اليوم : الخميس بسم الله الرحمن الرحيم التاريخ : 7-2-2019

تبييض فسيولوجي المحاضرة: 2 renal physiology

The topic from this lecture :
- to complete what we have previously talked about and to talk about urine formation .

* Let's go back to the structure of the nephron :
  - Loop of henle is twisted in a way that it meets the efferent and afferent arteriole of the **same** nephron .

JGA :

- The point where efferent & afferent arterioles meet with a part of the distal convoluted tubule .
- This specific part of the kidney "**changes**" and adapts to different situations , it has :
  1. a type of cells called "**Macula densa cell**" (in distal convoluted tubule) .
  2. special cells that has *renin enzyme* (in wall of afferent arteriole) .

* NOTE : Macula densa ⟶ it's measures and senses the Na ions concentration in the filtrate .

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* **Renin enzyme** : it's secreted from the wall of the afferent arteriole that's in contact with (**JGA**) or close to distal convoluted tubule specifically .

* **Angiotensinogen :** it's a hormone secreted from the **liver** .
  NOTE : it's name is derived from : Angio- = blood vessel .
  -tensin = vaso contraction (tension) .

- So we can see that it's going to rise the blood pressure .
- It's converted into (**Angiotensin I**) by the renin enzyme which is secreted from the kidney .

Angiotensinogen —renin→ **Angiotensin I**

* that's what we call the **renin-angiotensin system** (**RAS**) .

* When the blood supply to the kidney get low (blood pressure is low) → that system is gonna be avtivated to take it back to normal level → to get rid of toxics .

- **Angiotensin I** is gonna to be converted to **Angiotensin II** by an enzyme secreted from lungs , called (**angiotensin converting enzyme "ACE"**) .
NOTE : **ACE** → It's the enzyme secreted from lung .

Angiotensin I —ACE→ **Angiotensin II**

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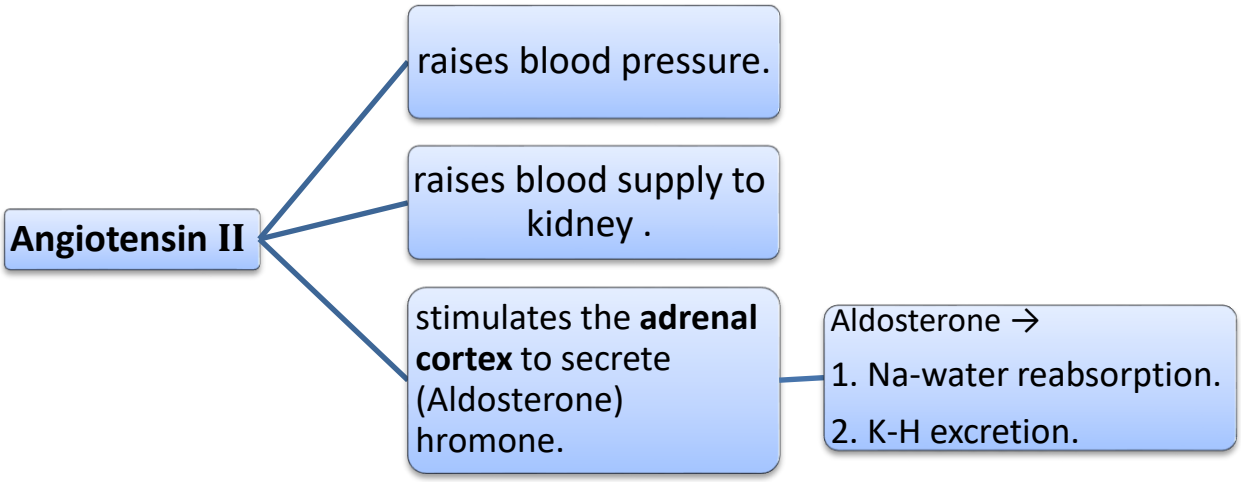
* Neither ***renin*** nor ***angiotensinogen*** are gonna cause the raise of blood pressure , **Angiotensin II** is the one responsible for that → it's aim is the blood vessel → **vasoconstriction** → raise blood pressure .

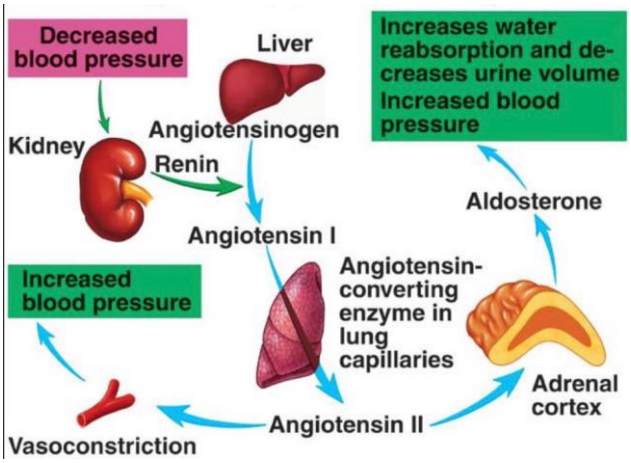


Angiotensinogen —renin→ **Angiotensin I** —ACE→ **Angiotensin II** —**→ **Aldosterone**

(hormone excreted from liver) (hormone excreted from adrenal cortex)

NOTE !!!!!

** Angiotensin II *stimulate* the adrenal cortex to secrete Aldosterone .



(((Renin-Angiotensin-Aldosterone system)))

Function of the kidney :

- **preserving blood volume :** if it get low , its gonna to increase water reabsorption , but if it gets high it's gonna increase urine excretion .
- **preserving ion concentration (Na ,K,Ca and P)** .
- **Acid-base balance :** by excreation of hydrogen ions or absorbing bi carbonate .
- **sectetory function :** as : renin , erythropoirtin and active form of vit. D .

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* the renin raises the blood pressure or goes to sympathetic (autonomic) nervous system .
Which makes us fright or fight so adrenalin excreted to stimulate renin .

- stimulus to secrete renin :
1) stess . 2) ischemia . (نقص وصول الدم للكلية)

NOTE !!!
Erythropoietin : hormone which synthesize the RBCs . (secreted from kidney) .
" erythro = RBC \\ Poietin = synthesis " .

KIDNEY AND VIT. D :

Vitamin D (inactive form)

↓ 25-hydroxylase (excreted from liver)

25-hydroxycholecalciferol

↓ 1-alpha hydroxylase (excreted from kidneys)

1,25-dihydroxycholecalciferol (active form)

URINE FORMATION :

1) **Glomerular filtration** ⟶ the filtrate passes through distal , proximal convoluted tubules and loop of henle .
2) **Reabsorption** ⟶ (mainly for water , sodium and good nutrients).
3) **secretion** ⟶ the molecules that escaped from filtration are gonna be secreted from peri-tubular capillaries to renal tubules "*tubular secretion*" .

*** Glomerular filtration** ⟶ fluid that are filtered by all the nephrons in both kidneys per minute (**GFR**) .

** The volume of blood = 6 liter .

**The kidney filters 180 liters\day , which means that blood gets filtered 30 times.

*The cardiac output = 6 liters , (20-25)% of it go to kidney to get filtered , the kidneys filter 180 liter of blood \day which means the blood passes through the kidney 30 times to be filtered , kidneys excrete 1-1.5 liter of urine per day and rest is re-absorbed .

GLOMERULAR MEMBRANE :

- The membrane through which filtration occur .

* It's structure :

1) Endothelium cells**.
2) Basement membrane .
3) Epithelium cells .

**Endothelium cells → these cells structure vary from one tissue or organ to another to suit it's function .

EX :

1) Lung alveoli capillaries include epithelial cells that are tightly packed to prevent the leakage for water into it . (they don't have pores at all or with very small size) .
2) Muscles epithelial (myoepithelium) also has small pores .
3) Kidneys → big pores to suit it's filtration function .

CHARACTERS OF GLOMERULAR MEMREANE :

*glomerular membrane is :

a. **Highly permeable membrane** → it's permeability = 100-500 of a usual tissue capillary and varies from one tissue to another .
b. **High degree of selectivity** → it's a highly selective membrane , according to molecular weight (MW) .

   - **Small molecular weight** → easily filtered less tham 10.000 MW .

   - **High molecular weight** → can't be filtered , greater than 80.000. (such as plasma protein) .

* filtrate is similar to the plasma but without plasma proteins because they can't pass through the glomerular membrane due to their large molecular weight .

DONNAN EFFECT :

- If there was a semi-permeable membrane with some negatively charged proteins on it's surface , that will cause the attraction of positively charged ions towards it .

- plasma proteins in the glomeruli is an example on it , they are molecules with high molecular weight so they are not gonna be filtered and will remain in the glomerulas causing the attraction of positively charged ions towards it ⟶ rearrangement of charges in the kidney ; due to it's attraction to +ve ions , the filtrate is gonna have more 5% –ve charges in it to balance and equal the electricity of the cell .

NOTE : plasma protein are negatively charged molecules .

*Albumin is a protein with low MW though can't be filtered through the glomerulus , why is that ?

- as we mentioned previously that plasma protein are negatively charged , the glomerular membrane is negatively charged too , so there will be repulsion between them and they won't cross .

FILTRATION FORCES :

* Starling force :

1) Hydrostatic pressure ⟶ **a) capillary** (+ve) **\ b) tissue** (-ve) **.**

2) Osmotic pressure ⟶ **a) capillary** (+ve) **\ b) tissue** (-ve) **.**

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* +ve means *helping* filtration forces .

* -ve means *opposing* filtration forces .

* Glomerular capillary hydrostatic pressure ⟶ the pressure of blood inside the capillary is high which helps in pushing (filtrating) the fluid.

- Has a +ve pressure value = 60 mmHg .

* Colloidal osmotic pressure of plasma protein ⟶ plasma protein in capillaries are acting on attracting water toward it (absorbing water) , this is means that it has an *opposite effect of filtration* (*against*) .

- Has a –ve pressure value = -32 mmHg .

* Bowman's capsule hydrostatic pressure ⟶ the fluid pressure inside the bowman's capsule itself act as an *opposing force of filtration* , it prevents the fluid to be filtrated from capillaries.

- Has a –ve pressure value = -18 mmHg .

*Bowman's capsule osmotic pressure ⟶ protein are not filtrated at all , this is means that *NO* occur osmotic pressure .

- Has a pressure value equal to ZERO .

- بالتوفيق لكم جميعاً

كان معكم زملاءكم : سُلاف المعايطة , وجد الحباشنة , ريف القيسي , منذر القطاونة .