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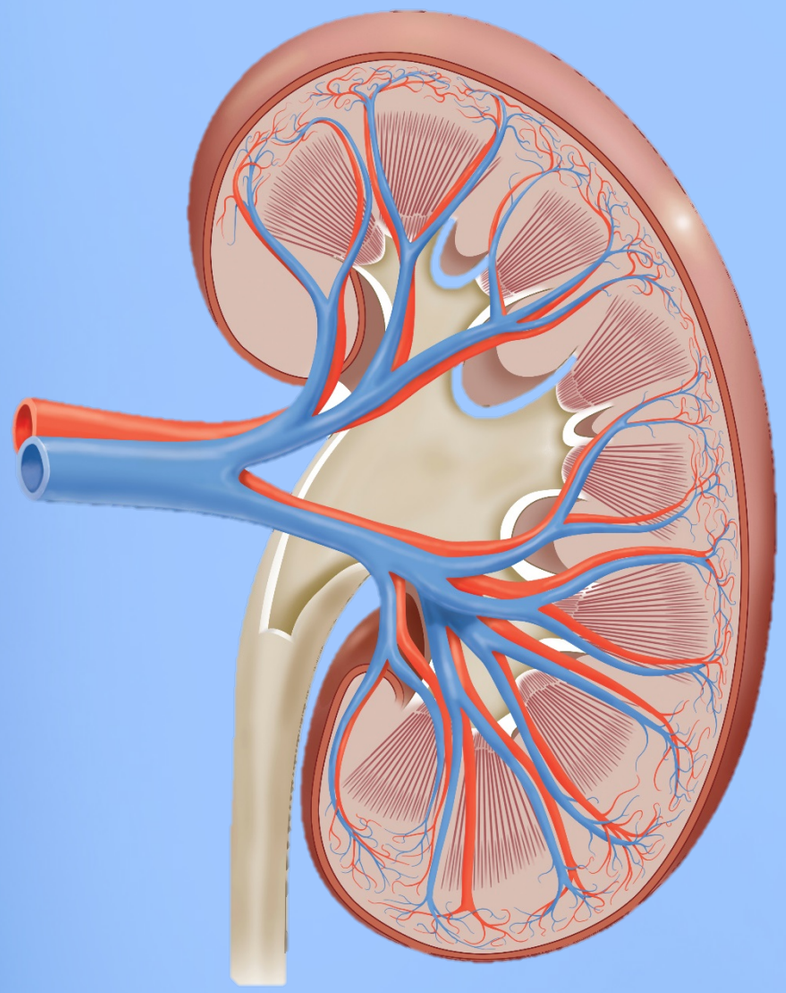
PHYSIOLOGY OF MICTURITION



Renal Block

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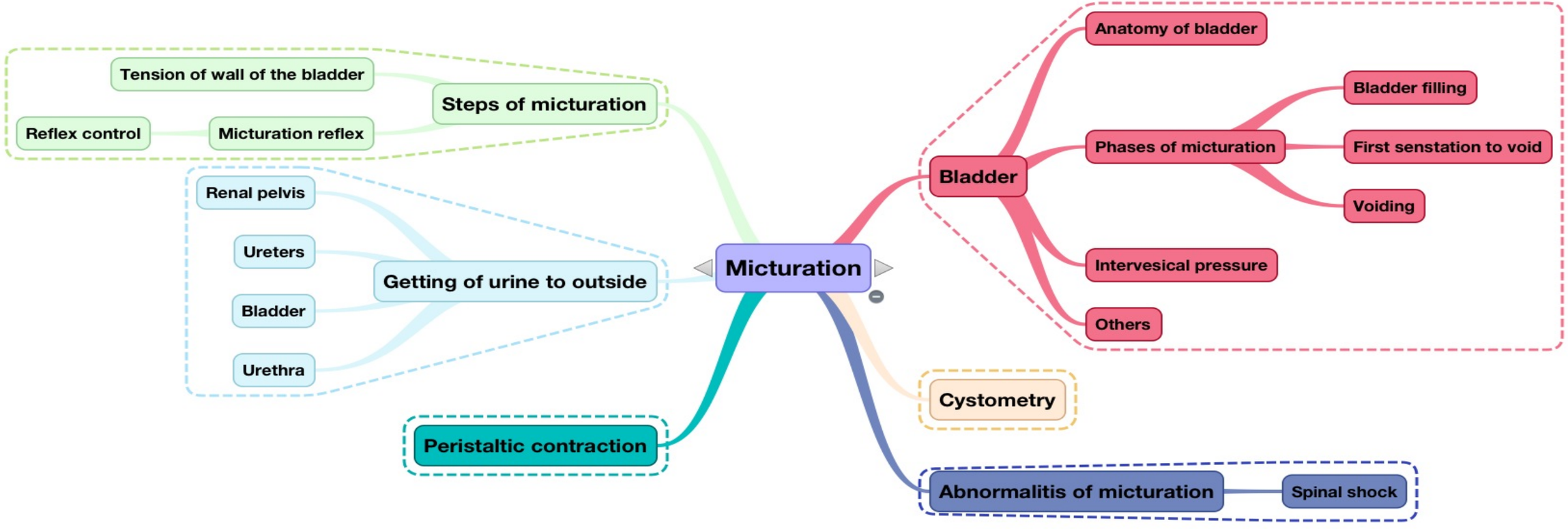
Objectives

- 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.

Key Outlines:

- Functional Anatomy of Urinary Bladder
- Describe the mechanism of filling and emptying of the urinary bladder
- Cystometrogram



Micturition

- It is a complete autonomic spinal reflex to get urine outside the body, that is facilitated or inhibited by higher brain centers. (in adults)

Micturition involves to main steps

1

The tension in the wall of the bladder rise above threshold level

2

Nervous reflex

(micturition reflex) at 150-200 ml of urine volume

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Getting Urine from the kidney to the outside

Processed tubular fluid is dumped by the collecting system into the renal pelvis where it enters the ureters.

Pelvis:

- Collects urine from collecting ducts.

Ureters:

- conduits that propel urine by peristaltic contractions toward the bladder.

Bladder:

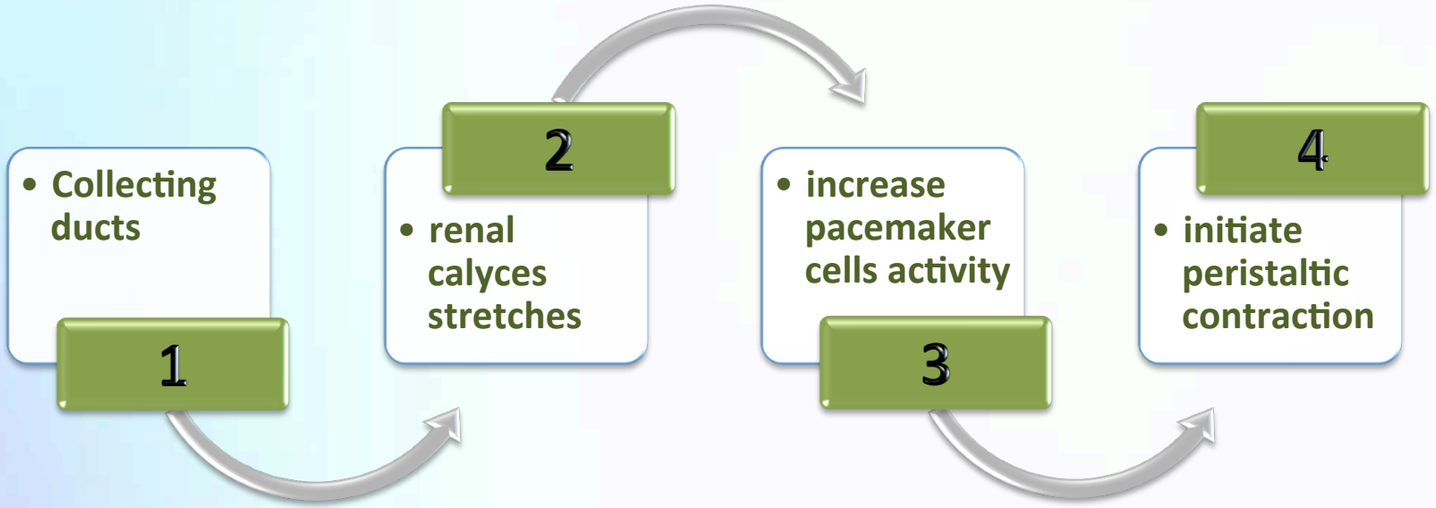
- a muscular “bag” that holds urine and forces it by contraction.

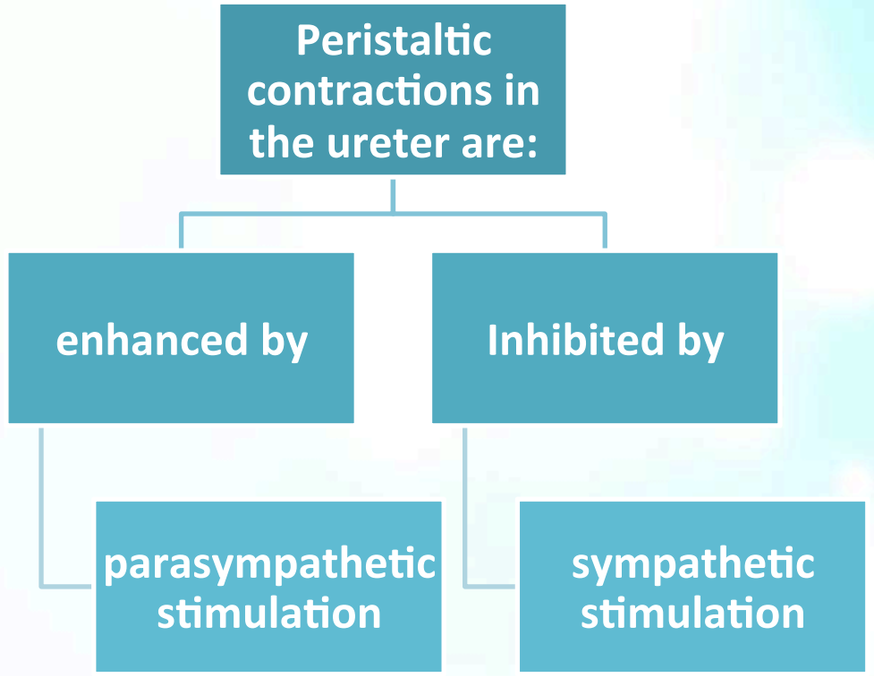
Urethra:

- the conduit for urine from the bladder to the outside .

What is the peristaltic contraction?

Fluid (urine) pathway to outside the body





Getting Urine from the kidney to the outside.

In the renal pelvis there are **"electrical pacemaker"** cells that initiate peristaltic waves in the smooth muscle sheaths of the ureteral wall. **(The pelvis to ureter is a functional syncytium).**

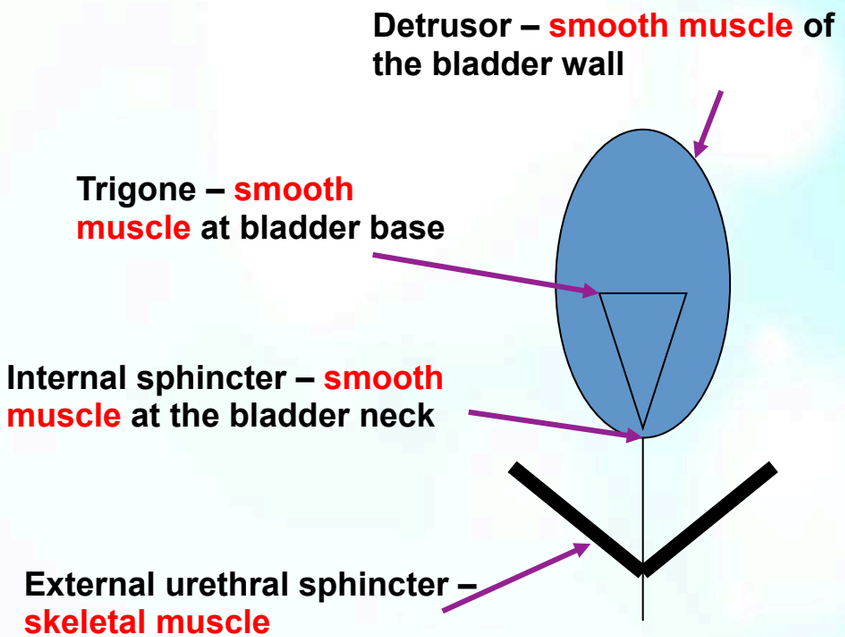
The pacemaker cells seem to be stimulated by the stretch of urine filling the pelvis.

The movement of the peristaltic wave is about **2-6 cm/sec.**, traveling from its origin at the pelvis down to the bladder .

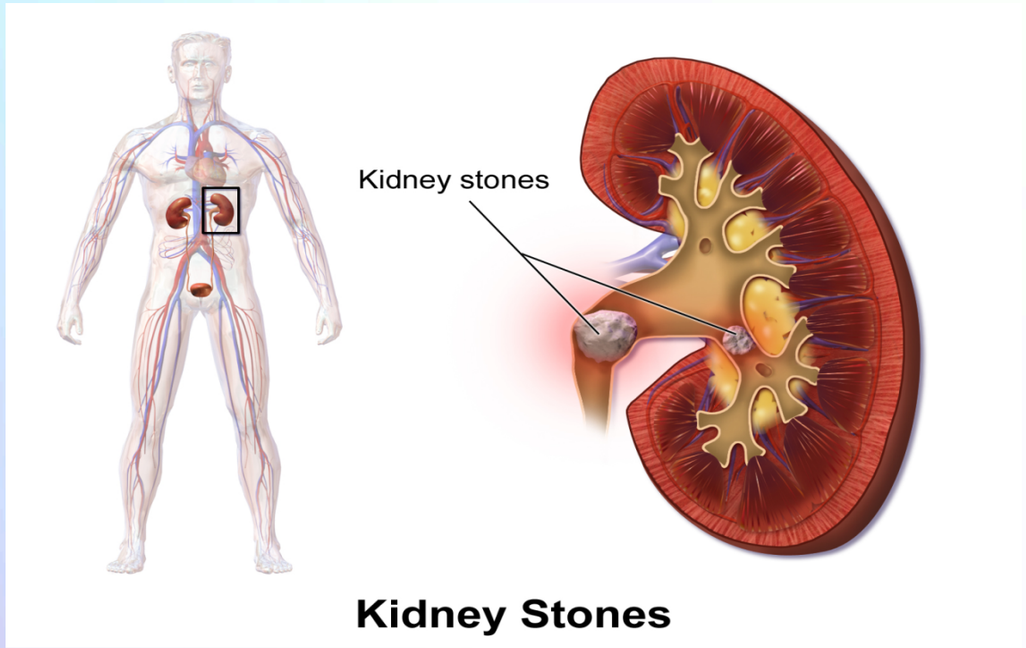
Anatomy of Urinary Bladder

Bladder is a Smooth muscle chamber .Made of 2 main parts:

The body in which urine collect	The neck which is the funnel shaped extension of the body (Lower part of the bladder neck is also called **posterior urethra** because of it's relation to it)
The smooth muscle of the bladder called: **Detrusor muscles** which can increase the pressure in the bladder when contracted Up to 40-60 mmhg → thus **contraction of detrusor muscle is a major step in emptying the bladder** Cells of the smooth muscle fuse together to allow an electrical potential to spread through the detrusor muscle **Trigone** at the lowermost apex is the region **where it opens to the posterior urethra and two ureters enter the bladder**	It's wall composed of **detrusor muscle** intercalated with large amount of elastic tissue The muscle in this area is called The Internal sphincter which is under control of **involuntary nervous system (Hypogastric nerve)** and can control urination. Urethra pass through a **layer of voluntary skeletal muscle** called The external sphincter which is under control of **voluntary nervous system (Pudendal nerve)** and can control urination.



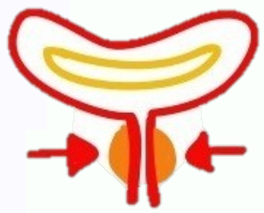
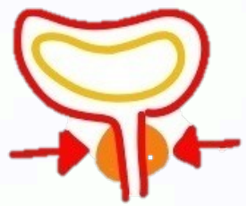
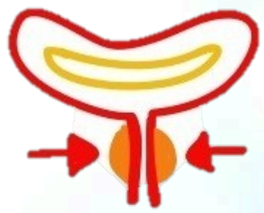
How obstruction cause hydronephrosis?



Kidney Stones

- Obstruction Interrupts the flow of urine and stops the flow
- back up of the urine through the ureter into the pelvis because of pressure increasing
- increase the nephron and subcapsular hydrostatic pressure resulting in condition called hydronephrosis
- The formation of kidney stones cause an autonomic pain fibers in the ureter representing as acute pain

HOW MICTURITION TAKES PLACE?

Phase	Bladder filling	1st sensation to void	Normal desire to void	Bladder filling
				
PELVIC NERVE(Parasympathetic)→ Detrusor muscle	Relax	Relax	contracted	Relax
1. Hypogastric (Sympathetic) 2. Pudendal (Voluntary) → sphincter	contracted	↑contracted	Relax	contracted

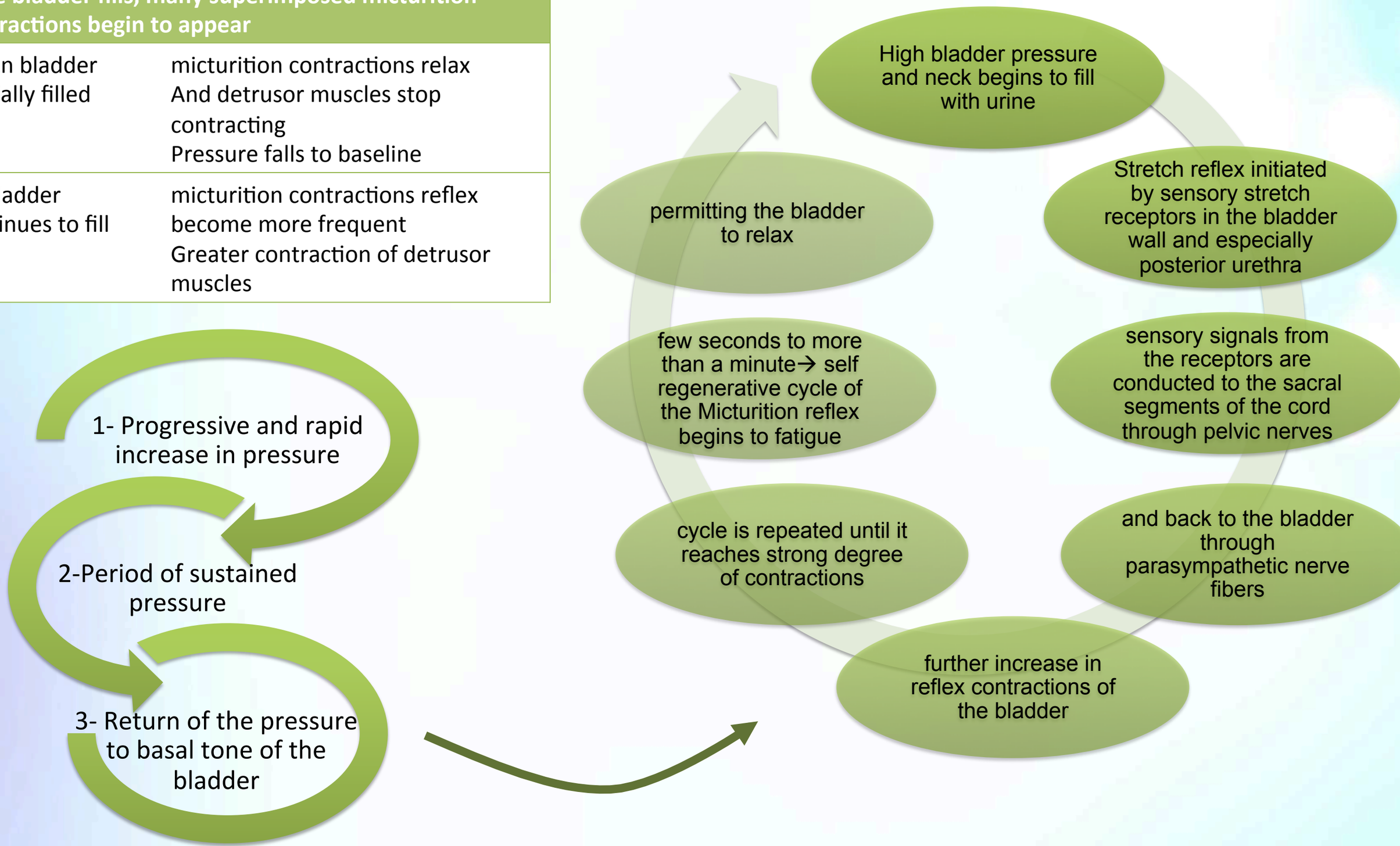
Bladder tone is derived from the volume and pressure exerted on the inside of the bladder (interavesical pressure)		
Volume	50 ml	Above 300ml
Interavesical pressure	Increases, but not much	rises steeply(sharply)

This increase in volume and pressure → increases bladder tone → triggering the micturition reflex
(open the flood-gates!)

Contraction of detrusor muscle of the bladder wall		expel the urine.
Voluntary contraction of the abdominal muscles		further contracts the bladder, increasing the voiding.
	During micturition	1. Internal urethral sphincter 2. External urethral sphincter **relaxed.** 1. The detrusor muscle **contract** **→urine passes out.**
back down to the "no tone" phase and the sphincters can close again		Once the bladder is empty
After urination		The female →urethra empties by gravity
		The male → urine remaining in the urethra is expelled by several contractions of bulbocavernous muscle.

Micturition Reflex

Once bladder fills, many superimposed micturition contractions begin to appear	
When bladder partially filled	micturition contractions relax And detrusor muscles stop contracting Pressure falls to baseline
As bladder continues to fill	micturition contractions reflex become more frequent Greater contraction of detrusor muscles



Reflex Control

Stimulus	• distension of bladder stimulate stretch receptors in bladder wall.
Afferent	• fibers in the pelvic nerves
Center	• sacral segments S2,S3,S4
Efferent	• Parasympathetic fibers to the bladder.
Response	• relaxation of the sphincters and contraction of bladder wall.
Higher control	• A facilitator area in the pontine region • and inhibitory area in the midbrain.

- In adults the volume of urine that initiates a reflex contraction is about 300-400 ml.
- Efferent impulses from the brain suppress the reflex (a learned reflex) until a decision is made to relax the external sphincter using voluntary nerves.
- Voiding begins with relaxation of the external sphincter, then the internal sphincter.
- Voluntary contraction of abdominal muscles helps the expulsion of urine by increasing intra-abdominal pressure, but voiding can be initiated with straining.

CYSTOMETRY & CYSTOMETROGRAM

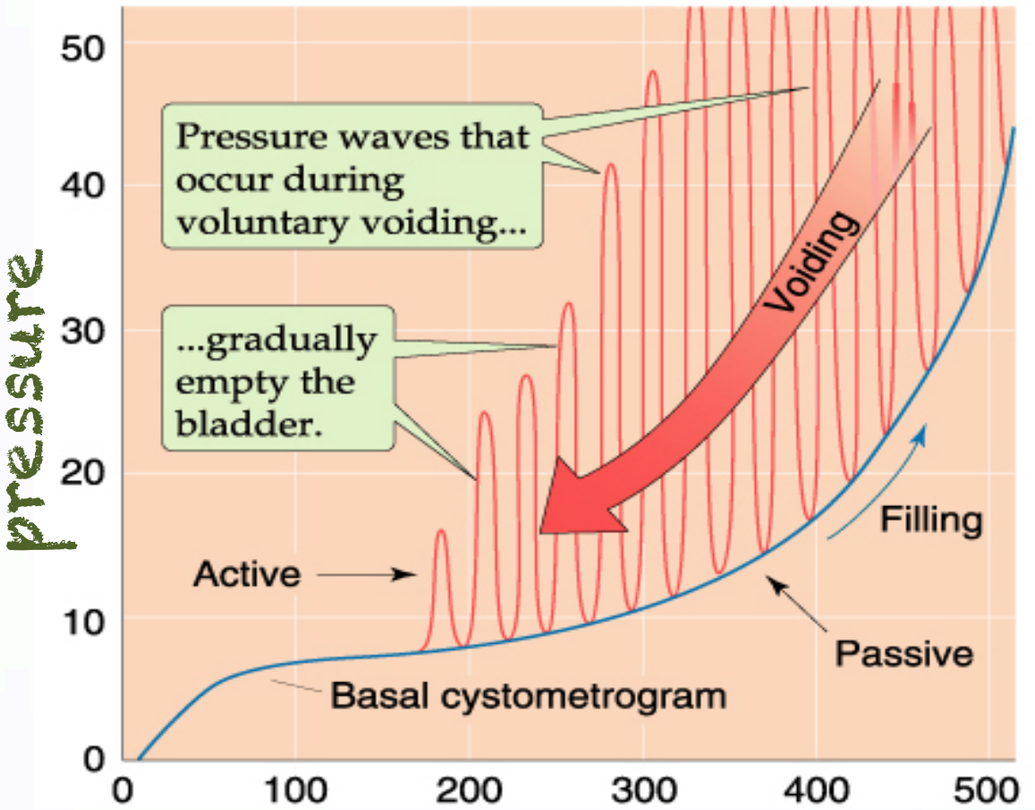
What's Cystometrogram ?

is a plot of intravesical pressure against the volume of fluid in the bladder

can be studied by :

by inserting a catheter and emptying the bladder

then recording the pressure while the bladder is filled with 50 ml increments of water or air.



Curve phases:

1- initial slight rise in pressure when the first increment in volume produced.

2- a long nearly flat segment is produced.

3- a sudden sharp rise in pressure as micturition reflex is triggered.

The first urge to void is felt at

pressure volume of 150 ml-200 ml.

and marked sense of fullness at about 400 ml.

Abnormalities of micturition

Effect of spinal cord transection:

Spinal shock:

- bladder becomes flaccid and unresponsive
- It becomes overfilled and urine dribbles through the sphincters (overflow incontinence).

After spinal shock phase has passed

- the voiding reflex returns with no voluntary control.

summary

Steps of micturition :

- Tension in the bladder's wall
- Nervous reflex

Fluid (urine) pathway to outside the body :

- Collecting ducts
- renal calyces stretches
- increase pacemaker cells activity
- initiate peristaltic contraction

Micturition phases

Increasing in the bladder pressure triggering the micturition reflex (open the flood-gates)

- Contraction of detrusor muscle of the bladder wall to expel th urine
- Voluntary contraction of the abdominal muscles causing increasing the voiding
- During micturition : internal & external urethral sphincters are relaxed but the detrusor muscle is contracted urine passes out
- No tone phase the sphincters close
- After urination : in females urethra empty by gravity but in males by contractions of bulbocavernous muscle

Micturition reflex

Progressive and rapid increase in pressure → **Period of sustained pressure** → **Return of the pressure to basal tone of the bladder**

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Afferent : fibers in the pelvic nerves

Stimulus : urine volume 300-400 ml

Reflex control

Center : S2 , S3 , S4

Efferent : parasympathatic fibers to the bladder

Higher control: facilitator area in the pontine region and inhibitory area in the midbrain.

Response : relaxation of sphincters & contraction of bladder wall

Cystometrogram

Curve phases

initial slight rise in pressure when the first increment in volume

a long nearly flat segment is produced.

a sudden sharp rise in pressure as micturition reflex is triggered.

Abnormalities of micturition:

Effect of spinal cord transection:

❖**Spinal shock:**bladder becomes flaccid and unresponsive , It becomes overfilled and urine dribbles through the sphincters (**overflow incontinence**).

❖ **After spinal shock phase has passed** : the voiding reflex returns with no voluntary control

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MCQs

1) Peristaltic contractions in the ureter are enhanced by sympathetic stimulation :

a. T
b. F

2) The micturition reflex is centered in the:

A. Medulla
B. Sacral cord
C. Hypothalamus
D. Lumbar cord

3) Which of these is under voluntary control:

A. Urethra
B. Detrusor muscle
C. Internal sphincter
D. External sphincte

4) which of the following actions happen when the sympathetic is activated:

A. bladder contraction , sphincter relaxation
B. bladder relaxation, sphincter contraction

5) A person had a car accident and there was an injury in his spinal cord(L1,L2)
after the initial phase of spinal shock, what happened to the bladder?

A. paralyzed and flaccid
B. Emptying with voluntary control
C. Loss of voluntary control

1. F 2. B 3. D
4. B 5. C

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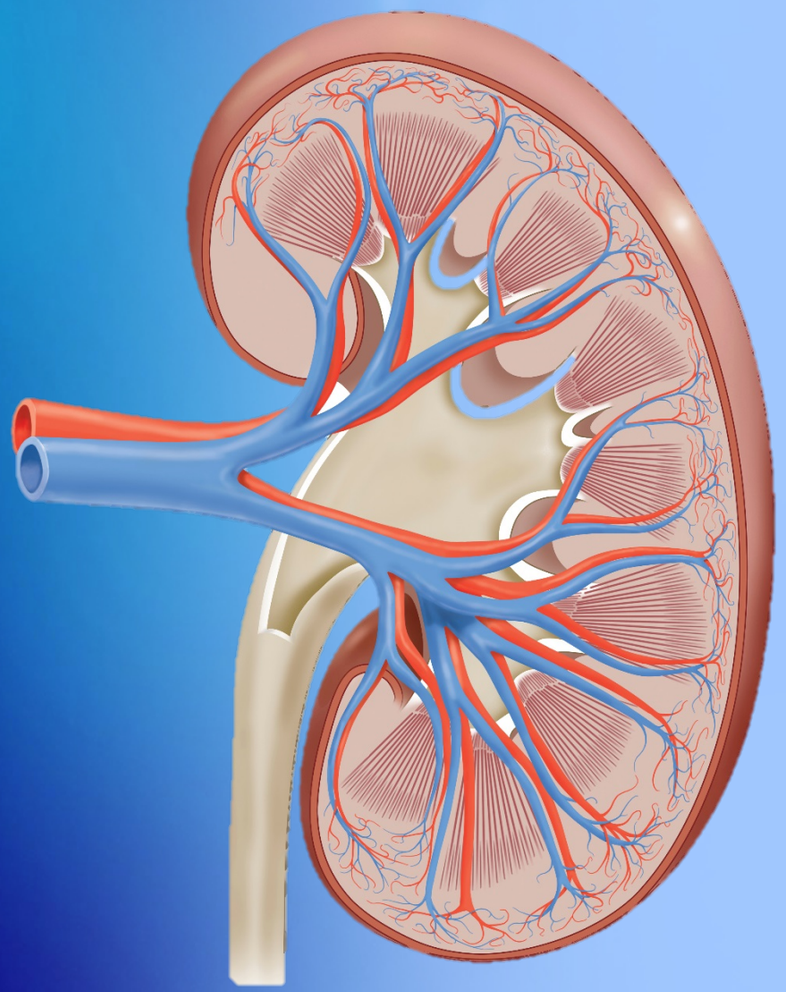

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