Renal Blood flow and Glomerular filtration

Renal blood circulation :

- Kidneys Receive 22 % of the cardiac output (1.1-1.2 L)
- The renal artery →**segmental arteries →interlobar arteries, arcuate arteries, interlobular arteries and afferent arterioles** which form the glomerular capillaries.
- **Glomerular capillaries** are first capillary network where large amounts of fluid and solutes (except the plasma proteins) are filtered to begin urine formation.
- **Peritubular capillaries** :are second capillary network that surround the renal tubules. They are formed from the **efferent** arteriole which is the distal ends of the capillaries of each glomerulus .
- **Vasa recta**: is a specialized peritubular capillaries that extend downward into the medulla, lying side by side with the loops of Henle of the juxtamedullary nephrons. It has an essential role in the formation of concentrated urine.
- These capillaries empty into the venous system, which run parallel to the arterial vessels.

Special features of the renal circulation :

- It has two capillary beds, the glomerular and peritubular capillaries arranged in **series** and separated by the efferent arterioles.
- Adjusting the resistance of afferent or efferent arterioles can affect glomerular pressure and GFR .
- High hydrostatic pressure in the glomerular capillaries (60mmHg) causes rapid fluid filtration while slow flow and low hydrostatic pressure in the peritubular capillaries (8-10 mmHg) permits rapid fluid reabsorption
- Blood flow to the medulla is < cortex and the O2 requirements is high in the Medulla due to high metabolic rate particularly to reabsorb Na + in the thick ascending limb of Henle→↑ the susceptibility of renal medulla to hypoxic injury of the kidney.
- Kidney has **Autoregulation mechanism of renal blood flow**

Hormones and chemical factors control the renal blood flow:-

↓RBF :

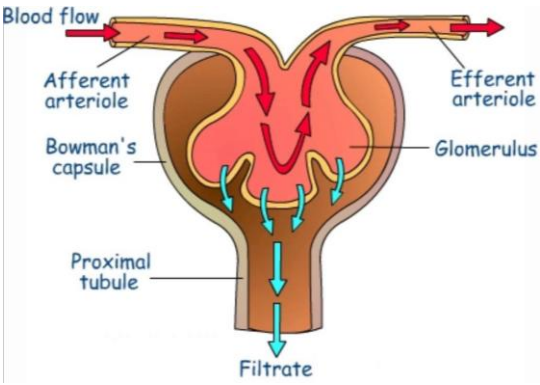
- Nor epinephrine ,epinephrine → constricts renal vessels mainly afferent arteriole →↓RBF
- Angiotensin II→ exerts a greater constrictor effect on the efferent arteriole more than the afferent arteriole →↓RBF .also (↑ glomerular hydrostatic pressure →↑GFR).
- Endothelin (a peptide that can be released by damage vascular endothelium of kidney and other tissue → constricts renal vessels →↓RBF

↑RBF:

- Dopamine →is made in the kidney and cause renal vasodilatations →↑RBF
- Prostaglandin PGE2 , PGI2→ ↑blood flow in the renal cortex
- Endothelial derived nitric oxide released by vascular endothelium ↑ RBF
- Acetylcholine causes vasodilation . ↑ RBF
- High protein diet ↑ RBF

Glomerular filteration :

Is the process by which the plasma filtrates in the glomeruli through the glomerular membrane.



- The filtered fluid (glomerular filtrate) is protein-free with no cellular elements. The concentrations of other constituents of the glomerular filtrate, including most salts and organic molecules, are similar to the concentrations in the plasma.(Isotonic)

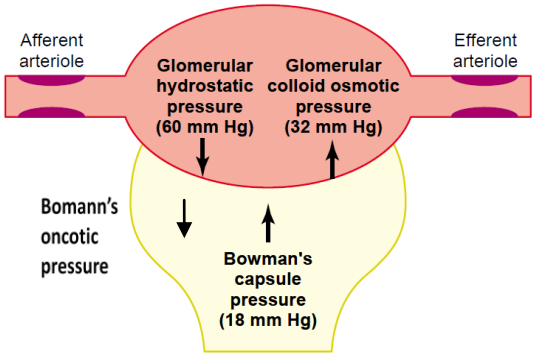
Factors affecting Glomerular filtration

1. **Filtration pressure** : determined by the hydrostatic and colloid osmotic forces across the glomerular membrane, These forces include :

   a) Glomerular hydrostatic pressure: hydrostatic pressure inside the glomerular capillaries which promotes filtration PG = 60mmhg

b) the hydrostatic pressure in Bowman's capsule which opposes filtration (PB=18 mmHg)
c) Colloid osmotic pressure of the glomerular capillary plasma proteins which opposes filtration (πG= 32 mmHg)
d) Colloid osmotic pressure of the proteins in Bowman's capsule (πB), which promotes filtration. (Under normal conditions, the concentration of protein in the glomerular filtrate is so low and considered zero.)

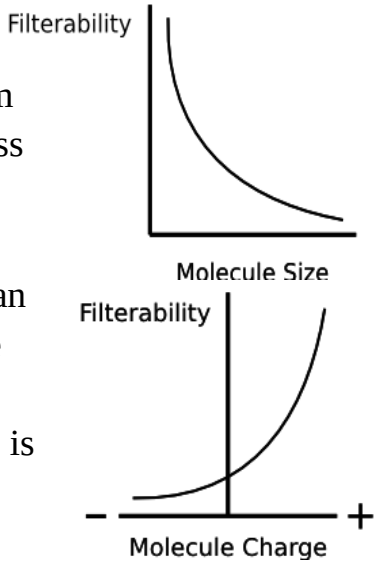
- The sum of the hydrostatic and colloid osmotic forces across the glomerular membrane gives the net filtration pressure.



Net pressure = outward pressure –inward pressure
=(PG + πB) – (PB + πG)
= PG -PB - πG
= 60 -18 -32 = 10 mmHg.

2. permeability of the capillary: depends on:

- size:
  - the pores of the glomeular membrane is about 8 nm
  - substances with diameter of 4 nm to < 8nm can pass freely & MW less than of (69000).
- Electrical charge:
  - filtration of –ve charged (anion) substance is < than +ve charged & neutral substance of the same size because basement have a –ve charge.(-ve charge substances repel each other) ex: albumin diameter is 6 nm but its filtration is very low



3. **Filtration surface area**: - It is the total size of the capillary bed available for filtration .it is affected by contraction of mesangial cells (↓S.A.)

Note :

- The product of the permeability and S.A gives the glomerular capillary filtration coefficient (Kf)
- In certain kidney diseases, the -ve charges on the basement membrane are lost→ albumin are filtered and appear in the urine, a condition known as proteinuria or albuminuria.