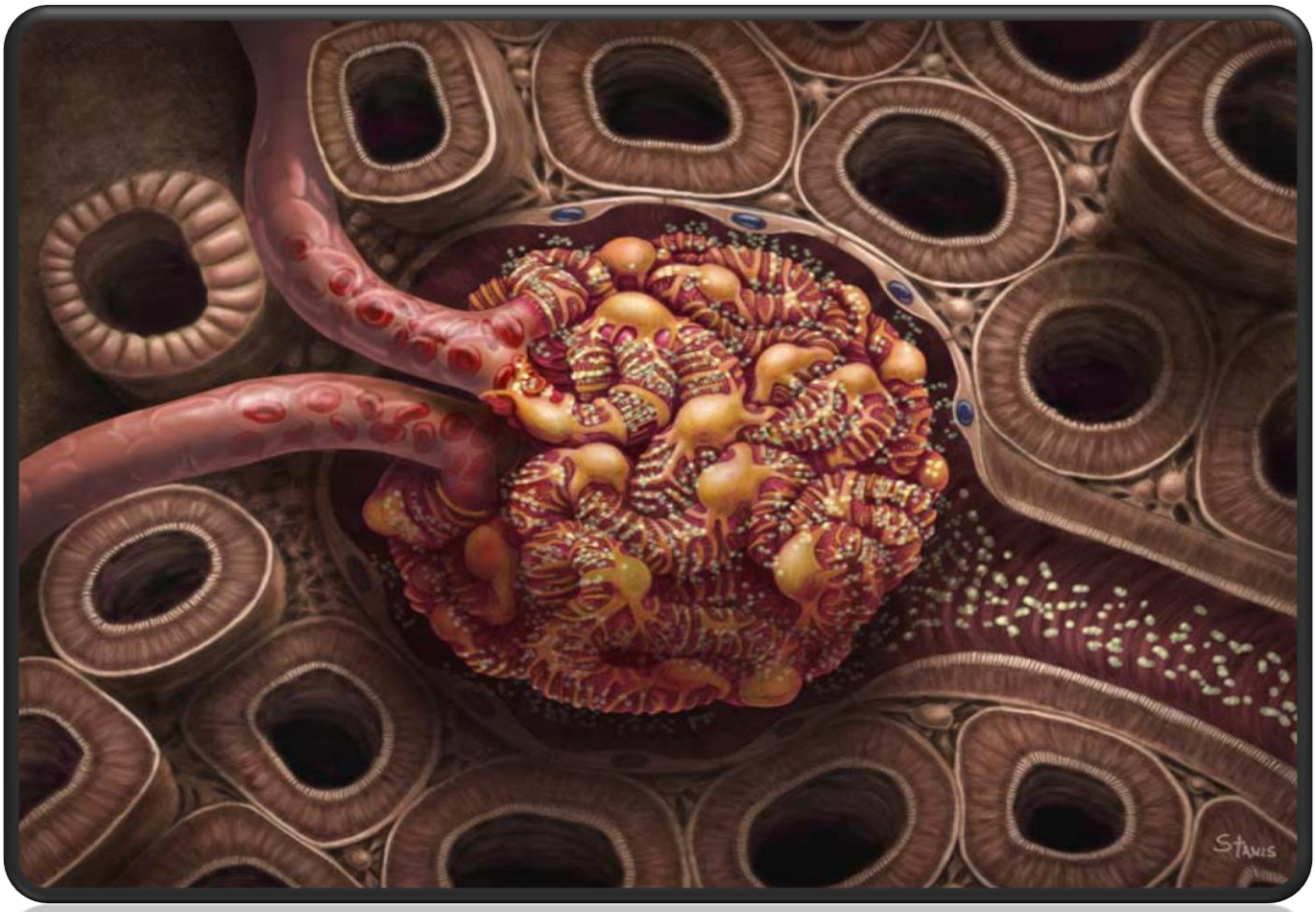
Physiology Team 431



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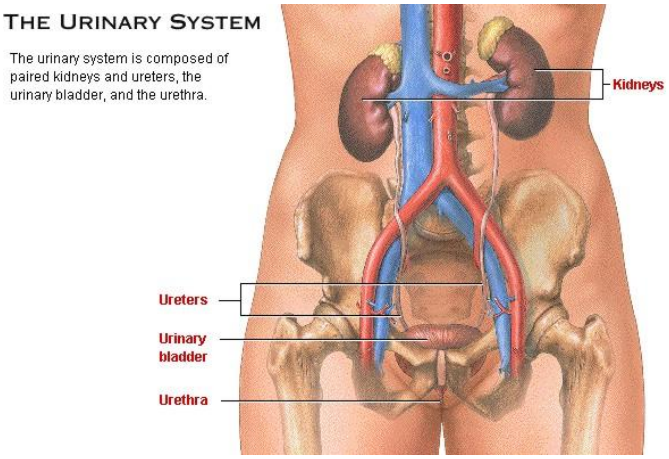
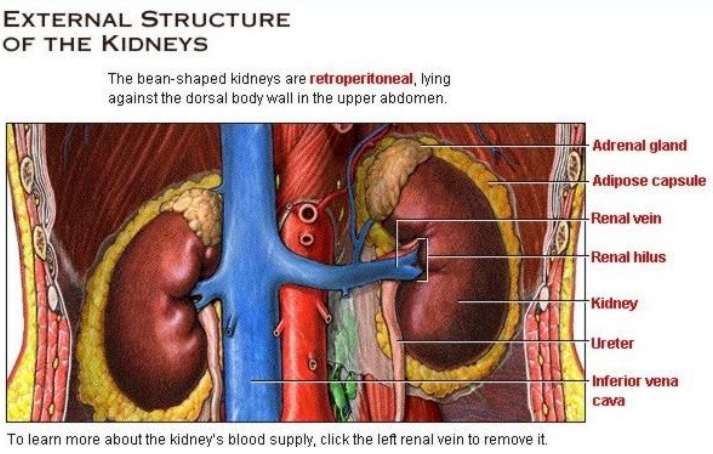
Renal Function

Renal Function

431 RENAL BLOCK

Renal System





➢ Kidney functions:

-The K concentration is 4.5- 5mEq/L . more than 5 → hyperkalemia → affect cardiac function "Arrhythmia"

-The Na concentration is 145mEq/l

1. Homeostatic function: "maintain the internal environment constant"

Regulates:

- Osmolality of ECF (250-300 miliosmol)
- Plasma ions concentration "electrolyte balance"
- ECF volume
- Arterial blood pressure "long-term regulation"
- Acid-base balance = pH, normal range is 7.4

2.Excretion:

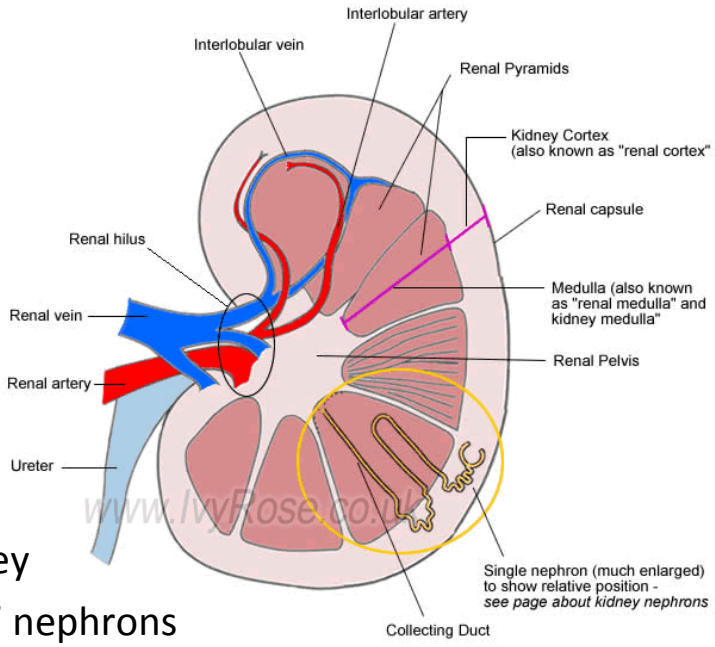
- **Metabolic end products** "generated in our body" : Urea, Creatinine, Uric Acid, Bilrubin
- **Foreign substances**: drugs, toxins

3.Biosynthesis

- Renin
- Erythropoietin "a hormone stimulates RBC formation"
- Activation of Vitamin D "Calciferol (1,25 dihydroxy Vit. D) "Vitamin D is converted by the kidneys to its biological active form "1,25-dihydroxycholecalciferol (1,25-(OH)2D3)""
- Glucose (gluconeogenesis), angiotensinogen, ammonia
- Prostaglandins, adenosine, endothelin, nitric , bradykinin

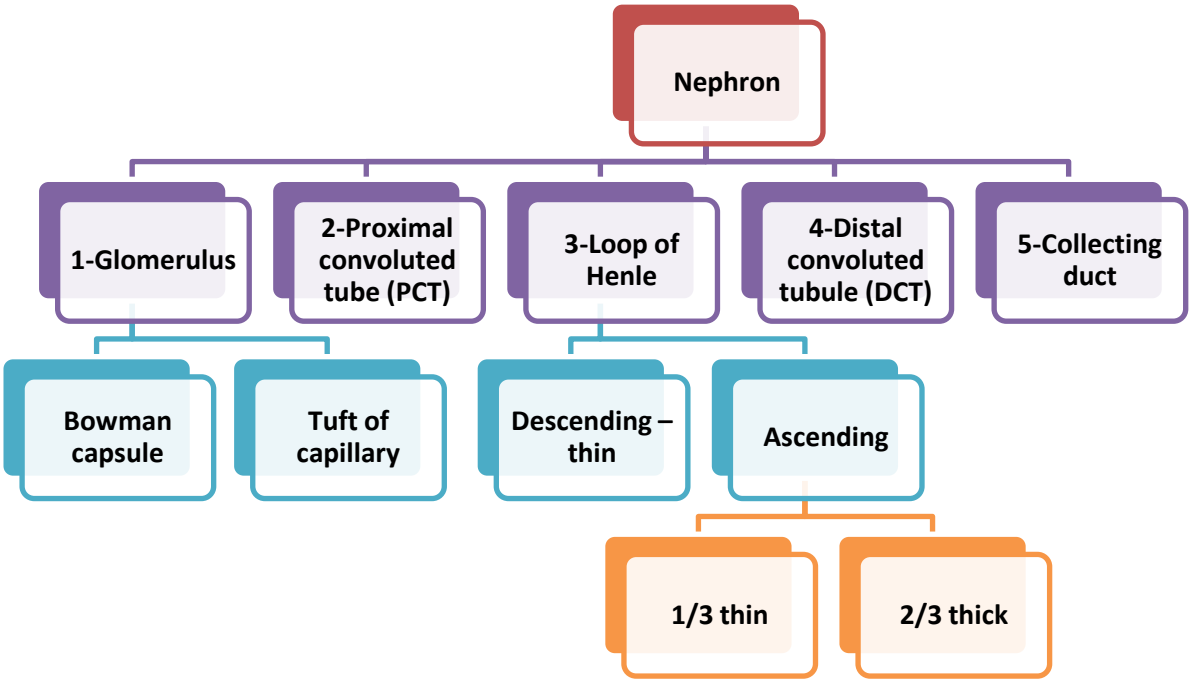
➢ Macroscopic structure of the kidney :

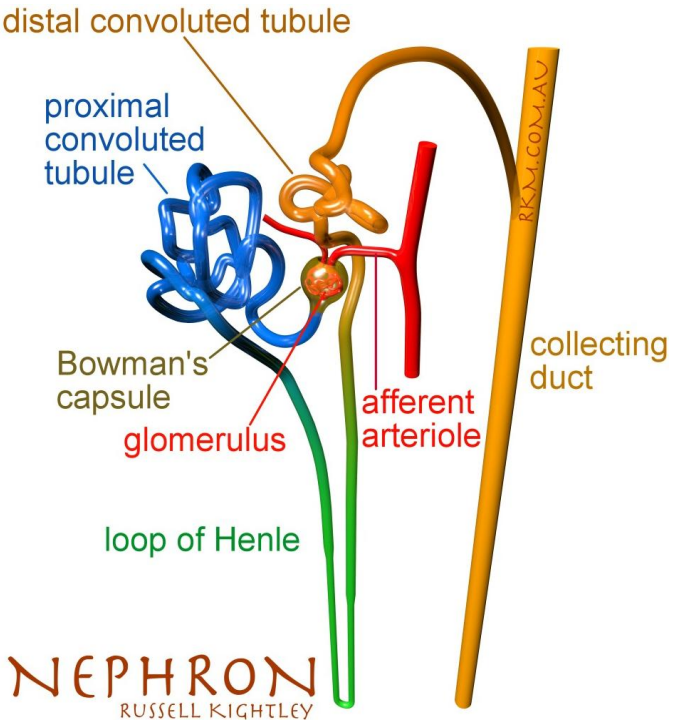
- Renal capsule
- Cortex
- Medulla – pyramid – papilla
- Pelvis – major & minor calyxes
- Ureter
- Bladder

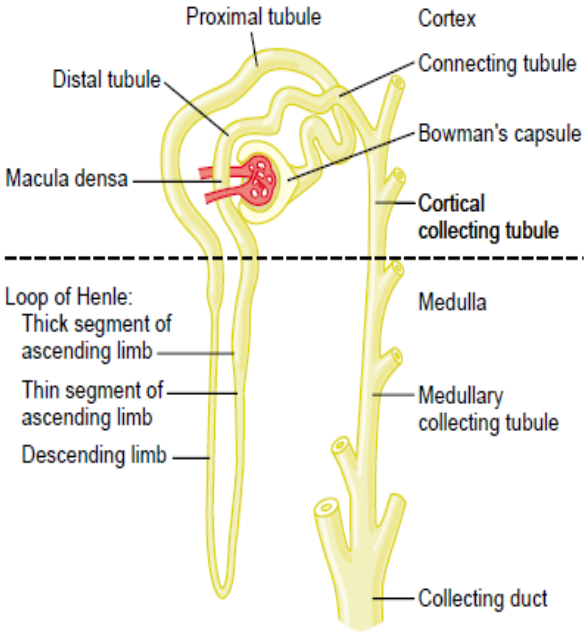


➢ Microscopic structure:

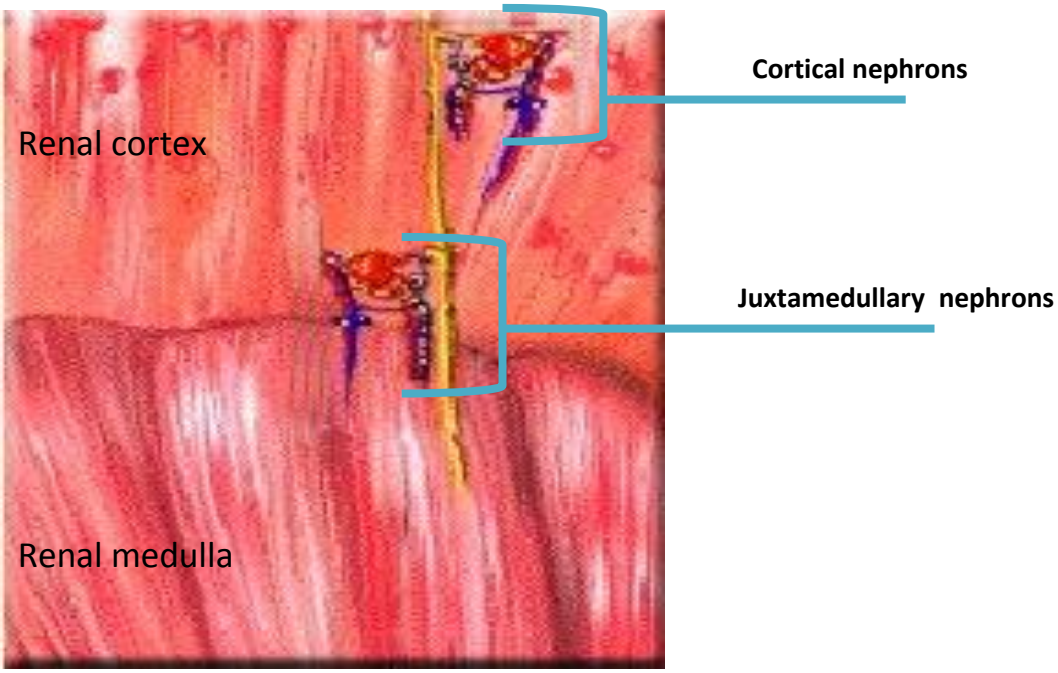
- Nephron is the basic unit of the kidney
- Each kidney consist of 10^6 "1 million" nephrons
- All kidney functions are performed by nephron
- Nephron is a blind tube consist of 5 different regions "blind tube= a tube has an open side and closed from the other side"





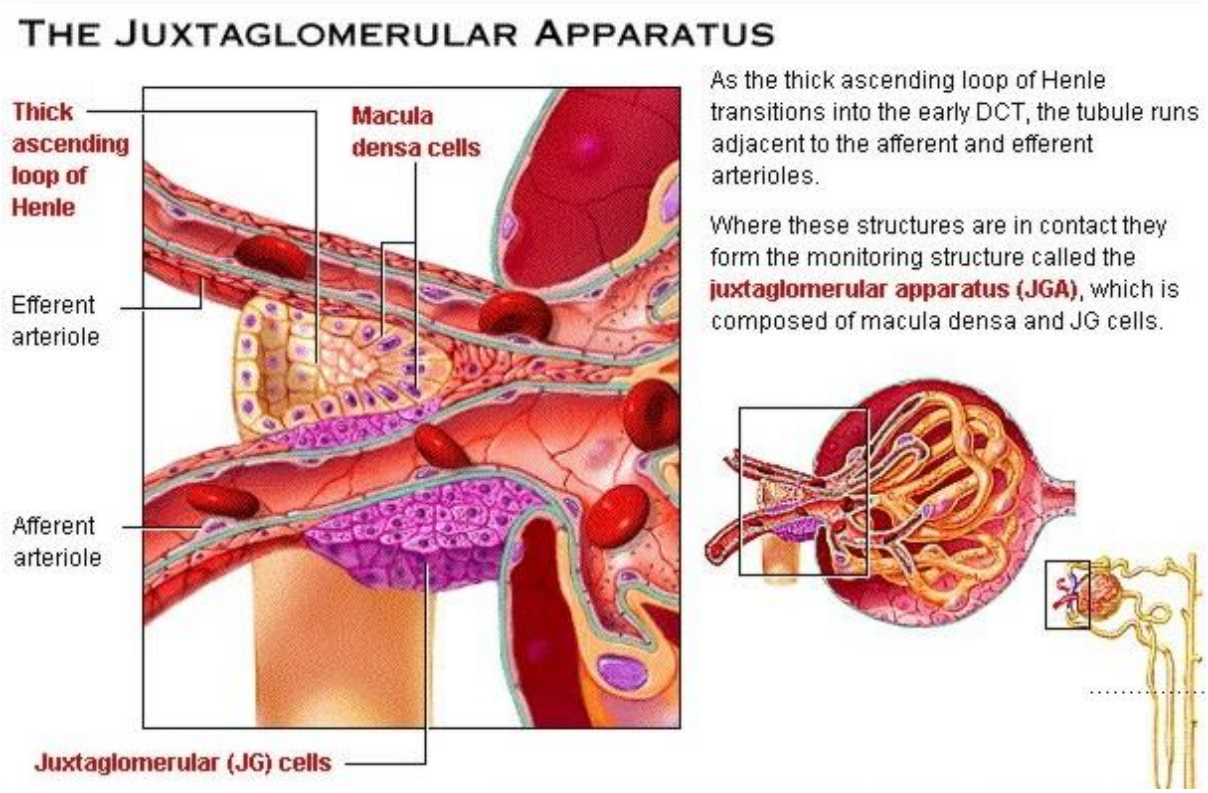


Difference \ Nephron type	Cortical	Juxtamedullary
Location	Cortex " In the Outer cortex"	Cortex and medulla "Deep in the cortex"
Percentage	85% of nephrons	15% of nephrons
Glomerulus size	Larger	Small
Loop length	Short	Long
Blood supply	Peritubular capillary	Vasa recta
	Capable of forming dilute urine	Capable of forming concentrated (>300 mOsm/kg) urine

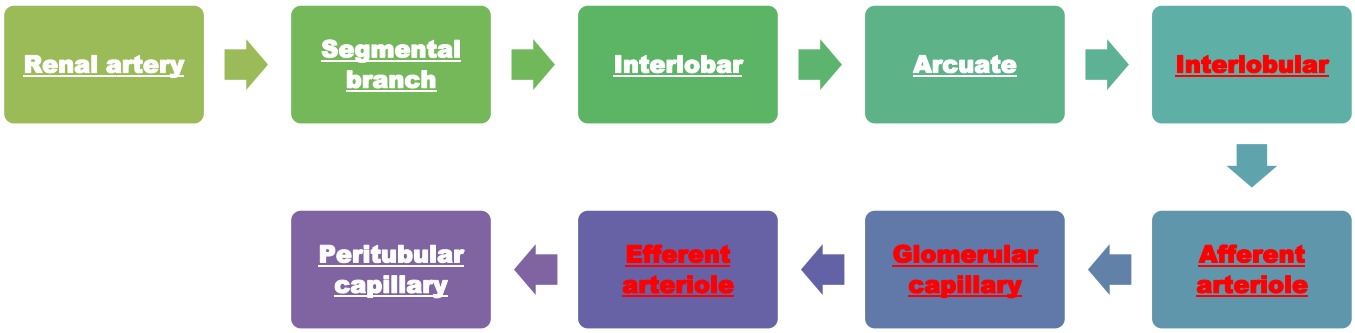


➢ Juxtaglomerular apparatus

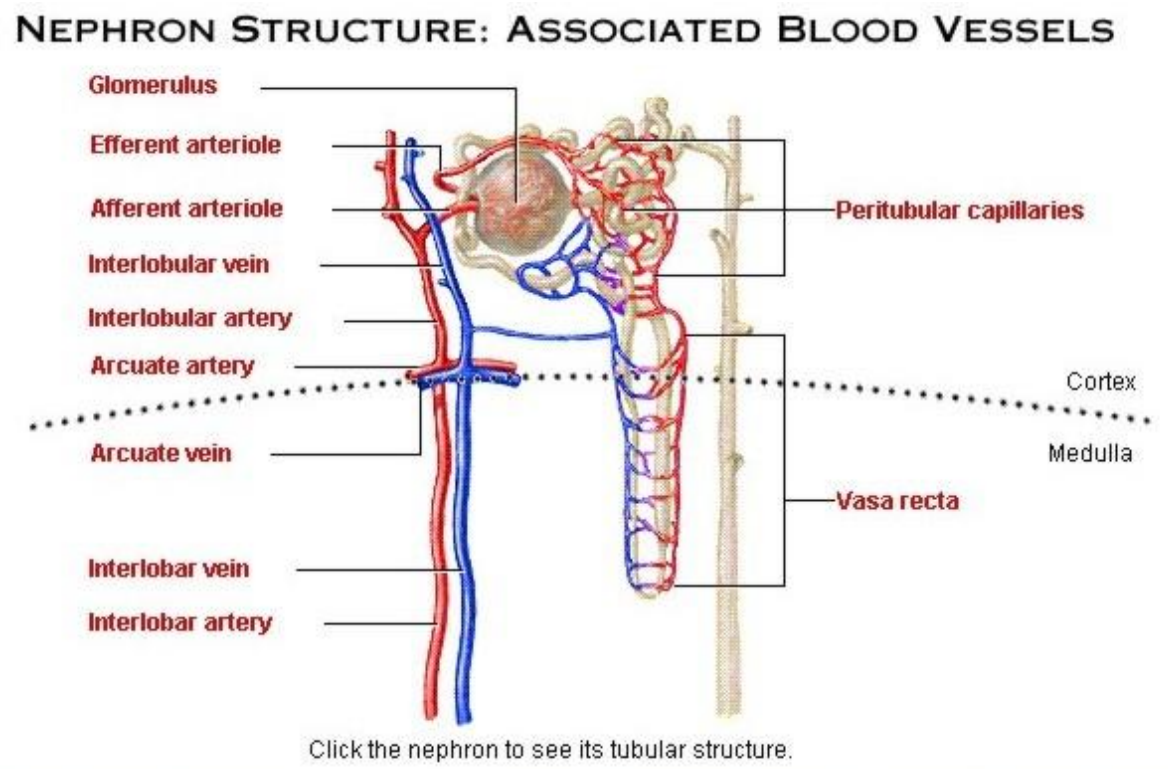
- Junction between thick limb "either at the end of the thick limb of loop of henle OR the beginning of the DCT" & afferent arteriole of its glomerulus
- It compsed of:
  - Tall columnar cells in tubule (macula densa) "send impulses to the granular cells to secrete renin"
  - Granular cell (JG Cell) on afferent arteriole (secrete renin)



➢ Renal circulation



- Afferent arteriole make bunch of capillary (glomerulus) and the bunch of capillary unite again to form efferent arteriole .
- The efferent arteriole divided again into peritubular capillary
- Normally for oxygenation we have: arteriole → capillary →venule
- But here we have a "Portal system" which has: arteriole → capillary →arteriole
- This system is for filtration not for oxygenation
- In the nephron Peritubular capillary delivered the O2 to the nephron parts but in the **Juxtamedullary nephrons** there is **a vasa recta after** the Peritubular capillary to supply the long lobe.



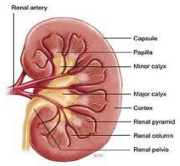
- **Renal Blood Flow (RBF):**
  - 1.2 l/min (25% of C.O.)
  - Cortical blood flow(~90%) > Medallary flow
  - Cortical blood flow meant for filtration
- **Renal innervations**
  - Renal plexus sympathetic "mainly"
  - Vasomotor regulate renal blood flow
  - Parasympathetic "very small"

Points mentioned in the male slides but not in the female

➢ Activation of Vitamin D

Naturally occurring vitamin D (cholecalciferol)

25-hydroxycholecalciferol 25-OHD3)



1α-hydroxylase enzyme ← **PTH**

1,25-dihydroxycholecalciferol (1,25-(OH)2D3)

We take vitamin D (***cholecalciferol***) from the skin by exposure to the sun light or from our diet, but this form of vD is not active. It is hydroxylated in the liver to make: 25hydroxycholecalciferol 25-OHD3), and this 25hydroxycholecalciferol 25-OHD3) is not active also, it is hydroxylated againe in the kidney by 1α-hydroxylase enzyme, and then it is converted to 1,25-dihydroxycholecalciferol (1,25-(OH)2D3) which is the active form of vD and it is essential for Ca absorption

And those people who have chronic renal diseases or renal failure they will have bone problem due to deficiency of vD which will lead to osteoporosis

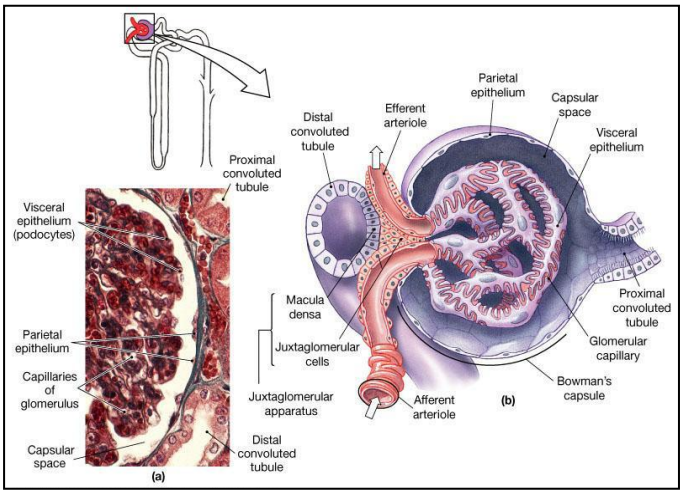
➢ NEPHRON

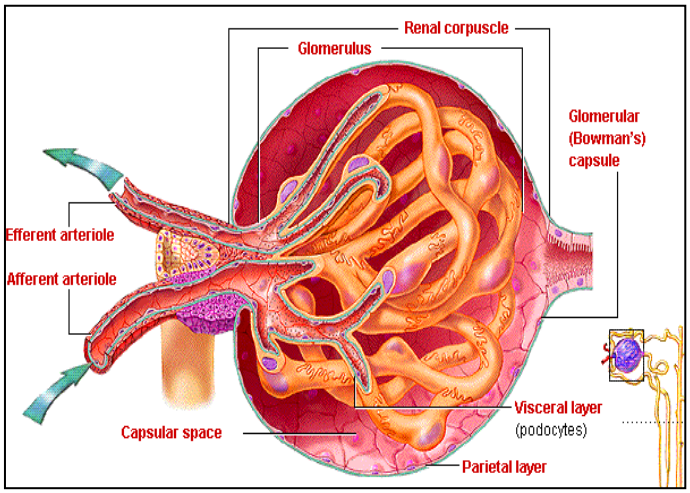
- **The kidney cannot regenerate new nephrons.**
- **After age 40, the number of functioning nephrons usually decreases about 10 per cent every 10 years; thus, at age 80, many people have 40 per cent fewer functioning nephrons than they did at age 40.**

➢ Parts of NEPHRON

- **8 to 10 cortical collecting ducts join to form a single larger collecting duct that runs downward into the medulla and becomes the medullary collecting duct.**
- **The collecting ducts merge to form larger ducts that eventually empty into the renal pelvis through the tips of the renal papillae.**

BOWMAN'S CAPSULE:





The Renal Corpuscle=Bowman's capsule + Glomerulus

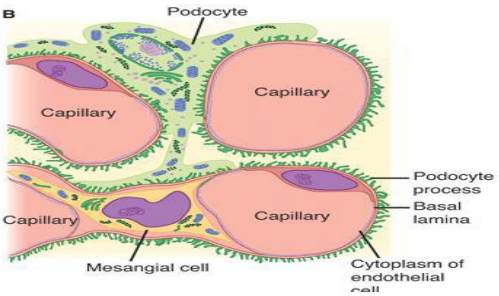
THE RENAL CORPUSCLE COMPRISES FOUR MAIN CELL TYPES:

1)Endothelial cells which are fenestrated

2)Visceral epithelial cells (podocytes) which support the delicate glomerular basement membrane by means of foot processes

3)Parietal epithelial cellswhich cover the Bowman's capsule;

4)Mesangial cells are contractile cells : when they contract the surface area for filtration becomes less . when they relax the surface area for filtration becomes wide



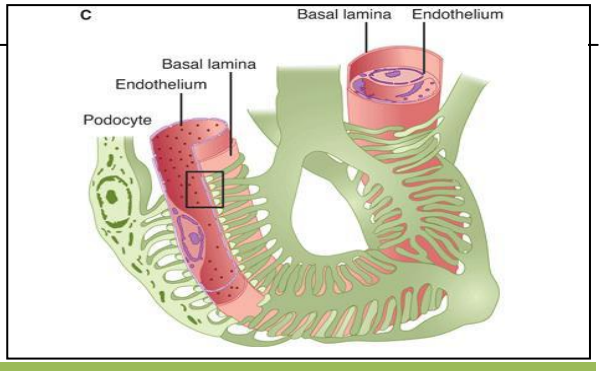
#Type I Medullary Interstitial Cells secrete PGE2 #

Which layer is in the connection with the endothelium of the Glomerulus? Visceral layer

The blood is filtiratid from glomerulus into bowman's capsule by crossing the endothelium og the glomerulus, basement membrane, and visceral layer of bowman's capsule

PODOCYTES:

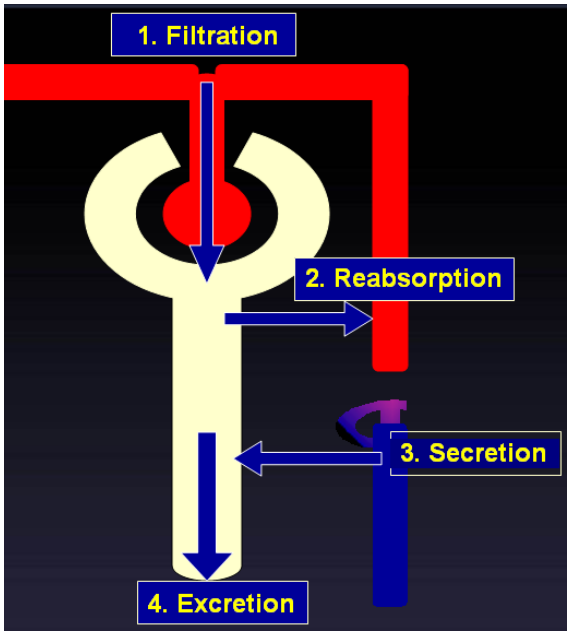
The visceral layer is made up of special type of cell noun as : podocyte



RENAL PROCESSES

1. Filtration
2. Reabsorption
3. Secretion
4. Excretion

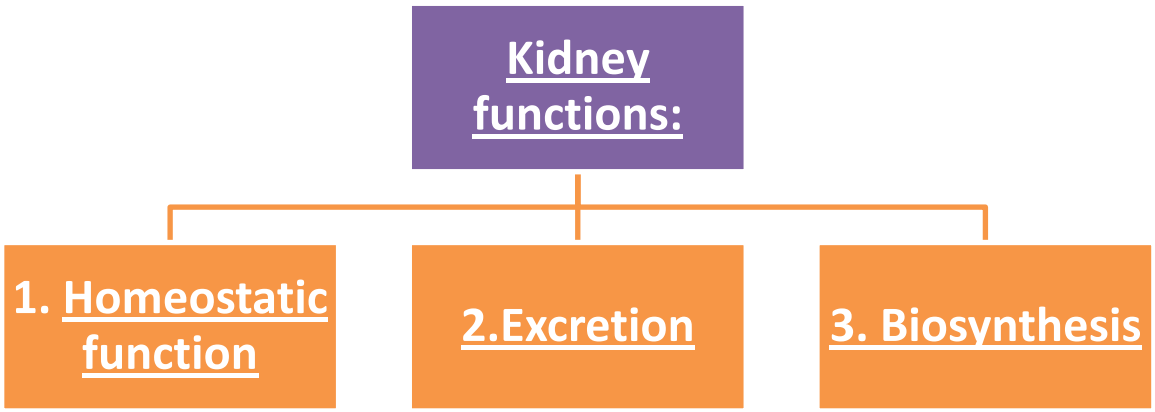
Urinary Excretion Rate =
Filtration Rate – Reabsorption Rate + Secretion Rate

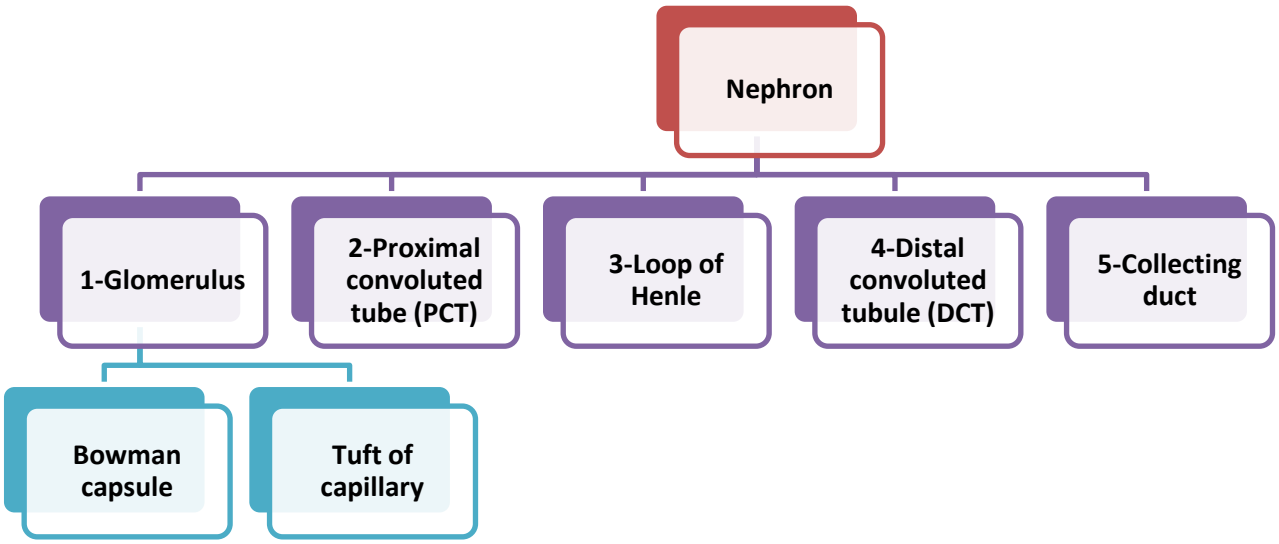


➢ **INVESTIGATIONS:**

- EXAMINATION OF THE URINE
- BLOOD AND QUANTITATIVE TESTS
- IMAGING TECHNIQUES
- TRANSCUTANEOUS RENAL B

SUMMERY





Nephron type / Difference	Cortical	Juxtamedullary
Percentage	85% of nephrons	15% of nephrons
Loop length	Short	Long
Blood supply	Peritubular capillary	Vasa recta

Juxtaglomerular apparatus compsed of:

- Tall columnar (macula densa)
- Granular cell (secrete renin)

Questions

T or F:

1- Kidney regulate extracellular osmolality
2- Vasa recta are the blood supply of cortical nephron

MCQs:

3- the majorty of nephrons are:
   a) Juxtamedullary nephron
   b) Cortical nephrone
   c) Both are equal
4- Which of the following statements is true regarding Rinin secration:
   a) Secreted by the liver and then it converted in the kidney
   b) Secreted by macula densa cells after getting the impulse from JG cells
   c) Secreted by JG cells after getting the impulse from macula densa cells

Answers:

1-T, 2- F, 3-B, 4-C