The Urinary System (1)

DR.ZAHID SARFARAZ KHAN

ASSIST PROF
KGMC
ANATOMY
DEPTT

Introduction

The urinary system consists of :

- Paired kidneys
- Ureters,
- Bladder,
- Urethra.

Introduction

Renal functions:

- Regulation of the balance between water and electrolytes.
- Execretion of metabolic wastes along with excess water and electrolytes in urine
- Execretion of many bioactive substances, including many drugs
- Regulation of arterial blood pressure by secretion of renin

Introduction

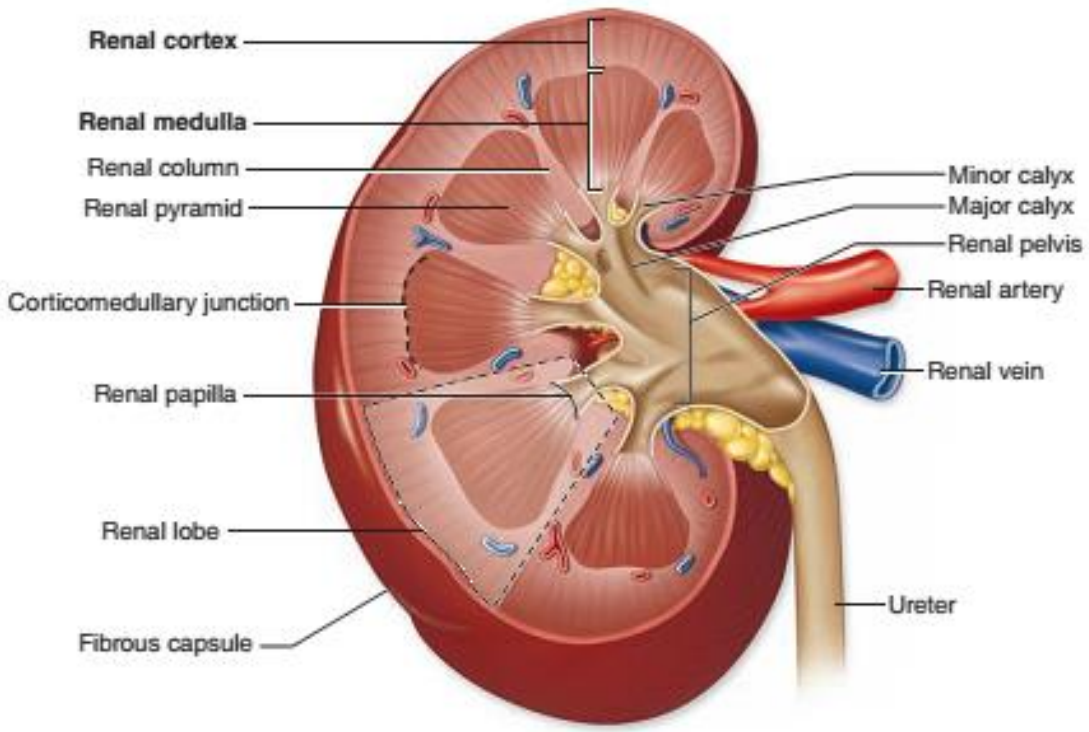
- Secretion of **erythropoietin,** that stimulates erythrocyte production in red marrow.
- Conversion of the **steroid prohormone vitamin D, initially** produced in the epidermis, to the active form (1,25-dihydroxyvitamin D3 or calcitriol).

KIDNEYS (Gross Structure)

- Each kidney has a concave medial border, the hilum —

  Where nerves enter, the ureter exits, and blood and lymph vessels enter and exit—

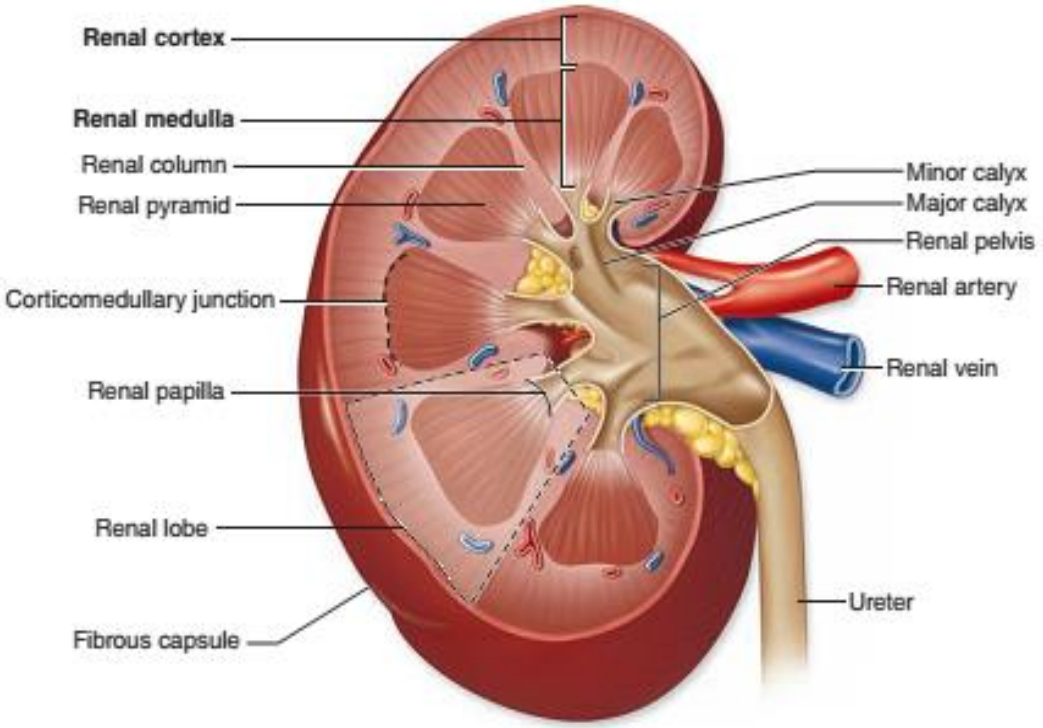
- convex lateral surface,
- both covered by a thin fibrous capsule .



KIDNEYS (Gross Structure)

- Hilum the upper end of the ureter expands as the renal pelvis and
- divides into two or three major calyces .
- Smaller branches,

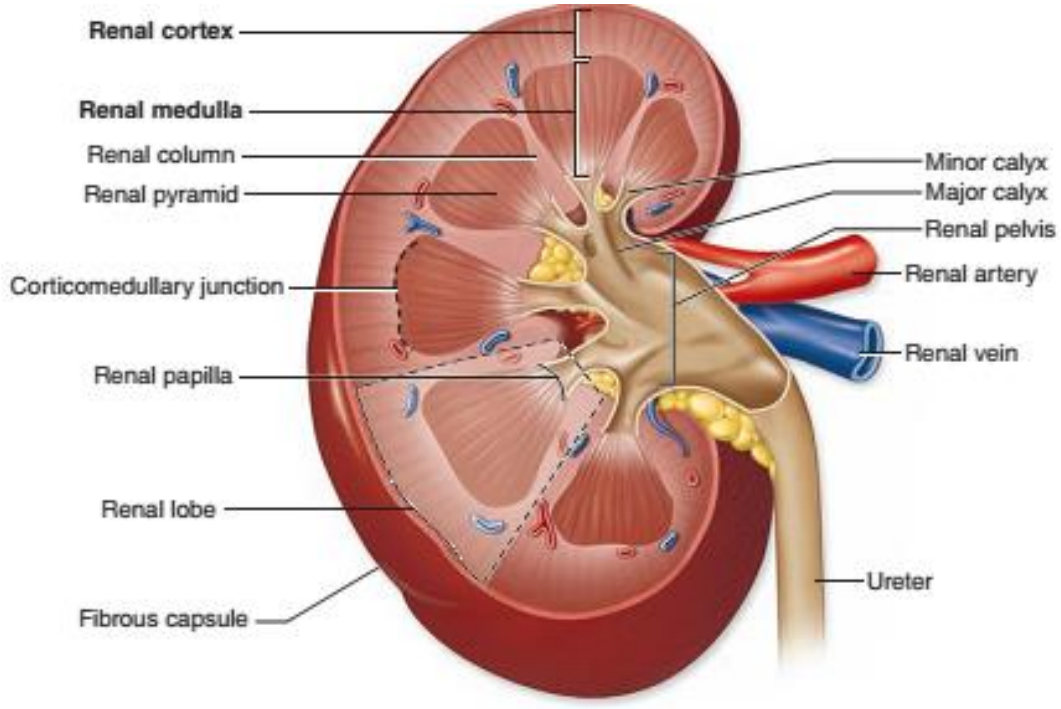
  the minor calyces , arise from each major calyx.
- The area surrounding the renal pelvis and calyces contains adipose tissue.



KIDNEYS (Gross Structure)

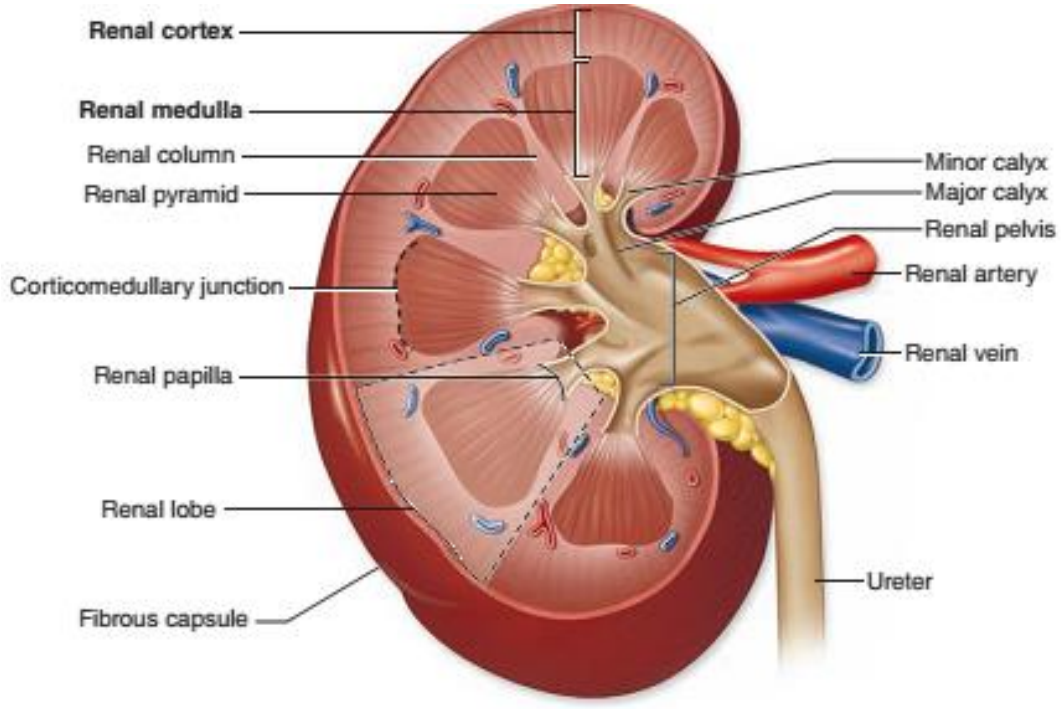
- The kidney has an **outercortex** ,
- And darker region.

  Inner medulla consisting of straight, aligned structures
- The renal medulla consists of 8-12 conical structures called **renal pyramids** , which are separated by extensions from the cortex **called renal columns .**



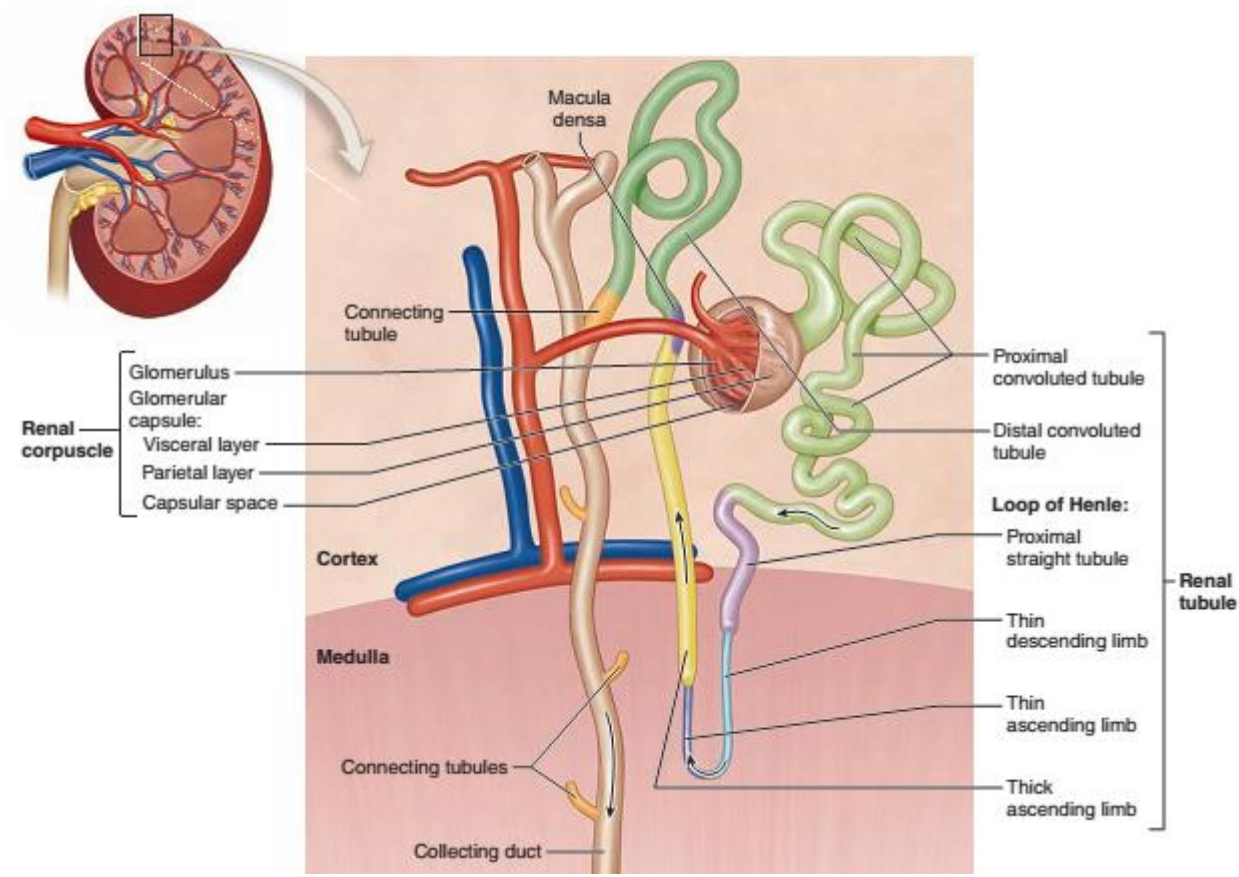
KIDNEYS (Gross Structure)

- Each pyramid plus the cortical tissue at its base and along its sides constitutes **a renal lobe** .
- The tip of each pyramid, called the **renal papilla** ,projects into a minor calyx that collects urine formed by tubules in the pyramid



Nephrons

- Each kidney contains around 1 million functional units called nephrons .
- That consist of simple, single layered epithelium along their entire lengths.

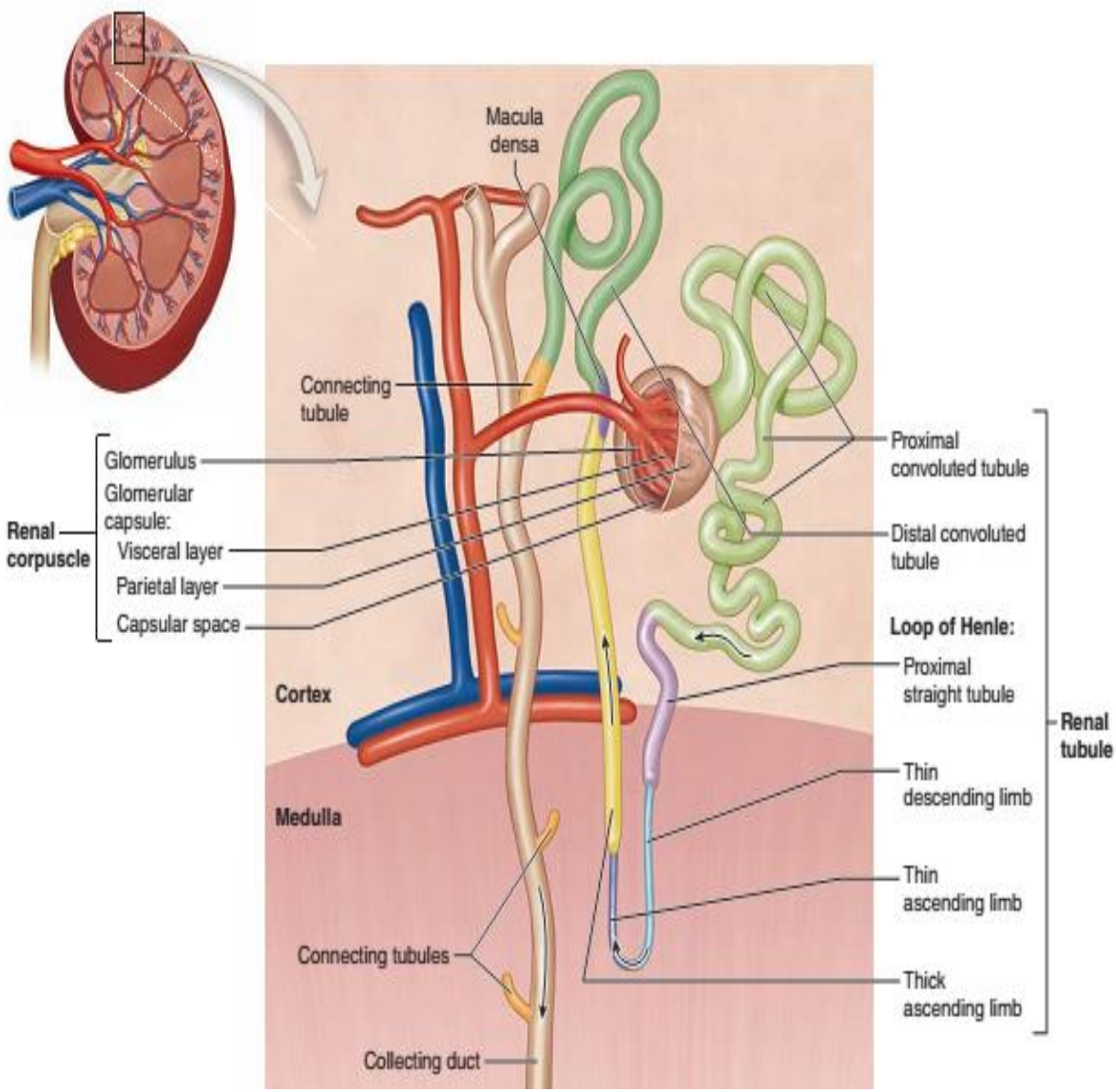


The major divisions of each nephron are the following

Renal corpuscle:-

- An initial dilated part enclosing a tuft of capillarys
- The site of blood fIltration, always located in the cortex

- Proximal tubule
- Distal tubule
- Loop of Henle (or nephron loop)
- Connecting tubule



The major divisions of each nephron are the following

■Proximal tubule ,

A long convoluted part, located entirely in the cortex, with a shorter straight part that enters the medulla

■ Loop of Henle (or nephron loop),

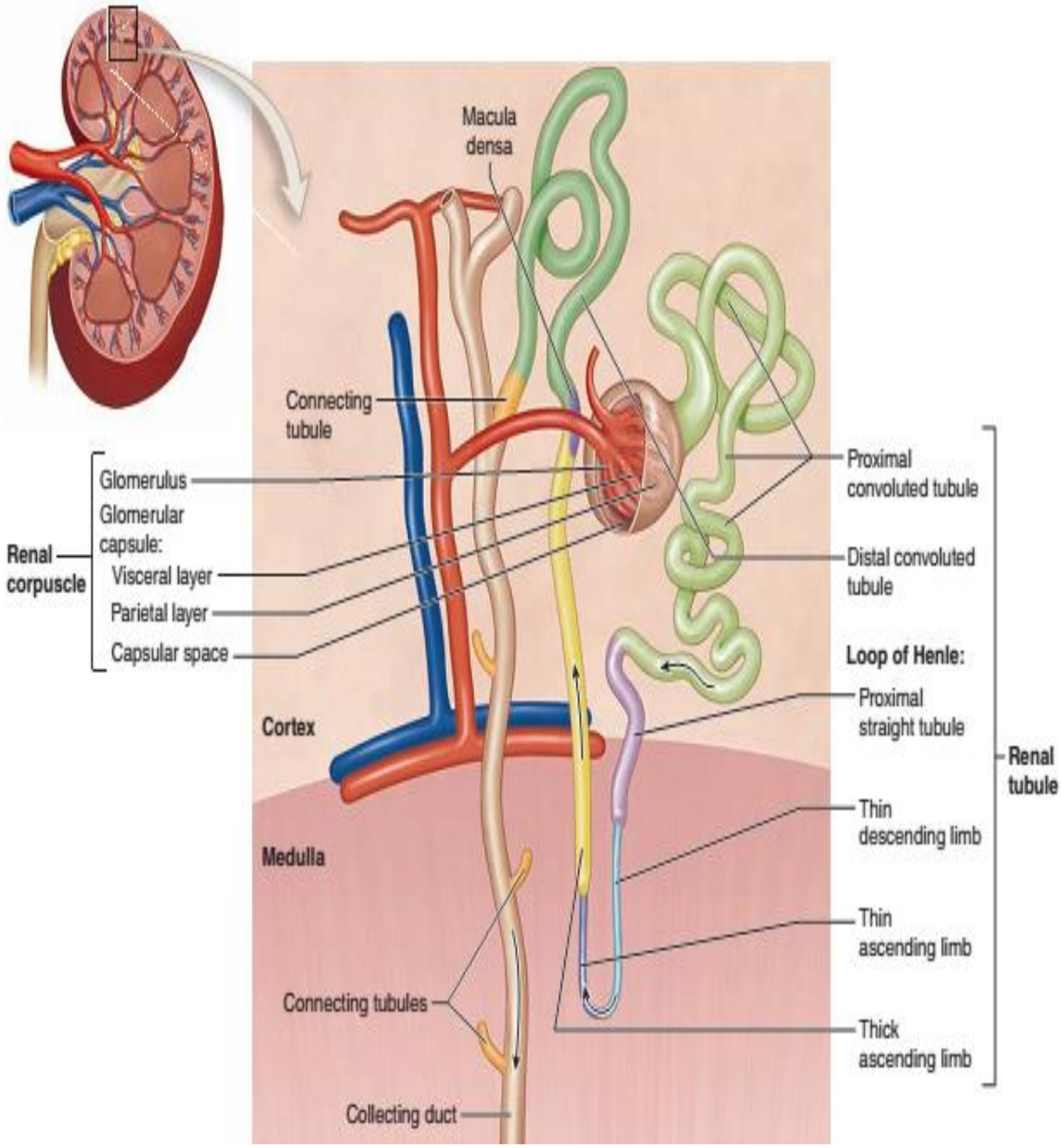
In the medulla, with a thin descending and a thin ascending limb

■ Distal tubule ,

Consisting of a thick straight part ascending from the loop of Henle back into the cortex and a convoluted part completely in the cortex.

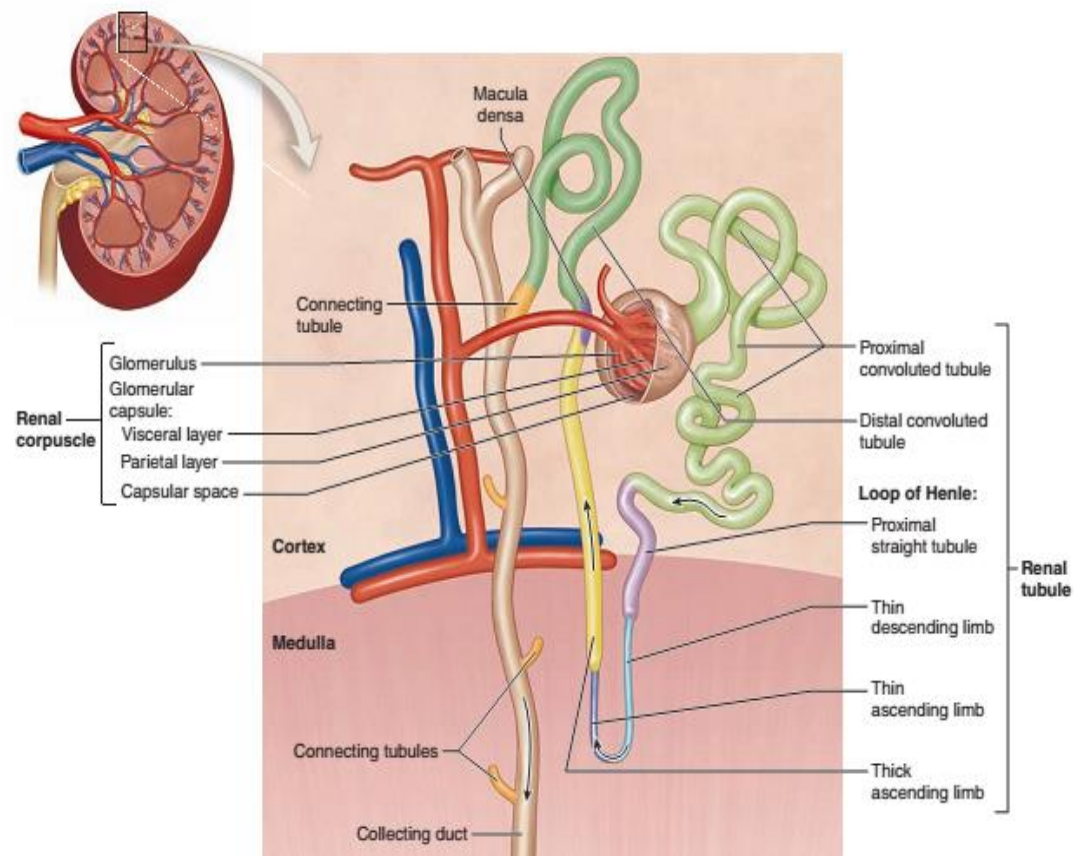
■ Connecting tubule,

A short fInal part linking the nephron to collecting ducts.



The major divisions of each nephron are the following

- From several nephrons merge to form collecting tubules
- That then merge as larger collecting ducts.
- These converge in the renal papilla,
- Where they deliver urine to a minor calyx.
- Cortical Nephrons
  Are located almost completely in the cortex
- Juxtamedullary Nephrons
  (about one-seventh of the total) lie close to the medulla and have long loops of Henle.



RENAL FUNCTION: FILTRATION, SECRETION, & REABSORPTION

- Filtration

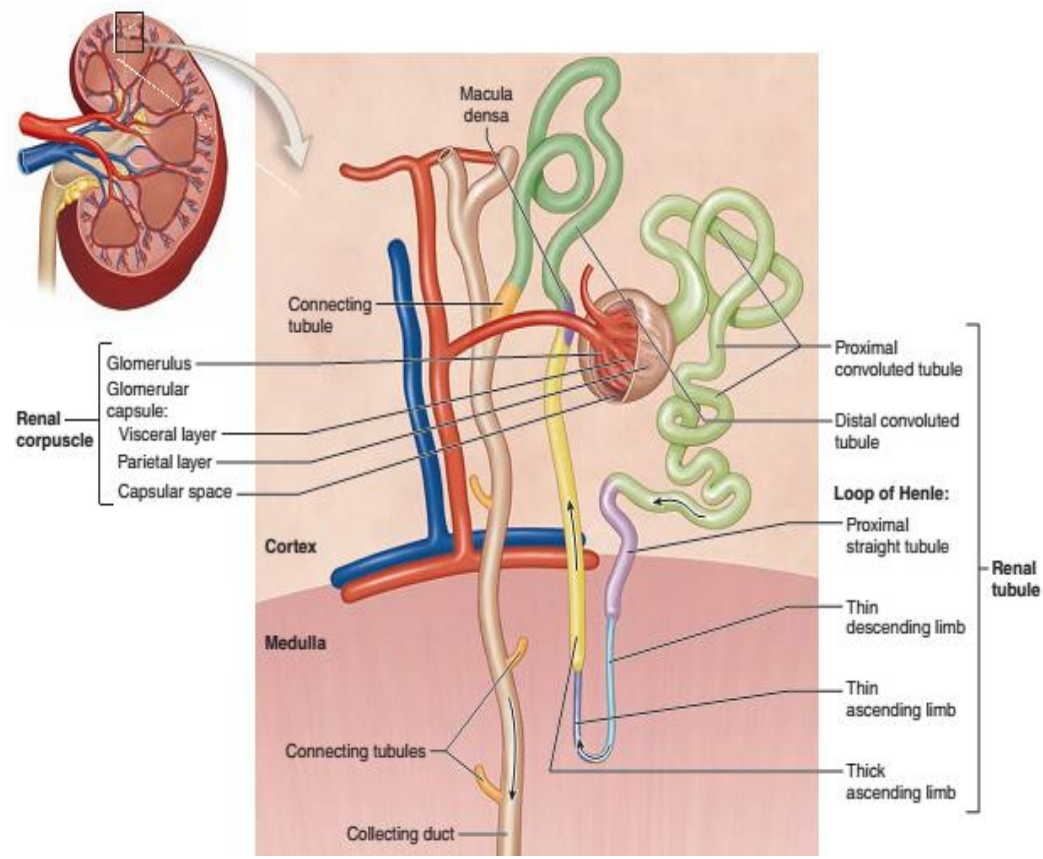
  By which water and solutes in the blood leave the vascular space and enter the lumen of the nephron;

- Tubular secretion

  By which substances move from epithelial cells of the tubules into the lumens, usually after uptake from the surrounding interstitium and capillaries; and

- Reabsorption

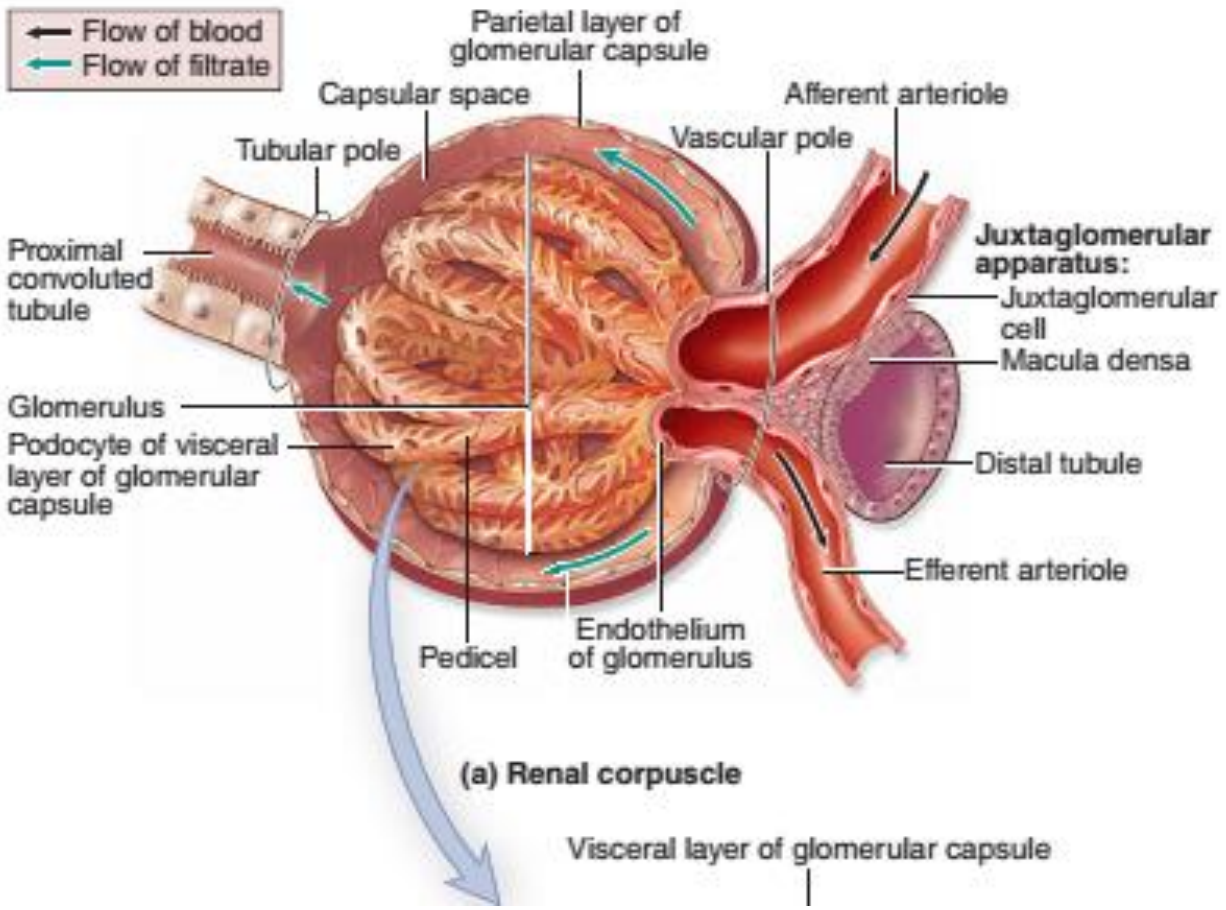
  By which substances move from the tubular lumen across the epithelium into the interstitium and surrounding capillaries.



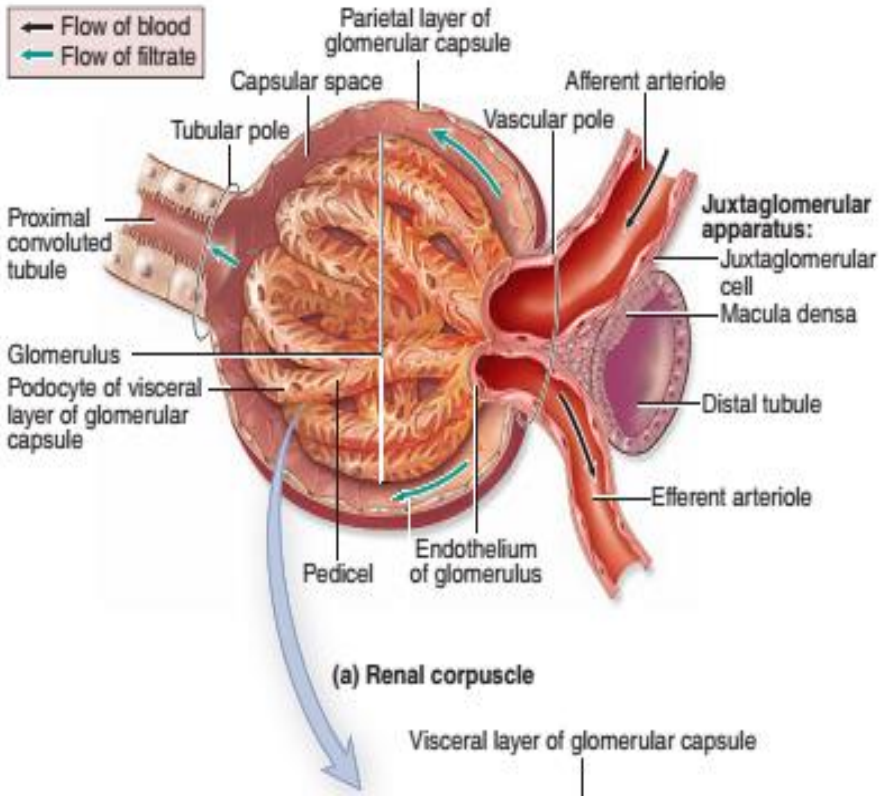
Renal corpuscle

- **Renal Corpuscles & Blood Filtration**

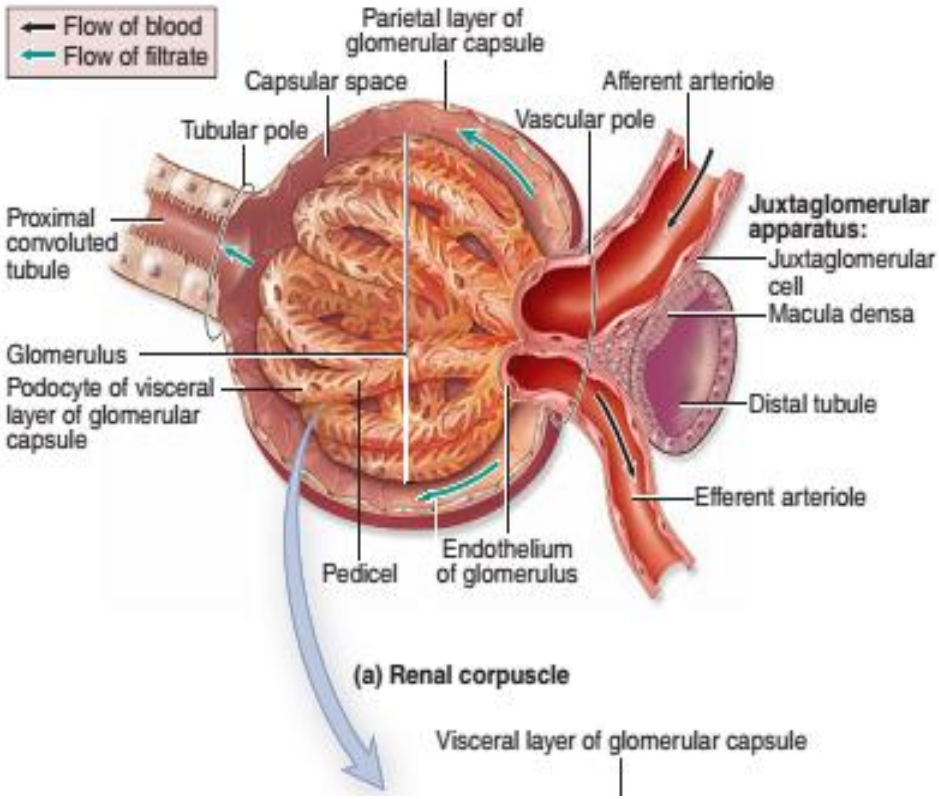
- ❑ **At the beginning of each nephron is a renal corpuscle.**
- ❑ **About 200 µm in diameter and containing a tuft of glomerular capillaries.**
- ❑ **Surrounded by a double-walled epithelial capsule called the glomerular (Bowman) capsule .**



- The internal or visceral layer of this capsule closely envelops the glomerular capillaries, which are finely fenestrated.
- The outer parietal layer forms the surface of the capsule.



- Between the two capsular layers is the capsular (urinary) space,which receives the fluid filtered through the capillary wall and visceral layer.
- Each renal corpuscle has a vascular pole, where the afferent arteriole enters and the efferent arteriole leaves, and a tubular pole, where the proximal convoluted tubule (PCT) begins

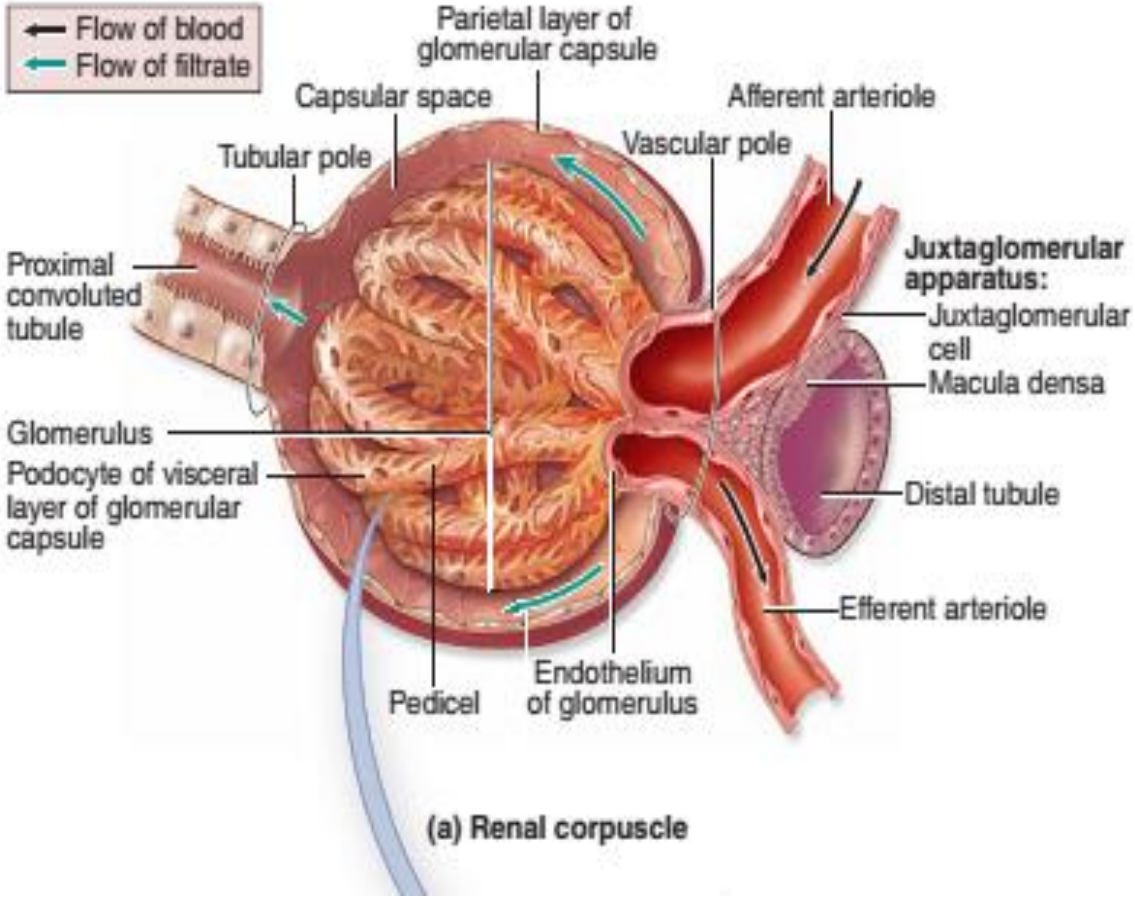


Outer parietal layer of a glomerular capsule

- Consists of a simple squamous epithelium supported externally by a basal lamina.

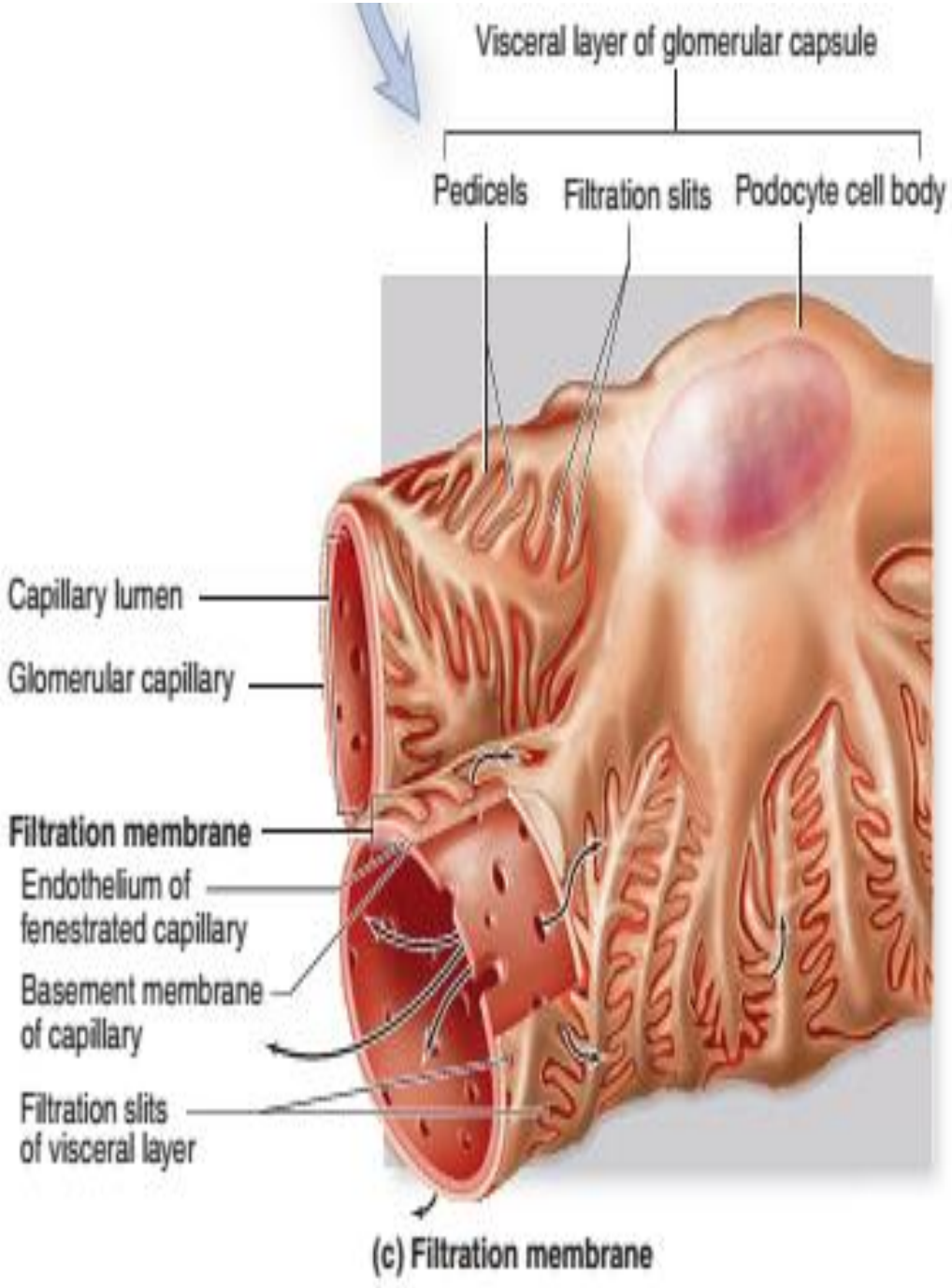
At the tubular pole

- Epithelium changes to the simple cuboidal epithelium that continues and forms the proximal tubule

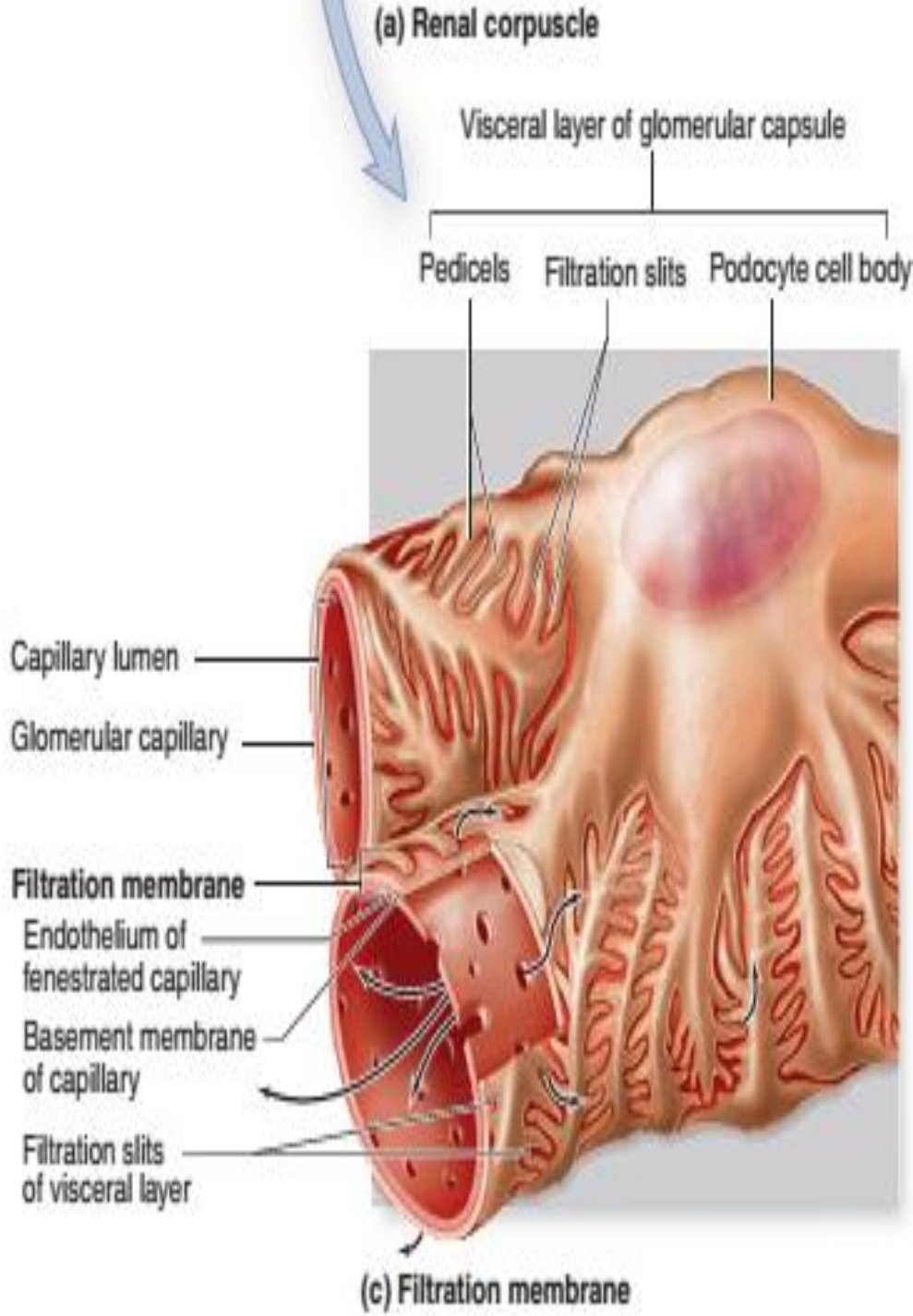


The visceral layer

- Consists of unusual stellate epithelial cells called podocytes
- Which together with the capillary endothelial cells compose the apparatus for renal filtration.



- From the cell body of each podocyte several primary processes extend and curve around a length of glomerular capillary.
- Each primary process gives rise to many parallel, interdigitating secondary processes or pedicels little foot
- The pedicels cover much of the capillary surface, in direct contact with the basal lamina.



➢The glomerular fitration barrier consists of three layered components

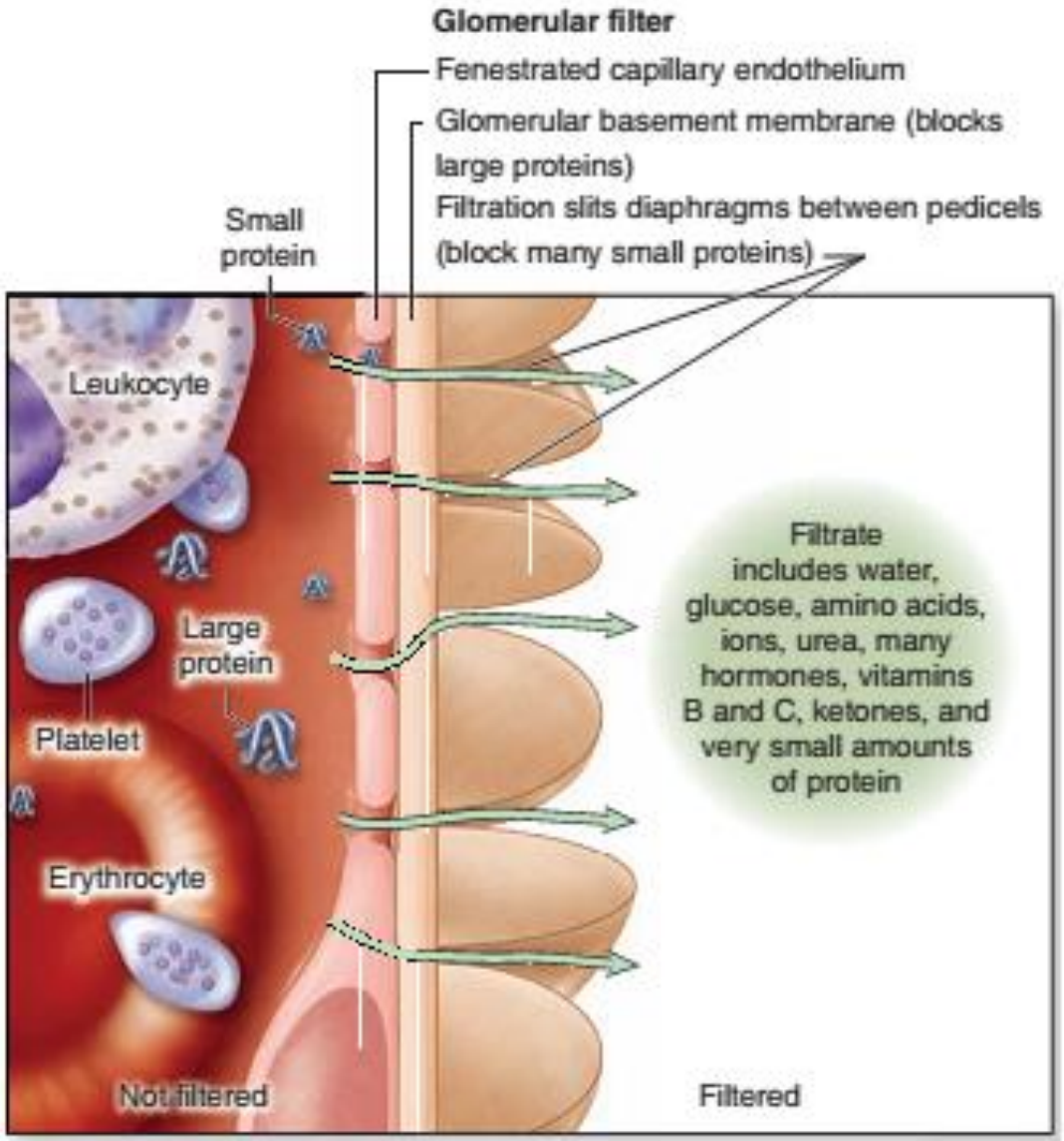
1-The fenestrated capillary endothelium

2-The glomerular basement membrane(GBM),
3- And fitration slit diaphragms between pedicels.

At higher magnifiation

- Both the fenestrations (F) in the endothelium (E) of the capillary (C)
- The fitration slits (FS) separating the pedicels (P) are clearly seen on the two sides of the thick, fused basement membrane (BM).
- Thin slit diaphragms (SD) bridge the slits between pedicels.
- Slit diaphragms are modified and specialized occluding or tight junctions.

(c) Diagram shows the three parts of the glomerular filter and their major functions.



(c) Substances filtered by filtration membrane

Glomerular diseases

There are many different glomerular diseases.

Involving the renal corpuscles.

Accurate diagnoses of such disorders by pathologists require sampling of the cortex.

May involve examination of the renal corpuscles by immunoflorescence

light microscopy or even by TeM

Glomerulonephritis

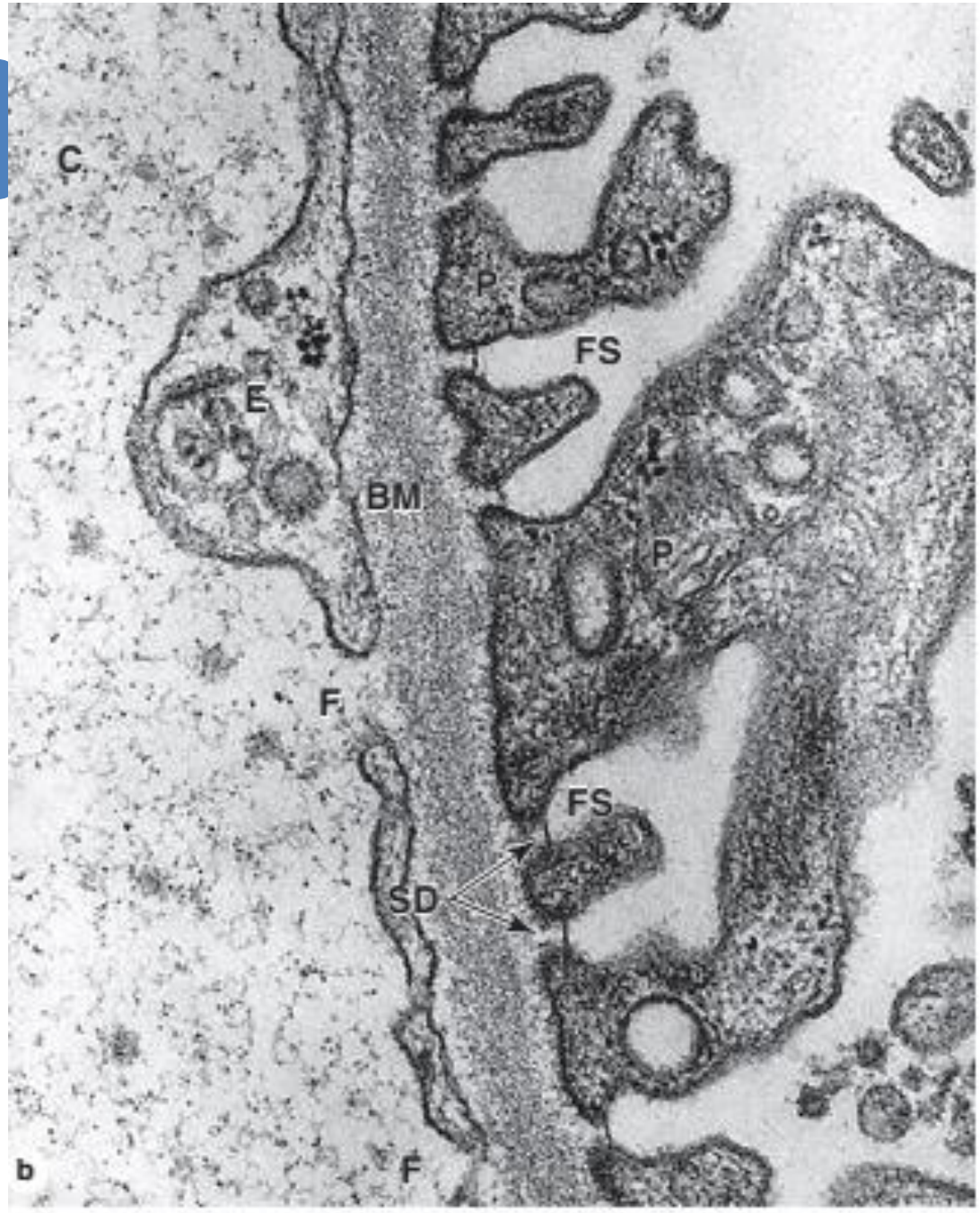
In diseases such as;

Diabetes mellitus and chronic hypertension

The glomerular filter is altered and becomes much more permeable to proteins

with the subsequent release of protein into the urine (proteinuria).

Proteinuria is an indicator of many potential kidney disorders.

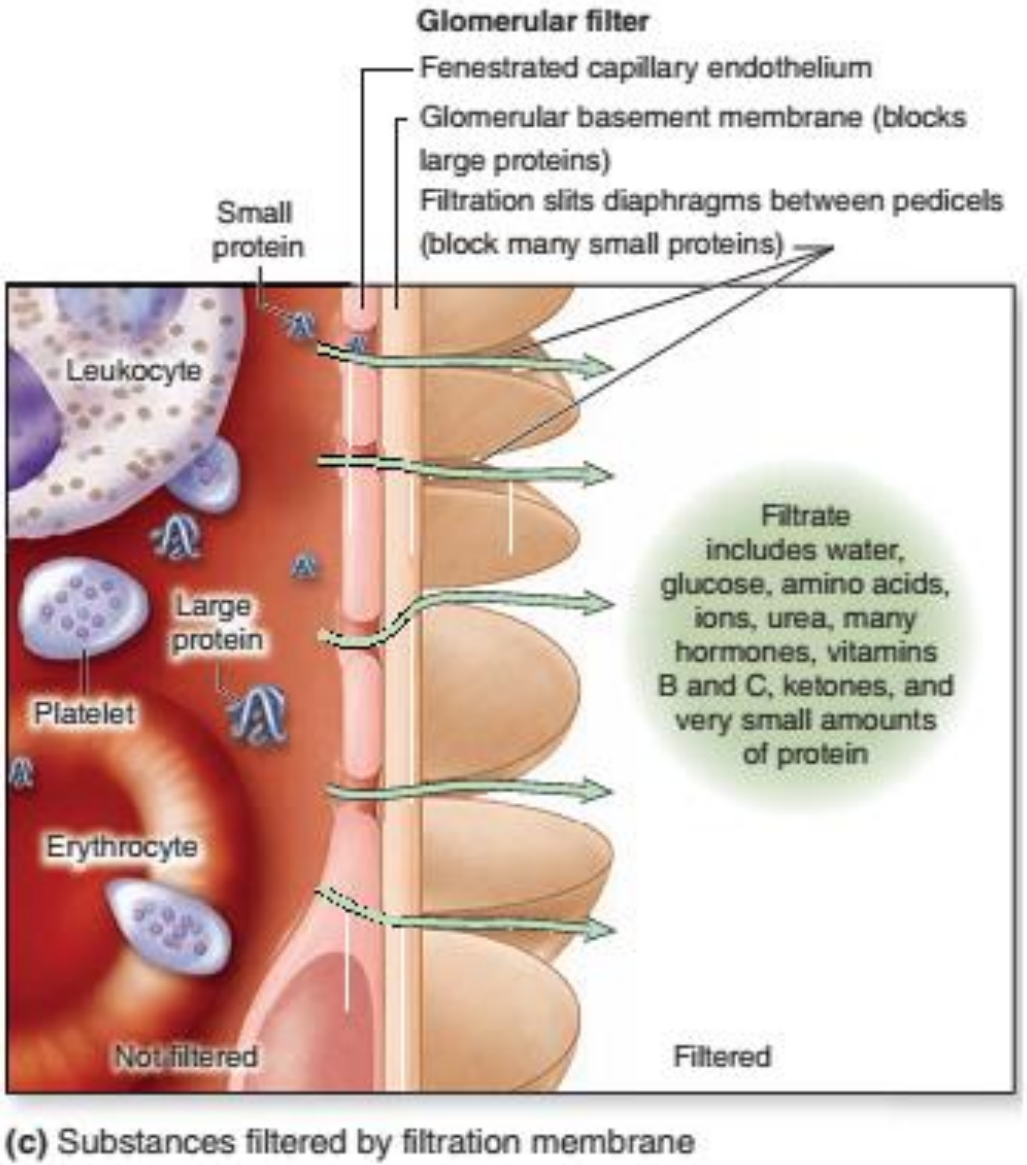


Diabetic glomerulosclerosis

The thickening and loss of function in the gBM produced as part of the systemic microvascular sclerosis in diabetes mellitus

Is the leading cause of (irreversible) end-stage kidney disease .

Treatment requires either a kidney transplant or regular artificial hemodialysis.



(c) Substances filtered by filtration membrane

Thank you