

Anatomy and physiology of the lower urinary tract

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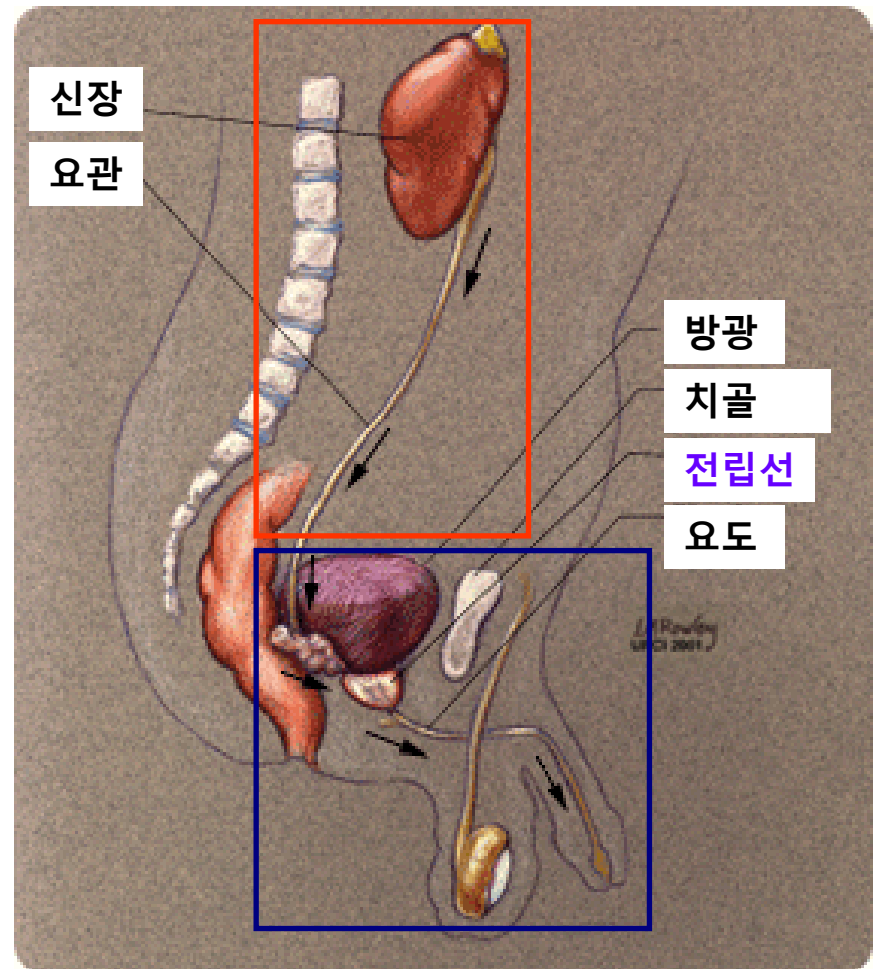
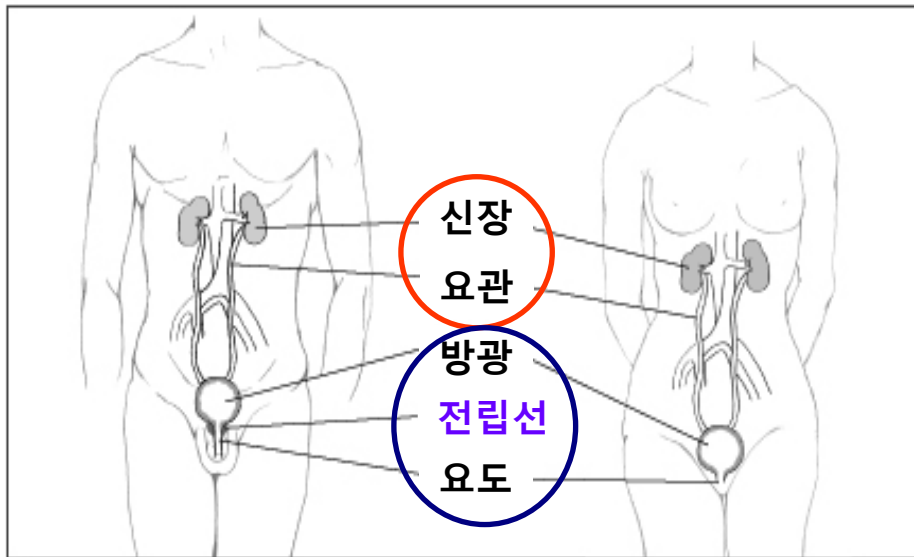
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1. Anatomy of the UT

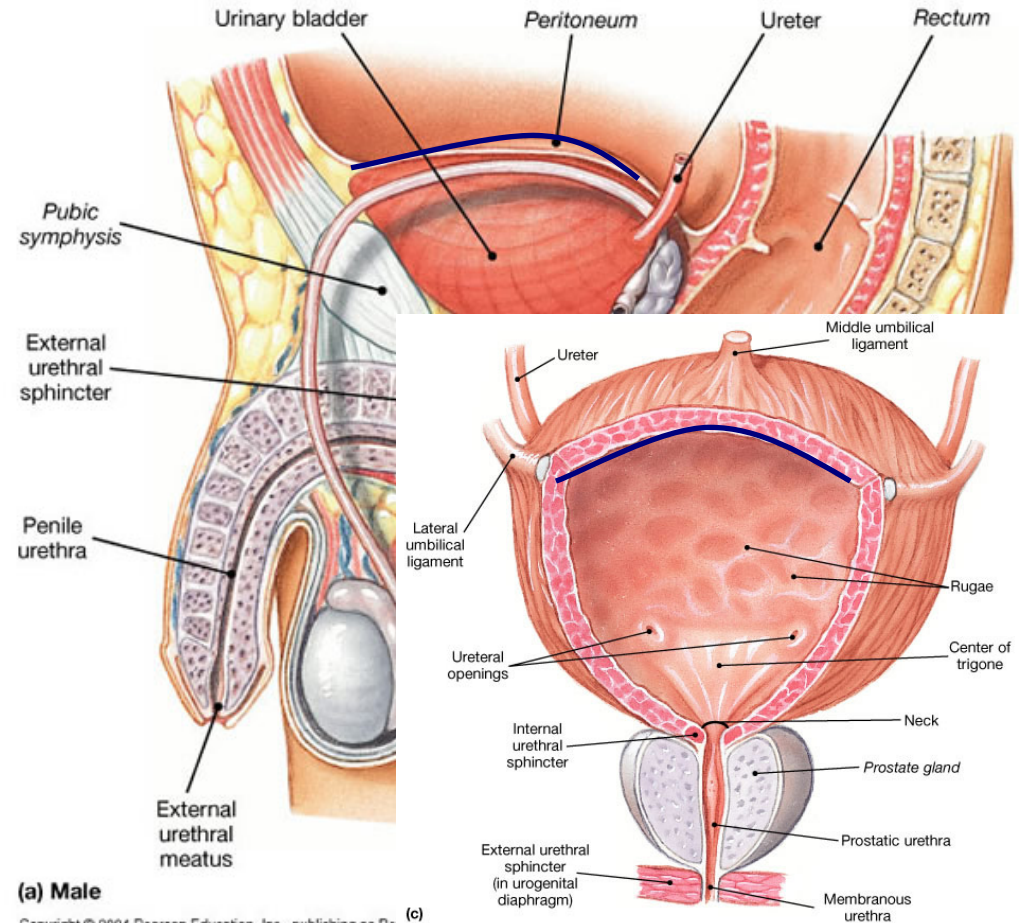
상부 vs. 하부요로 (upper vs. lower urinary tract)



방광 (Urinary Bladder)

■ Hollow muscular sac

1. Outer layer
(visceral peritoneum)
2. Detrusor muscle
(3 layers of muscle)
3. Submucosal layer
(nerve & vessels)
4. Inner layer
(epithelium)



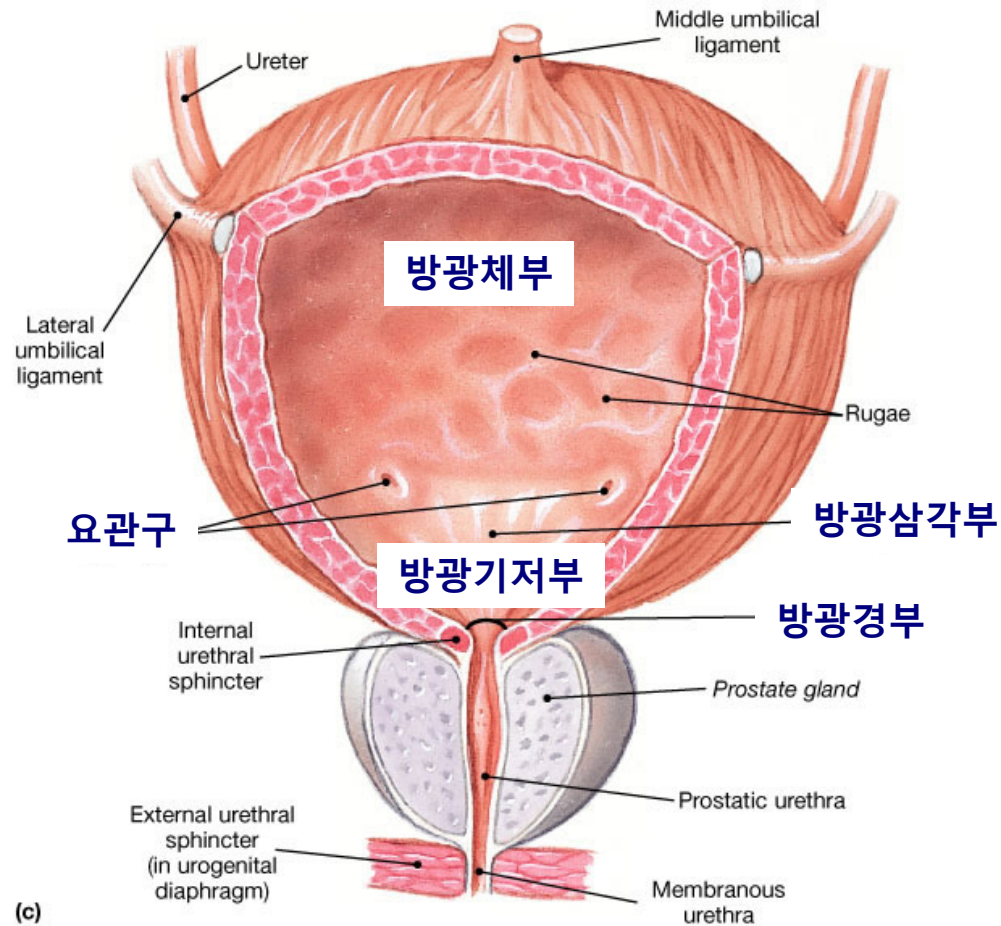
방광 (Urinary Bladder)

■ 체부 (Body or dome)

- supple, mobile and highly distensible
- capable of expanding into abdomen, depending on amount of urine stored

■ 기저부 (Base)

- not so distensible
- holds orifices in place (ureters and urethra)



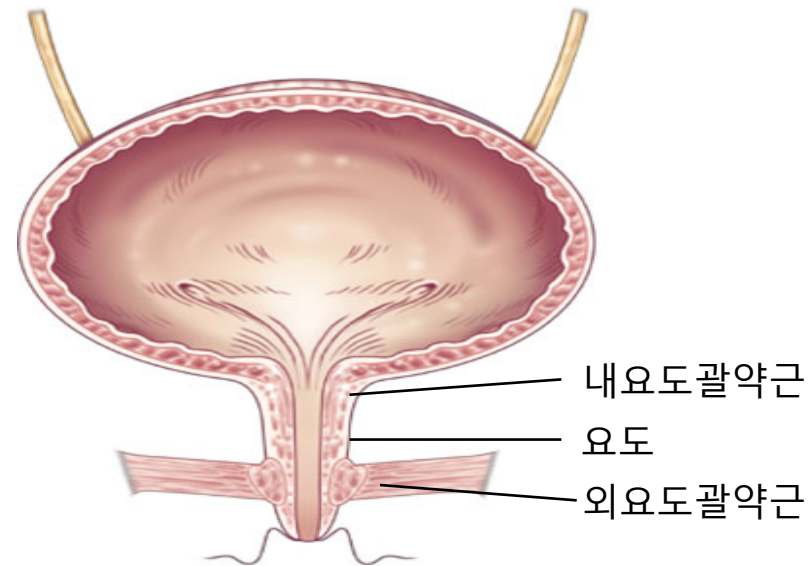
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요도 (Urethra)

■ 여성

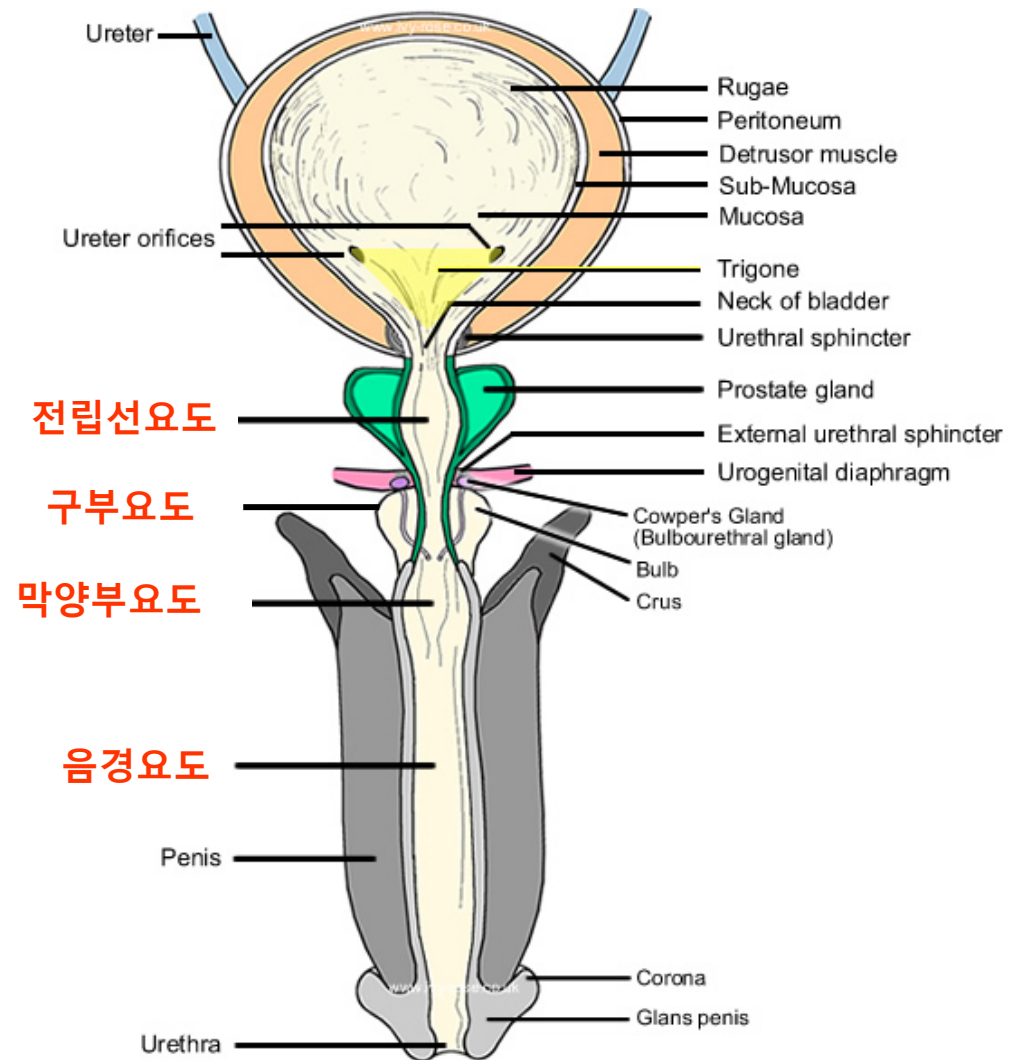
- 3-5cm long
- no well-defined sphincter at bladder neck
- smooth muscle extends throughout length of urethra
- striated sphincter (rhabdosphincter, external sphincter) located along middle third of urethra
- pelvic floor muscles help keep urethra closed & support bladder



요도 (Urethra)

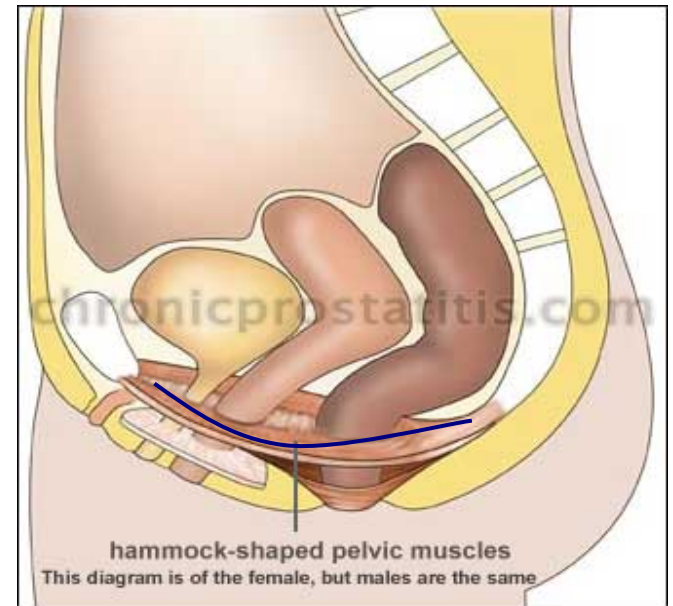
■ 남성

- 18 -22cm long
- 4 sections of urethra
 - 전립선요도
 - 구부요도
 - 막양부요도
 - 음경요도
- External sphincter striated muscle - control



골반저근 (Pelvic floor muscles)

- Supports the pelvic organs
- Contraction causes urethral compression – helps maintain continence during abdominal pressure
- Collectively called “Levator Ani”
- Muscle fibres (under Voluntary control)
- Striated muscle: slow and fast



외요도괄약근 (Ext. urethral sphincter)

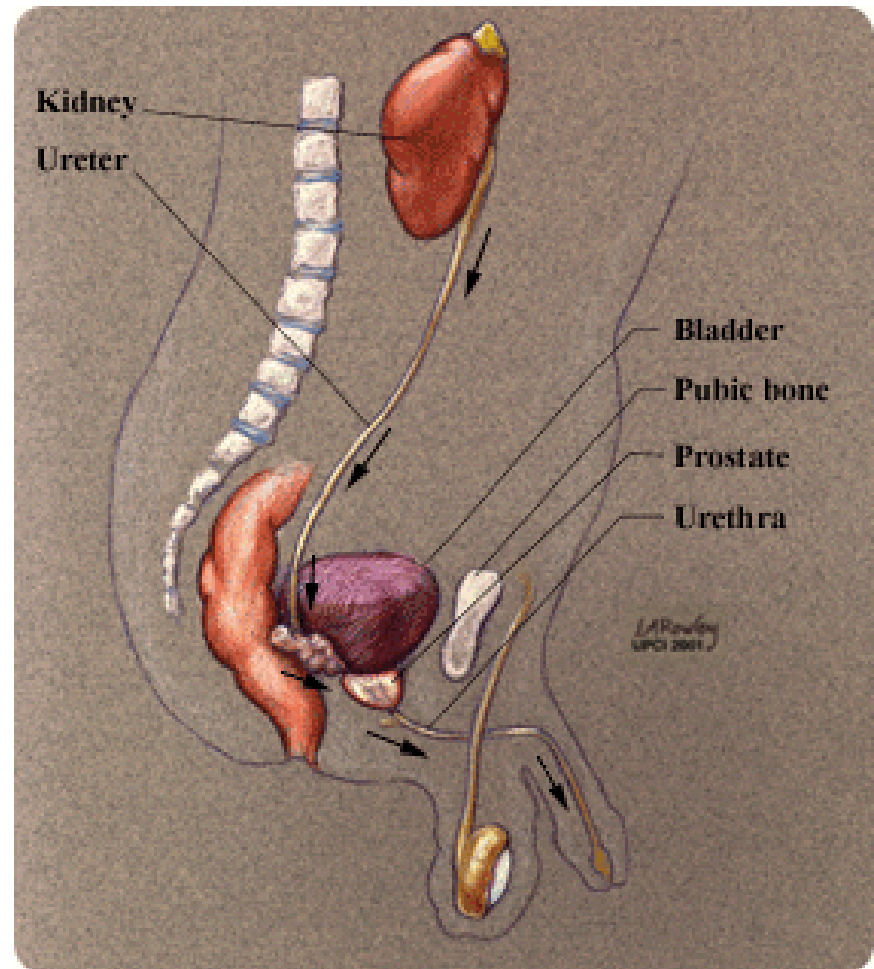
- In both sexes, the rhabdosphincter contains 2 different types of striated muscle fibres:
 - slow twitch
 - fast twitch
- **Slow twitch fibres** are able maintain sphincter contraction during the long storage phase
- **Fast twitch fibres** are used to increase contraction rapidly and/or voluntarily (e.g. for a cough or if leakage threatens) but fatigue quickly
- Slow twitch fibres normally predominate, but the proportions can be changed by exercise or lack of exercise



2. Physiology of the LUT

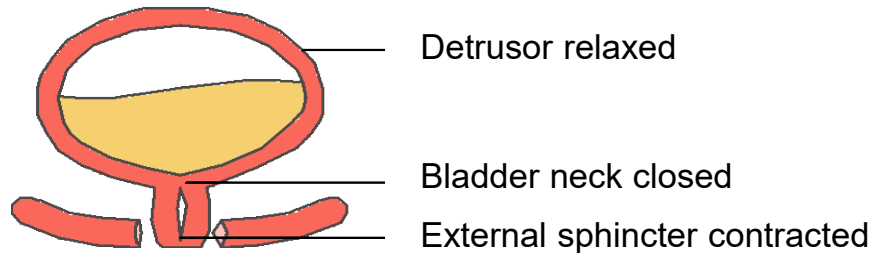
정상배뇨주기 (Normal micturition cycle)

- Cycle begins with urine filling bladder through ureters.



정상배뇨주기 (Normal micturition cycle)

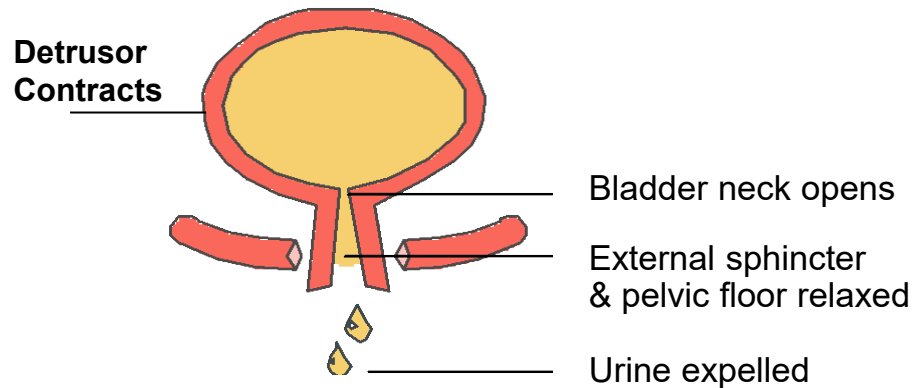
1. Storage Phase



- Pressure in bladder remains **low** during gradual filling.
- When bladder reaches certain distension, **stretch receptors** in bladder wall send this information to **spinal cord**; other nerves relay it to **brain** as sensation of fullness.

정상배뇨주기 (Normal micturition cycle)

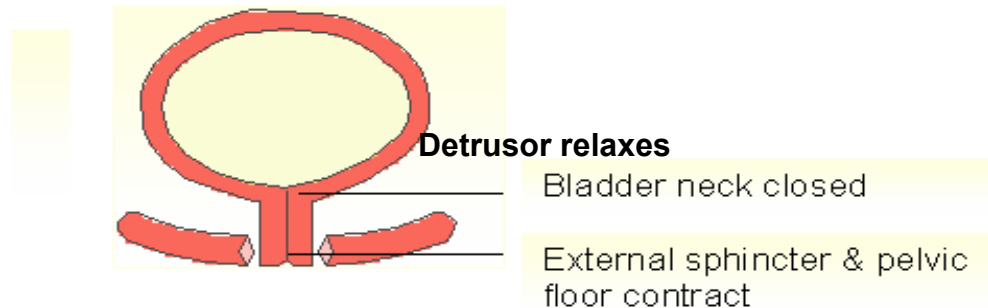
2. Emptying Phase



- If time and place are right, emptying takes place:
 - urethral sphincter relaxes & urethral pressure decreases
 - detrusor muscle contracts & bladder pressure rises
 - bladder neck and urethra open
 - urine flow begins and continues until bladder is empty

정상배뇨주기 (Normal micturition cycle)

3. Termination of voiding

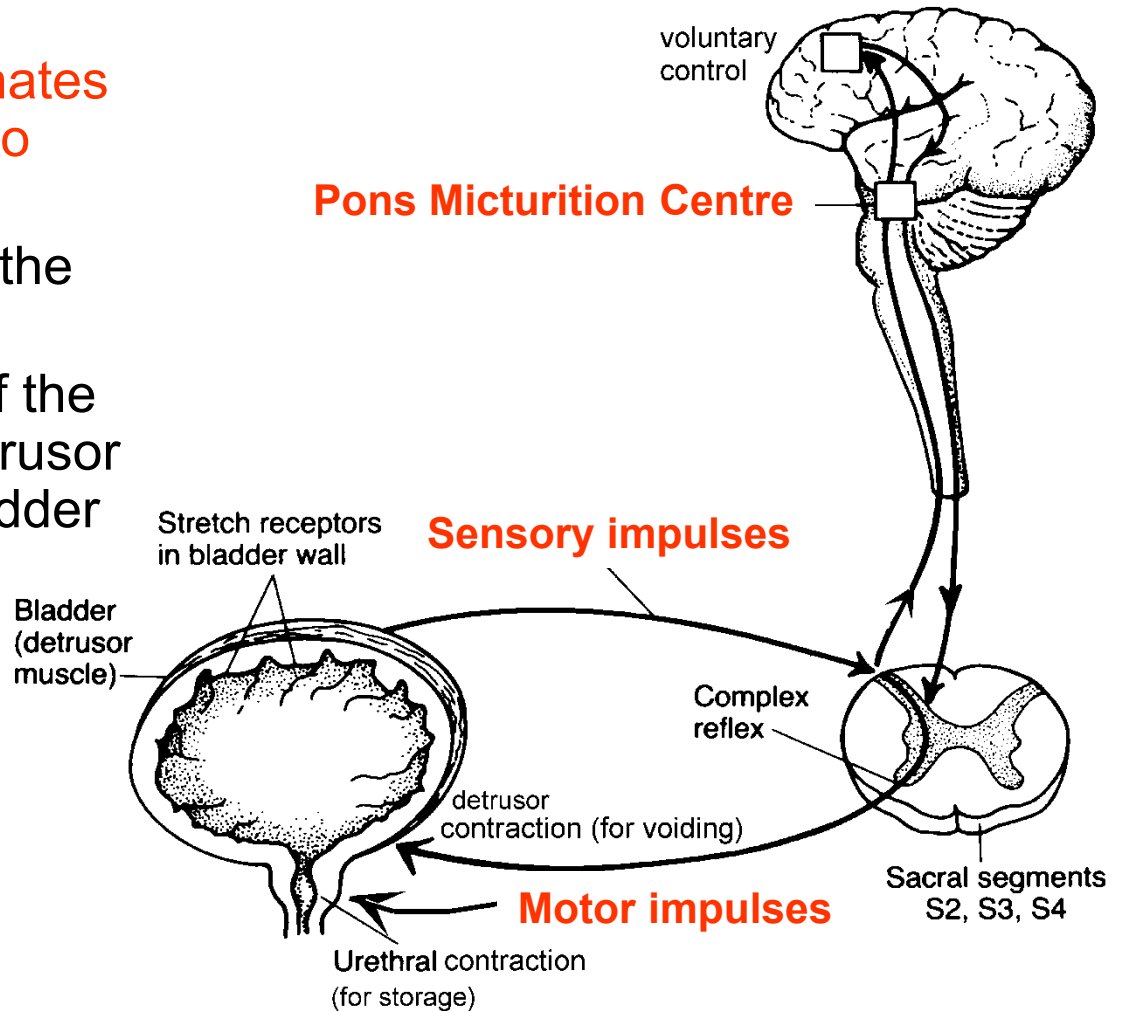


- Urethral sphincter contracts.
- Detrusor relaxes.
- Urine from ureters starts filling bladder again.

배뇨의 신경조절

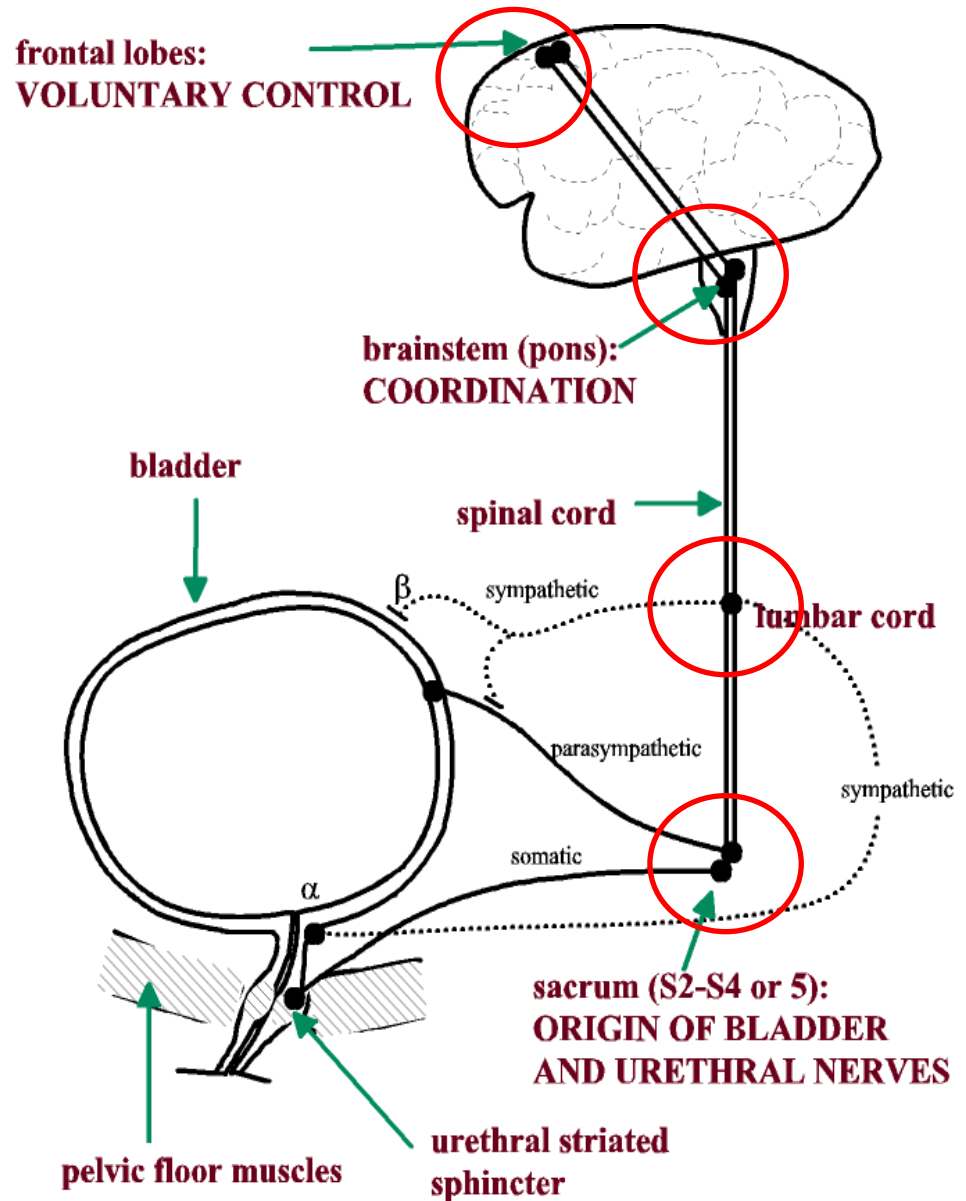
(Neuronal control of the bladder)

- Micturition centre co-ordinates the change from storage to voiding.
- Sensory impulses initiate the desire to void.
- Co-ordinated relaxation of the urethral sphincter and detrusor contraction allows the bladder to empty.



신경경로

- Voluntary control in brain
- Switch operated from brainstem
- sympathetic nerves from T11-L1
- main bladder and urethral nerves from S2-S4



운동 신경 경로

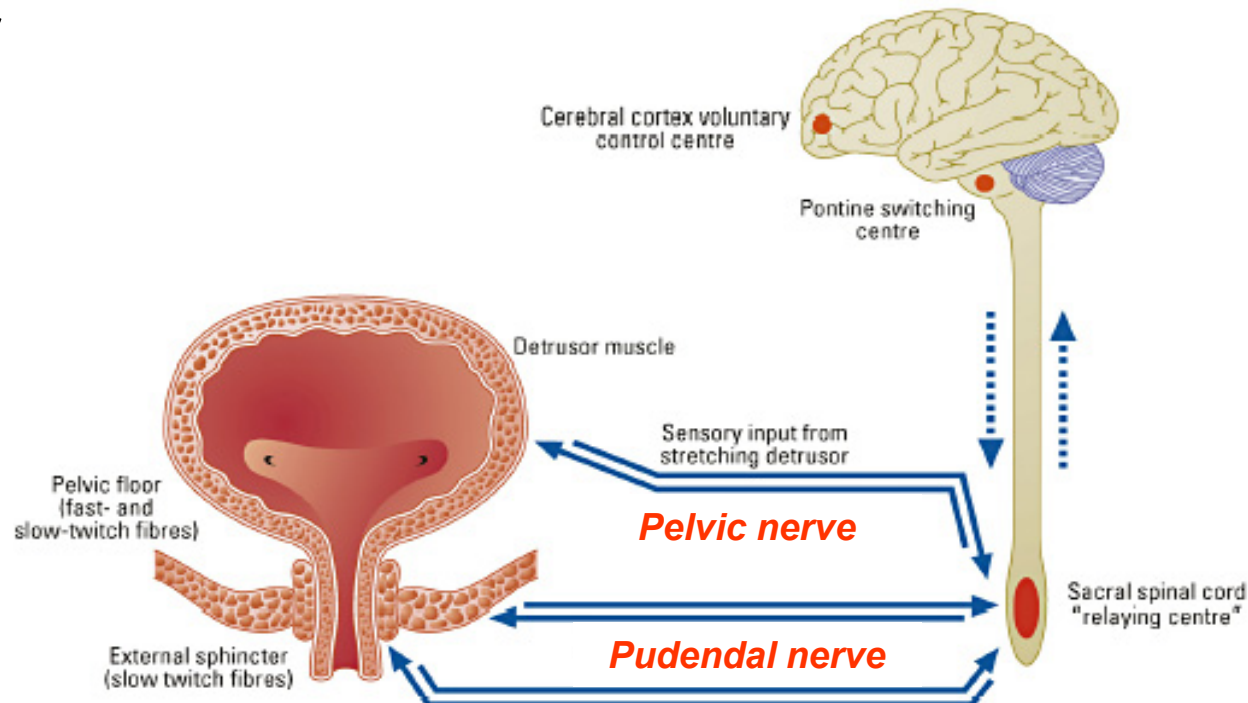
Bladder body (detrusor)

- smooth muscle
- parasympathetic
- via *pelvic nerve*
- excitatory
- active during emptying
- cholinergic,* but other neurotransmitters too

*anticholinergics in OAB
e.g. tolterodine,
oxybutynin,
solifenacin...

Striated urethral sphincter, pelvic floor

- striated muscles
- somatic
- via *pudendal nerve*
- excitatory
- active during storage



운동 신경 경로

Bladder body

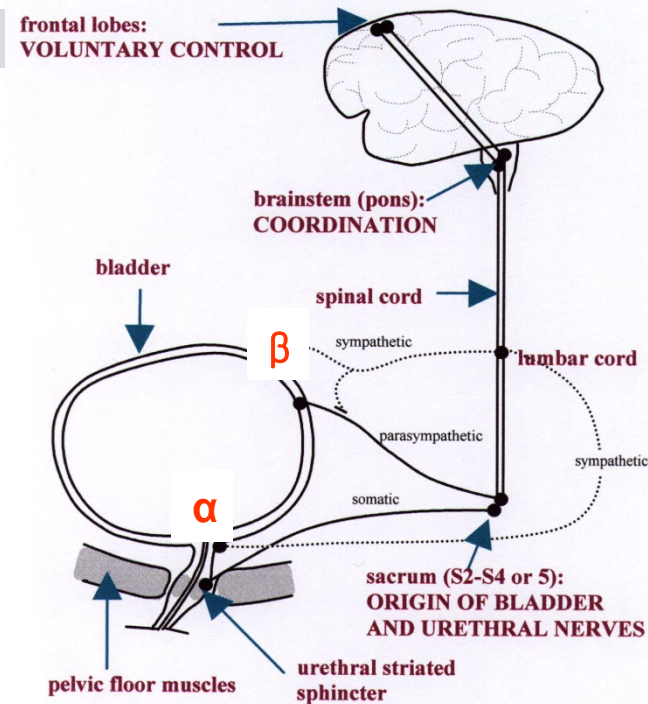
- *β -adrenergic*
- inhibitory
- may help storage
- secondary importance, affected by drugs

* β 3-agonist in OAB

Bladder base and proximal urethral smooth muscle

- *α -adrenergic*
- mainly excitatory
- may help storage
- secondary importance but useful in drug therapy

* α -blocker in BPH, e.g. cadura, terazosin, alfuzosin...



감각신경경로

- *Pelvic nerve* carries impulses both to and from the bladder - sensory (afferent) as well as motor (efferent).
 - Sensory information about tension in bladder wall carried in *myelinated (Ad) fibers*
 - Used *to fire reflex* and *for conscious sensation*.
- *Unmyelinated (C) fibers* normally carry sensations of pain and temperature.
 - After suprasacral nerve damage, C fibers may change role, *causing involuntary bladder contractions and incontinence*
 - C fiber receptors can be blocked by capsaicin (red pepper).

수의적 또는 불수의적? (Voluntary or involuntary?)

- Classical view:

- ☐ Smooth muscles (e.g. detrusor) are *involuntary*.
- ☐ Striated muscles (e.g. striated sphincter, pelvic floor) are *voluntary*.

- In fact:

- ☐ All LUT muscles have mixed behavior.
- ☐ *Voluntary* control of the detrusor has to be learned.
- ☐ During the storage phase, the striated sphincter maintains a tonic contraction *involuntarily*.

Landmarks and lesions

The crucial landmarks

:In principle (may be more complicated in practice)

❖ Cerebral cortex

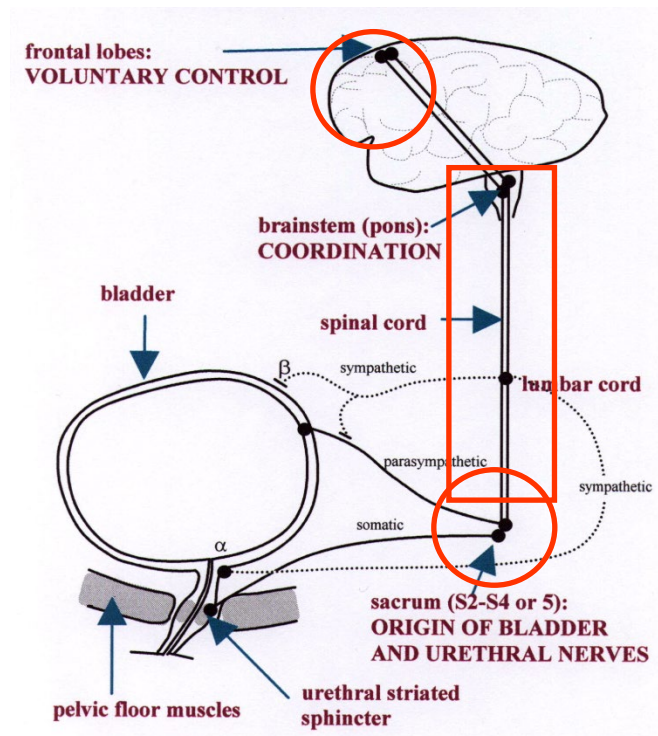
Lesion above brainstem affects voluntary control only, not coordination of bladder & urethra.

❖ Brainstem

Lesion between brainstem and sacral cord affects voluntary control & coordination.

❖ Sacral spinal cord

Lesion at sacral level may prevent bladder and urethra from working properly at all.





3. Function of the LUT



정상배뇨기능

	BLADDER	OUTLET
STORAGE	LOW PRESSURE RESERVOIR	CLOSED VALVE
EMPTYING	COORDINATED PUMP	UNOBSTRUCTED CHANNEL

배뇨장애의 분류

■ *Failure to Store*

- ☐ Because of the bladder
- ☐ Because of the outlet

■ *Failure to Empty*

- ☐ Because of the bladder
- ☐ Because of the outlet

저장장애 (Storage failure) 요실금 (Urinary Incontinence)

	BLADDER	OUTLET
STORAGE = Incontinence	URGE	STRESS
EMPTYING	COORDINATED PUMP	UNOBSTRUCTED CHANNEL

배출장애 (Emptying Failure)

요폐, 잔뇨 (Urinary Retention, Residual Urine)

	BLADDER	OUTLET
STORAGE	LOW PRESSURE RESERVOIR	CLOSED VALVE
EMPTYING	Detrusor Areflexia	BPH DESD

요역동학검사와 증상

- In urodynamics we examine the lower urinary tract (bladder and urethra).
- These are just part of a very extensive system.
- Dysfunction anywhere in the system, from brain to bladder, causes symptoms.
- The number of different symptoms is limited, but the number of possible causes is large.
- Urodynamics helps to determine the causes of the symptoms.

Storage vs. Emptying phase

Ideal and Reality

- The phases are easy to distinguish in the normal case, with good voluntary control.
- More difficult in abnormal situations because of:
 - leakage during the “storage” phase
 - incomplete or poor emptying during “voiding” phase
 - poor sensation of bladder filling
 - poor voluntary control of start of voiding
 - poor communication with patient, so that patient’s intention (to void or not to void) is not known
- These abnormal situations are what we investigate in urodynamics.



Urodynamics & the neural control system

- The neural control system of the lower urinary tract is bound up with the emotions and the emotional nervous system.
- Therefore it is susceptible to disturbance, e.g. in the artificial setting of a urodynamics examination.
- The art is to minimize this disturbance.

요역동학검사의 목적

- The aim is to **reproduce the symptoms**
 - under controlled and measured conditions
 - so as to identify the underlying causes
- To do this you need:
 - technically reliable measurements
 - experience, so that technique is second nature and you can concentrate on:
 - putting the patient at ease
 - reproducing their usual behavior
- That is why technical matters are so important.

*Thank you
for your attention!!*



Please try to void normally.