



ALAYEN IRAQI
UNIVERSITY
AUIQ



COLLEGE OF DENTISTRY

الفرع العلمي: العلوم الاساسية

المادة: General Physiology

المحاضرة: Renal physiology or Urinary system

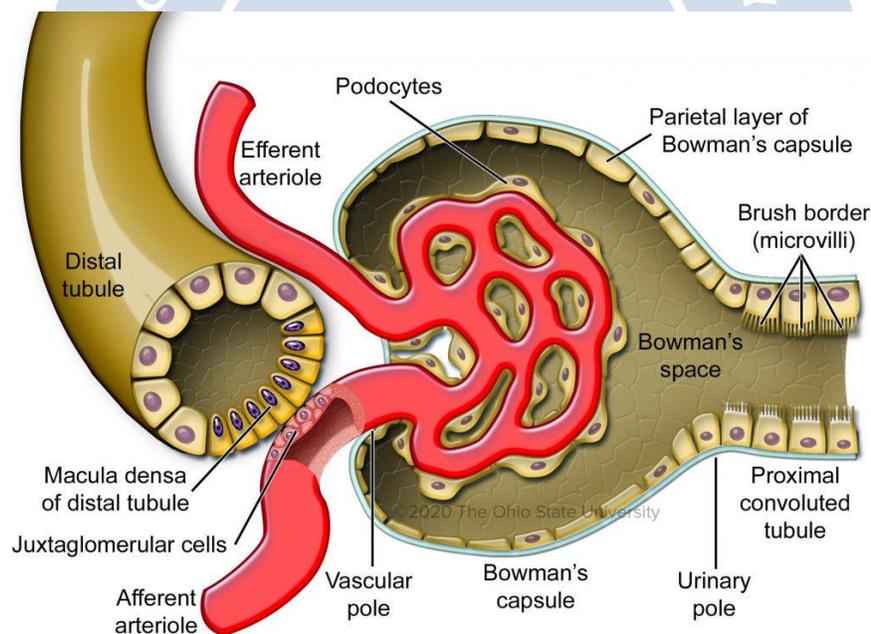
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اسم تدريسي المادة: أ.د. زينب إبراهيم محمد

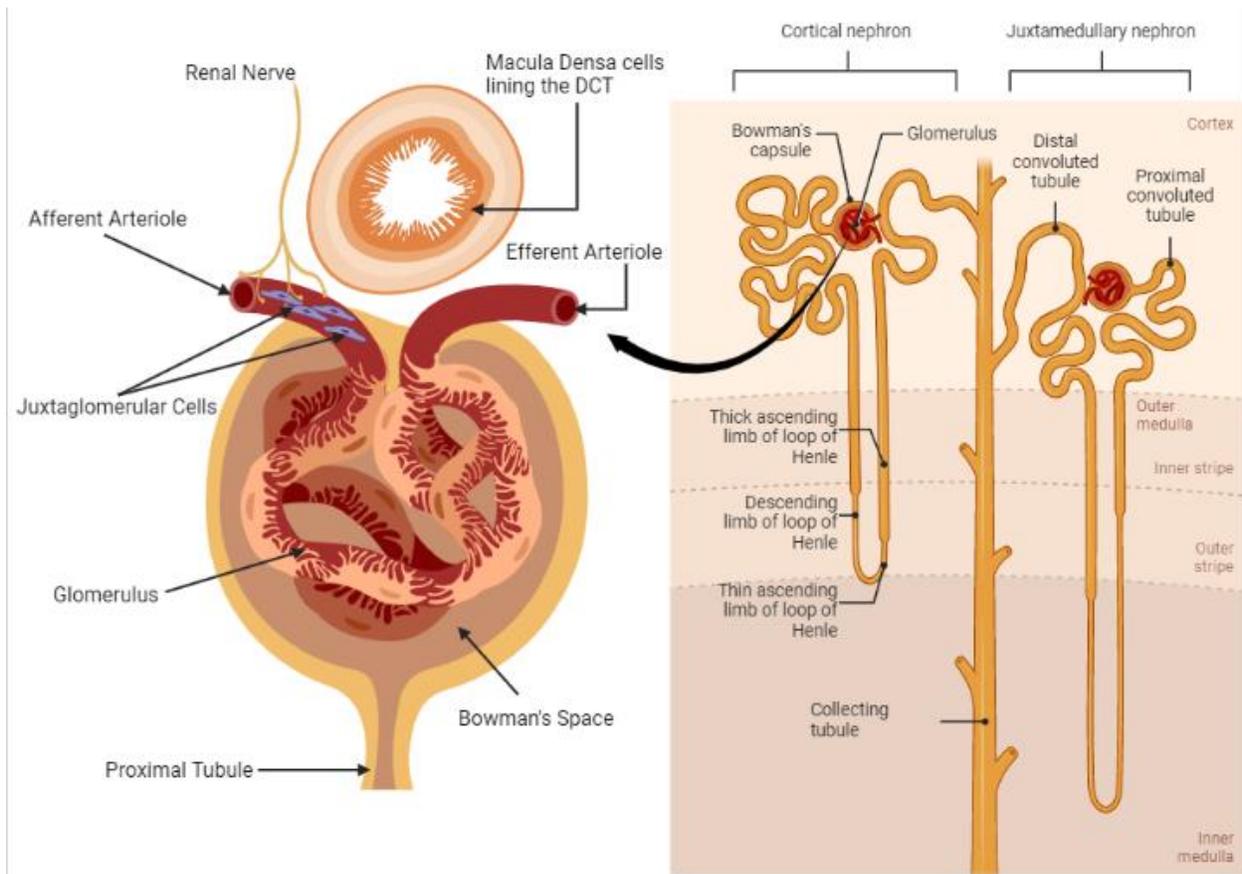
Juxta glomerular apparatus:

In each nephron, the ascending limb of loop of Henle makes contact with the afferent arteriole of its own renal corpuscle. The cells of the renal tubule in this region are tall and crowded together and that part is known as macula densa.

The wall of afferent arteriole contains modified smooth muscle fibers of tunica media, called Juxtaglomerular cells. The granules in the Juxtaglomerular cells store renin. Between the afferent and efferent arterioles in this area are present Lacis cells, Juxtaglomerular cells, Lacis cells and macula densa together constitute Juxtaglomerular apparatus.



The renin enzyme converts the inactive form of Angiotensinogen (a protein synthesized in liver) to Angiotensin I hormone in which is converted to Angiotensin II by convertase enzyme in the blood.



Functions of Angiotensin II are:-

A-Short term:

1. its a potent vasoconstrictive agent due to increasing Blood Pressure(BP).
2. it also activate the heart which results in increasing the Cardiac Output(CO).

B. Long term:

1. stimulate secretion of Antidiuretic Hormone(ADH) from the Pituitary gland.
2. stimulate secretion of Aldosterone from the Adrenal cortex which regulate the sodium level in the blood.(Aldosterone stimulate reabsorption of Na^+ ions & water excretion in urine).

Glomerular filtration rate:

GFR is the amount of filtrate produced by the kidney each minute.(each kidney contains about 6m^2 of filtration surface), GFR averages 125ml/min.

*The creatinine clearance test is used to estimate the GFR. Creatinine, which result from the break-down of creatinine phosphate in muscle tissue & its normally excreted in the urine, creatinine enters the filtrate at the glomerulus & not reabsorbed in significant amounts. (by monitoring the amount in blood and amount in urine we can easily estimate GFR).

The factors influencing GFR:

1-Net filtration pressure: filtration across the glomerular membrane depends on three main pressure, one that promotes filtration and two that oppose filtration.

a-Glomerular blood hydrostatic pressure(GBHP): this pressure promotes filtration. hydrostatic pressure is the force that a fluid under pressure exerts against the walls of its container.

b- Capsular hydrostatic pressure(CHP): opposes the filtration.

c-Blood colloid osmotic pressure(BCOP): opposes filtration. Osmotic pressure is the pressure required to prevent the net movement of water in to a solution containing solutes when the solutions are separated by a semi-permeable membrane like plasma membrane.

2-Permeability of the glomerular membrane:

Permeability of the glomerular capillary is 50 times that of other capillaries. The glomerular membrane restricts the filtration of molecules on the basis of their size and charge.

3-Surface area of the filtering membrane:

Effective area available for filtration is decreased when mesangial cells contract by the action of angiotensin II and thromboxane A_2 .

4-Age: After the age of 30, there is a progressive decline in GFR but this does not affect the excretory function of kidney.

Three interacting levels of control stabilize your GFR:

- *Auto regulation at the local level.
- *Hormonal regulation initiated by the kidney.
- *Autonomic regulation by sympathetic division of ANS.

Hormonal regulation of GFR:

GFR is regulated by hormones: renin & atrial natriuretic peptide (ANP).

► Renin is an enzyme released by JGA when:

- glomerular BP drops
- osmolarity of the tubular fluid at the DCT ↓es

Renin & Angiotensin II have four effects:

- it stimulate the adrenal production of Aldosterone causing Na⁺ retention & K⁺ loss at the kidney.
- it stimulate the secretion of ADH → stimulate water reabsorption.
- it stimulate thirst resulting in ↑es fluid consumption → elevation of blood volume.
- it stimulate the contraction of arterioles → elevates systemic BP.

Atrial natriuretic peptide:

this hormone is secreted endocrine cells (cardiac muscle cells) in the walls of the atria when:

*blood volume (venous blood received) becomes too great so these cardiac muscles excessively stretch & release the hormone ANP.

*(ANP is released in response to the stretching of the atrial walls by \uparrow es BP or blood volume (BV)).

*(ANP due to \rightarrow dilation of afferent arteriole & constriction of efferent arteriole \rightarrow elevates glomerular BP & \uparrow es GFR \rightarrow \uparrow es urine production and \downarrow es BV & BP.

Tubular Reabsorption:

As the filtrate passes through the renal tubules, **about 99% of it is reabsorbed and only 1% leaves the body as urine.** **Solutes are reabsorbed by active and passive processes.** Water accompanies solute reabsorption by osmosis. Small proteins and peptide hormones are reabsorbed by endocytosis.

Renal of reabsorption is maximal in the proximal tubule because of large surface area due to the presence of microvilli. Proximal tubule reabsorbs 100% of glucose and amino acid, 80-90% of HCO_3^- , 65% of water, Na^+ and K^+ , 50% of Cl^- and urea.

Formation of urine

Urine is formed in three steps:

- 1- **Filtration:** Blood enters the afferent arteriole and flows in to the glomerulus. Blood in **the glomerulus has both filterable blood components and non-filterable blood components.** **filterable blood components move toward the inside of the glomerulus while non- filterable blood components pass the filtration process by exiting through the effect arteriole.** **filterable blood components are water, nitrogenous waste, nutrients and salts.** **Non- filterable blood components include formed elements such as blood cells and plasma proteins.**

- 2- **Reabsorption:** within the peritubular capillary network, molecules and ions are reabsorbed back in to the blood. Sodium chloride reabsorbed in to the system increases the osmolarity of blood in comparison to the glomerulus filtrate. This reabsorption allows water to pass from the glomerular filtrate back in to the circulatory system. Glucose and various amino acids also are reabsorbed in to the circulatory system.
- 3- **Secretion:** Some substances are removed from blood through the peritubular capillary network in to the distal convoluted tubule or collecting duct. These substances are hydrogen ions, creatinine and drugs. Urine is a collection of substances that have not been reabsorbed during glomerular filtration or tubular secretion.

