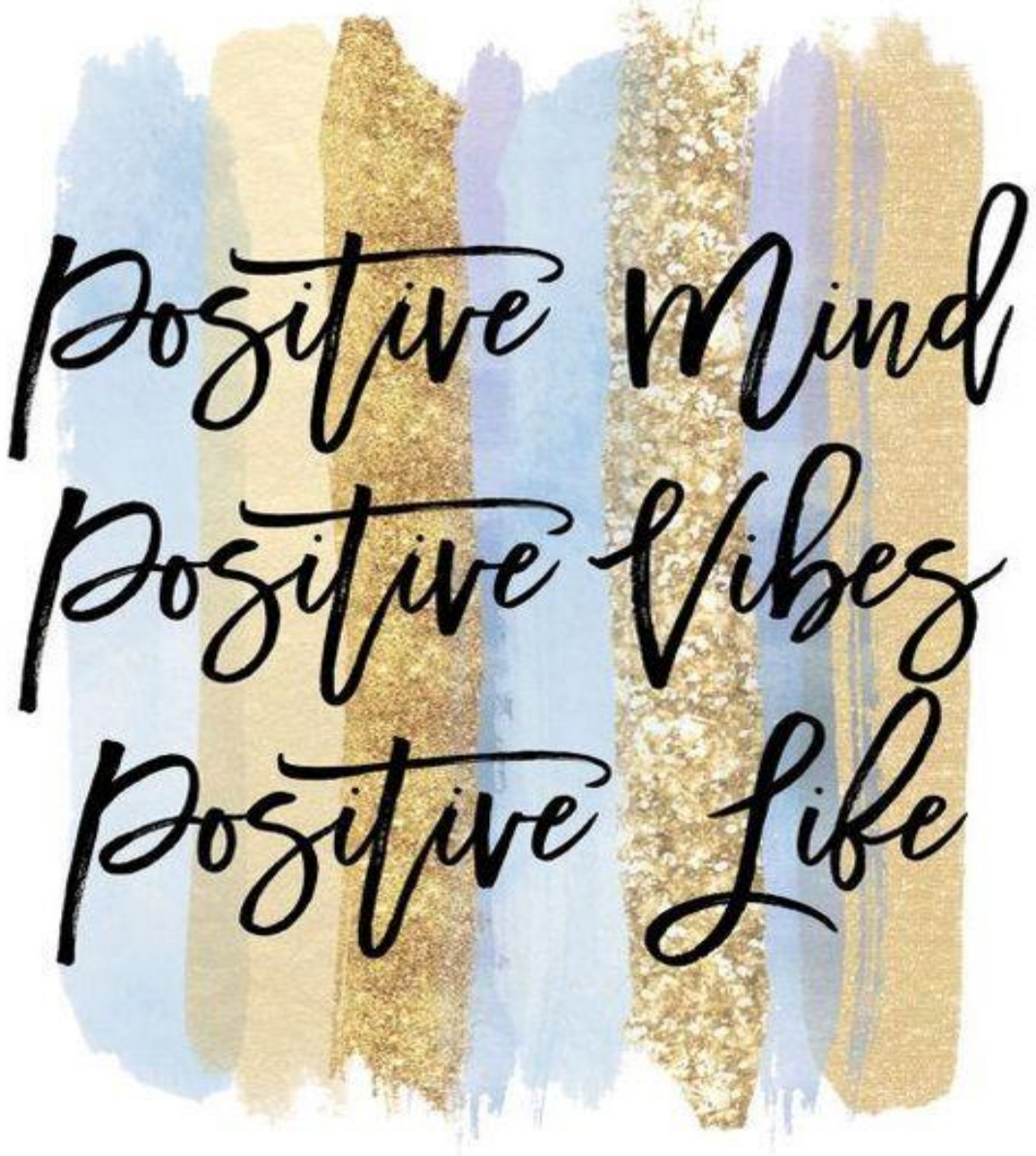
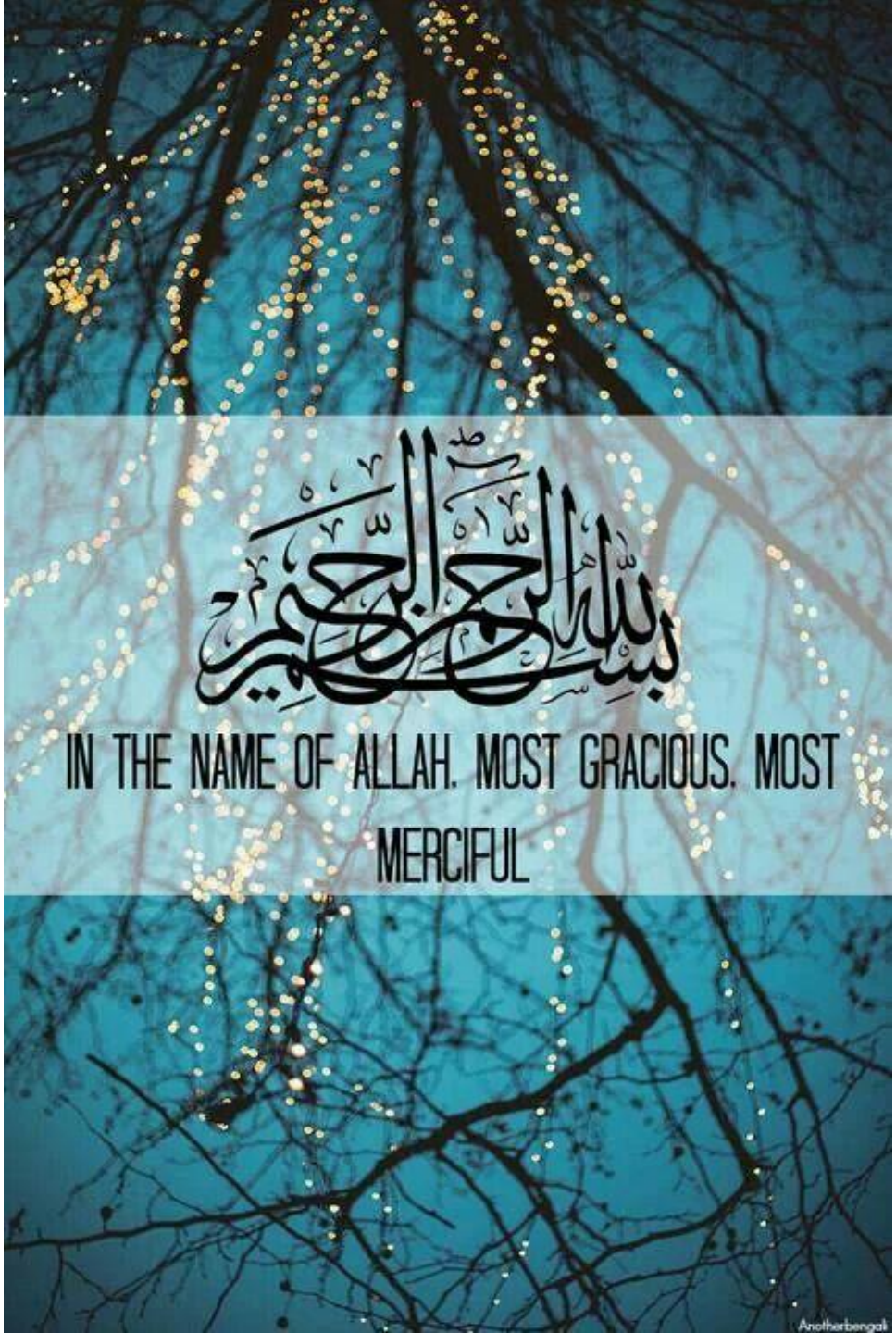
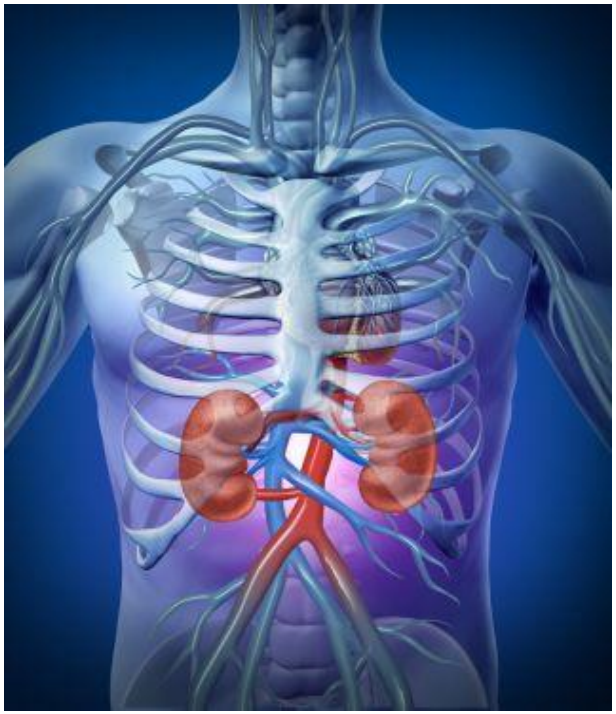

Positive Mind
Positive Vibes
Positive Life

Every morning when that alarm go off


بسم الله الرحمن الرحيم
IN THE NAME OF ALLAH. MOST GRACIOUS. MOST MERCIFUL
Anotherbengali

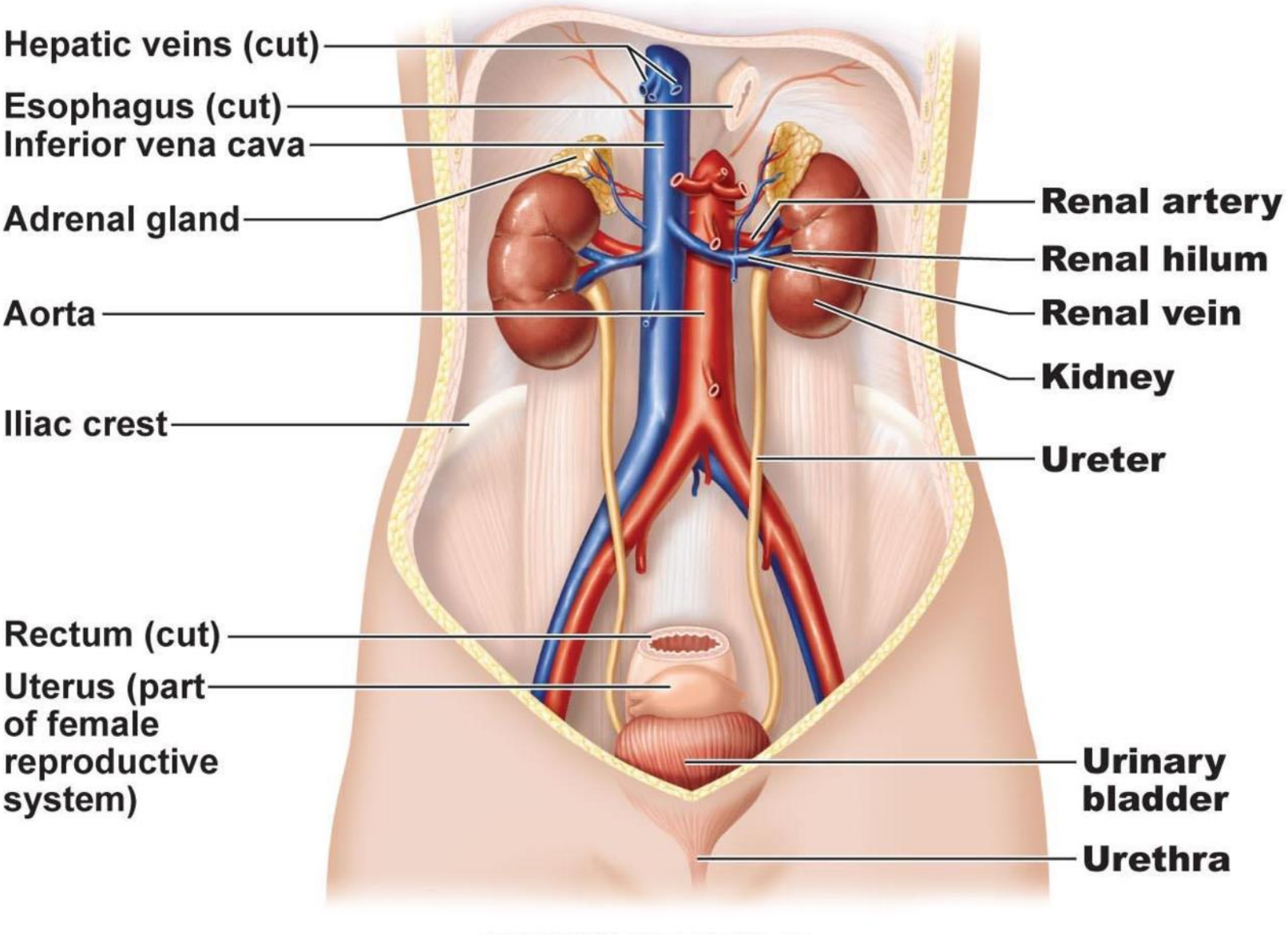


GENERAL ORGANIZATION OF THE KIDNEYS

DR SARAH SHAHID

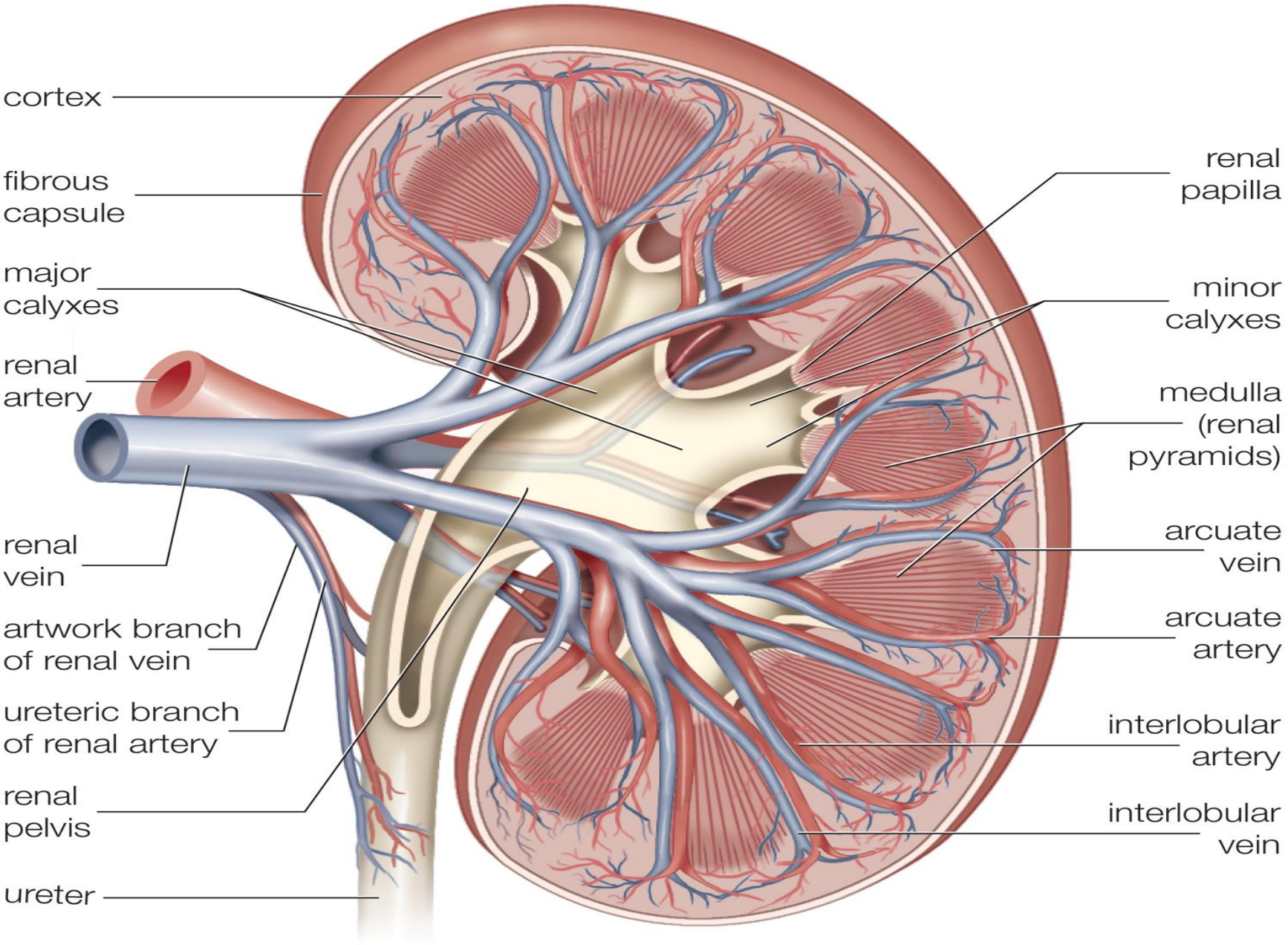
GENERAL ORGANIZATION OF THE KIDNEYS

- The two kidneys lie on the posterior wall of the abdomen outside the peritoneal cavity.
- Each kidney lies on one side of the vertebral column at the level of 12 thoracic to 3rd lumber vertebrae.
- Right kidney normally is situated lower than the left presumably because of the position of liver.
- Each kidney is about 10 to 12cm long, 5 to 6cm wide and 2.5 cm deep.
- Each kidney of the adult human weight about 150 grams and is about the size of the clenched fist.
- The medial side of each kidney contain an indented region called the hilum through which pass the renal artery and vein, lymphatics, nerve supply, and ureter that carries the final urine from the kidney to the bladder where it is stored until emptied.


Hepatic veins (cut)
Esophagus (cut)
Inferior vena cava
Adrenal gland
Aorta
Iliac crest
Rectum (cut)
Uterus (part of female reproductive system)
Renal artery
Renal hilum
Renal vein
Kidney
Ureter
Urinary bladder
Urethra

PHYSIOLOGY ANATOMY OF THE KIDNEYS

- the two major regions that can be visualized are
  - Outer cortex (granular in appearance)
  - Inner region medulla (striated triangles- renal pyramids)
- The medulla is divided into multiple **Cone shaped** masses of tissue called renal pyramids.
- The base of each pyramids originates at the border between the cortex and medulla and terminates in the **Papilla,** (8 to 18 per kidney) which projects into the space of the renal pelvis, a funnel shaped continuation of the upper end of the ureter.
- The outer border of the pelvis is divided into open ended pouches called **major calyces** that extend downward and divide into **minor calyces**



NEPRON

- Structural and functional unit of kidney.
- Each kidney consist of 1 to 1.3 million of nephrons.
- Nephron consist of:

Vascular Component

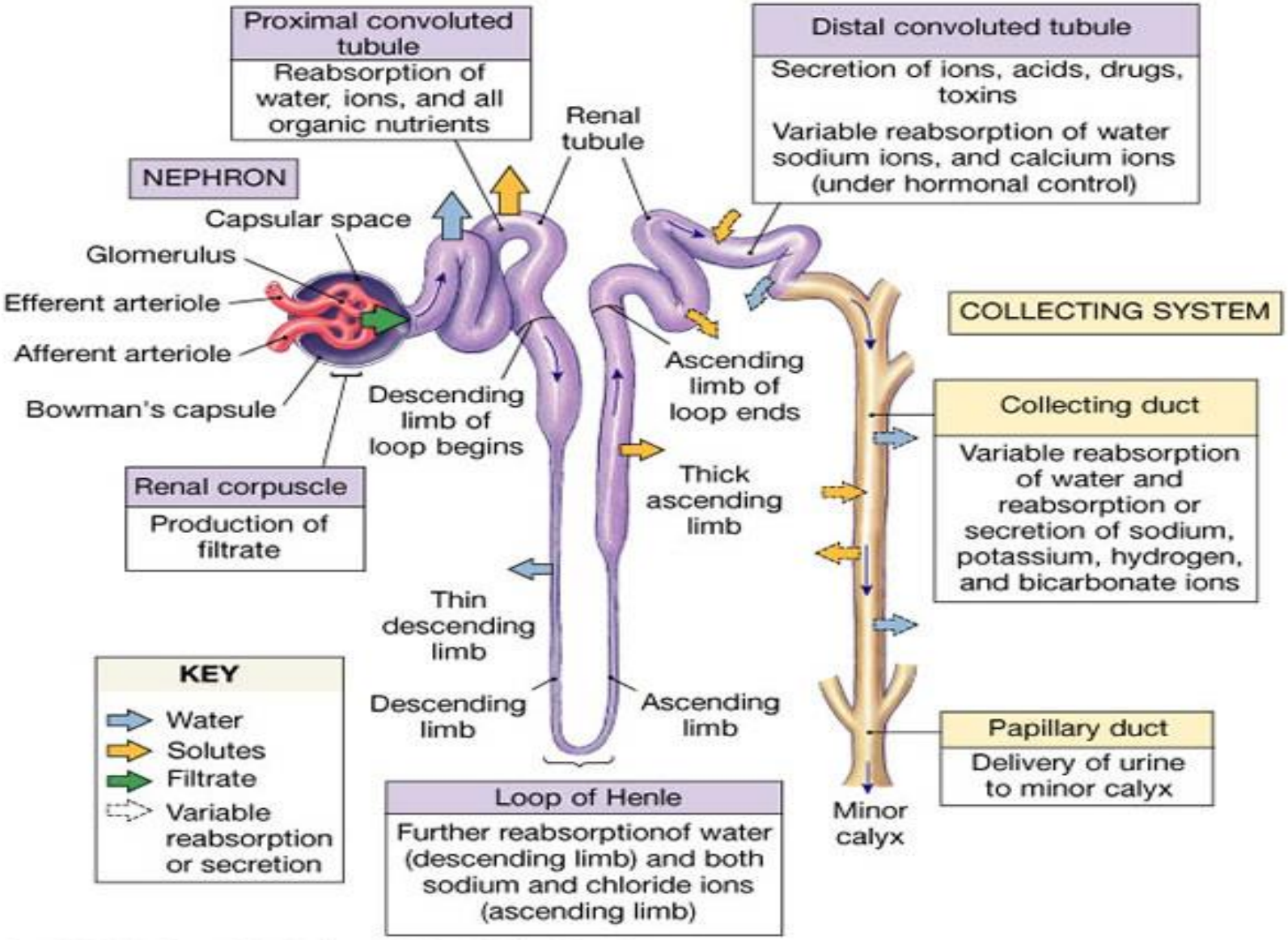
- Glomerulus
- Afferent arteriole
- Efferent arteriole

Tubular component

- Bowman’s Capsule
- Proximal tubule
- Loop of Henle
- Descending and ascending limb of Henle’s loop

Combined Vascular and tubular component

Juxtraglomerular apparatus



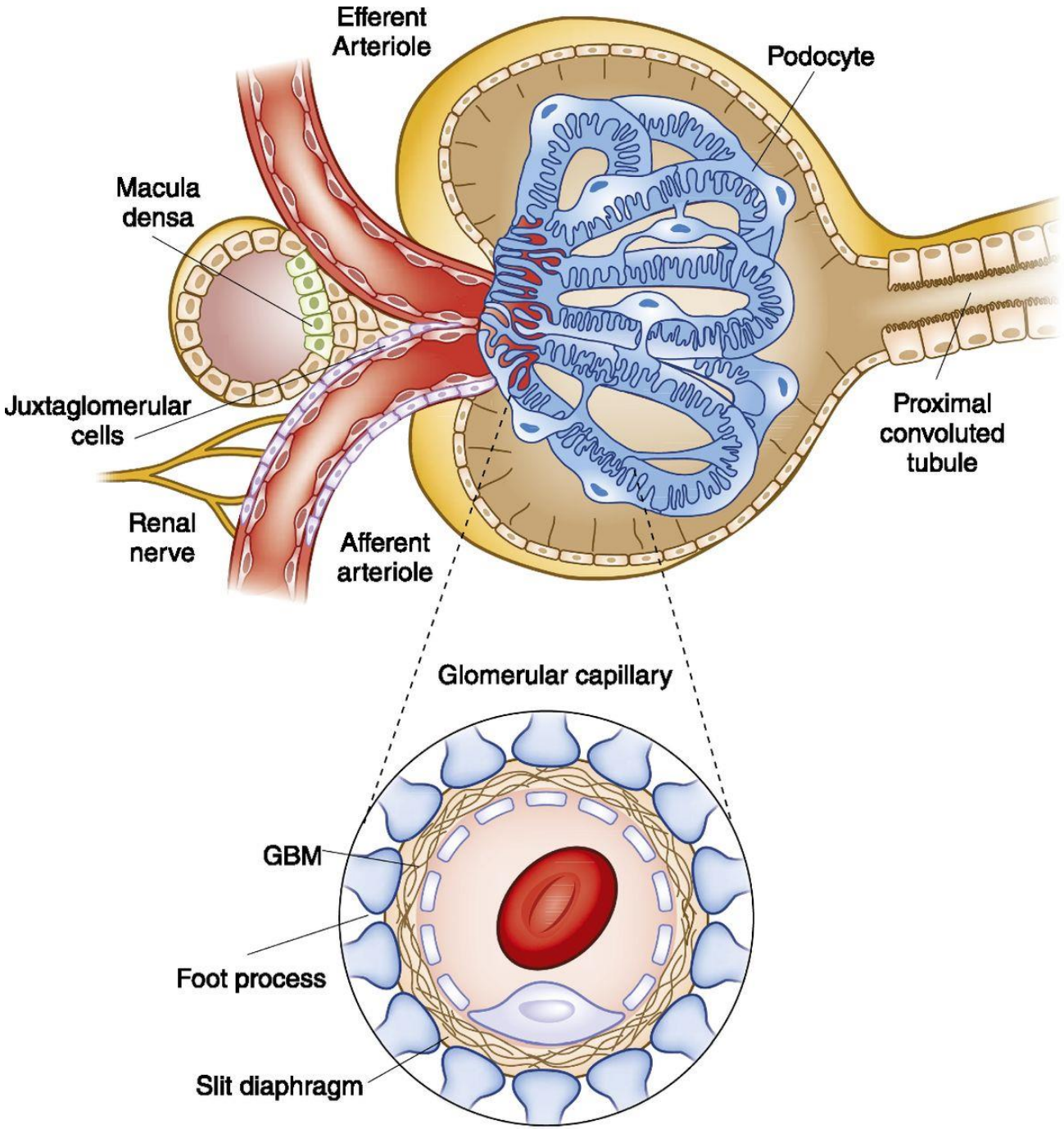
GLOMERULUS

- Capillaries(which forms outer layer of glomerular membrane) are made of single layer of endothelial cells attached to a basement membrane.

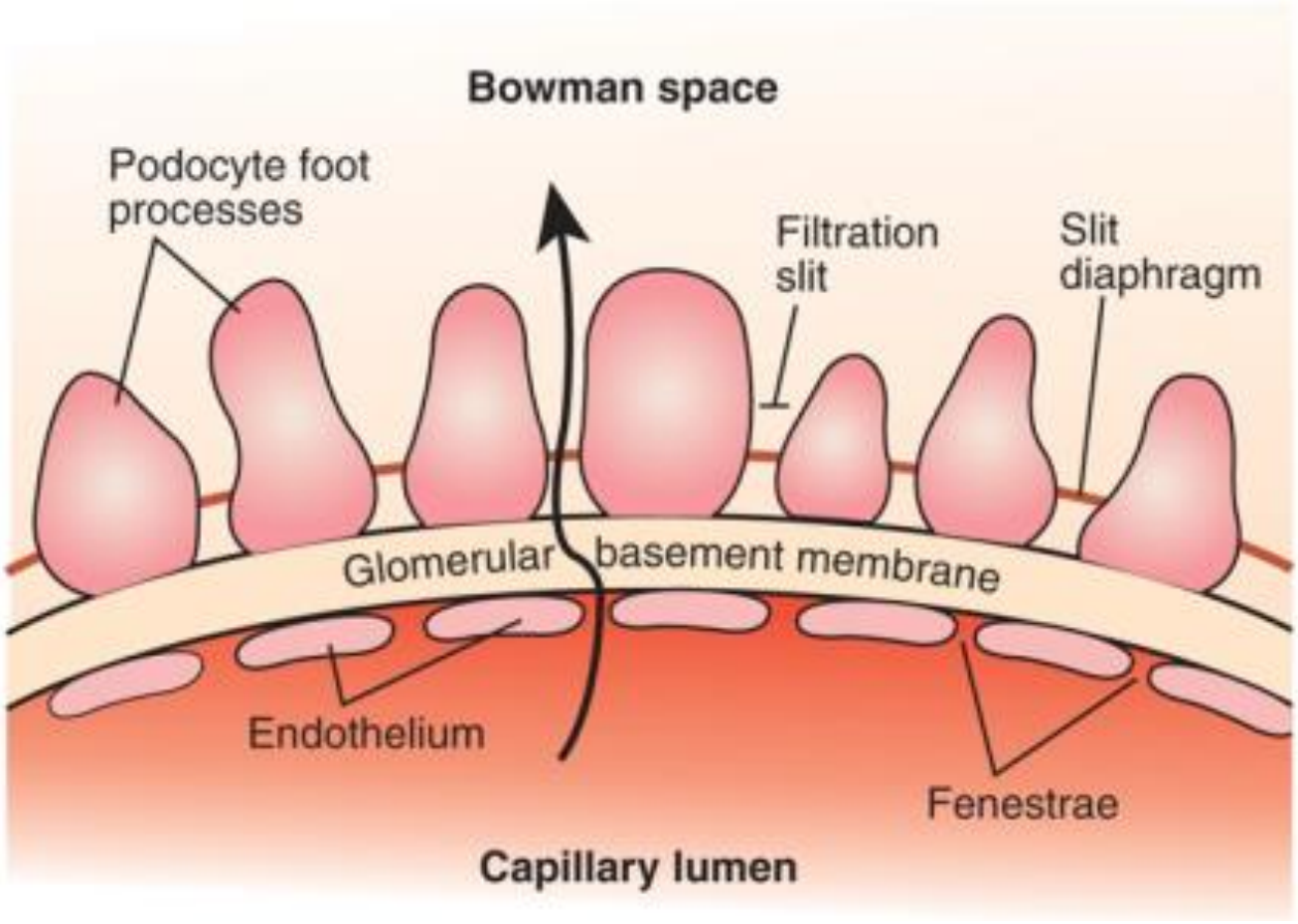
The endothelial layer has pores with a diameter of 0.1.The pores are called slit pores.

The pores are evidence of filtration function of the glomerulus. Pores that make over 100 times more permeable to water and solutes then capillaries elsewhere in the body.

The Basement membrane form the middle layer of glomerular membrane. It is a cellular gelatinous layer composed of collagen(structural strength) and glycoprotein layer(discourage the filteration of small plasma protein due to its negative charge)

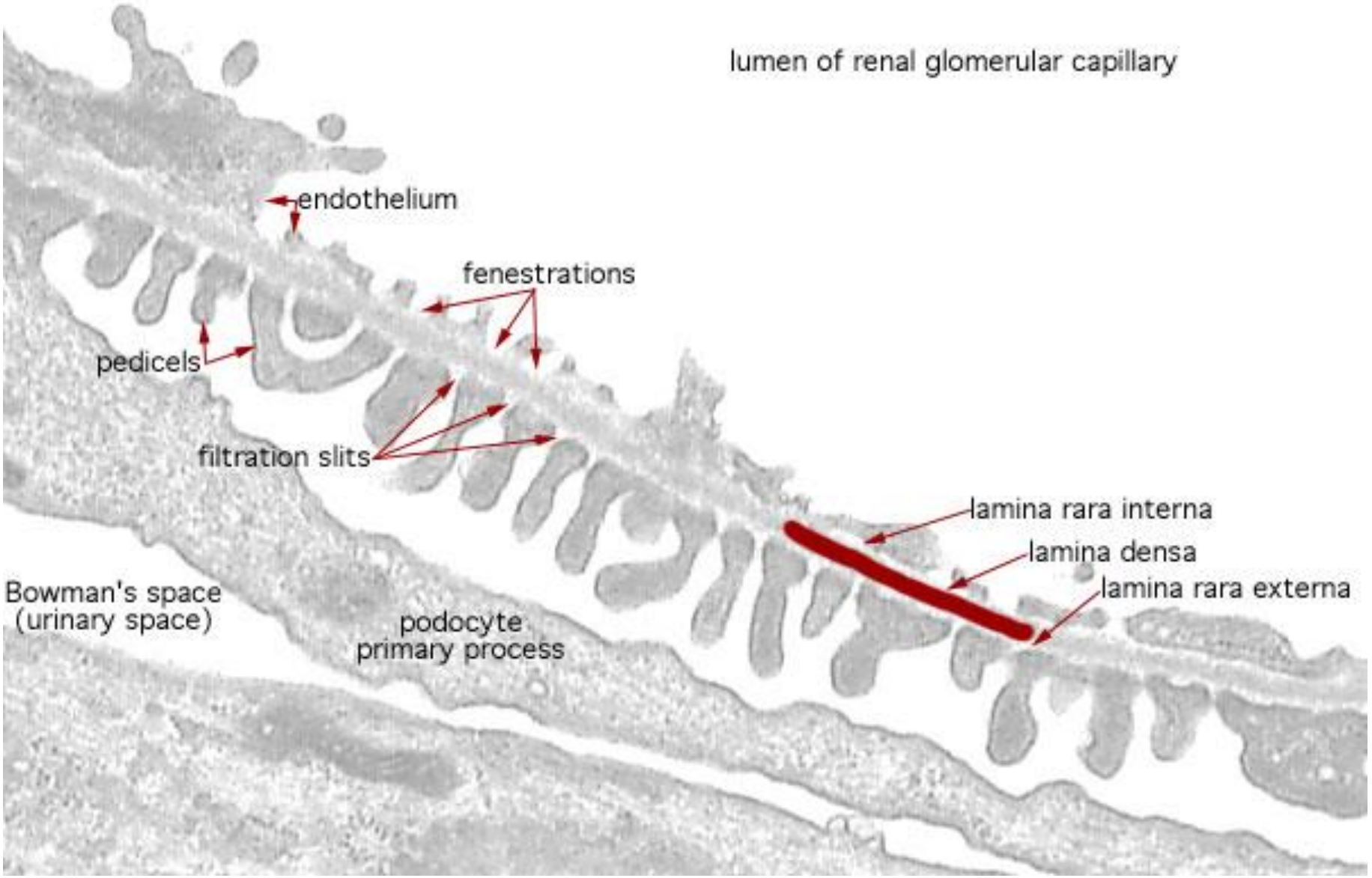

Efferent Arteriole
Podocyte
Macula densa
Juxtaglomerular cells
Proximal convoluted tubule
Renal nerve
Afferent arteriole
Glomerular capillary
GBM
Foot process
Slit diaphragm

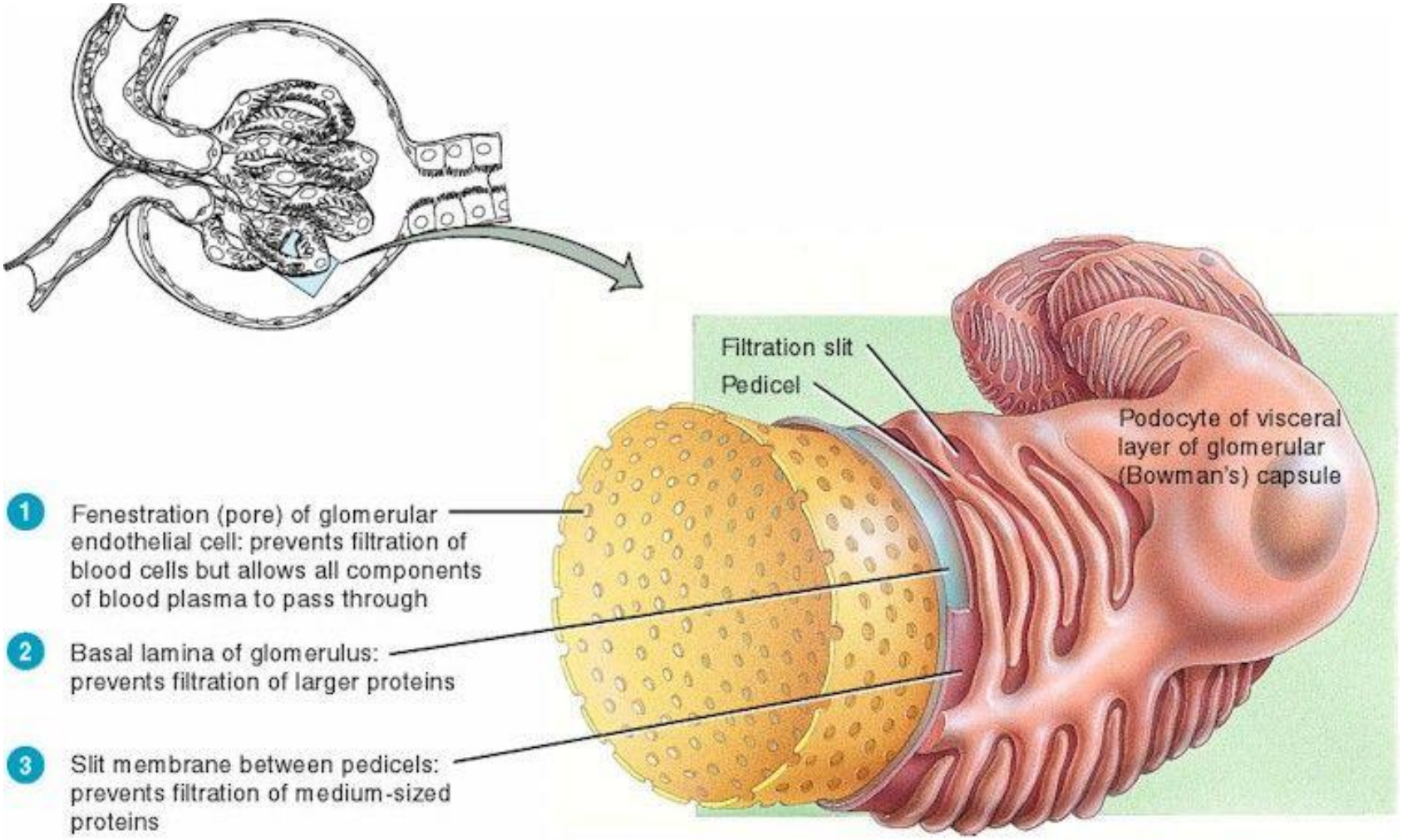
- **the inner layer of Bowmans capsule.**
- It bears many elongated foot processes. Slit between adjacent foot processes are functionally filtration slits which provide a pathways through which fluid exiting the glomerular capillaries can enter the lumen of Bowmans capsule
- The filterability of solutes is inversely related to their size.
- Glomerular filtration barrier is selective and based on their size and electric charge.
- Glucose and sodium are freely filtered.
- The molecular diameter of the plasma protein is 6 nanometer.
- The pores of Glomerular membrane is 8 nanometer (80 angstroms).
- Albumin is restricted from filteration because of Negative charge and the repulsion exerted by negative charge of the glomerular capillary wall proteoglycans


Bowman space
Podocyte foot processes
Filtration slit
Slit diaphragm
Glomerular basement membrane
Endothelium
Fenestrae
Capillary lumen

GLOMERULUS (CONTINUED)

- For any given molecular radius, positively charged molecules are filtered much more readily than negatively charged molecules.
- The kidney diseases, the negatively charges on the basement membrane are lost before there are noticeable changes in kidney histology minimal change nephropathy.
- Loss of negative charge on the basement membrane, and the low-molecular weight proteins ALBUMIN when filtered and appear in urine this condition is known as proteinuria or Albuminuria.


lumen of renal glomerular capillary
endothelium
fenestrations
pedicels
filtration slits
lamina rara interna
lamina densa
lamina rara externa
Bowman's space
(urinary space)
podocyte
primary process



(a) Details of filtration membrane

26.08b

TUBULAR COMPONENT

- Tubular componenet of each nephron is a hollow, fluid filled tube formed by a single layer of epithelial cells.
- The tubular component begins with.

Bowman's capsule

- An expended, double walled invagination that cups around the gromerulus to collect the fluid filtered from the glomerular capillaries.

BOWMAN'S CAPSULE

- Encloses the glomerulus.
- Formed by two layers.
- Inner layer is called visceral layers
- Outer layer is called parietal layer
- Visceral layer covers the glomerular capillaries
- The space between the visceral and parietal layers is continued as the lumen of the tubular portion.
- Diameter of bowman capsule is 200 μ.
- The basement membrane of the visceral layer fuses with the basement membrane of glomerular capillaries on which capillary endothelial cells are arranged.

BOWMAN'S CAPSULE (CONTINUED)

- Each epithelial cell of the visceral layer is connected with the basement membrane by series of processing called pedicles or feet.
- Pedicles are the cytoplasmic extensions of epithelial cells.
- These pedicles are arranged in an interdigitating manner leaving small cleft like space in between.
- **The epithelial cells with pedicles are called podocytes.**
- Urine formation begins with filtration from the glomerular capillaries into Bowman's capsule of large amount of fluid that is virtually free of proteins.

Proximal Convuluted tubule

- From the Bowman capsule the fluid filtered passes into the proximal tubule.
- This is the coiled portion arising from Bowman's capsule. This occupies the cortex near glomerulus. Length of proximal convuluted tubule is 14mm diameter is 55 μ.
- **Lies entirely within the cortex.**
- Highly coiled or convoluted throughout much of its course.

LOOP OF HENLE

- Direct continuation of the proximal convoluted tubule.
- The thick descending limb or segment.
- The thin descending limb or segment
- Hair bend
- Thin ascending limb or segment
- Thick ascending limb or segment
- Forms a sharp U shaped or hairpin loop
- **Dips into the renal medulla**

Descending Limb of Henle's Loop

- Plunges from the cortex in to the medulla.
- The thin descending segment of Henle's loop connects the thick descending segment with the hairpin bend of the loop, which is continued as thin ascending segment.
- Thin ascending segment is continued as thick ascending segment.

ASCENDING SEGMENT OF LOH

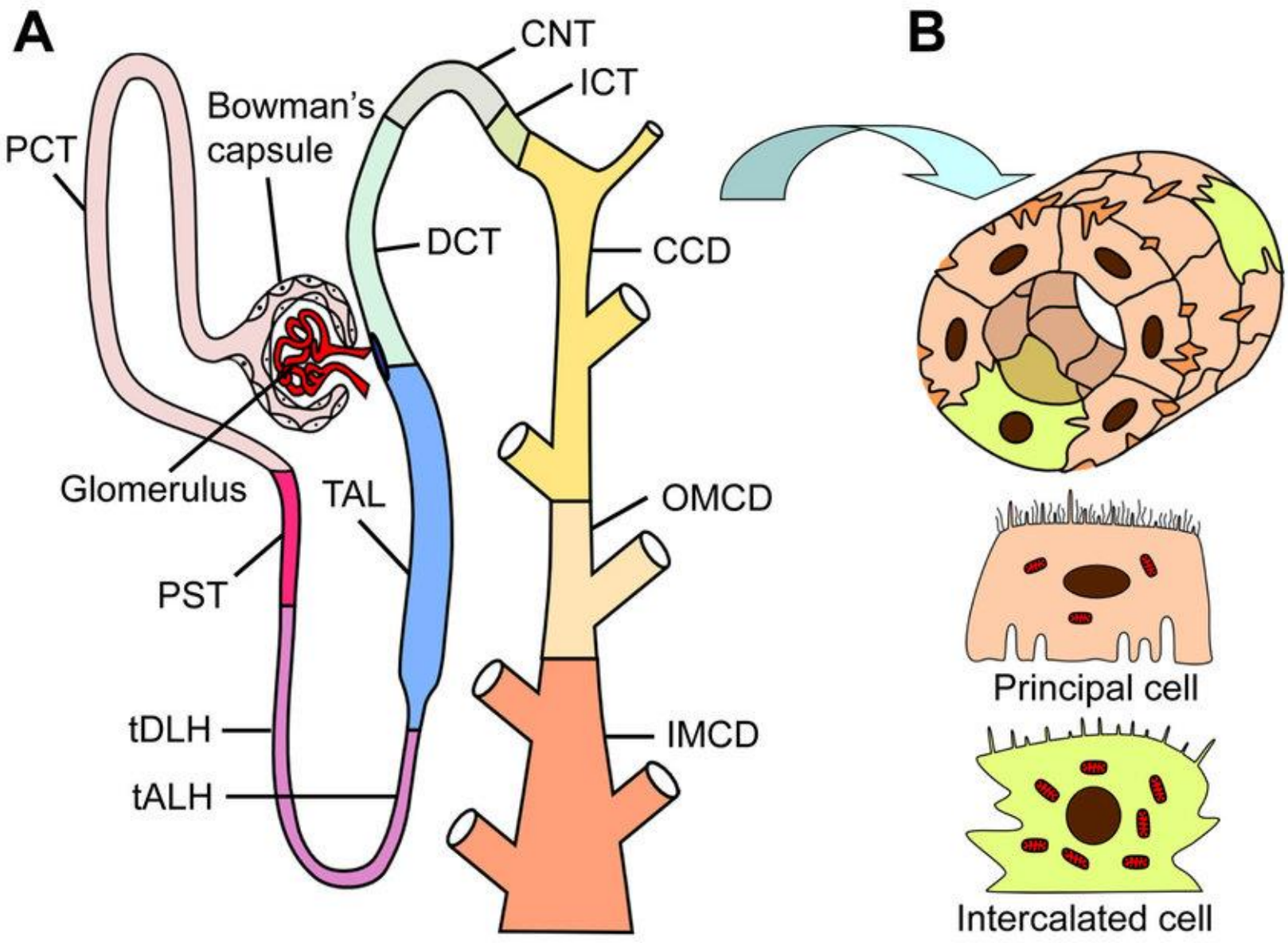
- Traverses back up into the cortex
- This segment of the loop is continued from thin ascending segment.
- This segment **ascends to the cortex** and forms distal convoluted tubule.
- The length is 9mm and its diameter is 30 μ.
- The cuboidal cells that is closely packed in the thick ascending segment is called macula densa.

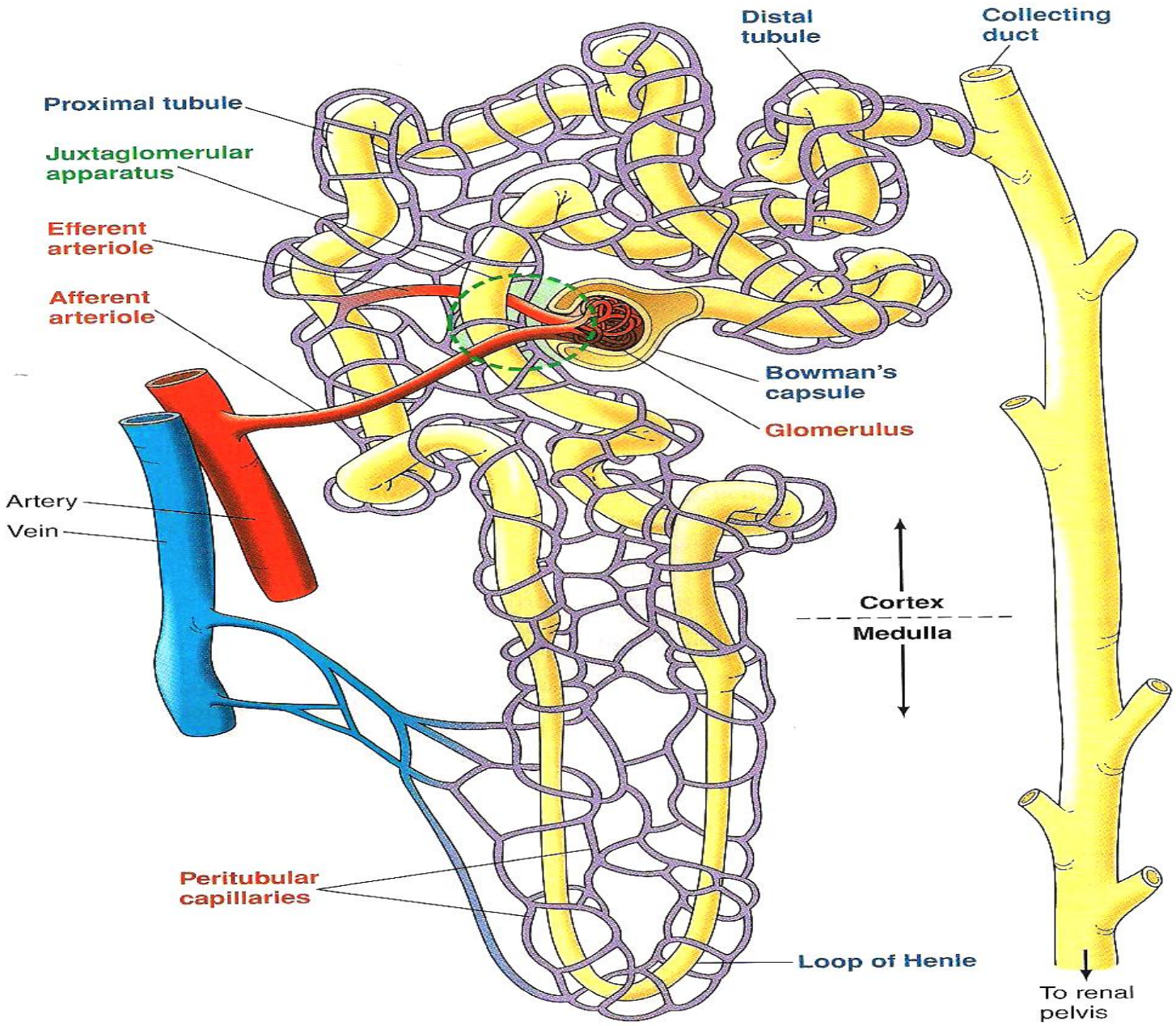
DISTAL CONVOLUTED TUBULE

- Continuation of thick ascending segment henle's loop and occupies the cortex of kidney.
- This segment opens into the collecting tubule.
- The length of distal convoluted tubule is 14.5 to 15mm.
- Sensitive to Aldosterone and absorbs sodium in exchange with potassium

COLLECTING DUCTS

- The distal convoluted tubule opens into the collecting duct which is in the cortex.
- The lower part of the collecting duct is in medulla.
- Seven to ten initial collecting ducts unite form the collecting duct, which passes through medulla.
- The straight tubule in the inner zone of medulla unite to form papillary ducts which open into minor calyces.
- Three or four minor calyces unite to form one major calyx. The major calyces open into the pelvis of the ureter.
- The pelvis is the extended portion of ureter present in the renal sinus.
- The length of collecting duct is 20-200mm.


A
CNT
ICT
Bowman's capsule
PCT
DCT
CCD
Glomerulus
TAL
OMCD
PST
tDLH
IMCD
tALH
B
Principal cell
Intercalated cell



Overview of Functions of Parts of a Nephron

Vascular component

- Afferent arteriole—carries blood to the glomerulus
- Glomerulus—a tuft of capillaries that filters a protein-free plasma into the tubular component
- Efferent arteriole—carries blood from the glomerulus
- Peritubular capillaries—supply the renal tissue; involved in exchanges with the fluid in the tubular lumen

Combined vascular/tubular component

- Juxtaglomerular apparatus—produces substances involved in the control of kidney function

Tubular component

- Bowman's capsule—collects the glomerular filtrate
- Proximal tubule—uncontrolled reabsorption and secretion of selected substances occur here
- Loop of Henle—establishes an osmotic gradient in the renal medulla that is important in the kidney's ability to produce urine of varying concentration
- Distal tubule and collecting duct—variable, controlled reabsorption of Na^+ and H_2O and secretion of K^+ and H^+ occur here; fluid leaving the collecting duct is urine, which enters the renal pelvis

RENAL BLOOD SUPPLY

- In adult, during resting condition both the kidneys receive 1300ml of blood per minute or about 26% of the cardiac out. Percent of total cardiac output that passes through kidneys is called renal fraction.

- Renal circulation has double network of capillaries. The afferent arterioles enter the bowman's capsule and efferent arteriole, leaves the bowman's capsule .
- The efferent arteriole forms a second capillary network called peritubular capillaries, which surrounds the nephrons.

Afferent arteriole

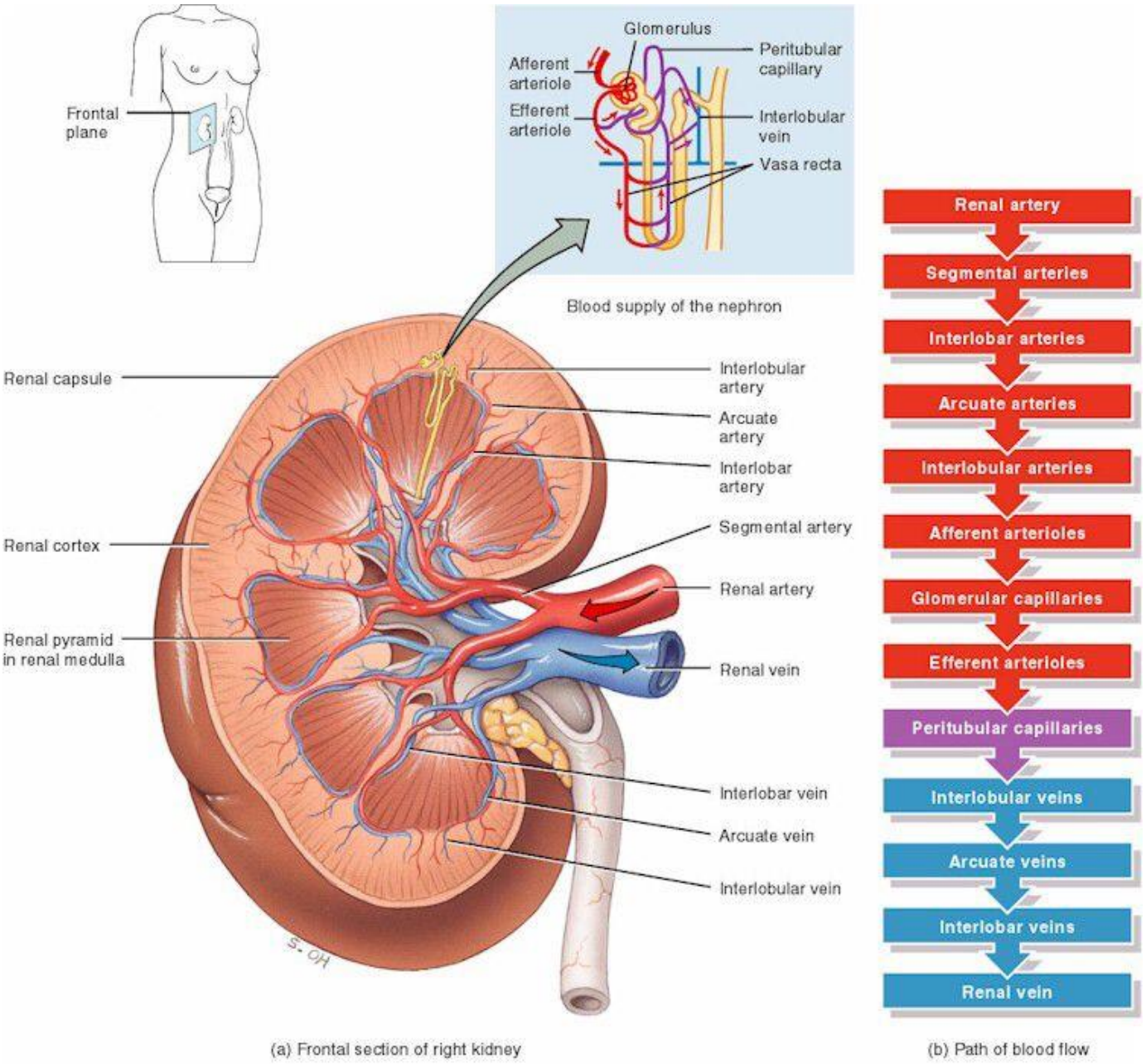
- Renal artery subdivides to many small vessels known as afferent arteriole one of which supplies each nephron.
- Afferent arterioles supplies blood to the glomerulus.

Efferent arteriole

- Blood was not filtered into the tubular component leaves the glomerulus.
- ***Efferent arterioles are the only arterioles in the body that drain from capillaries.***
- Efferent arterioles quickly subdivides into a second set of capillaries, the peritubular capillaries which supply the renal tissue with blood.

Peritubular capillaries(Peri means around)

- Important in exchange between the tubular system and blood during conversion of filtered fluid into urine.
- Peritubular capillaries are inter twined around the tubular system peri means around the peritubular capillaries rejoin to form venules and drain into renal vein.



(a) Frontal section of right kidney

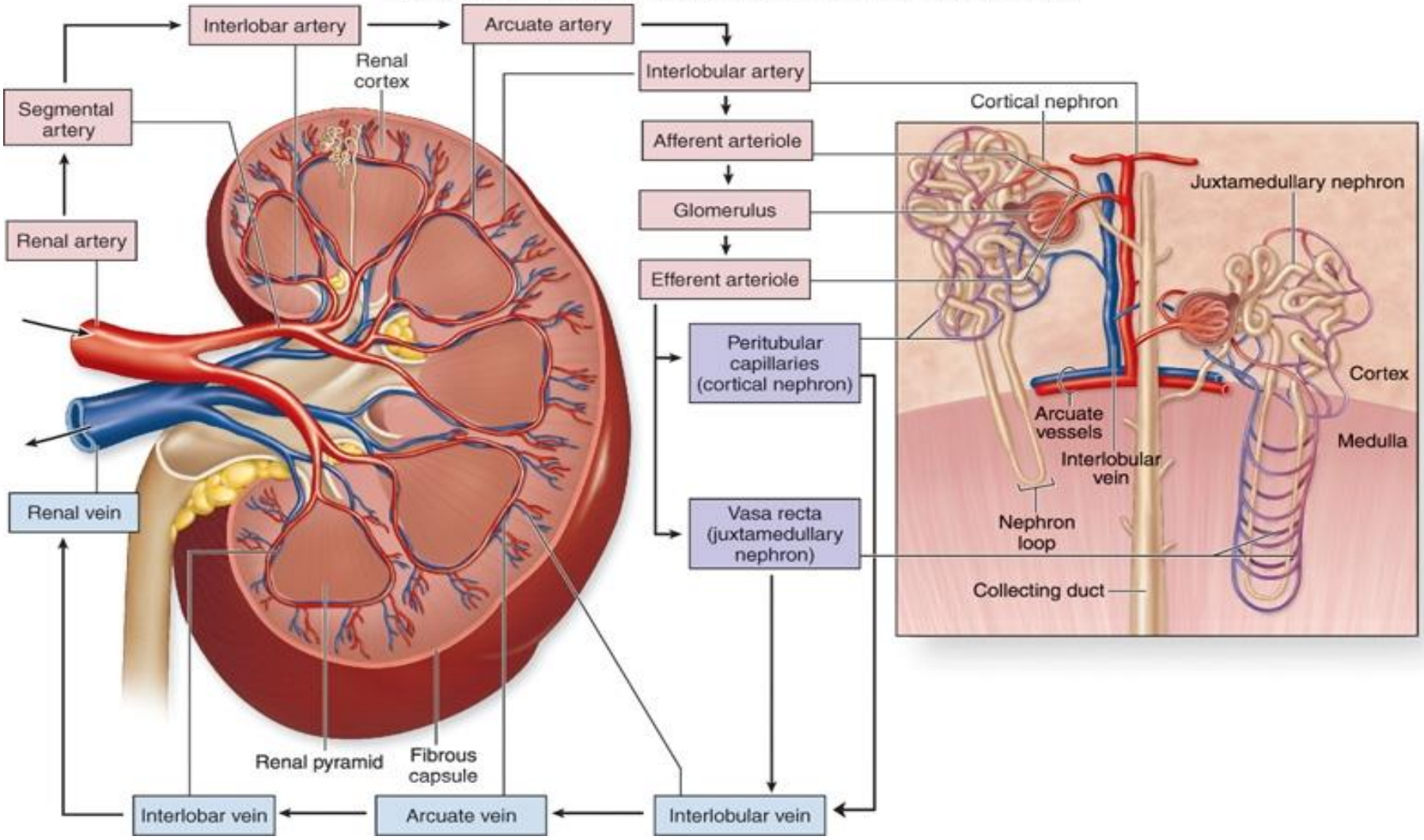
(b) Path of blood flow

RENAL GLOMERULAR CAPILLARIES

- Form high pressure bed with pressure of 60 – 70 mmHg.
- **Renal glomerular capillaries pressure** is much greater than the capillary pressure elswhere in the body which is about 25 to 30 mmHg.
- The diameter of the afferent arteriole is more than that of efferent arteriole.
- High capillary pressure **helps in glomerular filtration.**
- **Peritubular capillaries** form a low pressure bed with pressure of 8 to 10 mmHg.
- This low pressure helps tubular reabsorption.

Differentiating point

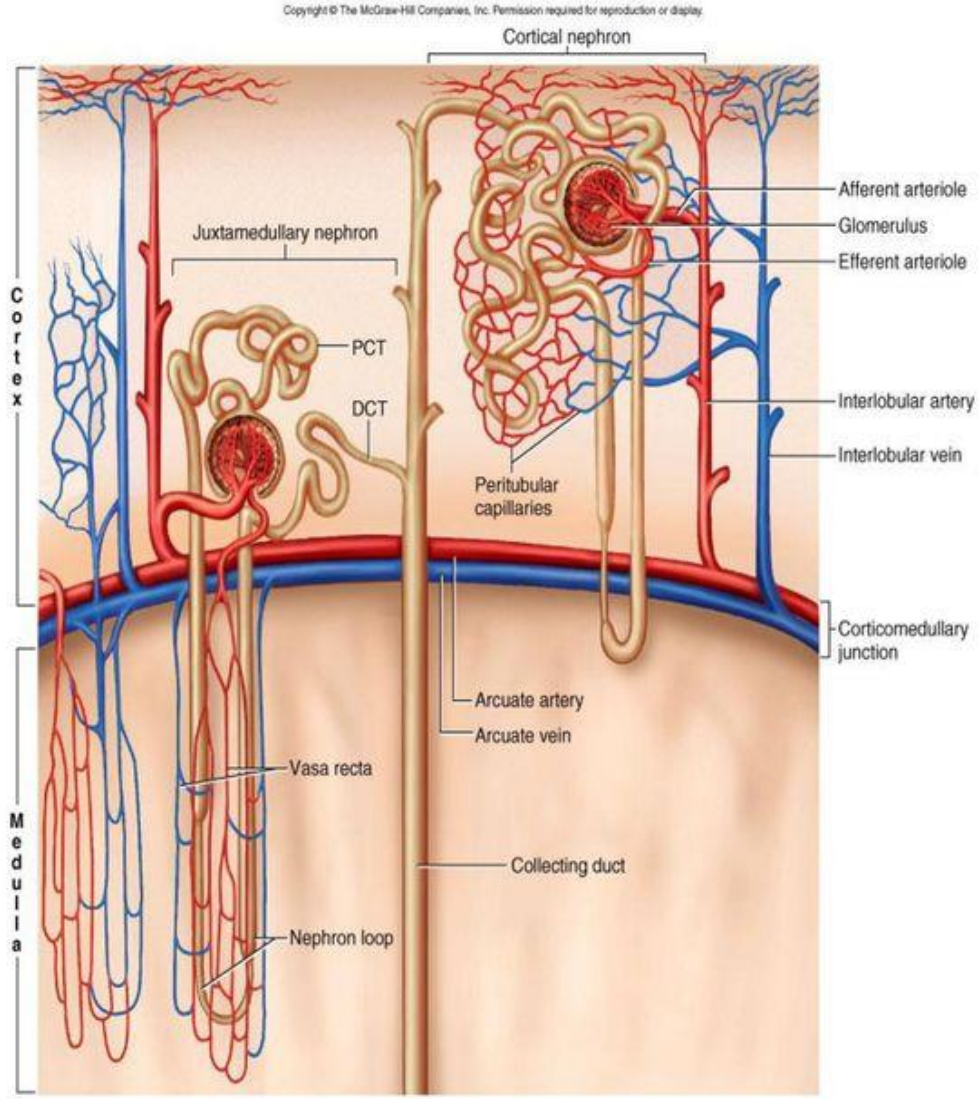
- Efferent arteriole is the only arterioles in the body that drain from capillaries.
- Normally arterioles break up into capillaries that rejoin to form venules but it does not happens in renal tubules



NEPHRON CLASSIFICATION BASED ON SITUATION

- Cortical or superficial nephrons.
- Juxtramedullary nephrons.

Types of Nephrons



Cortical nephrons

- 85% of all nephrons
- short nephron loops
- efferent arterioles branch into ***peritubular capillaries*** around PCT and DCT

Juxtamedullary nephrons

- 15% of all nephrons
- very long nephron loops, maintain salinity gradient in the medulla and helps conserve water
- efferent arterioles branch into ***vasa recta*** around long nephron loop

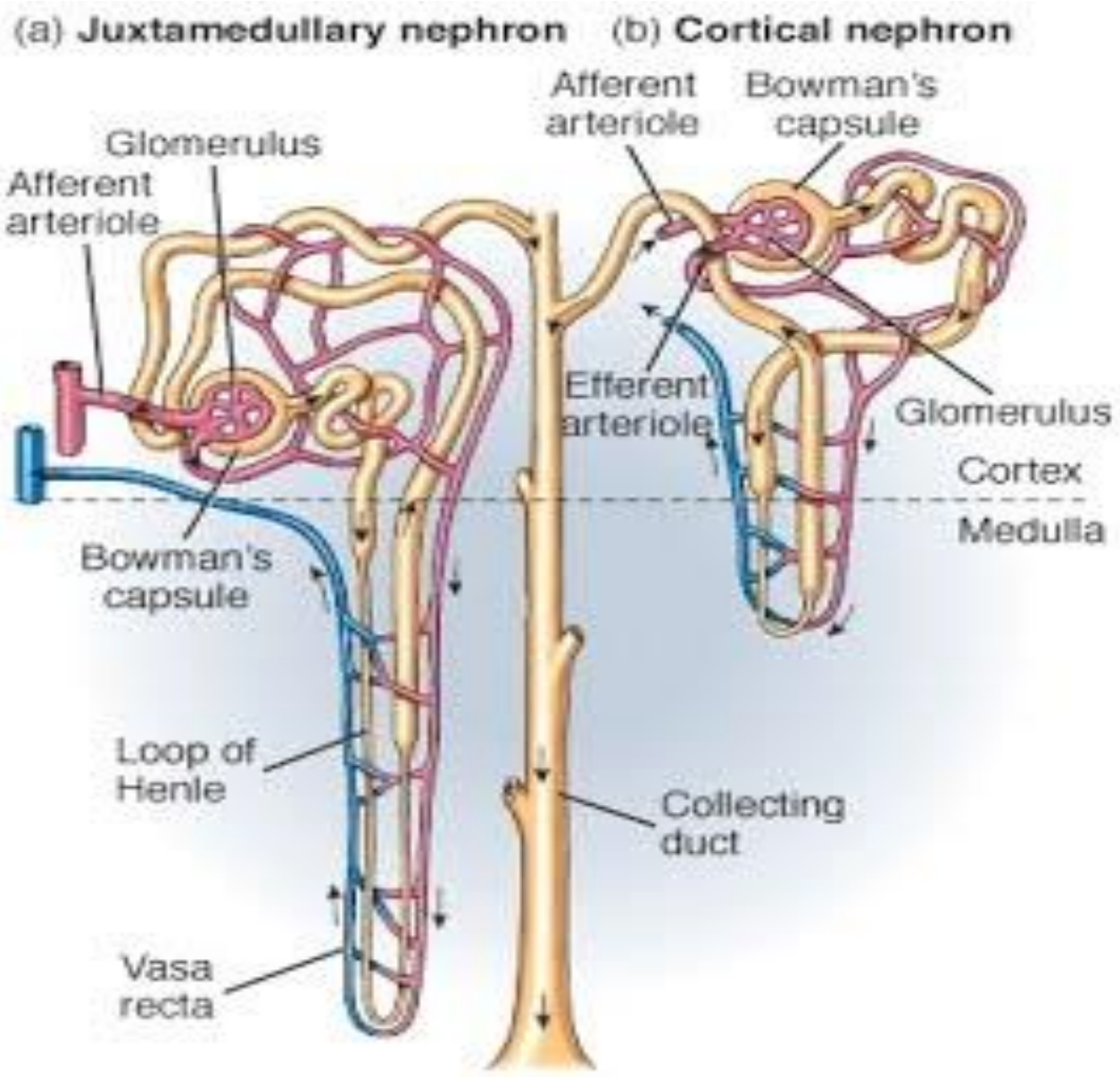
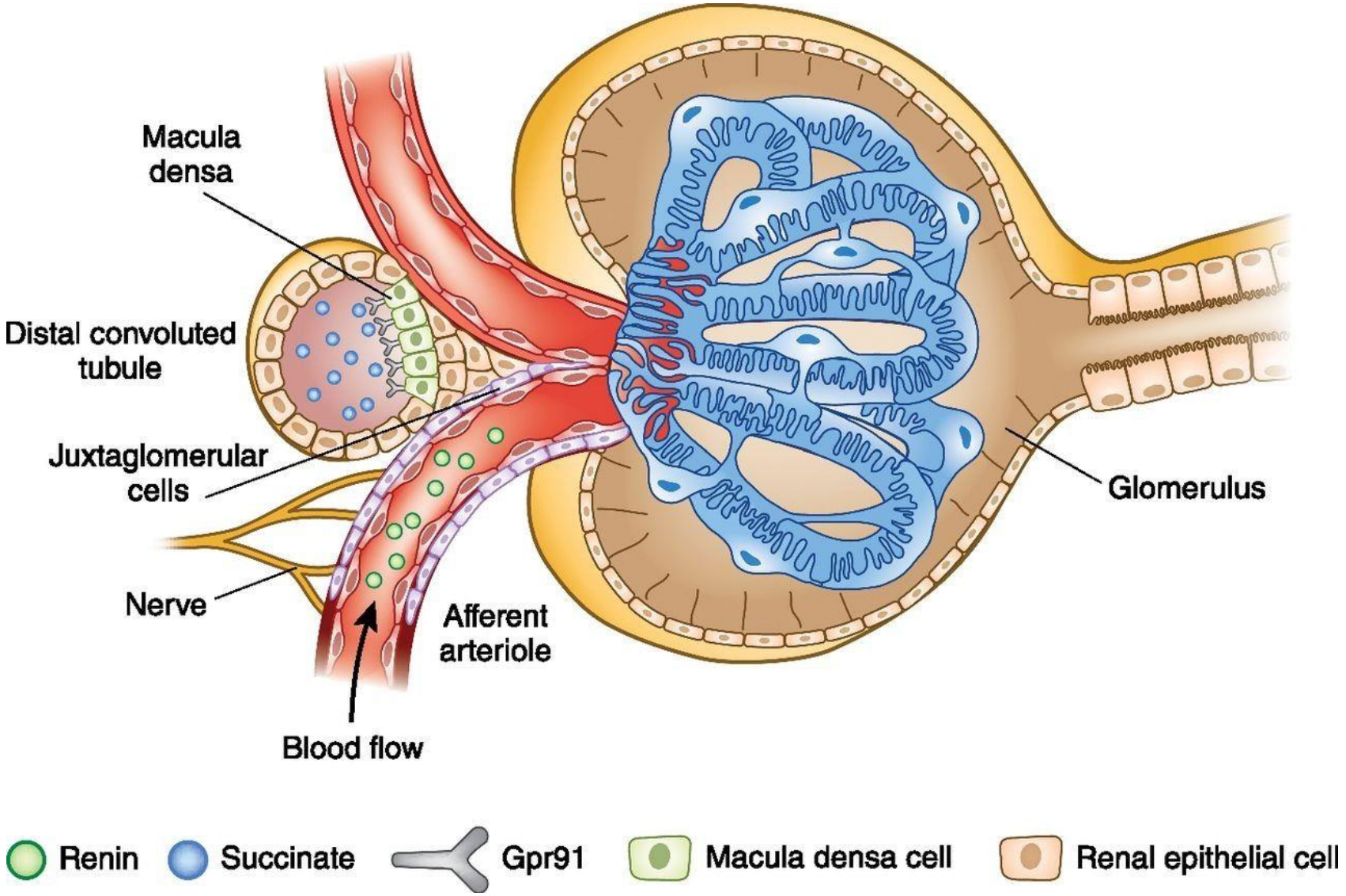

(a) Juxtamedullary nephron
(b) Cortical nephron
Afferent arteriole
Bowman's capsule
Glomerulus
Afferent arteriole
Efferent arteriole
Glomerulus
Cortex
Medulla
Bowman's capsule
Loop of Henle
Collecting duct
Vasa recta

TABLE 49-1: Features of two types of nephron

Features	Cortical nephron	Juxtamedullary nephron
Situation of corpuscle	Outer cortex near the periphery	Inner cortex near medulla
Loop of Henle	Short Hairpin bend penetrates only up to outer zone of medulla	Long Hairpin bend penetrates up to the tip of papilla
Blood supply to tubule	Peritubular capillaries	Vasa recta
Function	Formation of urine	Mainly the concentration of urine and Formation of urine


Macula densa
Distal convoluted tubule
Juxtaglomerular cells
Nerve
Afferent arteriole
Blood flow
Glomerulus
Renin
Succinate
Gpr91
Macula densa cell
Renal epithelial cell

The Juxtaglomerular apparatus

consists of three types of cells:

- the macula densa, a part of the distal convoluted tubule of the same nephron
- juxtaglomerular cells, (also known as granular cells) which secrete renin
- extraglomerular mesangial cells

"I don't know what's worse...you, Jenkins, snoring through my presentation, or you, Fredericks, complaining that it was keeping you awake!"

MULTIPLE FUNCTIONS OF THE KIDNEYS IN HOMEOSTASIS

BASIC THEORY OF NEPHRON FUNCTION

- **Basic function of nephron is to clear and clean blood plasma of unwanted substances.**
- It occurs in three steps and regulated according to the needs of the body.

Glomerular filtration---

Because of high pressure in glomerulus, it acts like arterial end of capillary, causing large portions of plasma to filter out of glomerulus into bowman's capsule.

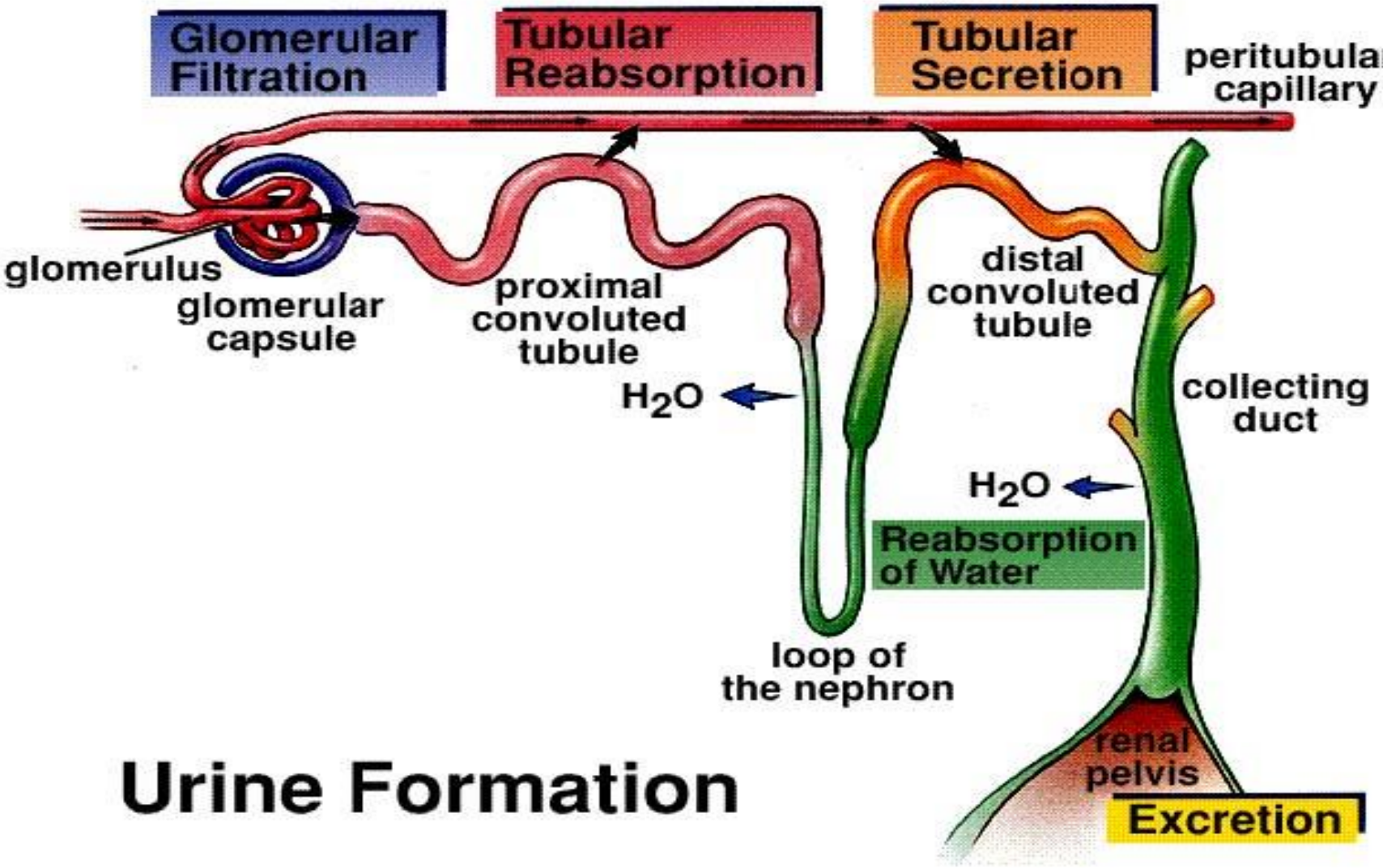
- Average plasma volume in an adult is 2.75 liters.
- Entire plasma volume is filtered by the kidneys about 65 times per day.
- If every thing is filtered were to pass out in the urine, the total plasma would be urinated in less then half an hour but this does not happens

Tubular reabsorbtion -

•This process includes the reabsorption of useful substances from the filtrate within the renal tubules into the capillaries around the tubules.
•These substances are water, glucose, amino acids, vitamins, bicarbonate ions, and the chloride salts of calcium, magnesium, sodium and potassium.
•Reabsorption starts in the proximal tubules and continues through the Henle's loop, to the distal tubule and then to the collecting tubules.

Tubular secretion –

• This mechanism also changes the composition of urine.
•Some substances are actively secreted into the tubules.
•Substances secreted into the urine include ammonia, hydrogen ions, potassium and some drugs



Urine Formation

FUNCTIONS OF THE KIDNEYS

- **Excretion of metabolic waste products and foreign chemicals**
- Kidneys are not only the **excretory organs** but are also the **regulatory organ** because their major role is in homeostasis.
  - Urea end product of amino acid metabolism.
  - Creatinine end product of metabolism of muscle.
  - Uric acid end product of nucleic acid metabolism.
  - Bilrubin end product of haemoglobin degradation.
  - Kidneys excrete harmful chemical substances. Toxins, Drugs, Heavy metals
- **Regulation of water and electrolyte balances**
- Kidney maintain water balance in the body.

MULTIPLE FUNCTIONS OF THE KIDNEYS IN HOMEOSTASIS (CONTINUED)

❑Regulation of body fluid osmolality and electrolyte concentration

➢Kidney response to sudden 10 fold increase in sodium intake from a low level of 30m Eq/day to high level of 300 m Eq/day within 2-3 days after rising the sodium intake, renal excretion also increases to about 300 m Eq/day.

❑Regulation of acid-base balance

➢Body is under constant threat to develop acidosis. Kidneys play major role in preventing acidosis.

❑Regulation of arterial pressure

➢Kidney play an important role in the regulation of arterial blood pressure kidney regulate arterial blood pressure by two ways.

➢By regulating the volume of ECF.

➢By renin angiotensin mechanism.

MULTIPLE FUNCTIONS OF THE KIDNEYS IN HOMEOSTASIS (CONTINUED)

- **Secretion, metabolism, and excretion of hormones**

➢ Kidneys secrete many hormonal substances, the hormones secreted by kidneys are:

1. Erythropoietin
2. Thrombopoitin
3. Renin
4. 1,25-Dihydroxy chole calciferol.
5. Prostaglandins

- **Gluconeogenesis**

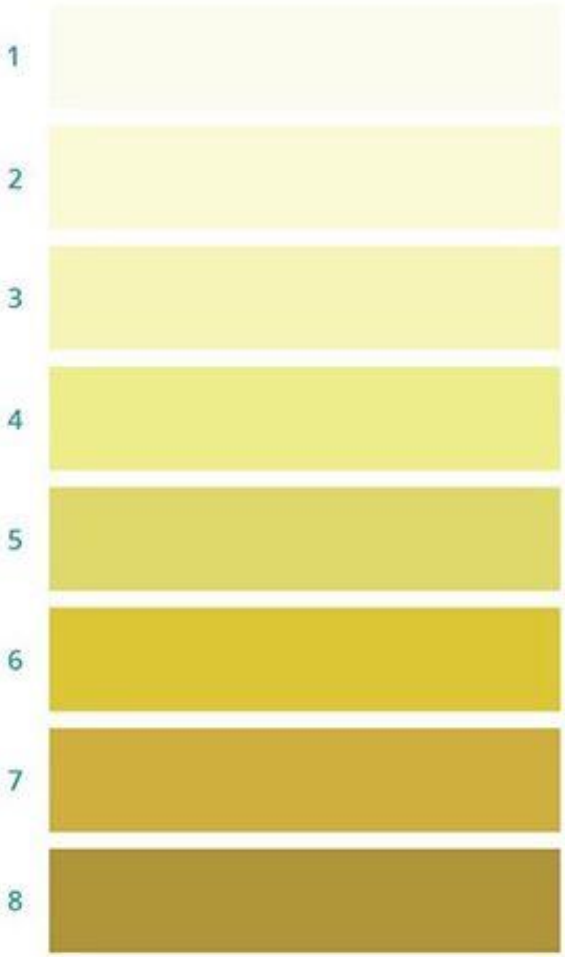
➢ Kidney synthesis glucose from amino acids and other precursors during prolong fasting a process referred as gluconeogensis.

- **Regulation of calcium bone metabolism**

➢ Regulation of blood calcium level by activating 1,25 Dihydroxy chole calciferol into vitamin D. Vitamin D is necessary for the absorption of calcium from intentines.

Am I drinking enough water?

Use this urine colour chart to assess how hydrated you are. It is important to drink plenty of water each day to stay healthy.



1 to 2: Hydrated

Pale, odourless and plentiful urine is often an indication that you are well hydrated.
Keep drinking at the same rate.

3 to 4: Mildly dehydrated

Slightly darker yellow urine can indicate that you need to drink more water.
Drink a glass of water now.

5 to 6: Dehydrated

Even darker yellow urine is often an indication that you are dehydrated.
Drink 2-3 glasses of water now.

7 to 8: Very dehydrated

Darker, strong-smelling urine in small amounts can be a sign of dehydration.
Drink a large bottle of water immediately.


KIDNEY STONE CLINIC
"THIS, TOO, SHALL PASS."
JONNY HAWKINS
CARTOONSTOCK
Search ID: jhan1063


I am happy that
now you know
more about me!!!

Recommended Books

- Guyton & Hall
- Sherwood
- Sembalingum


That's all Folks!