• Frequent urination of small volume</li> </ul>

# Quiz

**1. Which of the following is the sympathetic afferent effect of the bladder?**

- A. Sensation of pain
- B. Sensation of fullness
- C. Contraction of the internal sphincter
- D. Contraction of the detrusor muscle

**2. Which of the following is the MAIN trigger of the micturition reflex?**

- A. Urine volume
- B. Bladder distention
- C. Trigone sensitivity
- D. Intravesicular pressure

**3. Which of the following bladder volumes reflects the discomfort sensation?**

- A. 150 ml
- B. 350 ml
- C. 550 ml
- D. 650 ml

**4. Which of the following is involved in the voluntary control of micturition?**

- A. External sphincter
- B. Internal sphincter
- C. Detrusor muscles
- D. Trigone

**5. What happens to the I.V.P. when the bladder volume reaches 150 ml?**

- A. Decrease
- B. Increase
- C. Constant
- D. Fluctuated

Answers: A, D, C, A, C

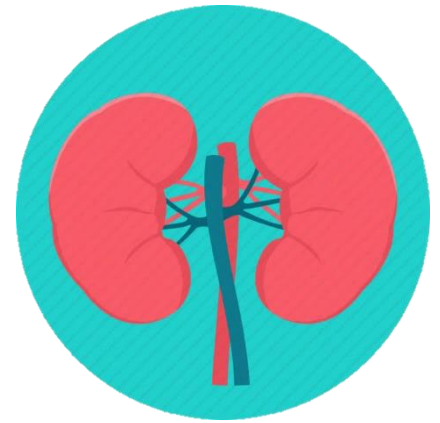
**Extra reading material:**

[Source 1](#)

[Source 2](#)

[Source 3](#)

# Thank You



## Leaders

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Sedra Elsirawani

Abdulrahman Alhawas

## Members

Lama Alzamil

Ghada Alsadhan

Badr Almuhanna

Nouf Alhumaidhi

Nouran Arnous

Leen Almazroa

Omar Alghadir

Abdullah Aldawood

Arwa Alemam

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