Anatomical considerations of the ureters, urinary bladder

- **Ureters** are tubes extend from the kidney to the urinary bladder. They extend from the renal pelvis at the renal hilum of each kidney to reach the urinary bladder.
- **Urinary bladder** is a hallow muscular container that lies in the pelvis cavity.
- **The urethra** transports urine to the outside of the body.
- **The walls of ureters and bladder are lined with:**

- Transitional epithelial mucosa.
- Smooth muscle muscularis (stimulated to contract by parasympathetic fiber).
- Fibrous connective tissue adventitia.

- The outlet of the urethra is graduated by two sphincters:

1. Internal sphincter involuntary sphincter of smooth muscle.
2. External sphincter is skeletal muscle surrounds the urethra as it extends through the pelvic floor. It acts as a valve that controls the flow of urine through the urethra.

Urine collection and micturition

Passage of urine from kidney to bladder

- Urine moves from the **collecting ducts** of the renal tubules to the **renal pelvis** by **hydrostatic pressure**.
- Urine moves from the **pelvis** into the **ureter** by the **smooth muscles contraction**.
- The **peristaltic wave** which propagates along the ureters length propels urine into the bladder to store the urine.

Micturition

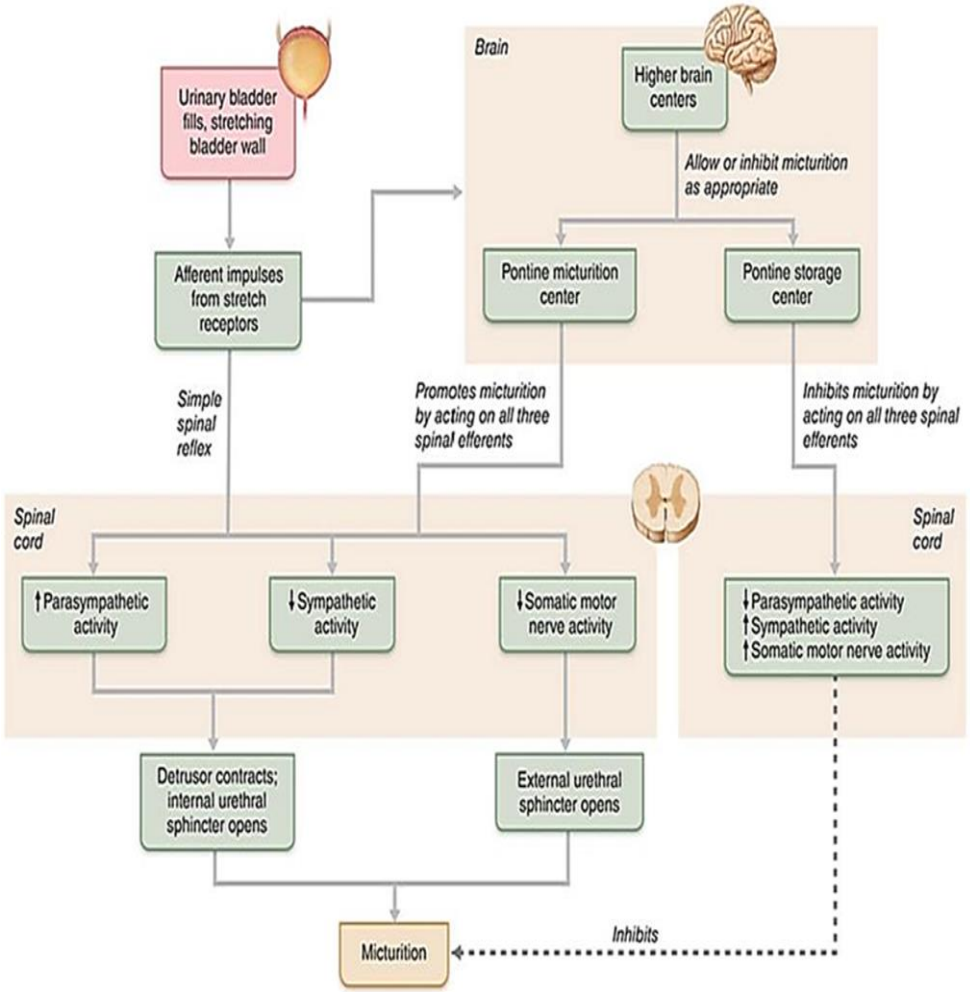
- The flow of urine to the urinary bladder is relatively continuous .
- The urinary bladder acts as a reservoir for urine until it can be eliminated at appropriate time.
- The bladder can distend to accommodate the large volume of fluid . The maximum volume it can contain is **1L**, and discomfort begins when urine volume exceeds **500ml**.
- The capacity of the urinary bladder to distend is due to the following factors:

1. The walls of the urinary bladder contain large folds, which develop to enlarge the lumine of the urinary bladder.
2. The lining of urinary bladder is stretchable transitional epithelium .
3. Smooth muscle (detrusor muscle) wall of the urinary bladder stretch to accommodate the fluid volume.

- The bladder expands as the urine flows into it , but the internal pressure does not increase because its structure.

Micturition reflex

- Micturition reflex is activated when the bladder wall is stretched resulting in elimination of urine from the urinary bladder **(micturition) .**
- Integration of the micturition reflex occurs in the **sacral region** of the spinal cord and modified in the pons of cerebrum.
- When urine fills the bladder stimulates **stretch receptors** which produce action potential .
- Action potential is carried by sensory neurons to spinal cord through the **pelvis nerves**.
- Action potential is carried to the bladder through parasympathetic fibers.
- Parasympathetic stimulation causes contraction of smooth muscles of the bladder and decrease somatic motor action potentials causing the external urinary sphincter to relax.
- Urine flows from the bladder to the urethra by increase the pressure.



Diuretics

- Diuretics chemicals that enhance urinary output.
- An osmotic diuretic is a substance that is not reabsorbed and that carries water out with it (e.g. the high blood glucose levels of a diabetes patient).
- Alcohol induce diuresis by inhibiting release of ADH.
- Other diuretics increase urine flow by inhibiting Na^+ reabsorption and the obligatory water reabsorption such as caffeine (found in coffee, tea and colas) and many drugs for hypertension or the edema of congestive heart failure.
- Common diuretics inhibit Na^+ -associated symports such as Lasix which acting at the ascending limb of Henie's loop. While Thiazides are acting at the DCT.

Body fluid regulation

- Water balance is regulated by mechanisms that prevent the large change in plasma osmolality.
- Plasma osmolality (concentration of body fluid) is measured the amount of dissolved substances per unit mass of water (it is given in unit mol\Kg).
- Plasma osmolality is determined by plasma Na^+ concentration.
- Plasma osmolality is regulated by changes in water intake and excretion.

Regulation of body osmolality

- ❑ Water is lost from the body by :
- Breathing
- Sweating
- In faces
- Via the kidney ,the most important to keep plasma osmolality constant.
- ❑ Water is provided for body by drinking and by water content in the feed.
- Osmoreceptors play a major role in the regulation of water by kidneys and thirst.
- ADH regulates water excretion and osmolality.
- Osmoreceptors respond to change in plasma osmolality by shrinking or swelling, resulting in change in ADH output from the posterior pituitary gland.
- ❑ An excessive loss of water from the body leads to increase plasma osmolality and the osmoreceptors stimulate secretion of ADH (which conserves water) and cause sensation of thirst.

Regulation of acid –base balance

- ❑ The maintenance of H^+ concentration within narrow range is essential for normal metabolic reactions, because H^+ affect the activity of many enzymes and chemical reactions within the body.
- ❑ The mechanisms that regulate the H^+ concentration are :**buffer system, respiratory system and the kidneys.**

Acid and bases

- Acids are substances that release H^+ into a solution, while base binds to H^+ and removes them from the solution.
- Acids and bases are either strong or weak. **Strong acids** dissociate completely to form ions in the solution. **Weak acid** dissociate partially.
- Weak acids are common in living system because they play an important role in the preventing significant changes in the body fluid PH.
- Buffer system resist changes in the PH of solution. Buffer within the body fluid regulate PH by binding to excess H^+ or by releasing H^+ when H^+ concentration decreases.
- There are several buffer systems function together to resist PH changes of body fluid :

1. Carbonic acid / bicarbonate buffer system

- Carbonic acid H_2CO_3 is weak acid dissolved in water:

$$\mathbf{H_2CO_3 \leftrightarrow HCO_3^- + H^+}$$

2. Protein molecules buffer system

- Hemoglobin is one of the most important intracellular proteins.
- The capacity of these proteins is due to the functional groups of amino acids e. g., carboxyl and amino groups, which act as weak acids and base:

- As the H^+ concentration increases, more H^+ ions bind to the functional groups. When H^+ decreases, more H^+ ions are released from the functional group.

3. Phosphate buffer system

- Phosphate containing molecules e.g., DNA, RNA, ATP and HPO_4^{-2} in solution act as buffers.
- Phosphate ions act as weak acids can bind to H^+ to form H_2PO_4 when H^+ increase and release H^+ when these ions decrease.

Renal regulation of acid-base balance

- Renal tubules regulate acid base balance by increasing or decreasing the H^+ into the filtrate and HCO_3^- reabsorption.
- Carbonic anhydrase in the nephron cells catalyzes the formation of H_2CO_3 from CO_2 and H_2O.
- Secretion of H^+ into the filtrate by antiport mechanism in exchange for Na^+ causing to decrease PH of the filtrate.
- Bicarbonate ions move into the interstitial fluid and then diffuse into the capillaries.
- In the capillaries HCO_3^- combine with H^+ causing to decrease the H^+ concentration and increase blood PH.