Physiology (code)-year 2

Renal physiology

Lecture 2 (Urine formation)

By Dr. Rafida AL-Amiri

Basic Science Department

college of dentistry

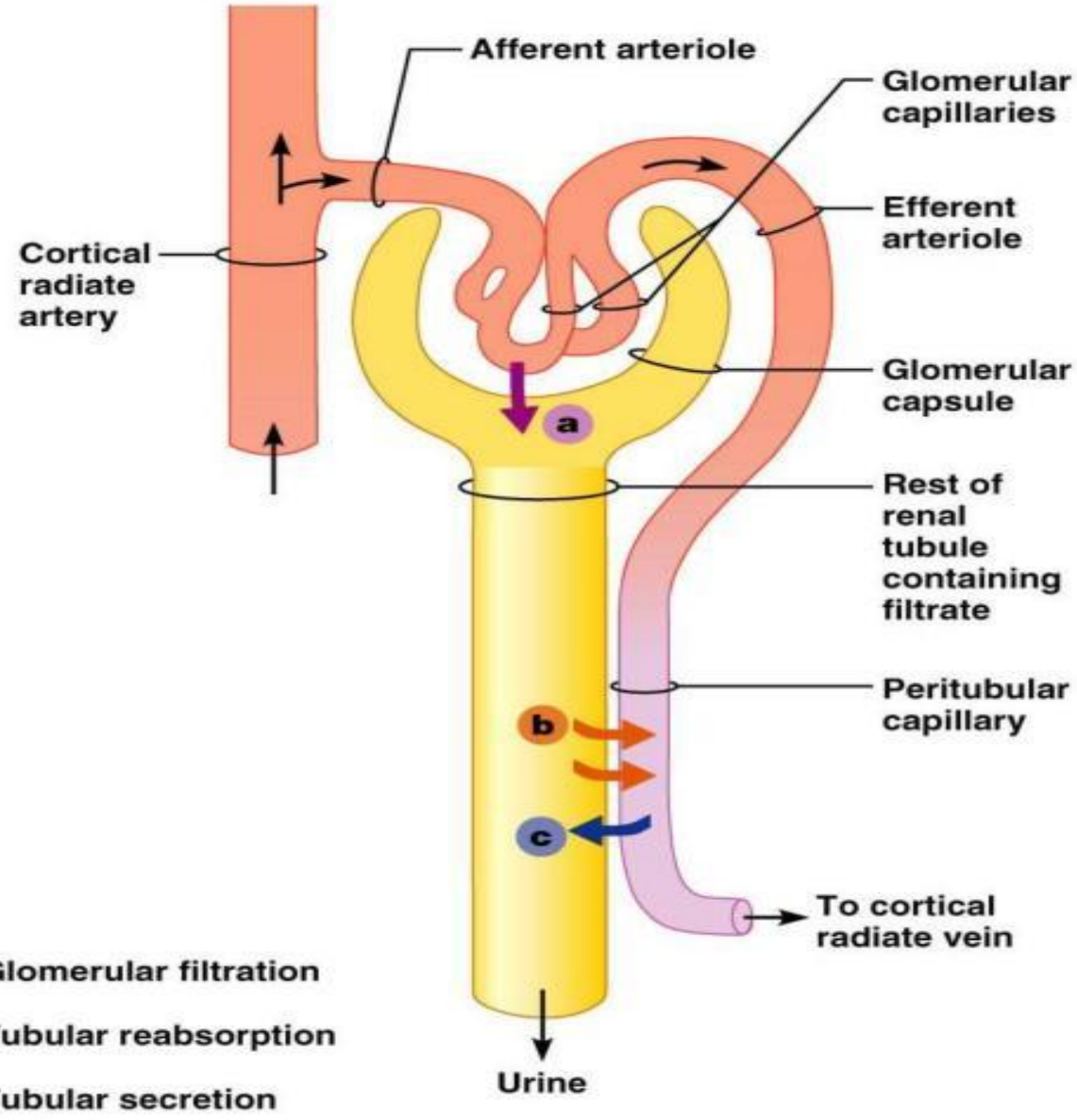
University of Basrah

Learning objectives

- To describe the mechanisms of urine formation.
- Pressure determining filtration,
- Micturition
- Renal Function Tests
- Relation between renal disease & oral health

Mechanisms of Urine Formation

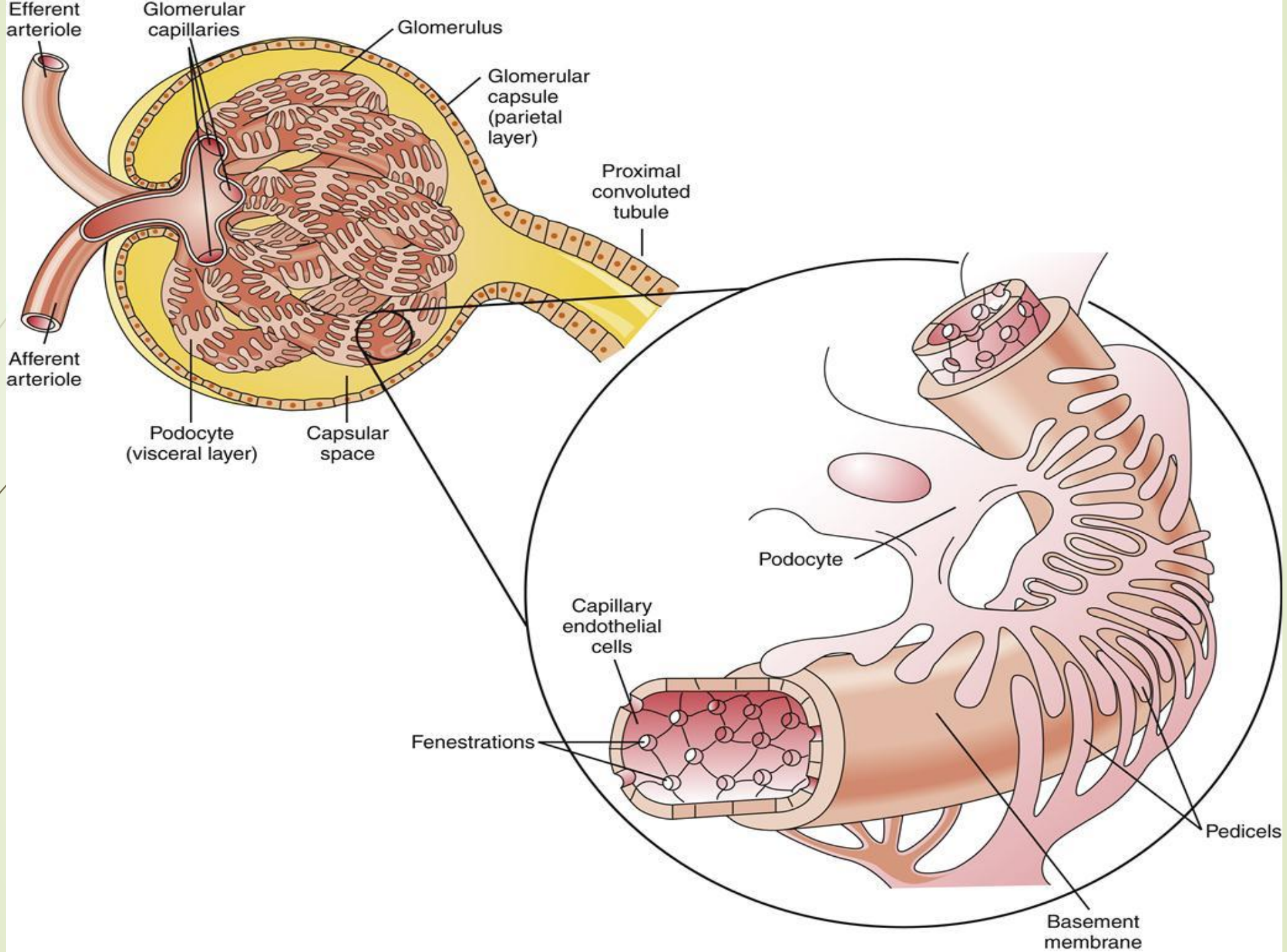
- Urine formation and adjustment of blood composition involves three major processes
  - Glomerular filtration
  - Tubular reabsorption
  - Secretion



Glomerular filtration

- The first step in production of urine
- It occurs in the renal corpuscle across the endothelial-capsular membrane.
- Blood pressure forces water and dissolved blood components through the endothelial-capsular membrane.

- The resulting fluid is called as filtrate.
- The filtrate contains all the materials present in the blood except the formed elements and large plasma proteins.


Efferent arteriole
Glomerular capillaries
Glomerulus
Glomerular capsule (parietal layer)
Proximal convoluted tubule
Afferent arteriole
Podocyte (visceral layer)
Capsular space
Podocyte
Capillary endothelial cells
Fenestrations
Pedicels
Basement membrane

Glomerular filtration

- 20% of blood plasma is filtered by the glomeruli out of which only 1% is excreted while the remaining 19% is reabsorbed in blood.
- The amount of blood filtered in all renal corpuscles per minute is called as the **glomerular filtration rate** and is around 125ml/min in males and 105 ml/min in females.

Tubular Reabsorption

- The movement of water and solutes back into the blood of a peritubular capillary called as **tubular reabsorption.** So, these solutes are reabsorbed both by active and passive processes.
- As the fluid passes through the renal tubules about 99% of it is reabsorbed means returned to the blood. Thus, only 1% of the filtrate leaves the body as urine (about 1.5 liters/day).
- Solutes that are reabsorbed includes **glucose, amino acids, urea** and **ions** such as **Na+ , K+ , Ca+2 , Cl- , HCO3 _** and **HPO4**

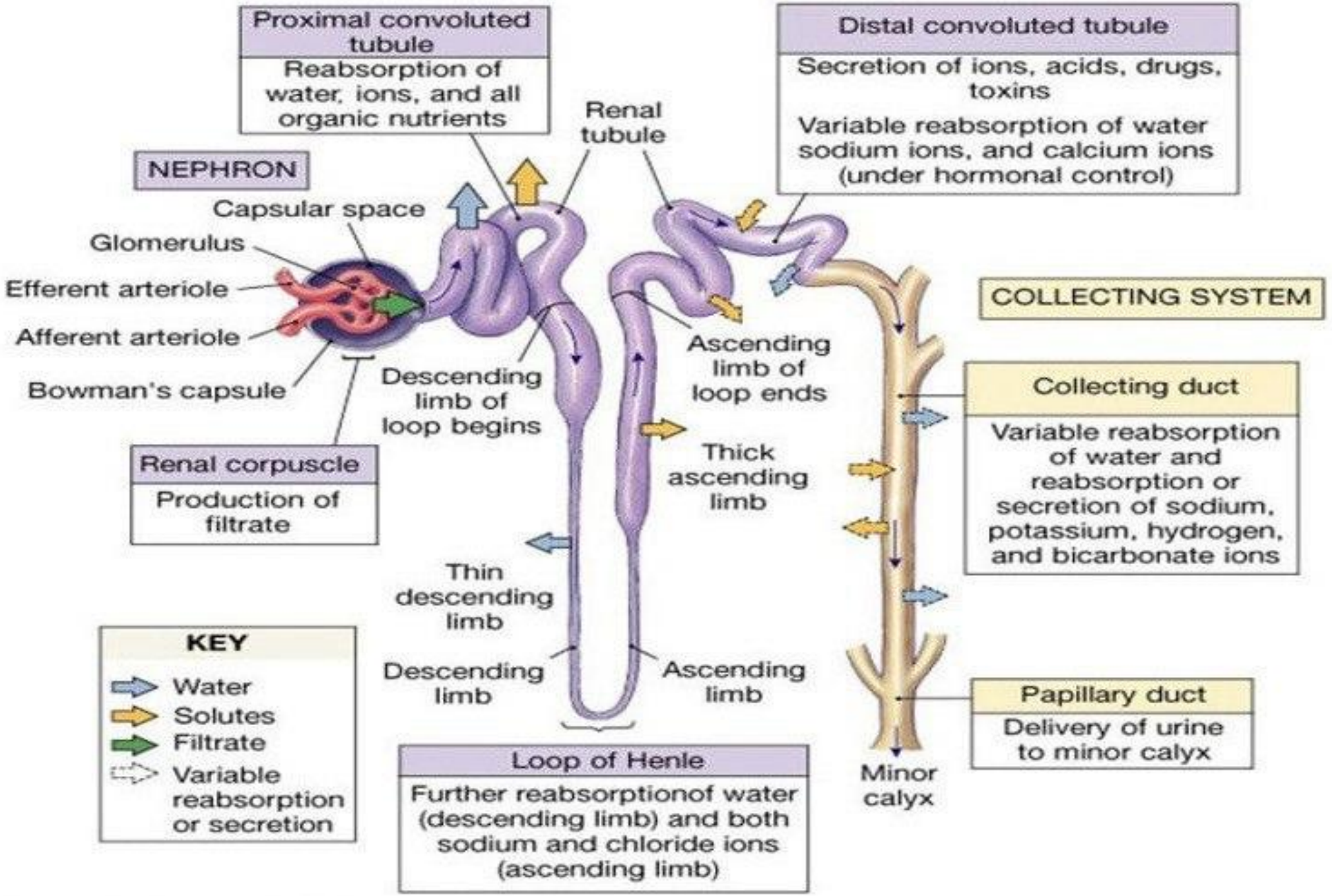
Tubular Reabsorption

Reabsorption is regulated by various hormones.

- **Parathyroid hormone (PTH):** It is secreted by Parathyroid gland and **calcitonin** from Thyroid gland together regulates reabsorption of Calcium and Phosphate.
- **Antidiuretic hormone (ADH):** It is secreted by posterior lobe of Pituitary gland increases water reabsorption.
- **Aldosterone:** It is secreted by Adrenal cortex increases reabsorption of Na+ and excretion of K+ .
- **Atrial natriuretic hormone (ANP):** It is secreted by the Atria of heart decreases reabsorption of sodium and water in PCT and collecting ducts.

Tubular Secretion

- The third process involved in urine formation.
- Tubular secretion removes materials from the blood and adds them to the filtrate. This process helps in removal of toxic substances from body in the form of urine.
- These secreted substances are K+ , H+ , ammonium ions, creatinine & drugs.
- Tubular secretions of hydrogen ions are important in blood pH maintainace.


Proximal convoluted tubule
Reabsorption of water, ions, and all organic nutrients
Renal tubule
Distal convoluted tubule
Secretion of ions, acids, drugs, toxins
Variable reabsorption of water sodium ions, and calcium ions (under hormonal control)
NEPHRON
Capsular space
Glomerulus
Efferent arteriole
Afferent arteriole
Bowman's capsule
COLLECTING SYSTEM
Ascending limb of loop ends
Descending limb of loop begins
Collecting duct
Variable reabsorption of water and reabsorption or secretion of sodium, potassium, hydrogen, and bicarbonate ions
Renal corpuscle
Production of filtrate
Thick ascending limb
Thin descending limb
KEY
Water
Solutes
Filtrate
Variable reabsorption or secretion
Descending limb
Ascending limb
Papillary duct
Delivery of urine to minor calyx
Loop of Henle
Further reabsorptionof water (descending limb) and both sodium and chloride ions (ascending limb)
Minor calyx


© 2016 Nucleus Medical Media. All Rights Reserved.

PRESSURES DETERMINING FILTRATION

1. Glomerular Capillary pressure
2. Colloidal Osmotic pressure in the glomeruli
3. Hydrostatic pressure in the Bowman capsule.

Glomerular Capillary pressure is the pressure exerted by the blood in glomerular capillaries. It is about 60 mm Hg .

Glomerular capillary pressure is the highest capillary pressure in the body.

This pressure favors glomerular filtration.

Colloidal Osmotic pressure It is the pressure exerted by plasma proteins in the glomeruli. The plasma proteins are not filtered through the glomerular capillaries and remain in it which is about 25 mm Hg.

- It opposes glomerular filtration.

- **Hydrostatic pressure** the pressure exerted by the filtrate in Bowman capsule. It is also called **capsular pressure**. It is about 15 mm Hg.
- It also opposes glomerular filtration.

What is the capsular pressure?

•**Micturition** is the process by which the urinary bladder empties when it becomes filled.

• This involves two main steps:

• First, the bladder fills progressively until the tension in its walls rises above a threshold level;

• this elicits the second step, which is a nervous reflex called the **micturition reflex** that empties the bladder or, if this fails, at least causes a conscious desire to urinate.

Although the micturition reflex is an autonomic spinal cord reflex, it can also be inhibited or facilitated by centers in the cerebral cortex or brain stem.

Innervation of the Bladder

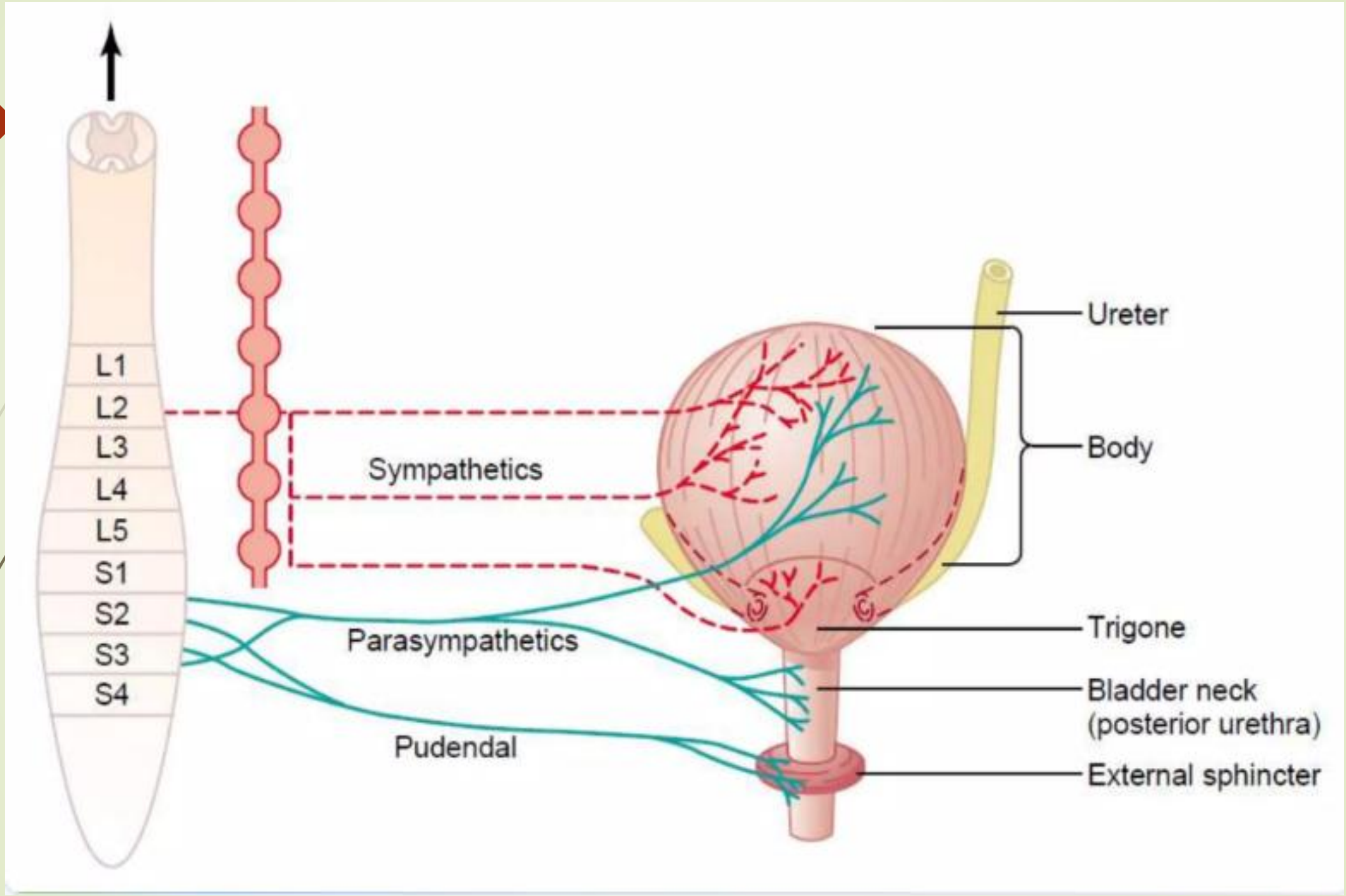
• The principal nerve supply of the bladder is by way of the **pelvic nerves**, which connect with the spinal cord through the sacral plexus, mainly connecting with cord segments S-2 and S-3.

• Coursing through the pelvic nerves are both **sensory nerve fibers** and **motor nerve fibers**.

The sensory fibers detect the degree of stretch in the bladder wall.

The motor nerves transmitted in the pelvic nerves are **parasympathetic fibers**.

These terminate on ganglion cells located in the wall of the bladder. Short postganglionic nerves then innervate the detrusor muscle.


L1
L2
L3
L4
L5
S1
S2
S3
S4
Sympathetics
Parasympathetics
Pudendal
Ureter
Body
Trigone
Bladder neck
(posterior urethra)
External sphincter

Renal function test

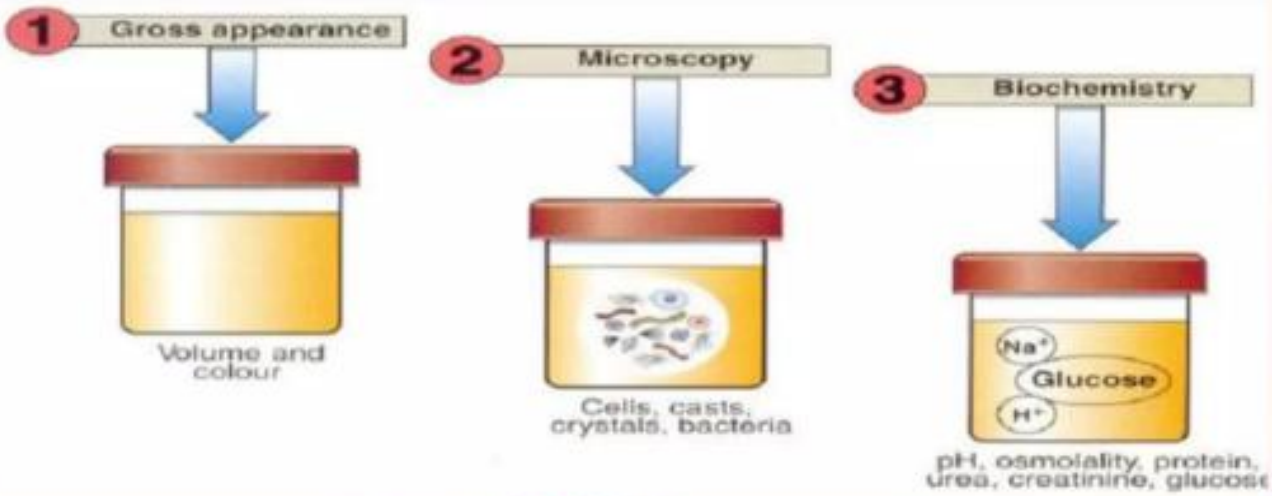
What to examine???

Renal function tests are divided into the following:

- **Urine analysis**
- **Blood examination**

URINE ANALYSIS

- Urine examination is an extremely valuable and most easily performed test for the evaluation of renal functions.
- It includes physical or macroscopic examination, chemical examination and microscopic examination of the sediment.



Urine analysis involves

Physical examination-

- Normal urine output – 800-2000 ml/day
- Anuria and oliguria can be because of various conditions like renal failure.
- Anuria - <100 ml/day
- Oliguria - <400 ml/day
- Polyuria - >2000 ml/day which can be caused by various conditions like diabetes mellitus.

Macroscopic examination

Colour

• Normal- pale yellow in colour due to pigments urochrome, urobilin and uroerythrin.

•Cloudiness may be caused by excessive cellular material or protein, crystallization or precipitation of salts upon standing at room temperature or in the refrigerator.

•If the sample contains many red blood cells, it would be cloudy as well as red.

BLOOD EXAMINATION

- Done to measure substance in blood that are normally excreted by kidney.
- Their level in blood increases in kidney dysfunction.
- As markers of renal function creatinine, urea,uric acid and electrolytes are done for routine analysis

ORAL MANIFESTATIONS IN CHRONIC RENAL FAILURE

- Oral symptoms are observed in 90% of patients with renal disease

❑CLINICAL MANIFESTATIONS

- Odor of urea on breath
- Metallic taste
- Uremic stomatitis
- Enlarged (asymptomatic) salivary glands
- Decreased salivary flow
- Dry mouth

Figure 1 - Adherent white patch on ventral surface of tongue and floor of the mouth.

Dark brown stains on crowns

1.Extrinsic (secondary to liquid ferrous sulfate therapy)

2. Intrinsic (secondary to tetracycline staining)

Enamel hypoplasia and *tetracycline stains* in a young patient with end-stage renal disease

Petechiae and ecchymosis

Erosive glossitis

Candidal infections

Drifting

Dental malocclusions

- Increase caries rate
- Gingival inflammation
- Increased calculus formation
- Bleeding from gingiva
- Prolonged bleeding
- Burning and tenderness of mucosa
- Dehiscence of wounds
- Tooth mobility


THANK
YOU