
بسم الله الرحمن الرحيم

وَفَوْقَ كُلِّ

ذِي عِلْمٍ

عَلِيمٌ

يوسف(٧٦)

(Renal Physiology 4)
Micturition

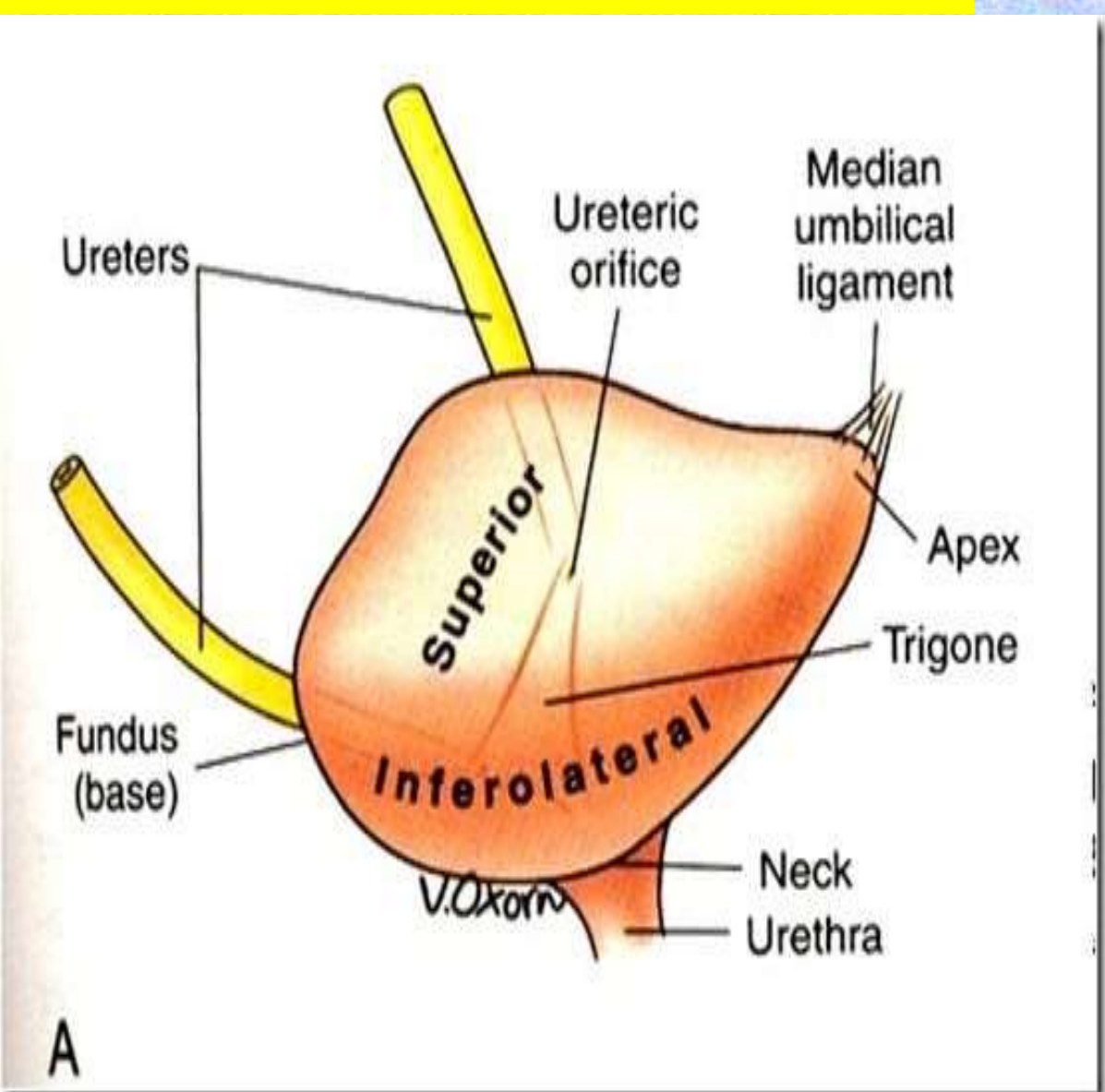
Learning Objectives:

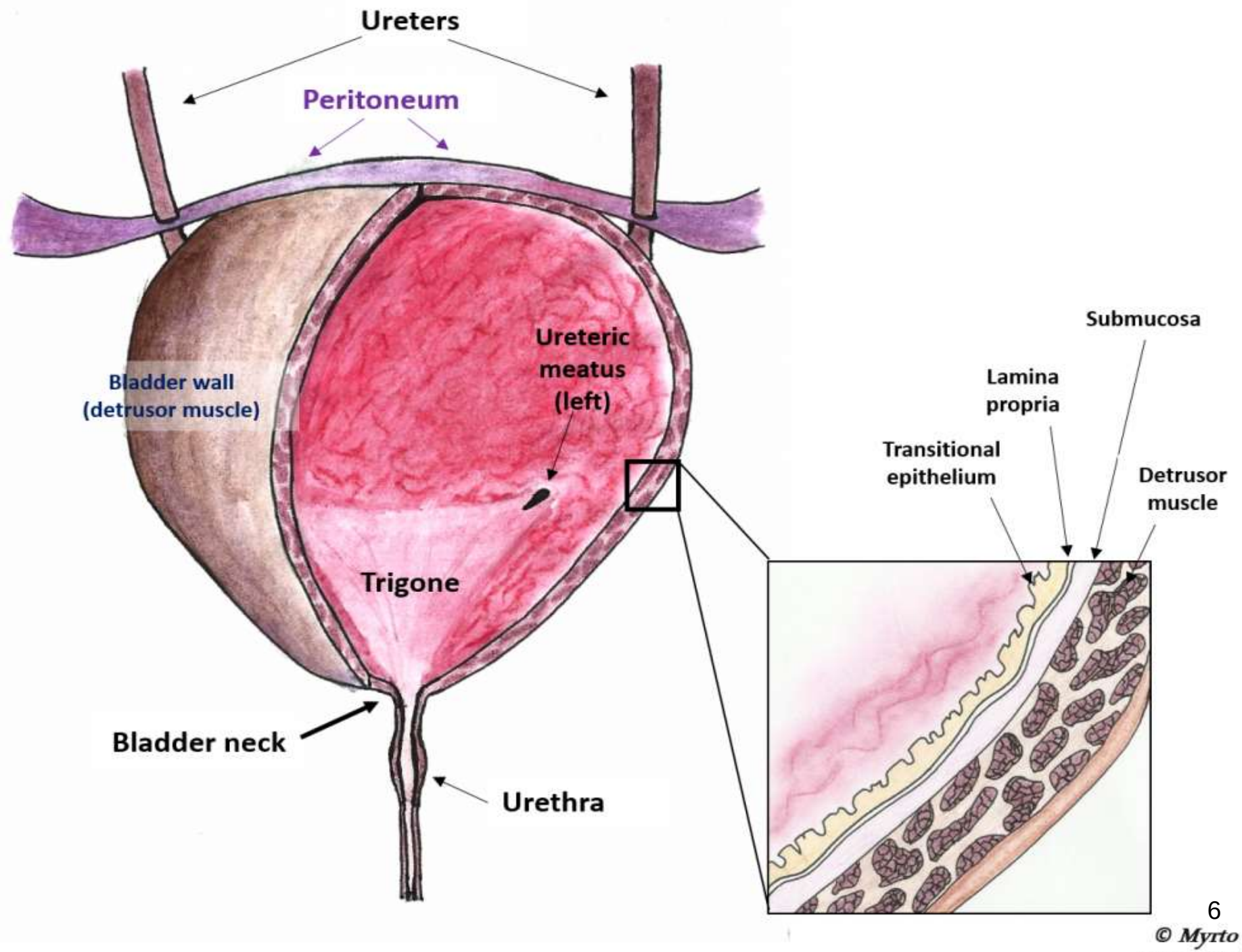
- Identify and describe the Functional Anatomy of Urinary Bladder.
- Describe the mechanism of filling and emptying of the urinary bladder.
- Cystometrogram.
- Appreciate neurogenic control of the mechanism of micturition and its disorders.

Urinary Bladder Anatomy

It has 4 parts:

- Apex
- Base
- Superior surface
- Inferolateral surfaces

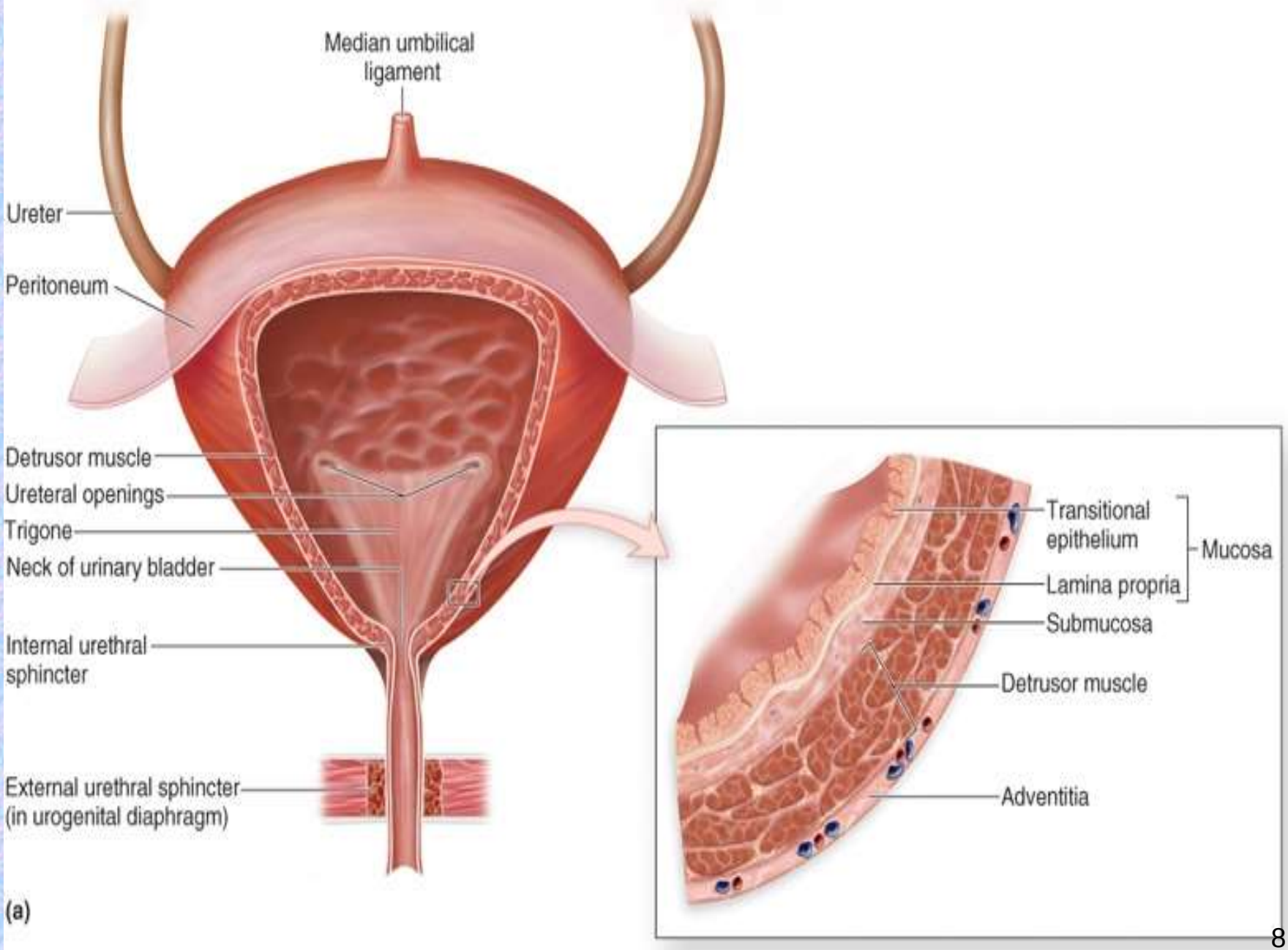




Urinary Bladder Anatomy

Mucosa

- The wall of UB is lined by a **transitional epithelium** that is continuous with that in the ureters.
- When the bladder is empty, the mucosa has numerous folds called **rugae**.
- As the bladder fills with urine these **rugae flatten out** and distend with little change in **intravesical pressure.**
- This results in **high compliance** of the bladder, so the volume of the bladder can ↑ **from 10 ml** to **400 ml** with a pressure change of only **10 cm H2O.**



Nerve Supply to the Bladder

Afferent supply:

A.Sympathetic nerve

➢It transmit impulses from the pain receptors to the upper lumbar segment (via the lumbar dorsal n. roots) ⇒ resulting in the perception of pain sensation from the urethra & bladder e.g. severe bladder distention & in inflammation.

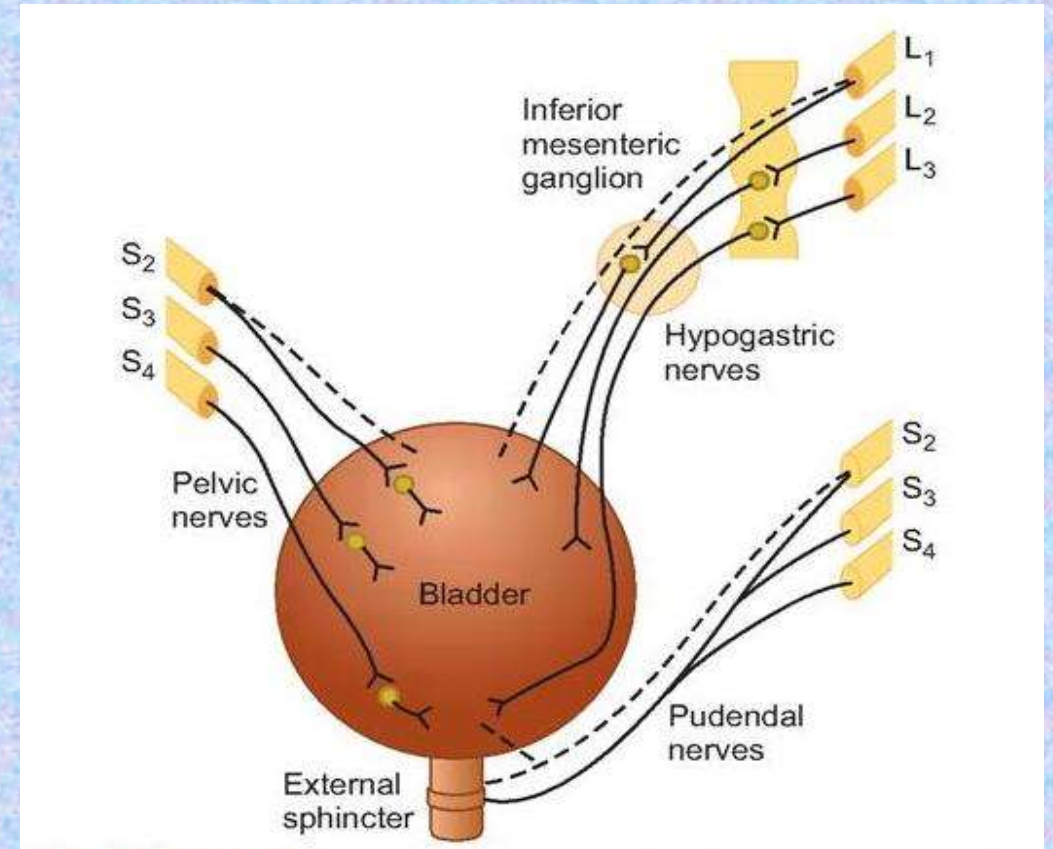


FIGURE 38–20 Innervation of the bladder. Dashed lines indicate sensory nerves. Parasympathetic innervation is shown at the left, sympathetic at the upper right, and somatic at the lower right.

Nerve Supply to the Bladder

B. Pelvic nerve

- It transmit impulses from the tension (stretch) & pain receptors present in the wall of U.B. to the sacral region of spinal cord (via the sacral dorsal n. roots) ⇒ resulting in both reflex micturition & sensation of bladder fullness (i.e. desire for micturition) [The tension receptors are stimulated when I.V.P. ↑]

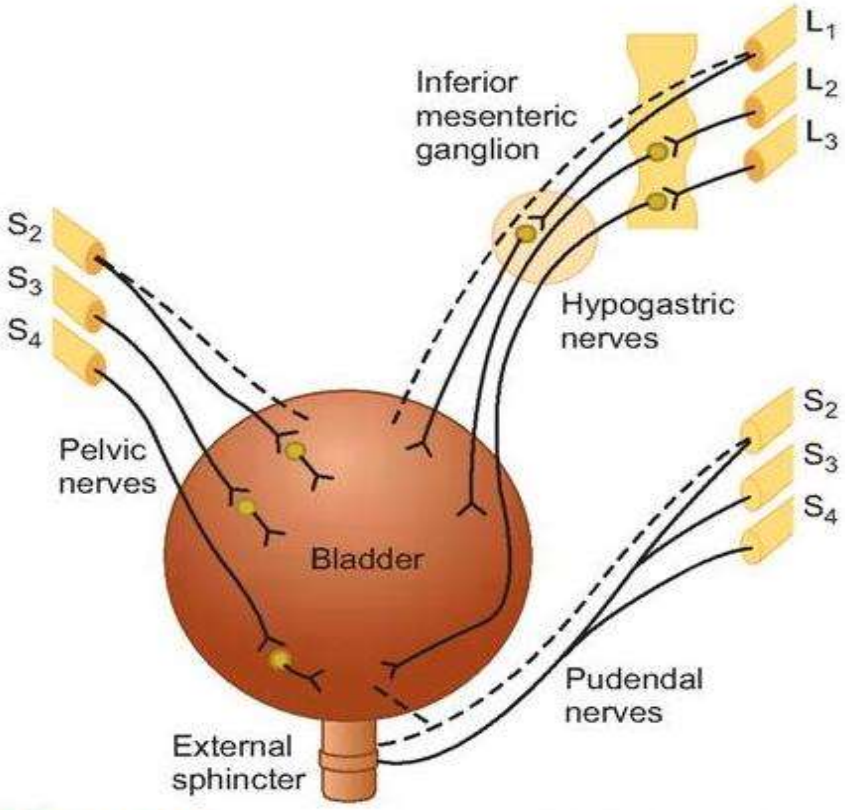


FIGURE 38–20 **Innervation of the bladder.** Dashed lines indicate sensory nerves. Parasympathetic innervation is shown at the left, sympathetic at the upper right, and somatic at the lower right.

Nerve Supply to the Bladder

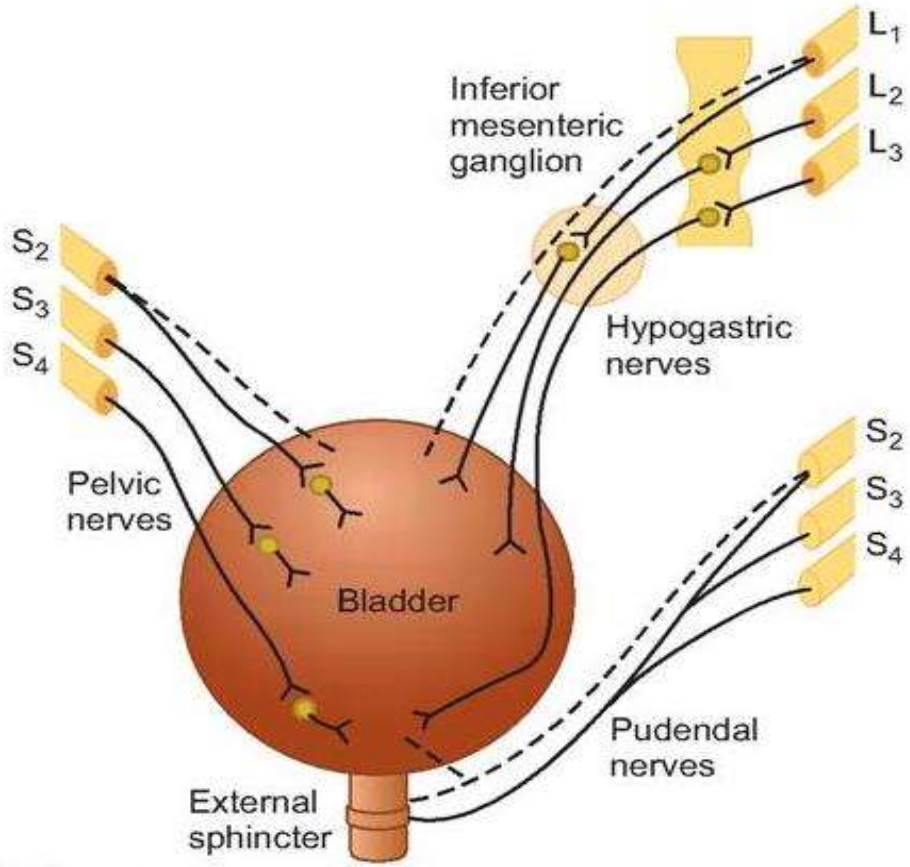


FIGURE 38–20 **Innervation of the bladder.** Dashed lines indicate sensory nerves. Parasympathetic innervation is shown at the left, sympathetic at the upper right, and somatic at the lower right.

C. Pudendal nerve

- It transmit impulses for the sensation of:
  - Distention of the urethra.
  - Passage of urine through the urethra.

Nerve Supply to the Bladder

Efferent Supply

A. Sympathetic supply

- Inhibitory to the bladder wall (detrusor muscle).
- Motor to the internal urethral sphincter.
- Motor to the seminal vesicle, ejaculatory duct.

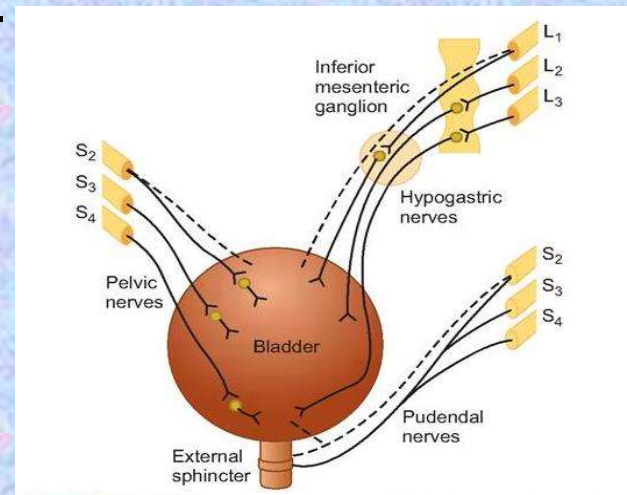


FIGURE 38–20 **Innervation of the bladder.** Dashed lines indicate sensory nerves. Parasympathetic innervation is shown at the left, sympathetic at the upper right, and somatic at the lower right.

B. Parasympathetic supply

- Motor to the bladder wall (detrusor muscle).
- Inhibitory to the internal urethral sphincter.

C. The somatic supply (Pudendal N.)

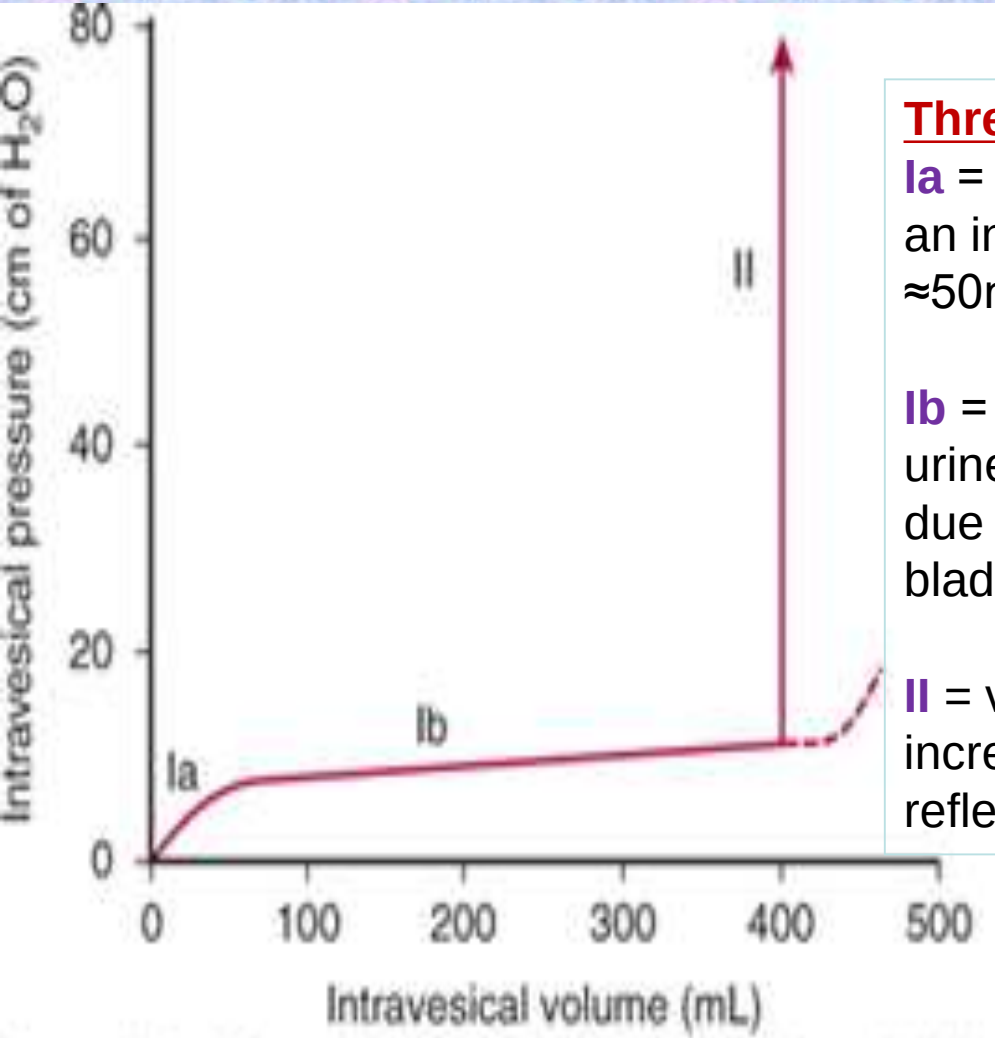
- Motor to the external urethral sphincter.

The Reservoir function of U.B

- Urine enters the urinary bladder without producing much increase in I.V.P. till the bladder becomes well-filled.

- A plot of I.V.P. against the volume is called “cystometrogram”.
- It is composed of three components:

The Cystometrogram



Three phases:

Ia = an increase in IVP (0 to ≈10 cm H_2O) at an initial increase in volume from 0 to ≈50ml).

Ib = filling of bladder from 50 to ≈400ml of urine causes no significant increase in IVP due to the high compliance of the urinary bladder during this stage.

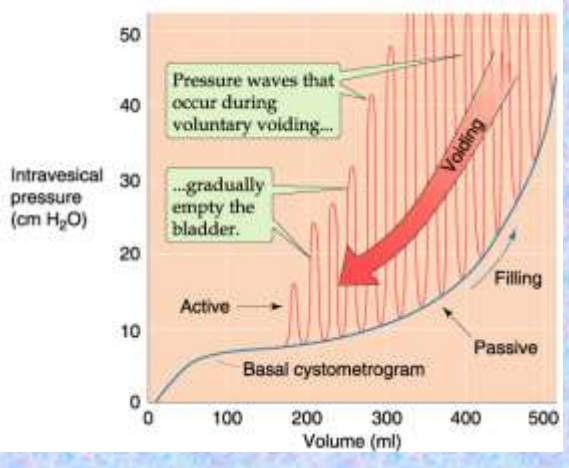
II = volumes > 400ml will cause a steep increase in IVP triggering the micturition reflex.

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

Cystometrogram

- In the urinary bladder ⇒ the tension on the wall increases as the volume increases & also the radius increases, so there is little change in pressure until the organ is filled & any increase in volume beyond this will not be accommodated & is reflected by rapid rise of pressure.

- Superimposed on this curve, periodic acute increase in pressure which lasts very few seconds, & called "micturition waves" & are caused by micturition reflex.



Sensations from the U.B at different urine volumes:

- At a urine volume of **150 –300 ml** ⇒ the first urge to void urine.
- From **300 –400 ml** ⇒ sense of fullness of the bladder.
- From **400 –600 ml** ⇒ sense of discomfort.
- From **600 –700 ml** ⇒ sense of pain.
- **Micturition reflexes** start to appear at the first stage. They are progressively intensified in the subsequent stages up to stage 4. Micturition reflexes can be voluntarily suppressed.
- At about 700 ml ⇒ break point ⇒ micturition can not be suppressed.

Micturition reflexes

The micturition reflexes can be summarized as follows:

- Distention of the U.B. (as a result of ↑ I.V.P. & not by an ↑ in the bladder volume) produces reflex contraction of its wall & relaxation of the internal urethral sphincter & external urethral sphincter.

- The flow of urine in urethra will produce contraction of the U.B. wall & relaxation of both internal & external urethral sphincters.

Micturition

A) Unconditioned (automatic) micturition:

- In infants ⇒ urination occurs through a series of spinal reflexes called "**the micturition reflexes**" which are automatic (not under voluntary control) because the nerve tracts are not yet myelinated in infants.

- The stimulus that initiates these reflexes is rise of the IVP (which stimulates stretch receptors in the bladder wall)

Micturition reflexes

- **B) Voluntary or conditioned micturition:**
  - In adults ⇒ the act of micturition occurs also through the micturition reflexes, but however, it can be voluntarily controlled by certain higher (or supra-spinal) centers in the brain, which include the following:

Facilitatory	***Inhibitory***
• In pontine area. • Posterior hypothalamus. • Other cortical centers	• In the mid

Mechanism of voluntary control of micturition:

- Filling of the bladder beyond **300 –400 ml** causes stretching of sensory stretch receptors.

- These sensory signals stimulate sacral segment, which is consciously appreciated by higher centers.

If the condition is favourable

- The cortical centers facilitate micturition by discharging signals that leads to:
  - Stimulation of sacral micturition center.
  - Inhibition of pudendal nerves $\Rightarrow$ relaxation of external urethral sphincter.
  - Contraction of anterior abdominal muscle & diaphragm to increase intra-abdominal pressure $\Rightarrow$ the intra-vesical pressure is increased. This intensifies the micturition reflex.

If the conditions are unfavorable

- The higher centers will inhibit the micturition reflex by:
  - Inhibition of sacral micturition center.
  - Stimulation of pudendal nerves $\Rightarrow$ contraction of external urethral sphincter.

Disturbances of micturition

- **Denervation of the afferent supply e.g.in tabes dorsalis (tabetic bladder):**
- **Characterized by:**
  - Loss of the U.B. sensations & reflex micturition.
  - Some intrinsic responses of the smooth muscle are retained.
  - The bladder becomes distended, thin walled & hypotonic (a tonic bladder).
  - There is retention with overflow i.e. dribbling of urine when the bladder becomes over filled.

Disturbances of micturition

- **Denervation of the afferent & efferent supply e.g. tumour, injury to cauda equine syndrome.**
- **Characterized by:**
  - Reflexes are abolished.
  - Intrinsic responses of the smooth muscles are increased.
  - The bladder is hypertonic.
- This is due to denervation hypersensitivity because:
  - ↓ degradation of acetyl choline by process of reuptake.
  - ↓ cholinesterase in the tissue
  - ↑ number of cholinergic receptors.
- This condition is associated with uncontrolled periodic micturition about 25 – 100 ml at a time

Disturbances of micturition

- **Spinal cord transection (above the sacral region).**

1) Stage of spinal shock

- This occurs due to the sudden separation of the spinal centers from the higher centers that control them.
- The spinal centers become functionless for 2 – 6 weeks. So, the micturition reflex is abolished ⇒ **"*retention with overflow*"** i.e. the bladder distends until the I.V.P. exceeds the urethral sphincter resistance & so, urine starts to dribble.

Disturbances of micturition

2) Stage of recovery of the spinal centres

- "**Automatic micturition**" occurs as soon as the I.V.P. rises to 15 – 20 cm water ⇒ reflex micturition occurs.

3) Stage of failure recovery

- Damage of the spinal centers by toxins of bacterial infections ⇒ abolishes the micturition reflex ⇒ "**Retention with overflow**".


Thanks