

Formation of Urine : Process of Glomerular Filtration

Learning Objective

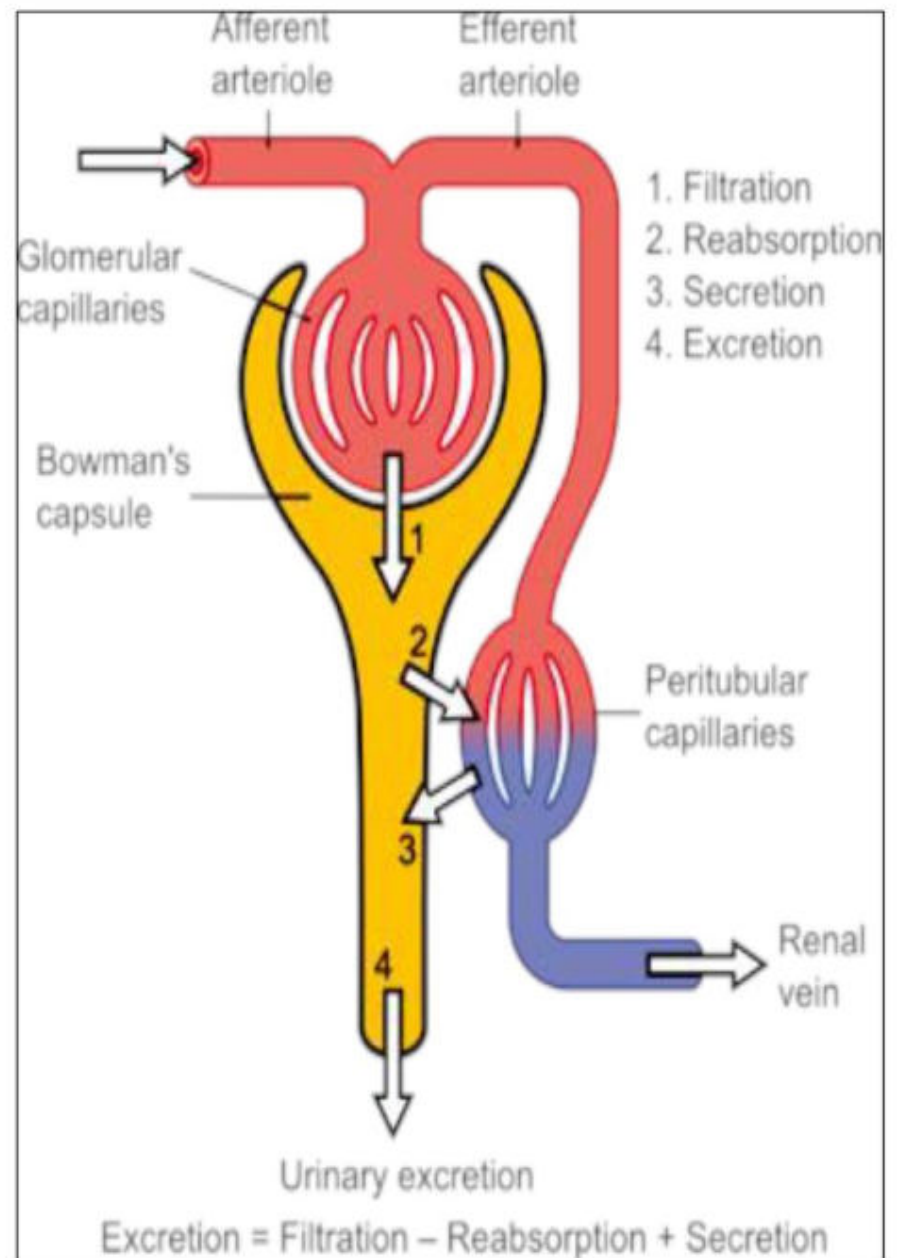
- To understand the function of the filtration membrane
- To define glomerular filtration rate, renal blood flow
- To measure glomerular filtration rate, renal blood flow

Basic Processes required for Formation of Urine

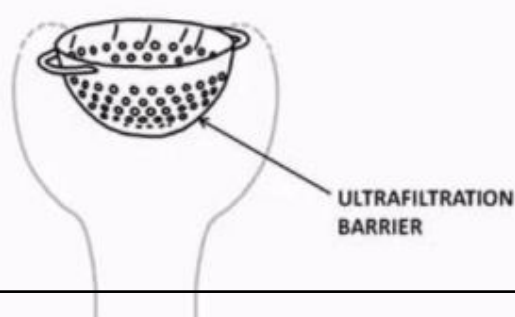
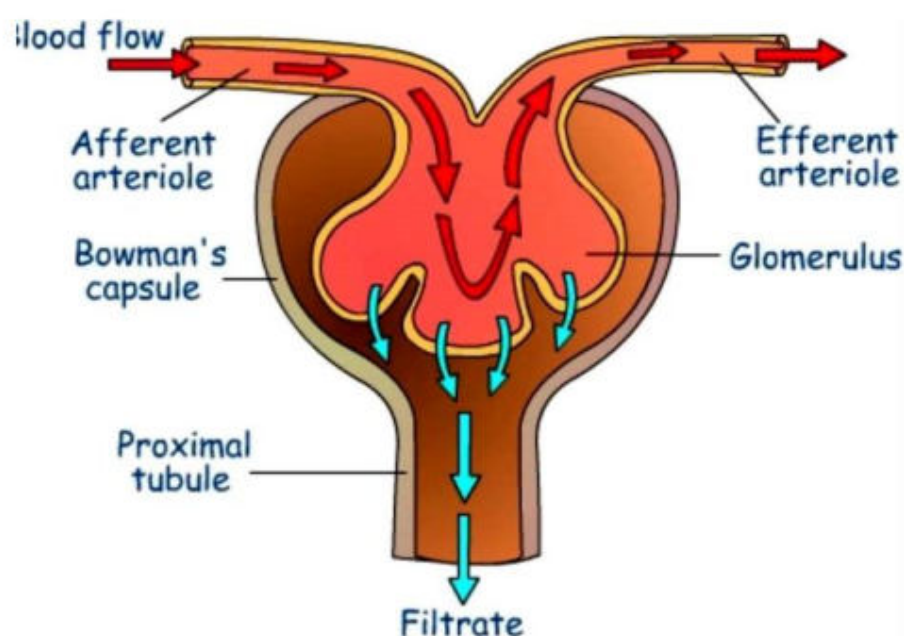
1. Glomerular filtration-

2. Tubular processing-
a. reabsorption &
b. secretion)

3. Urinary excretion-

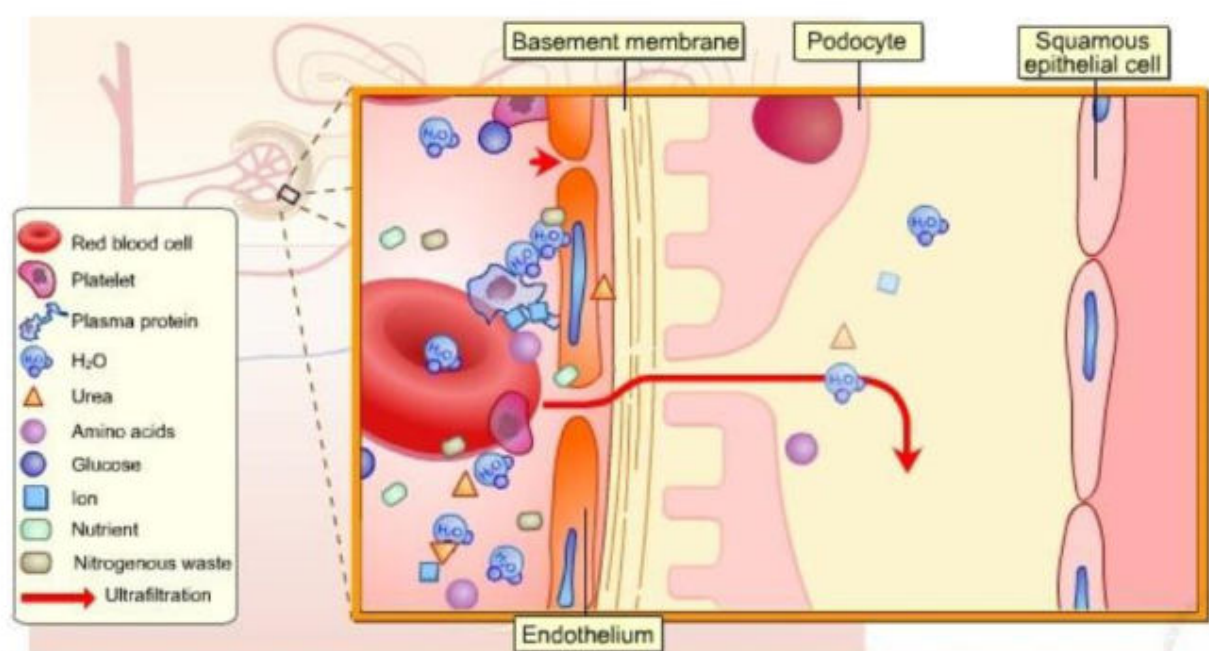


Site of filtration - Glomerulus



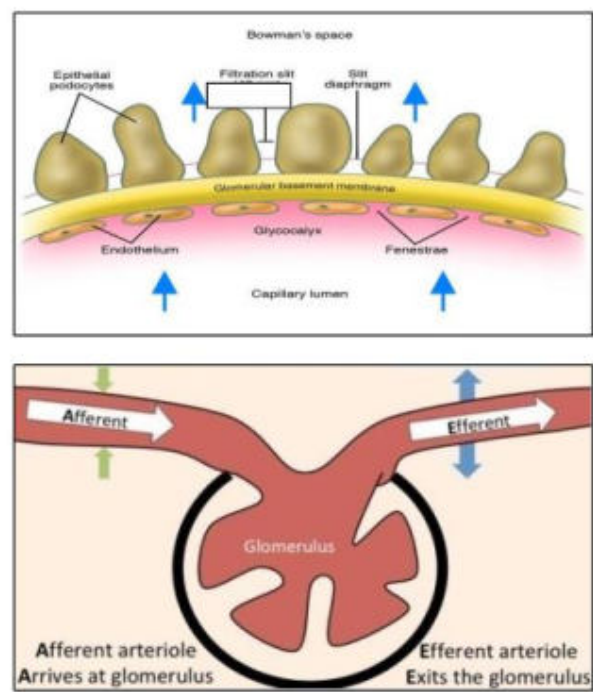
Physiology of Glomerular filtration

Glomerular filtrate



Glomerular ultrafiltrate-protein & cellular elements free blood

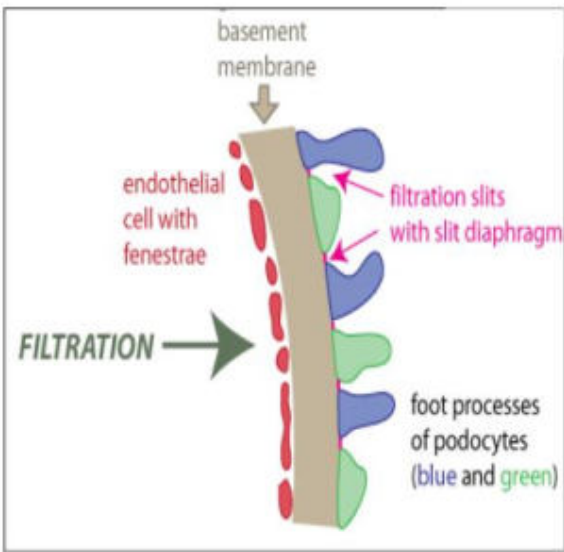
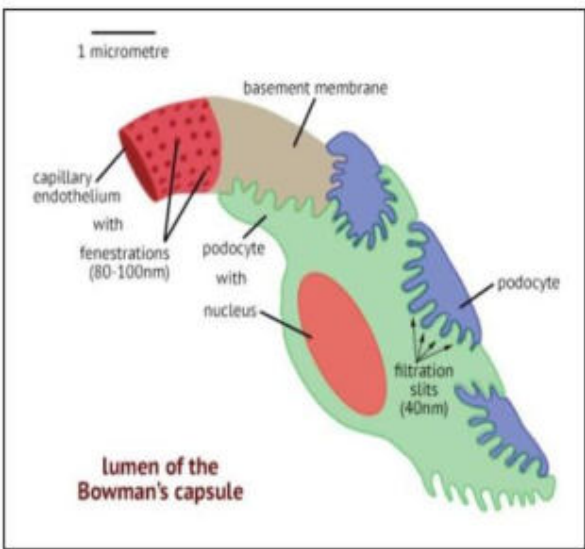
Important contributors:
1. Filtration Membrane (Barrier)
2. Unique pressure dynamics within the glomeruli



https://www.researchgate.net/publication/285735121_Regulation_of_renal_hemodynamics/figures?lo=1

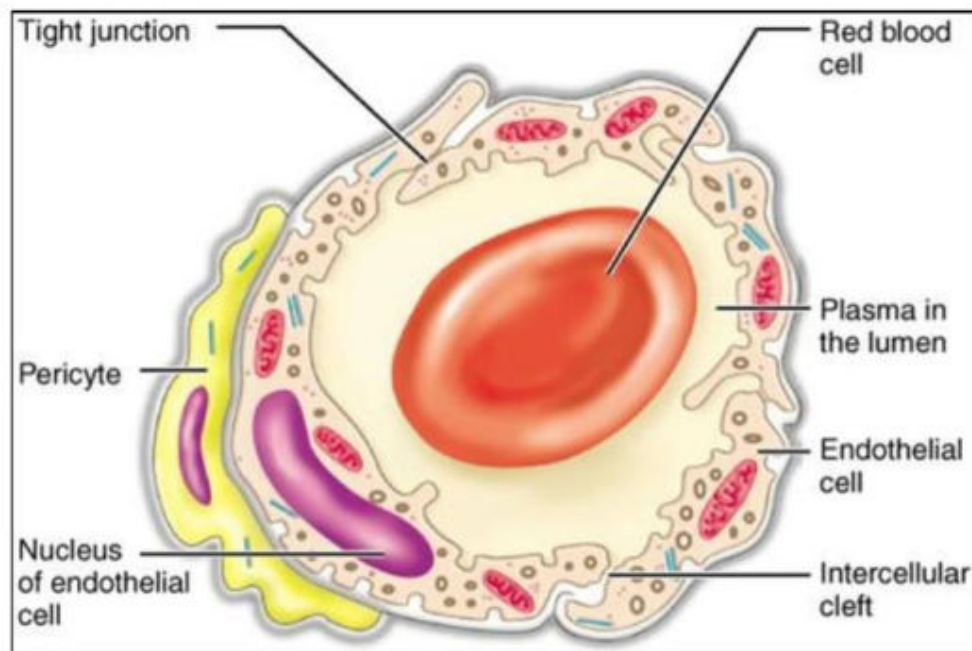
Glomerular Filtration Membrane / Barrier

- 1) Endothelial cells layer of the capillary,
- 2) Basement membrane and
- 3) Epithelial cells (podocytes) – surrounding outer surface of cp basement membrane.



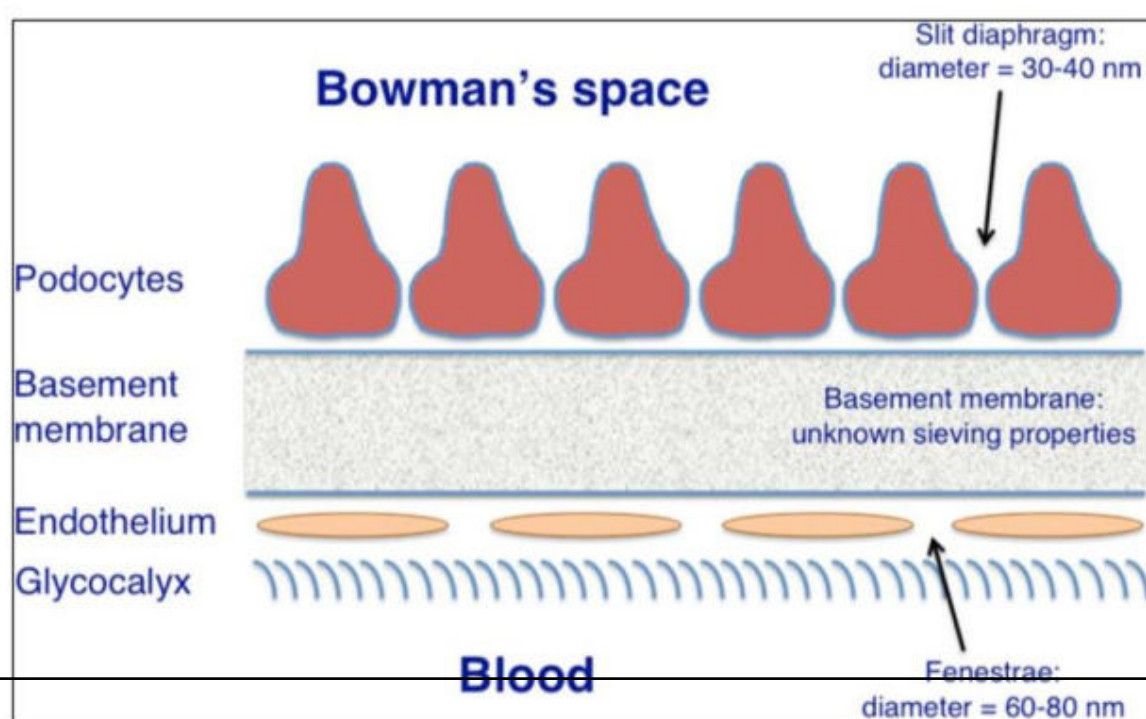
Glomerular Filtration Barrier – Cp Endothelial layer

- The capillary endothelium has thousands of small holes called **fenestrae**
- But loaded with negative charged glycoproteins



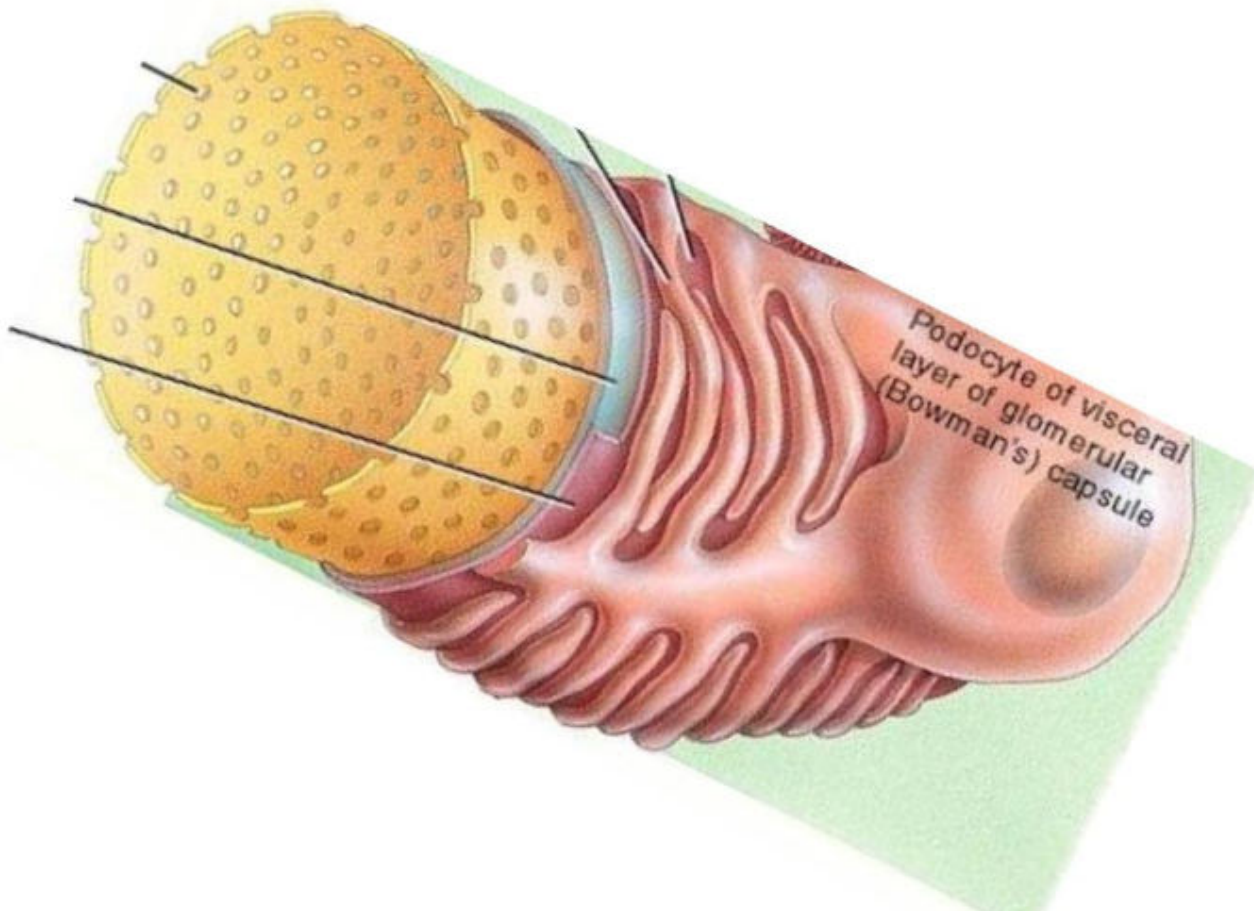
Glomerular Filtration Barrier - basement membrane

- The surrounding basement membrane - is a porous meshwork of proteins – contain type IV collagen and proteoglycan fibrillae.

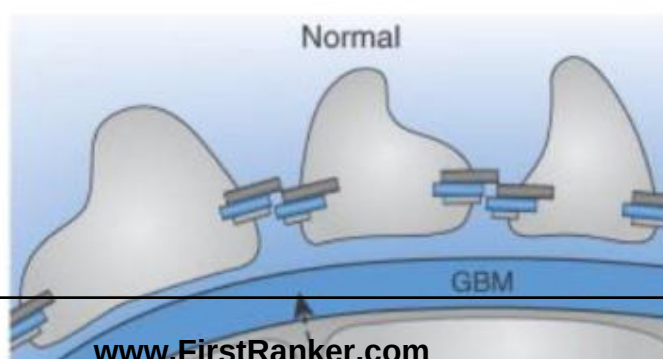
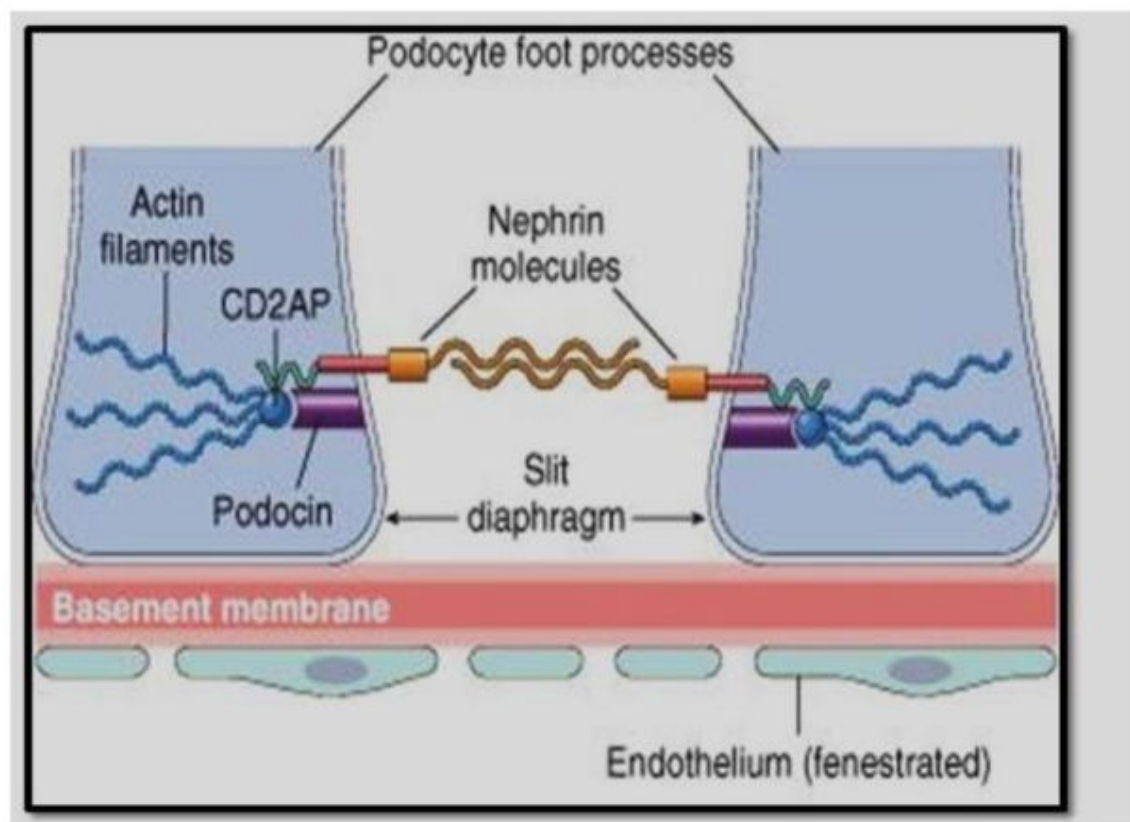


Glomerular Filtration Barrier– Podocytes Layer

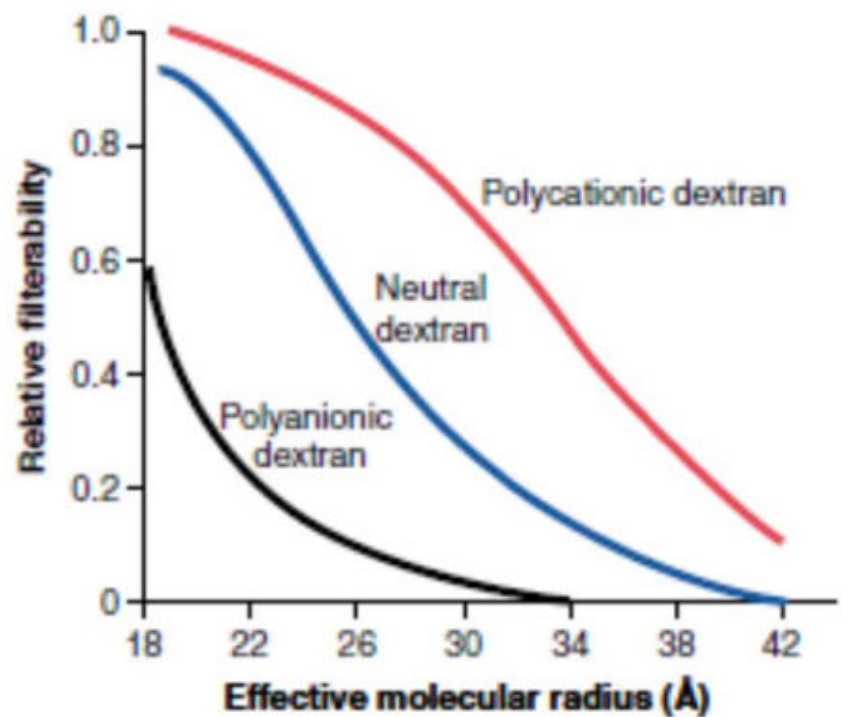
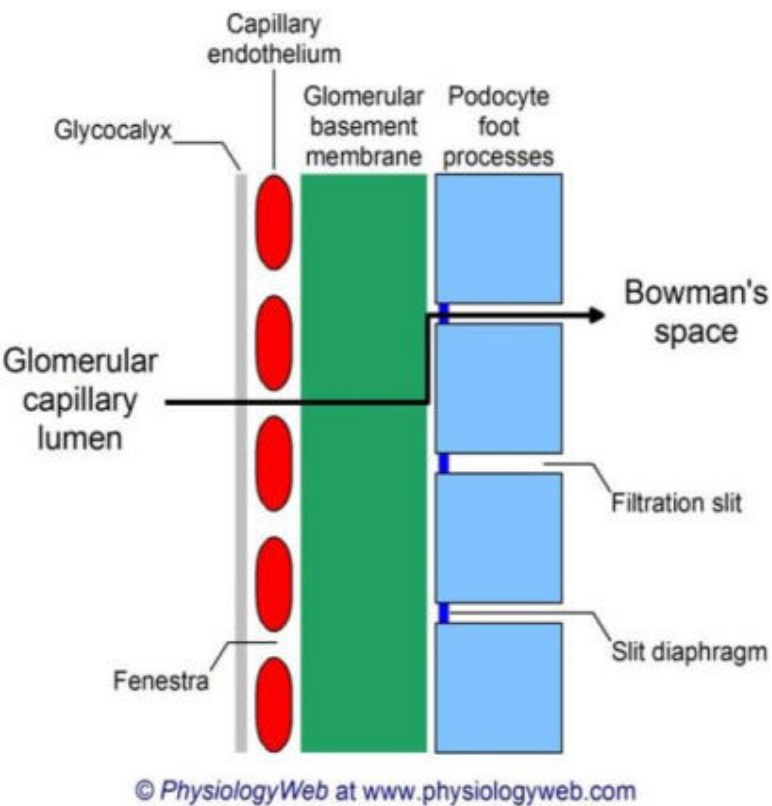
- The long finger like processes of the podocytes interdigitate to cover the basement membrane and are separated by apparent gaps called **filtration slits**.



Glomerular Filtration Barrier– Podocytes Layer



GFB restricts the filtration of substances on the basis of Size & Electrical charges

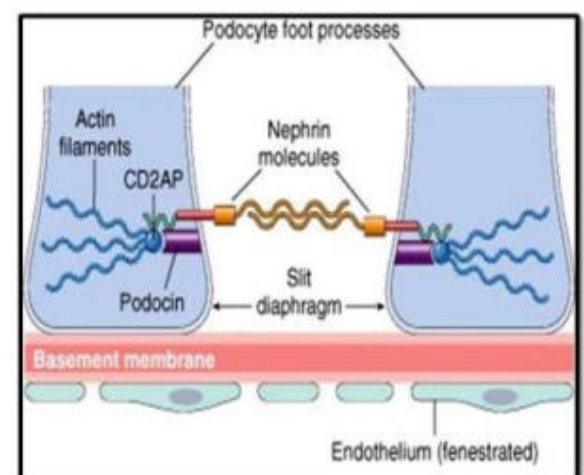


Applied - Kidney diseases (Nephropathies) and Filtration Barrier

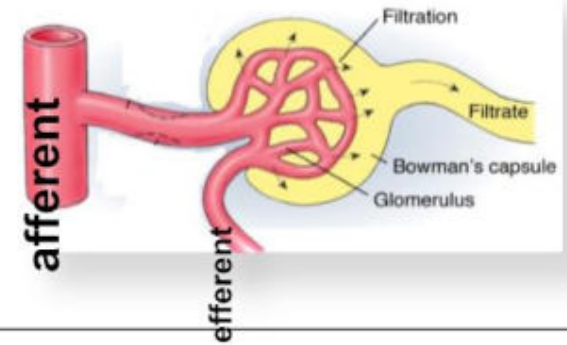
Nephrotic syndrome

Glomerulonephritis

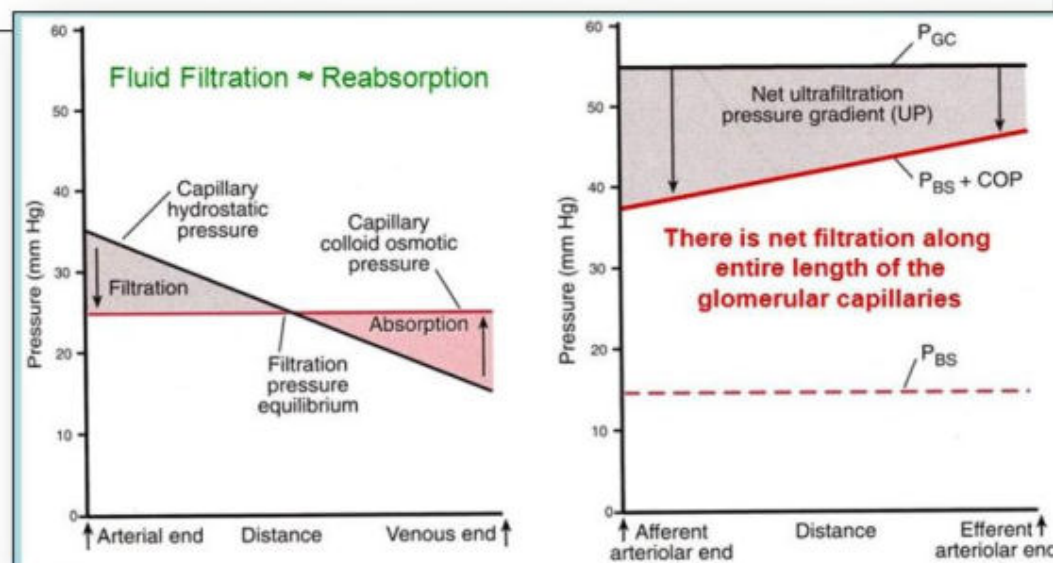
Hypertension



2. Unique pressure dynamics within the glomeruli

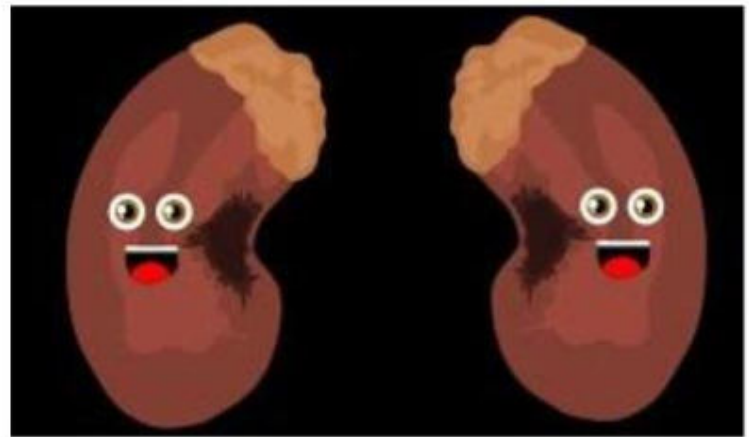
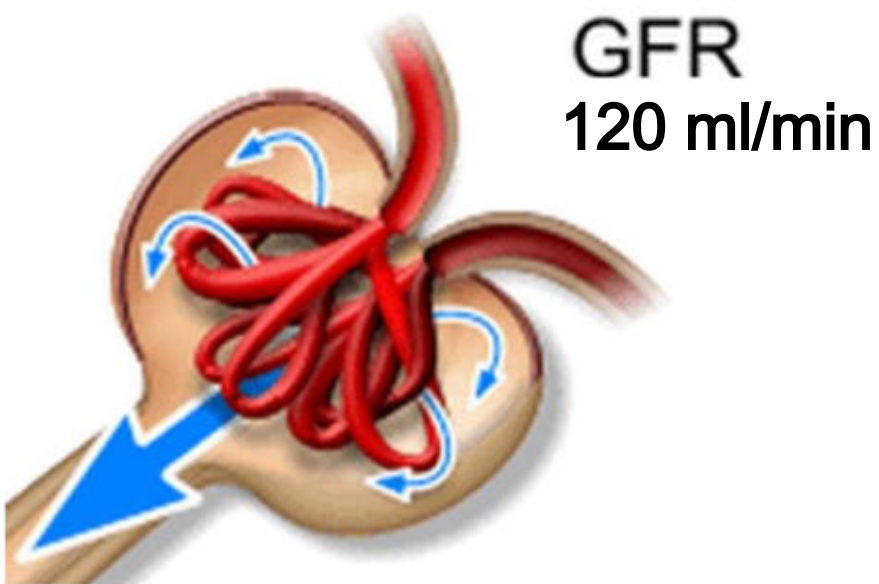


- Dia of afferent arteriole > efferent glom arteriole –
- Capillary bed between two arteries–



Glomerular Filtration Rate

Glomerular Filtration Rate



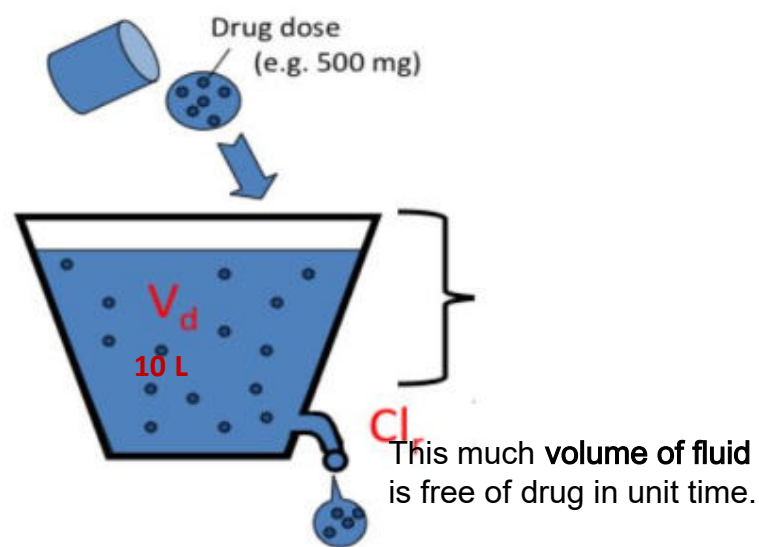
Renal Blood Flow

RBF
 ≈ 1100 ml/min,

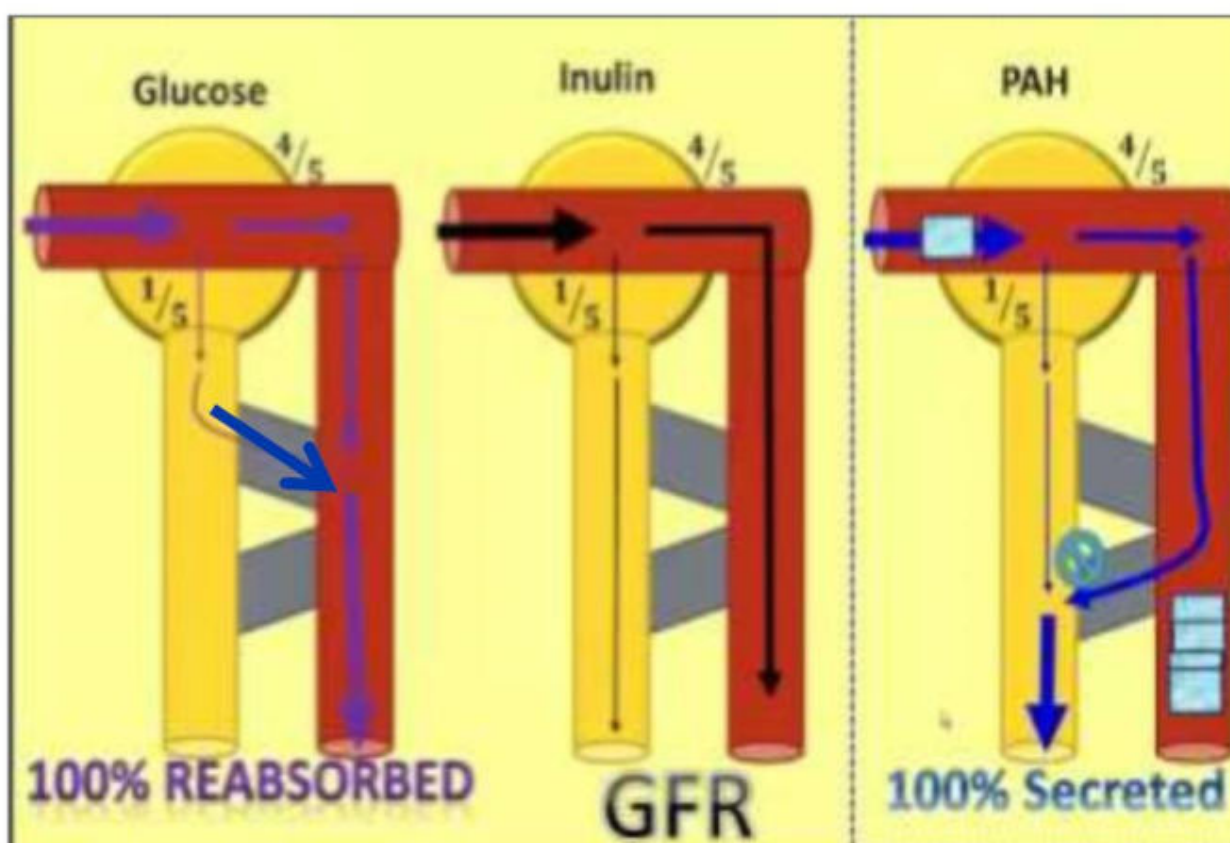
RBF is important as -

Renal Clearance/ Renal plasma clearance

Drug Clearance by the Kidney

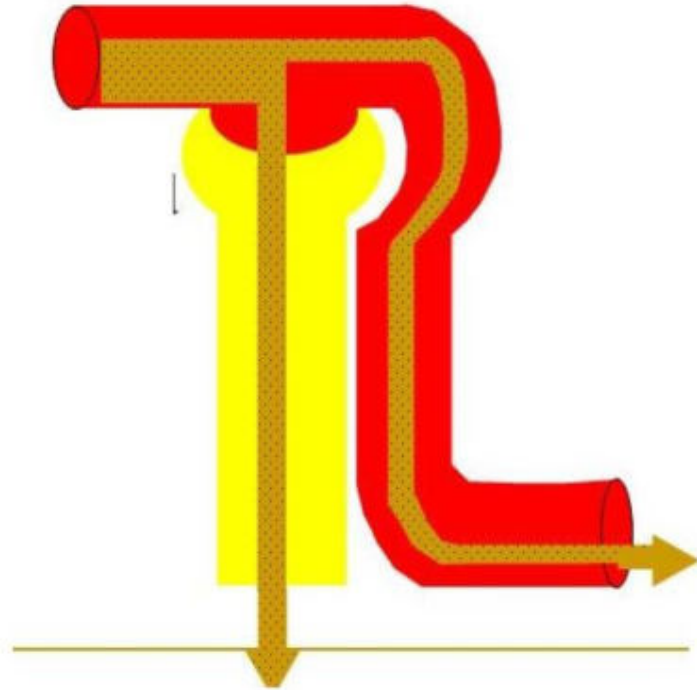


Relative clearances of substances



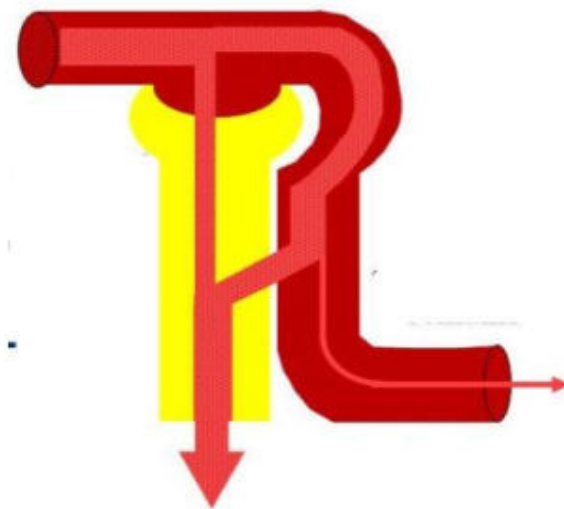
Estimation of GFR by Renal Plasma Clearance

GFR:
Substance: Inulin



Estimation of RBF by Renal Plasma Clearance

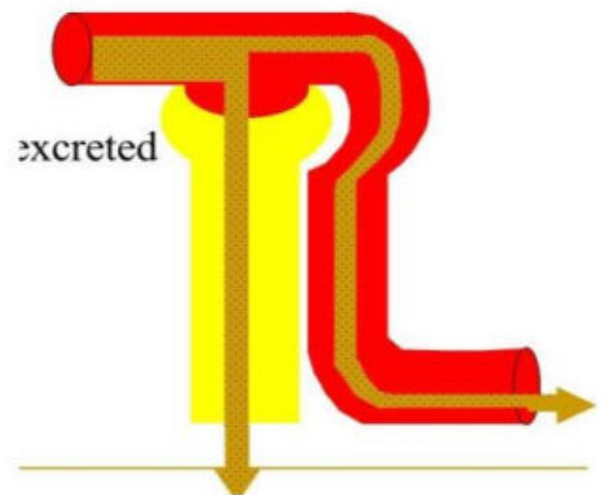
RBF:
Substance: PAHA



Estimation of GFR– Renal Plasma Clearance

GFR

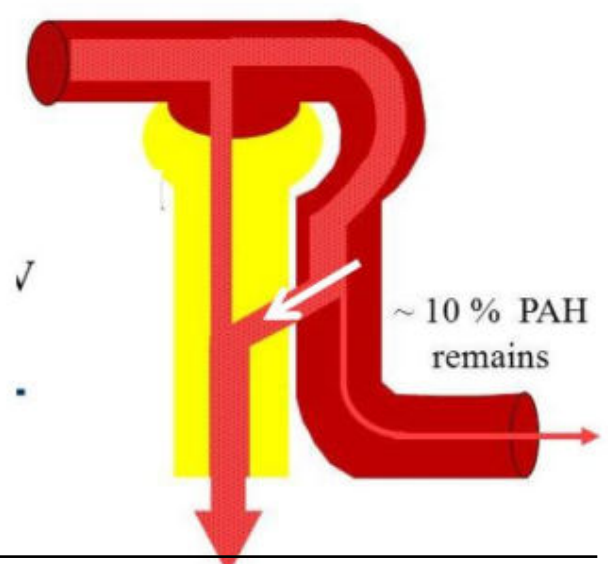
$$(C_{in}) = U_{in} \times V / P_{in}$$



Estimation of GFR and RBF – Renal Plasma Clearance

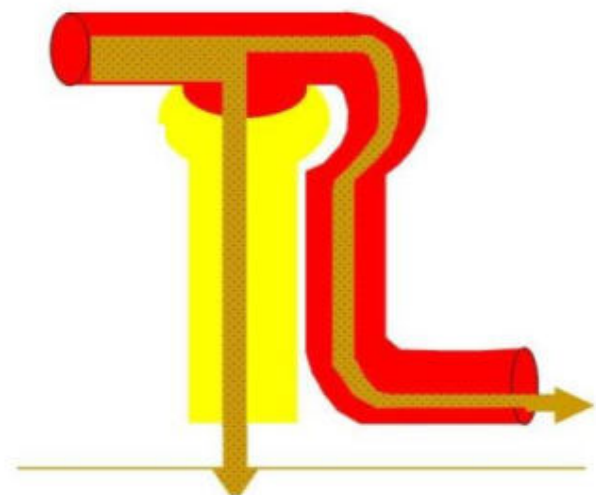
RBF:

$$RBF = RPF / 0.9 \text{ (1-hematocrit)}$$



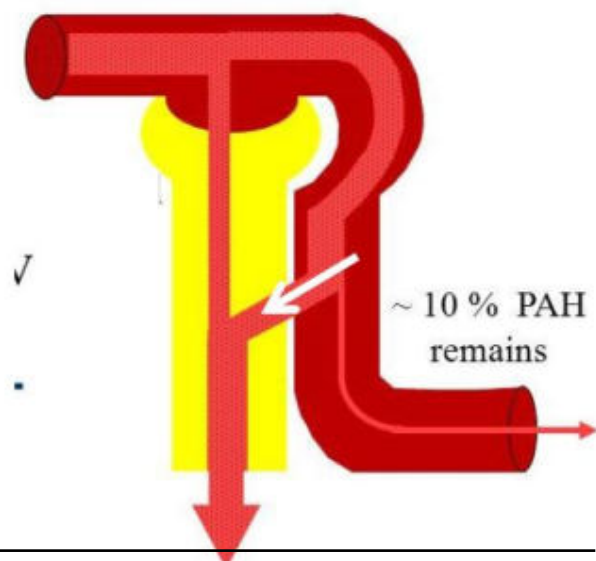
Estimation of GFR and RBF – Renal Plasma Clearance

Clinical problem – TO calculate GFR :



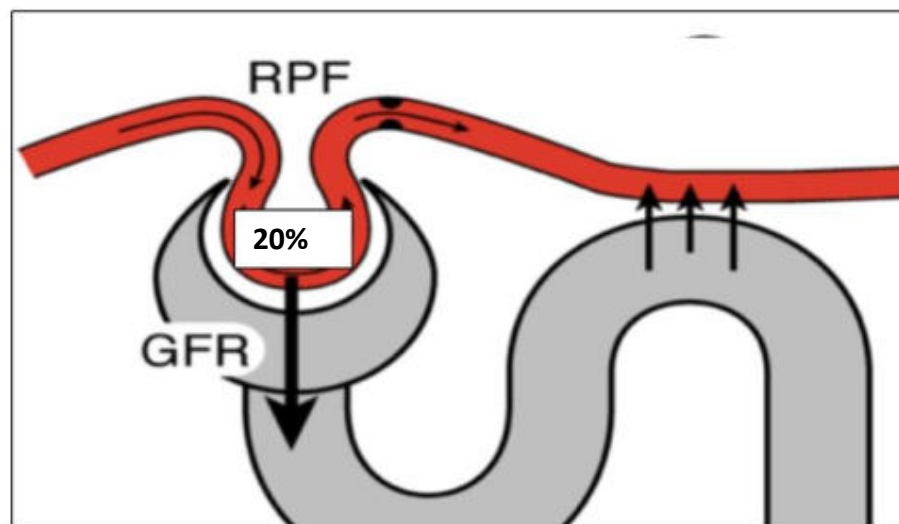
Estimation of GFR and RBF – Renal Plasma Clearance

Problem-RBF: Calculate RBF of a patient



Filtration Fraction

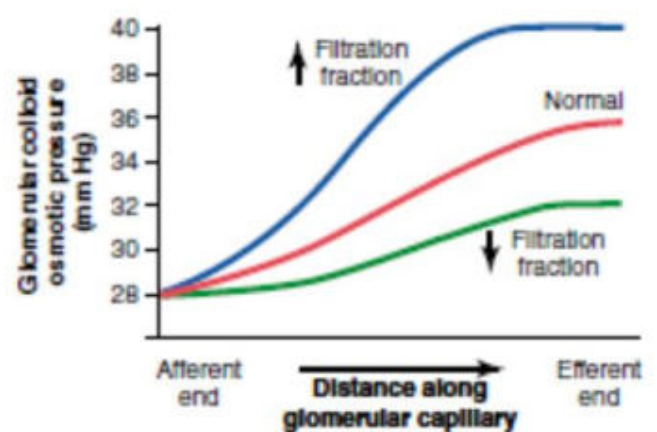
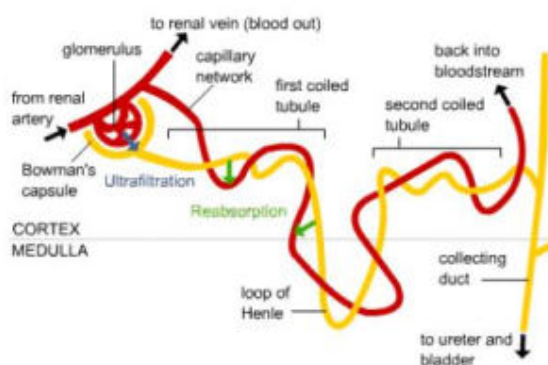
$$\text{Filtration Fraction} = \text{GFR/RPF} = 125/625 = 0.20$$



Filtration Fraction

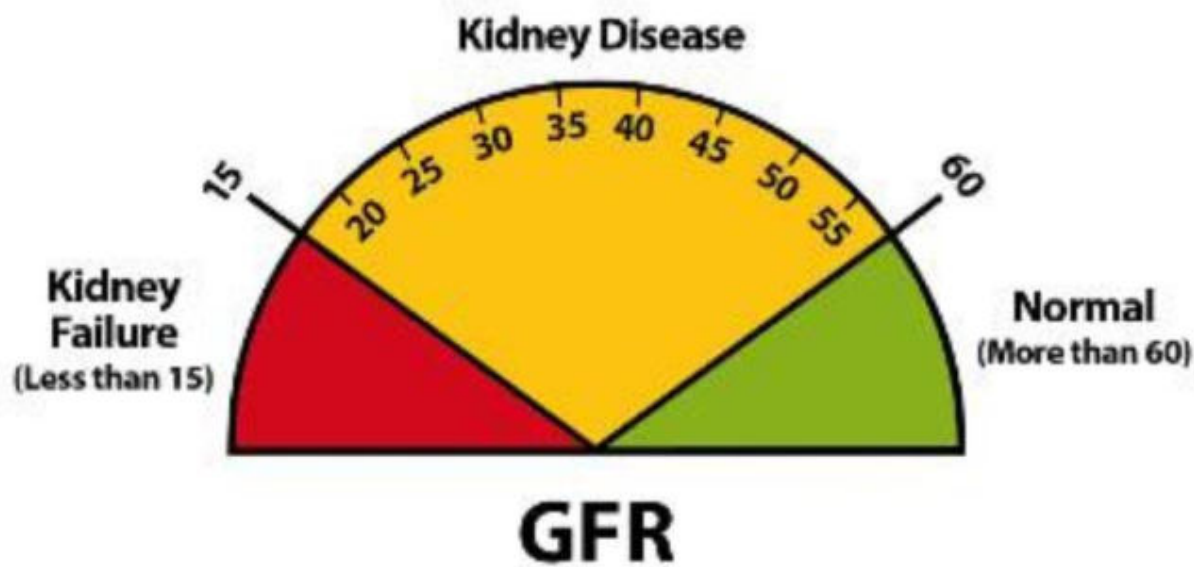
Increase in the filtration fraction -

Decrease in the filtration fraction -



Applied Physiology

Glomerular filtration rate (GFR) is an important clinical indicator of status of kidney function.



Applied Physiology

Serum Creatinine:
normal value =

Significant points in lecture

Filtration barrier, Slit diaphragm, disorder in nephrotic syndrome

Uniqueness of pressure dynamics in glomeruli

GFR, RBF

Substances of measurement and clearance

MCQ

renal clearance of a substance is the VOLUME OF PLASMA from which that substance is completely removed (cleared) per unit time. In that case following is a false statement:

- a) Renal clearance = GFR $\rightarrow$ when No net reabsorption, secretion
- b) Renal clearance = GFR $\rightarrow$ when No net reabsorption
- c) Renal clearance > GFR $\rightarrow$ Net secretion
- d) Renal clearance < GFR $\rightarrow$ Net reabsorption

If a normal person has a plasma creatinine level 1 mg/dl that later becomes 2 mg/dl, what happens to GFR?

Ans: 50% of the value of GFR at 1 mg/dl.

THANK YOU

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