SNS COLLEGE OF ALLIED HEALTH SCIENCES
SNS Kalvi Nagar, Coimbatore - 35
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DEPARTMENT : PHYSICIAN ASSISTANT

COURSE NAME : NEPHROLOGY

UNIT : GENITO URINARY SYSTEM

TOPIC : RENAL HEMODYNAMICS AND GLOMERULAR FILTRATION

RENAL HEMODYNAMICS

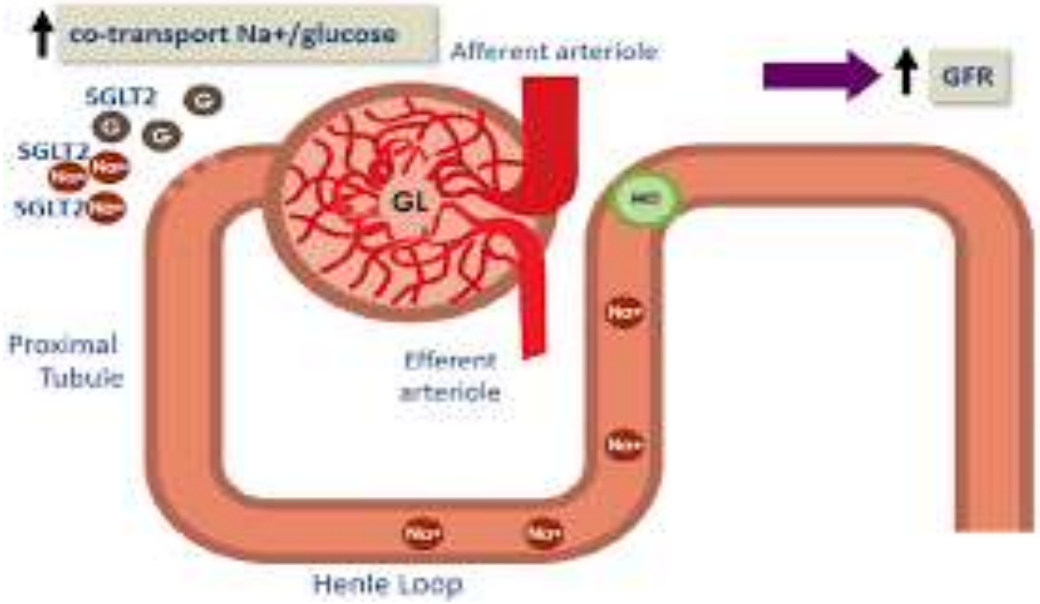
- Renal hemodynamics refers to the study of the blood flow dynamics within the kidneys, encompassing the intricate processes involved in the circulation of blood through the renal vasculature and the regulation of blood flow to maintain optimal kidney function

Renal Blood Flow (RBF):

- RBF refers to the volume of blood passing through the kidneys per unit of time. It is crucial for maintaining renal function and filtration.

- Normal RBF is approximately 1 L/min, which constitutes about 20-25% of cardiac output.

- The kidneys receive blood via the renal arteries, which branch into smaller vessels, ultimately leading to the glomerular capillaries.


co-transport Na+/glucose
Afferent arteriole
GFR
SGLT2
SGLT2
SGLT2
GL
Proximal Tubule
Efferent arteriole
Henle Loop

Renal Vasculature:

- The renal arteries branch into segmental arteries, interlobar arteries, arcuate arteries, and then into afferent arterioles.

- Afferent arterioles lead to the glomeruli, where filtration occurs. Efferent arterioles exit the glomeruli, leading to the peritubular capillaries.

Glomerular Hemodynamics:

- Glomerular filtration occurs in the renal corpuscles, comprising the glomerulus and Bowman's capsule.
- The glomerular capillaries have a high hydrostatic pressure due to the diameter of the afferent arteriole being larger than that of the efferent arteriole.
- This pressure gradient drives filtration of plasma components into Bowman's capsule.

Glomerular Filtration Rate (GFR):

- GFR is the volume of filtrate formed by all the glomeruli in both kidneys per unit of time. It is a crucial indicator of renal function.
- The average GFR in healthy individuals is approximately 125 mL/min or 180 L/day.
- GFR is regulated by renal autoregulation mechanisms, neural control, and hormonal factors.

Renal Autoregulation:

- Renal autoregulation ensures stable GFR despite changes in systemic blood pressure.
- Myogenic mechanism: Contraction or relaxation of afferent arteriolar smooth muscle in response to changes in perfusion pressure helps maintain stable GFR.
- Tubuloglomerular feedback: Macula densa cells in the distal tubule sense changes in tubular fluid composition and adjust arteriolar resistance.

Neural Regulation:

- Sympathetic nervous system activation causes vasoconstriction of renal arterioles, reducing RBF and GFR.

- Parasympathetic input to the kidneys is minimal but may modulate renal blood flow under certain conditions.

Hormonal Regulation:

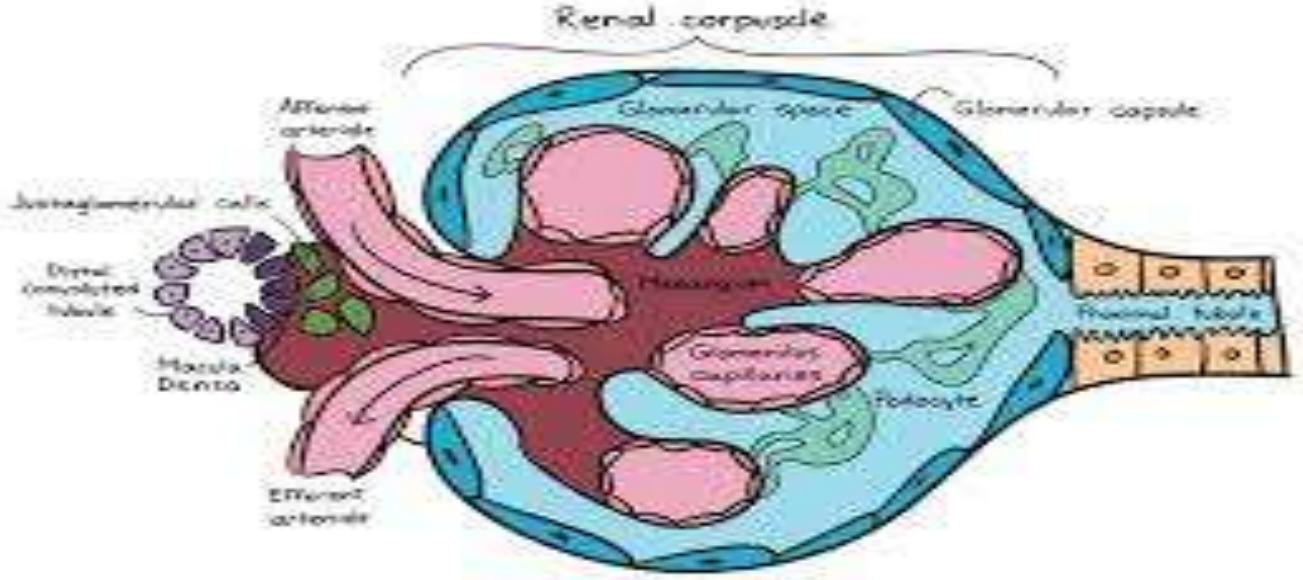
- Renin-angiotensin-aldosterone system (RAAS) plays a crucial role in regulating renal hemodynamics.
- Angiotensin II causes vasoconstriction of both afferent and efferent arterioles, thereby modulating GFR.
- Aldosterone promotes sodium reabsorption in the distal tubule and collecting ducts, indirectly influencing renal blood flow.

Intrarenal Factors:

- Various local factors within the kidney, such as prostaglandins, nitric oxide, and endothelin, regulate renal blood flow and GFR.
- These factors interact with systemic regulatory mechanisms to maintain renal function under diverse physiological conditions.

GLOMERULAR FILTRATION

- Glomerular filtration is the first step in making urine. It is the process that your kidneys use to filter excess fluid and waste products out of the blood into the urine collecting tubules of the kidney, so they may be eliminated from your body.


Renal corpuscle
Afferent arteriole
Glomerular space
Glomerular capsule
Juxtaglomerular cells
Distal convoluted tubule
Macula Densa
Glomerular capillaries
Podocyte
Efferent arteriole

Filtration Barrier:

- The glomerular filtration barrier comprises three layers: endothelial cells, basement membrane, and podocytes (visceral layer of Bowman's capsule).
- Podocyte foot processes create filtration slits, preventing the passage of large proteins while allowing smaller molecules to pass.

Filtration Forces:

- Filtration across the glomerular membrane is governed by Starling forces: hydrostatic pressure (glomerular capillary pressure) and oncotic pressure (plasma colloid osmotic pressure).

- Net filtration pressure (NFP) determines the direction and rate of filtration: NFP = (P_gc + π_bc) - (P_bs + π_gc), where P_gc is glomerular capillary pressure, π_bc is Bowman's capsule oncotic pressure, P_bs is Bowman's space pressure, and π_gc is glomerular capillary oncotic pressure.

Filtration Fraction:

- Filtration fraction (FF) is the ratio of GFR to renal plasma flow (RPF).
- FF = GFR / RPF
- Normally, FF is about 20%, indicating that about one-fifth of plasma reaching the glomerulus is filtered.

Regulation of Glomerular Filtration:

- GFR is tightly regulated to maintain body fluid and electrolyte balance.
- Autoregulation, neural influences, and hormonal factors, such as angiotensin II and prostaglandins, modulate afferent and efferent arteriolar tone, thereby influencing GFR.

Measurement of GFR:

- GFR can be estimated using various methods, including clearance of endogenous substances like creatinine or exogenous markers such as inulin or radiocontrast agents.
- Clearance techniques involve measuring the rate at which a substance is removed from the blood by the kidneys.

ASSESSMENT

- What is Renal Hemodynamics ?
- What is Glomerular Filtration ?