Al- Mustaqbal College University
kidney dialysis

Anatomy

2nd stage

BY:-

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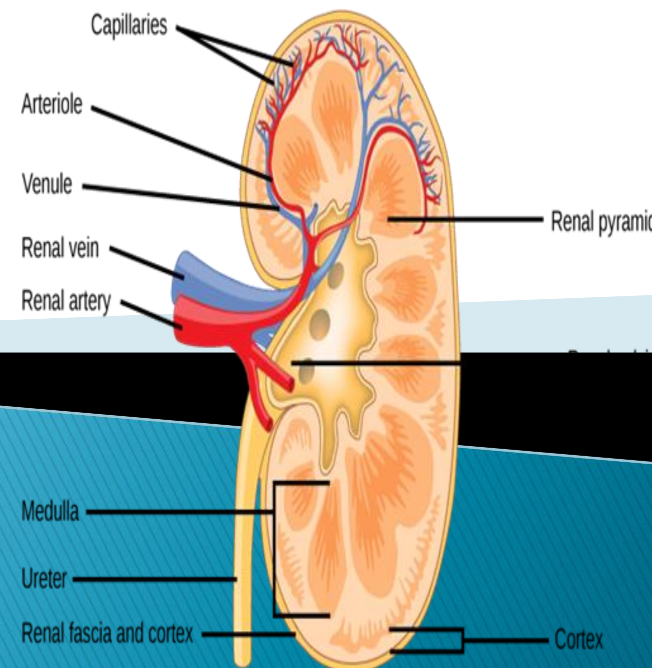
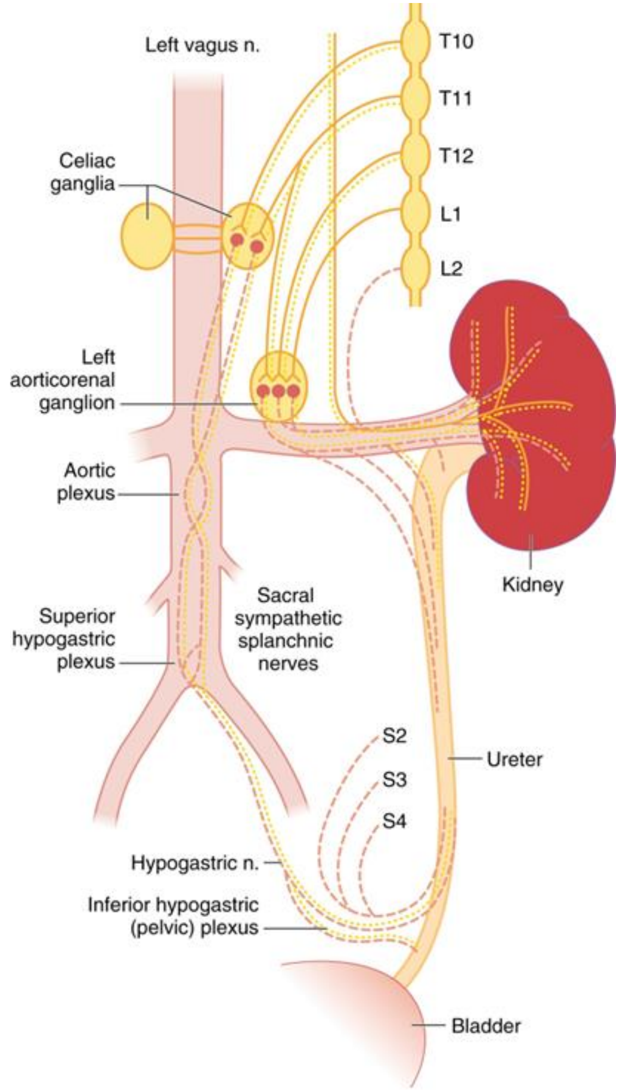
Innervation Of renal system



Renal nerves originate from the renal plexus, a network of nerve fibers that surrounds the renal arteries. The renal plexus receives contributions from the celiac plexus, the aortic plexus, and the splanchnic nerves. The renal nerves course along the renal arteries and enter the kidney at the hilum.



The Types of Nerve Fibers Present in the Renal Nerves

Renal nerves contain both **efferent and afferent nerve fibers**. Efferent nerve fibers are further divided into **sympathetic and parasympathetic** fibers. Sympathetic fibers are responsible for the regulation of renal blood flow, glomerular filtration rate, and sodium reabsorption. Parasympathetic fibers, on the other hand, have a minimal role in renal physiology.

Nerve Fiber Type	Function
Sympathetic Efferent	Regulates renal blood flow, GFR, and sodium reabsorption
Parasympathetic Efferent	Minimal role in renal physiology
Afferent	Transmits sensory information from the kidney to the CNS

The Distribution of Renal Nerves Within the Kidney

- Renal nerves are distributed throughout the kidney, with a higher density in the renal cortex than in the medulla. The nerves innervate various structures within the kidney, including the renal vasculature, tubules, and juxtaglomerular apparatus.

The kidneys are innervated by both **sympathetic and parasympathetic nerves**, primarily through the renal plexus, which regulates various kidney functions.

Sympathetic Innervation

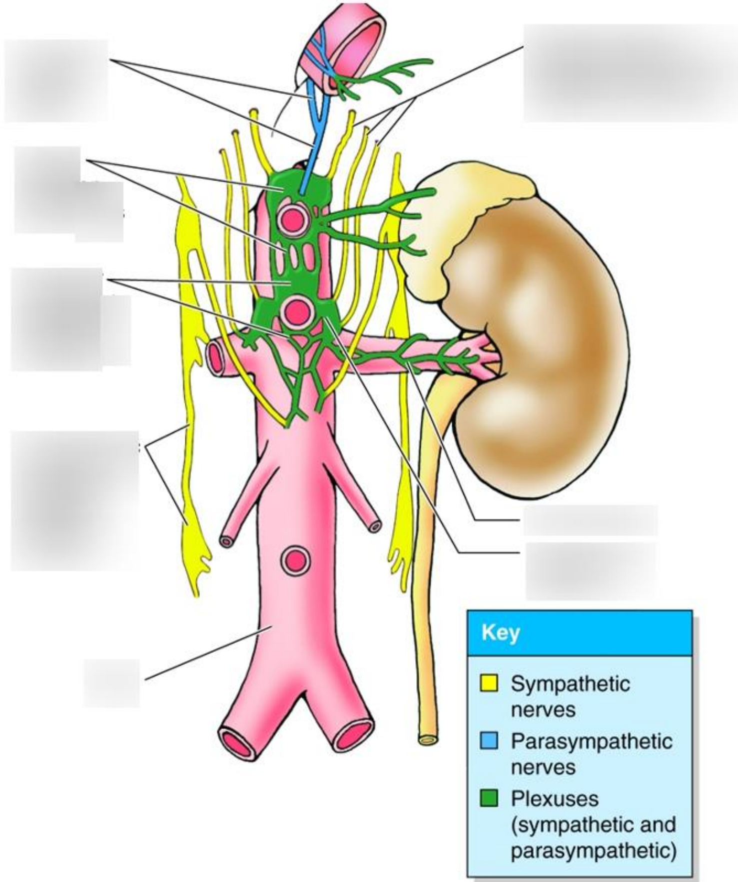
Origin: The sympathetic nerves that innervate the kidneys originate from the thoracolumbar region of the spinal cord, specifically from T10 to L1. These fibers travel via the thoracolumbar splanchnic nerves and synapse at the renal and celiac ganglia.

Function: Sympathetic stimulation leads to vasoconstriction of the renal arterioles, which reduces renal blood flow and glomerular filtration rate. This response is crucial during stress or low blood volume situations, as it helps conserve water and maintain blood pressure. Additionally, sympathetic nerves regulate renin release from juxtaglomerular cells, influencing blood pressure and fluid balance.

Parasympathetic Innervation

Origin: The parasympathetic fibers primarily come from the vagus nerve (cranial nerve X) and the intermesenteric plexus, which includes fibers from the sacral spinal cord (S2 to S4).

Function: Parasympathetic stimulation generally promotes vasodilation of the renal arterioles, increasing renal blood flow and enhancing urine production. This activity contrasts with the sympathetic response, facilitating kidney function during rest and digestion.

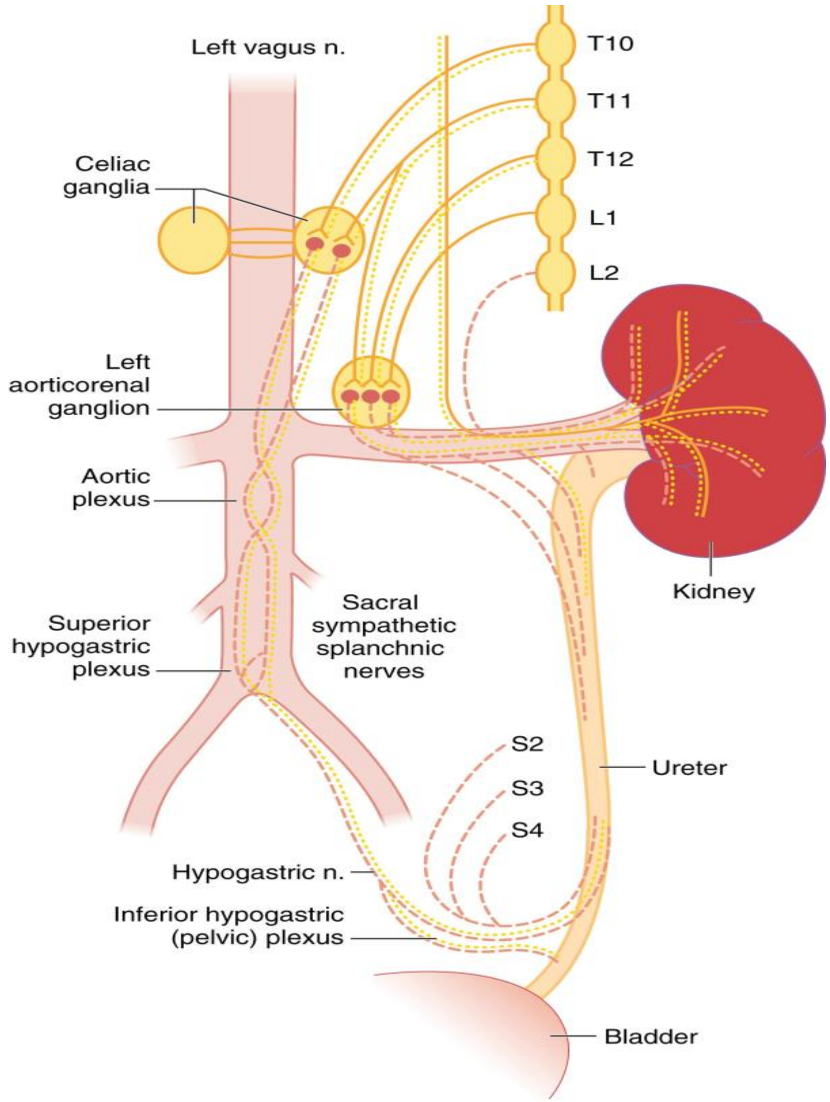

Key
Sympathetic nerves
Parasympathetic nerves
Plexuses (sympathetic and parasympathetic)

Afferent Sensory Nerves

Role: Afferent sensory nerves convey information about the kidney's status to the central nervous system. They play a role in detecting pain, such as that caused by kidney stones, and can influence sympathetic activity, contributing to the regulation of blood pressure and fluid balance.

Summary

The kidneys receive a rich innervation from both the sympathetic and parasympathetic nervous systems through the renal plexus. This dual innervation allows for precise regulation of kidney function, including blood flow, filtration rate, and urine production, adapting to the body's needs in various physiological states..

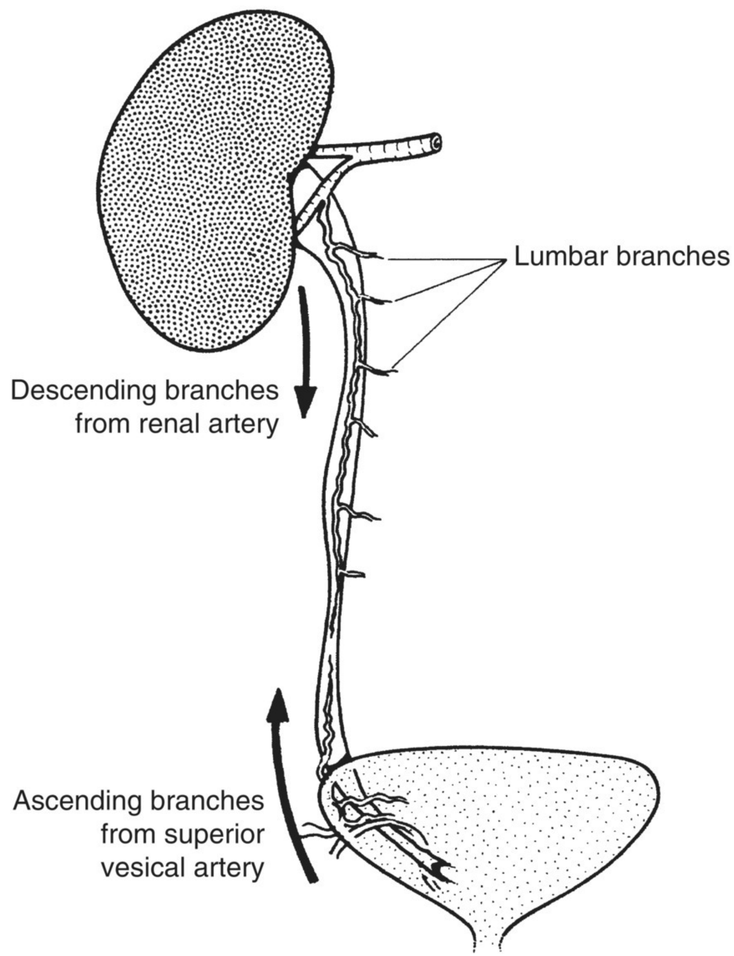

Left vagus n.
T10
T11
T12
L1
L2
Celiac ganglia
Left aorticorenal ganglion
Aortic plexus
Kidney
Sacral sympathetic splanchnic nerves
Superior hypogastric plexus
S2
S3
S4
Ureter
Hypogastric n.
Inferior hypogastric (pelvic) plexus
Bladder

Innervation of the ureter

Nerve Supply: The ureters receive their innervation from the autonomic nervous system, specifically through the sympathetic and parasympathetic fibers.

Sympathetic Innervation: Arises from the thoracolumbar region (T11-L2) and travels via the renal plexus and aortic plexus to the ureters. This innervation is involved in regulating peristalsis and blood flow.

Parasympathetic Innervation: Comes from the pelvic splanchnic nerves (S2-S4), which stimulate peristalsis and promote urine transport


Lumbar branches
Descending branches
from renal artery
Ascending branches
from superior
vesical artery

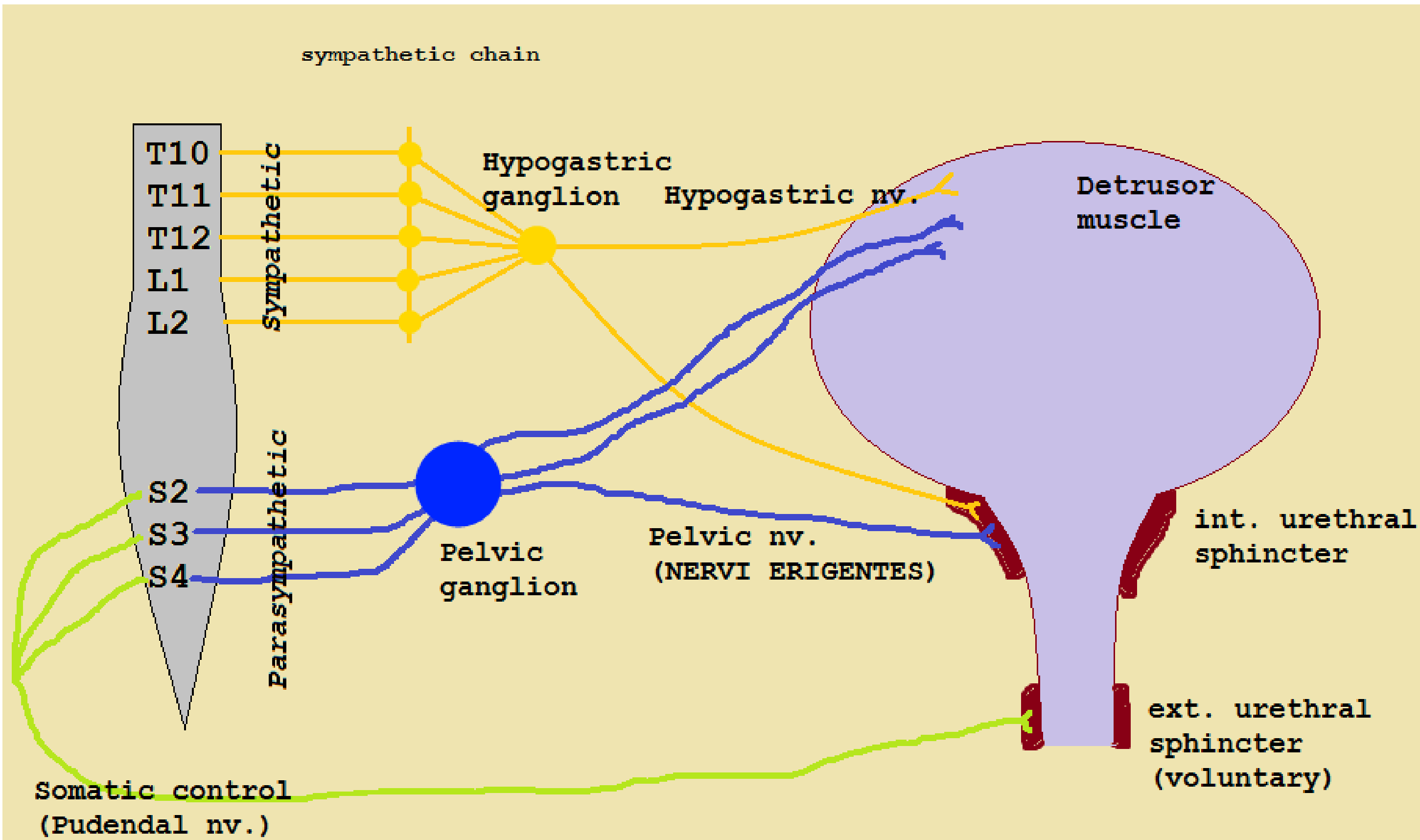
Nerve supply of the bladder

Neurological control is complex, with the bladder receiving input from both the autonomic (sympathetic and parasympathetic) and somatic arms of the nervous system:

Sympathetic – hypogastric nerve (T12 – L2). It causes relaxation of the detrusor muscle, promoting urine retention.

Parasympathetic – pelvic nerve (S2-S4). Increased signals from this nerve causes contraction of the detrusor muscle, stimulating micturition.

Somatic – pudendal nerve (S2-4). It innervates the external urethral sphincter, providing voluntary control over micturition.



sympathetic chain
T10
T11
T12
L1
L2
Sympathetic
Hypogastric
ganglion
Hypogastric nv.
Detrusor
muscle
S2
S3
S4
Parasympathetic
Pelvic
ganglion
Pelvic nv.
(NERVI ERIGENTES)
int. urethral
sphincter
ext. urethral
sphincter
(voluntary)
Somatic control
(Pudendal nv.)

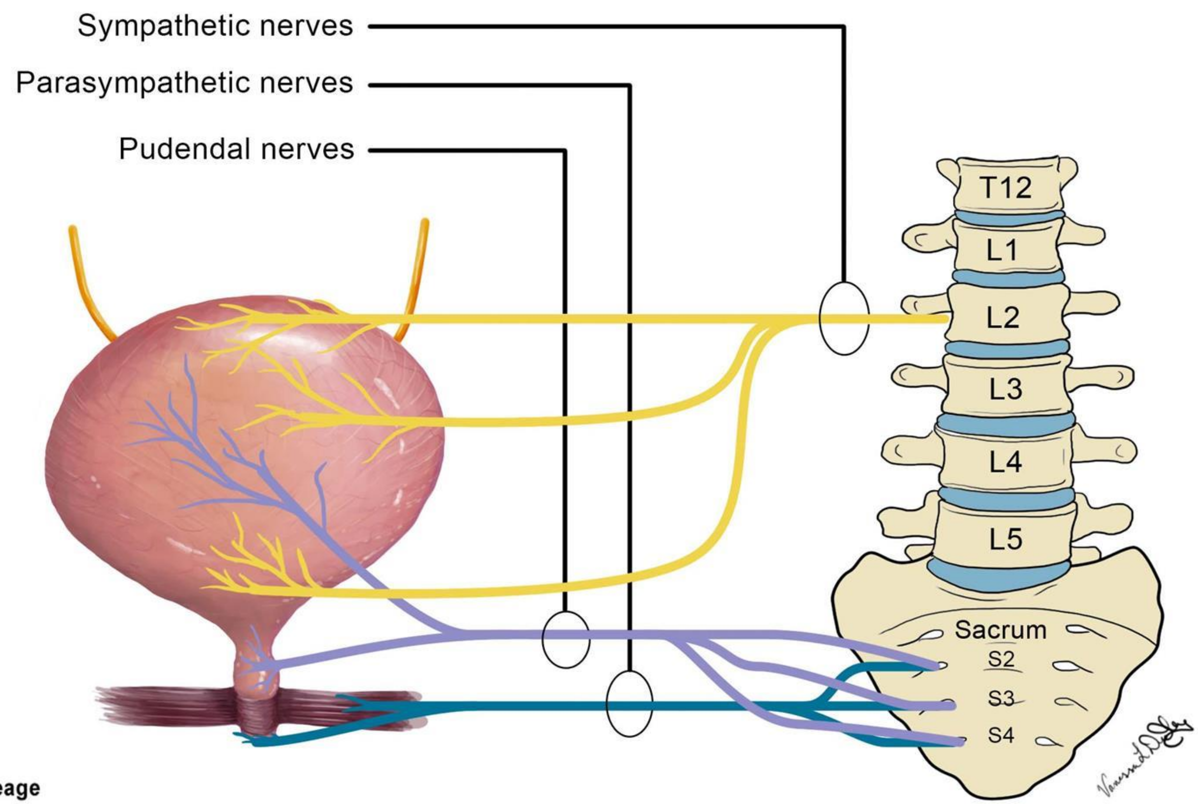
In addition to the efferent nerves supplying the bladder, there are sensory (afferent) nerves that report to the brain. They are found in the bladder wall and signal the need to urinate when the bladder becomes full.

The Bladder Stretch Reflex

The bladder stretch reflex is a primitive spinal reflex, in which micturition is stimulated in response to stretch of the bladder wall..

During toilet training in infants, this spinal reflex is overridden by the higher centers of the brain, to give voluntary control over micturition.

Bladder Innervation



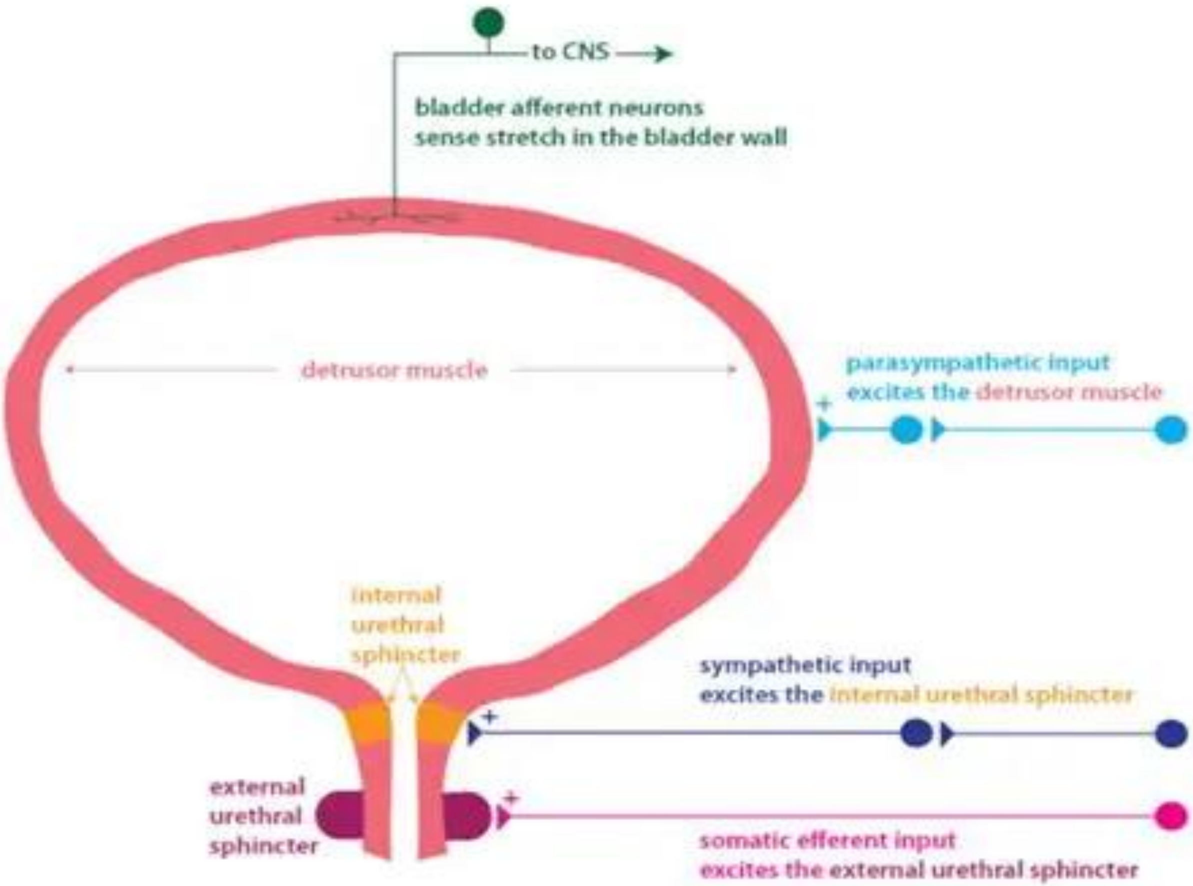
The reflex arc:

Bladder fills with urine, and the bladder walls stretch.

Sensory nerves detect stretch and transmit this information to the spinal cord.

Interneurons within the spinal cord relay the signal to the parasympathetic efferents (the pelvic nerve).

The pelvic nerve acts to contract the detrusor muscle, and stimulate micturition.

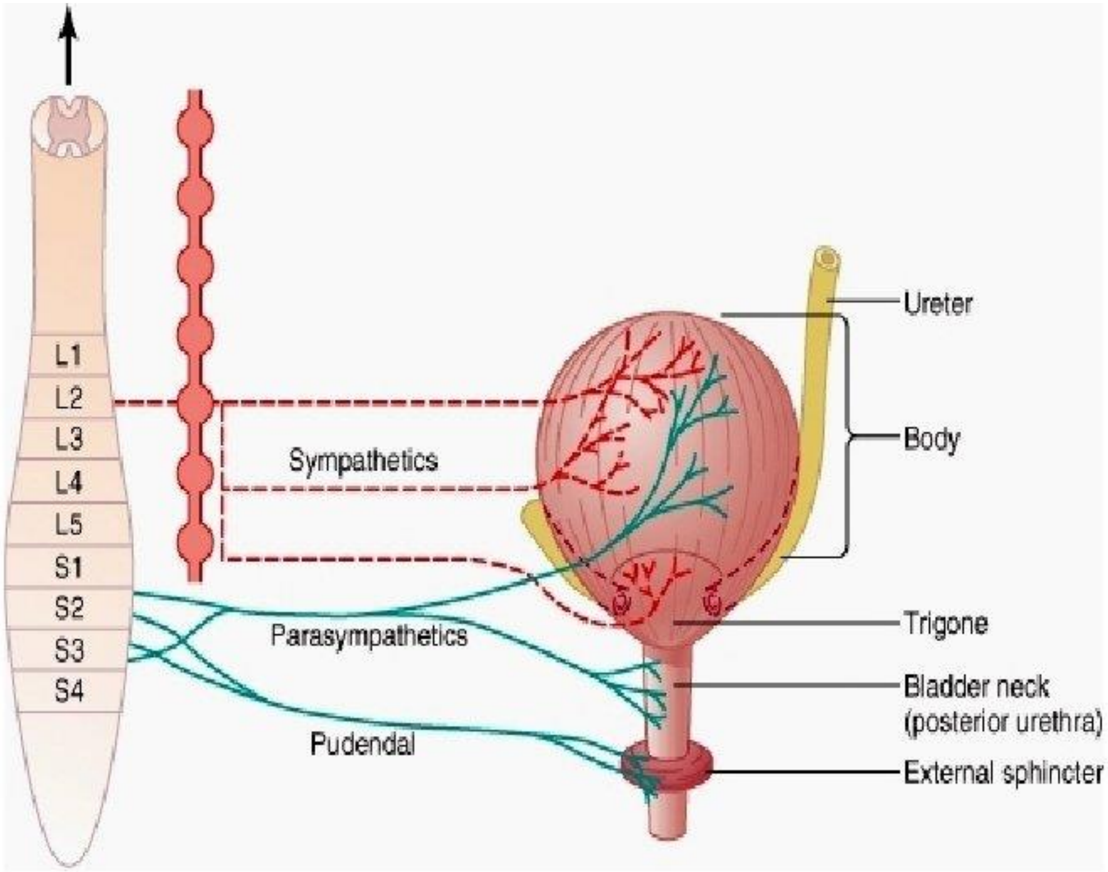

to CNS
bladder afferent neurons
sense stretch in the bladder wall
detrusor muscle
parasympathetic input
excites the detrusor muscle
internal
urethral
sphincter
sympathetic input
excites the internal urethral sphincter
external
urethral
sphincter
somatic efferent input
excites the external urethral sphincter

Innervation of urethra

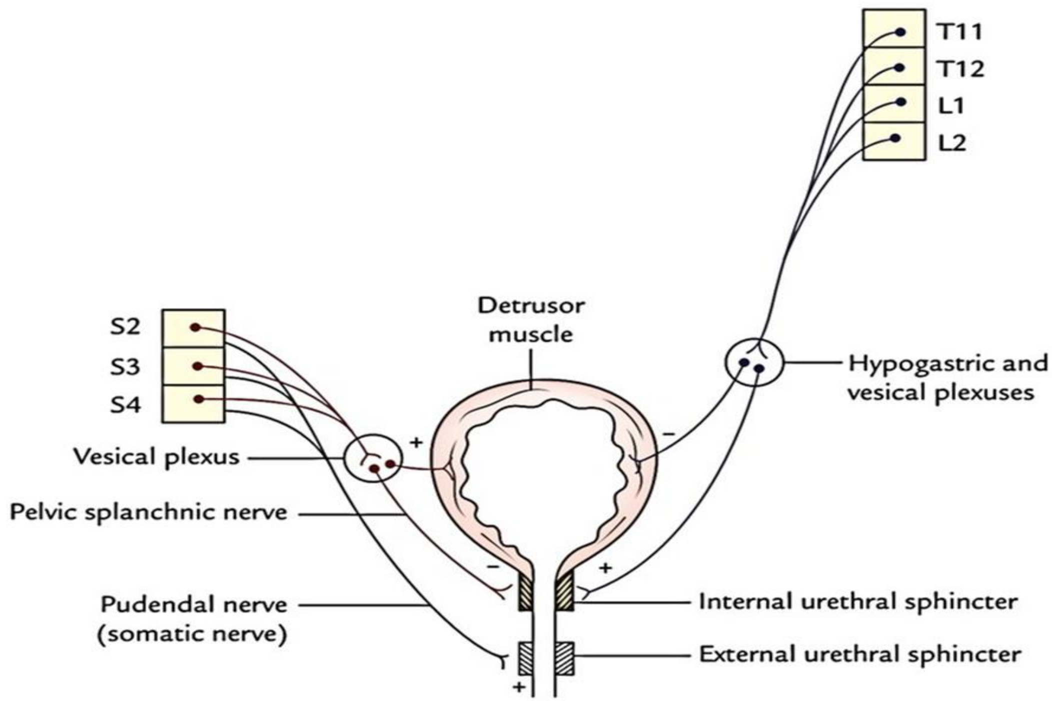
The urethral sphincter complex receives both somatic and autonomic innervation. These supply its voluntary and involuntary components, respectively.

The smooth muscle fibers of the internal urethral sphincter receive both sympathetic and parasympathetic innervation.

Sympathetic supply arises from the lower thoracic and upper lumbar (T11 - L2) segments of the spinal cord. These nerves maintain tonic contraction of the internal urethral sphincter, thereby preventing urine outflow from the bladder into the urethra the parasympathetic supply arises from sacral levels S2 - S4 (spinal micturition center). It acts to “inhibit” the internal sphincter muscle, thereby relaxing it and allowing urine to pass from the bladder into the urethra.



The external urethral sphincter is innervated by the pudendal nerve (S2–S4), which provides somatic motor innervation. This innervation allows for voluntary control of the sphincter, playing a crucial role in urinary continence.



Clinical Significance of Renal Nerves

Role in Hypertension and Cardiovascular Disease

Renal nerves play a significant role in the development and maintenance of hypertension.

Increased sympathetic activity contributes to the pathogenesis of hypertension by increasing renal vascular resistance, sodium reabsorption, and renin release.

Impact on Chronic Kidney Disease and Renal Failure

Renal nerves also contribute to the progression of chronic kidney disease (CKD) and renal failure. Increased sympathetic activity promotes fibrosis and inflammation in the kidney, accelerating disease progression