

\* The Kidney filters everything except cells, plasma protein

فسيولوجي

17/11/20

cardiac output = 5000 ml/minute

← output, etc

ق ق ق

that's mean -> Kidney is vital organ

### Process of urine Formation

- About 1200 ml of blood reach kidney/ minute i.e., containing about 700 ml plasma and these are called "renal plasma flow".
- Of these 700 ml plasma about 125 ml of protein free plasma are filtered from the glomerular membrane and reach renal tubules and they are called the glomerular filtration rate" (GFR).
- The rest of the plasma (700-125= 575 ml) return back to the efferent arterioles and runs, through the Peri-tubular capillaries; side by side with the glomerular filtrate in the kidney tubules.
- After filtration in glomeruli, renal tubules do the following processes:
  - a) Reabsorption:** Definition: reabsorption is the movements of substances from lumen of renal tubules crossing tubular cells back to the blood.
    - Certain substances undergo complete reabsorption as amino acids & glucose, while other undergoes partial reabsorption as  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{HCO}_3^-$ .
    - 99% of the Glomerular filtrate is reabsorbed.
    - Solute reabsorption occurs by: \* Active mechanism: against electrochemical gradient as glucose & amino acids. \* Passive mechanism: under
  - b) Secretion:** Definition: Secretion is the movement of substances from blood surrounding the tubules to the tubular lumen to be excreted with urine.
    - Secretion may be complete (all substance that enter kidney is excreted in urine (e.g., injected PAHA) or may be partial secretion (e.g.,  $\text{H}^+$  ion or  $\text{K}^+$ ).
    - Secretion may also be active or passive & has a transport maximum.
  - c) Synthesis:** Definition: Synthesis is the formation of new substances as ammonia (for  $\text{H}^+$  regulation).
    - ↳ its waste product of protein
  - d) Excretion:** Definition: Excretion is the final substances that are found in urine.
    - Only 1 ml/minute of 125 ml filtered fluid is excreted as urine (in normal adult = 1500 ml/day in normal adult).
    - Urine contains  $\text{H}_2\text{O}$  and products of drugs, toxic substances, urea, uric acid & creatinin.

Glomerular Filtration + Reabsorption + Secretion + Synthesis = Urine

Glomerular capillary → لها أن ضغط في الجسم ← لها ر Capillary الوعية داخل  
 جينا التي من جهة arteriole والشعب، الثانية بوض arteriole (afferent & efferent)  
 (Function of Kidney) فترقة  
 (Filtration)

### GLOMERULAR FILTRATION RATE (GFR)

**Definition:** It is the amount of protein free plasma, which is filtered in both kidneys per minute across the glomerular membrane.

It equals 125ml/min in normal 70 kg young adult.

- It is about 10% less in females than males.
- The process of filtration is passive.

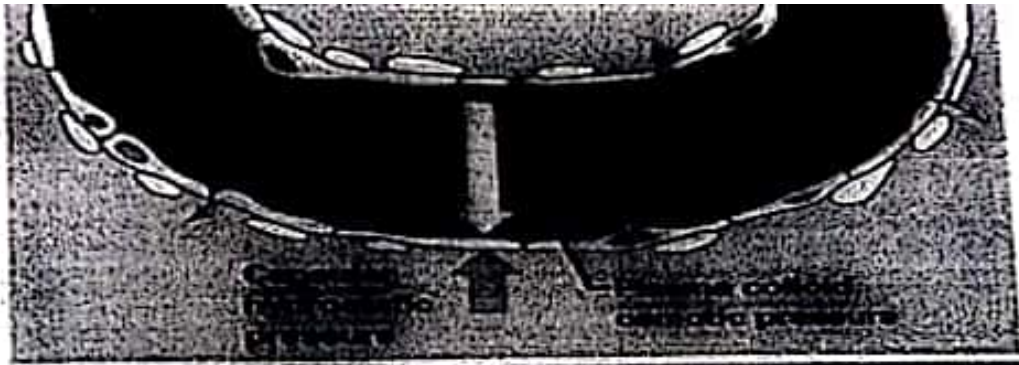
**Filtration fraction:** • It is the percentage of GFR as regard the renal plasma flow.

فترقة =  $(\frac{\text{GFR}}{\text{Renal plasma flow}}) \times 100 = (\frac{125}{700}) \times 100 = \text{about } 20\%$

Shift of reabsorbed fluids from the interstitium to the peritubular capillaries

**Starling forces** or Hydrostatic forces that control fluid transport between interstitium and peritubular capillaries they are the driving forces that act across the Peritubular capillaries and control fluid transport between interstitium and peritubular capillaries.

It is determined by 4 forces:



Net Outward	
→ Outward force, glomerular hydrostatic pressure	= +60 mm
→ Inward force of plasma colloid osmotic pressure	= -32 mm
Inward force of capsular hydrostatic pressure	= -18 mm
<b>Net outward pressure</b>	<b>= +10 mm</b>

There is 2 Forces inside capillaries & 2 Forces outside capillaries

(ع) (ع) Ⓢ oncotic pressure = osmotic pressure of plasma protein (32) } inside capillary

(ع) Ⓢ hydrostatic pressure of blood (60) ?

(ع) Ⓢ hydrostatic pressure of interstitial fluid (18) } outside capillary

(ع) Ⓢ interstitial fluid protein pressure (normally No protein outside) = 0



\* any vital organ has Auto-regulation

### 5 - Systemic blood pressure:

- GFR remains more or less constant between blood pressure <sup>range</sup> 70 & 210 mmHg due to Auto-regulation of renal blood flow.
- Marked decrease of blood pressure below 70 mmHg as in severe haemorrhage there is marked decrease in GFR & may even stop → acute renal failure.  
*Chronic, مزيج تزداد, الفشل الكلوي المزمن*
- Marked elevation above 210 mmHg causes an increase in GFR and urine formation phenomena called "pressure diuresis" *الارتفاعات الحادة*

6 - Sympathetic stimulation: Marked sympathetic stimulation as in severe exercise or intense emotional stress diminishes GFR by constricting the renal artery *Severe*

### Renal Handling of Sodium

*Functions of sodium in the body are:*

1. Keeping volumes of both extracellular fluid & blood constant → maintains normal ABP.
  2. Formation of resting membrane potential, action potential & conduction of nerve impulse
2. Skeletal & smooth muscle contraction by releasing  $Ca^{++}$  from sarcoplasm

CS

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Na<sup>+</sup> ← } 70% ↓  
(obligatory) water ← }

tonic concentration of the fluid remaining will be **iso**tonic

2. Electrical gradient (in lumen - 3 mv & inside cell - 70 mv).

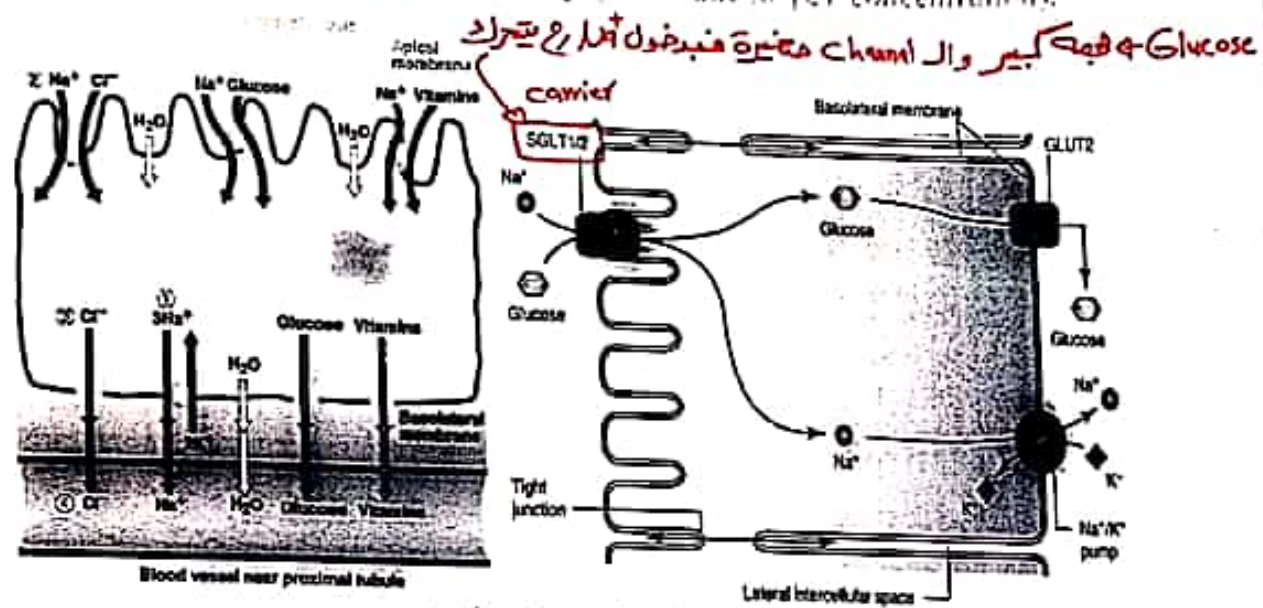
- This is helped by large surface area of brush border of PCT & by presence of carriers.
- At baso-lateral border: Na<sup>+</sup> crosses to interstitium fluid by *active pump* against its electrochemical gradient by Na<sup>+</sup>- K<sup>+</sup> ATPase activity (for each 3 Na<sup>+</sup> pumped out only 2K<sup>+</sup> ions are carried in).
- After entering the cell K<sup>+</sup> ions *diffuses back* again to the interstitium helped by concentration gradient & high permeability of cell membrane → maintain the *intracellular negativity* in relation to luminal fluid → ↑ Na<sup>+</sup> entry to the cell (help the *facilitated diffusion*).

*This reabsorption result in:*

\* Reabsorption of 70% of water "obligatory water reabsorption" because of the high osmolality created by Na<sup>+</sup> reabsorption.

S2. Active co-transport transport of glucose, amino acids, HCO<sub>3</sub><sup>-</sup> & other organic acids (these substance are carried by same carrier of Na<sup>+</sup>).

- ... high osmolarity created by  $\text{Na}^+$  reabsorption.
- 2- Active co-transport transport of glucose, amino acids,  $\text{HCO}_3^-$  & other organic acids (these substance are carried by same carrier of  $\text{Na}^+$ ).
- 3- Passive diffusion of  $\text{Cl}^-$  (in 2<sup>nd</sup> half of PCT due to  $\downarrow \text{Cl}^-$  concentration).



$\text{Na}^+$  reabsorption in PCT

2)  $\text{Na}^+$  reabsorption in the loop of Henle (20%) (concentration gradients) \*  $\text{Na}^+$  تركيزی افتلاف تركيزه

①  $\text{Na}^+/\text{K}^+$  pump → Baso-lateral  
 3  $\text{Na}^+$  تدارد 3  $\text{Na}^+$  پمپ  
 2  $\text{K}^+$  و تدارد 2  $\text{K}^+$  پمپ  
 → intracellular negativity

$\text{Na}^+$  ←  $\text{Na}^+$  پمپ سے  $\text{Na}^+$  کے بغیر  $\text{Na}^+$  کے بغیر  $\text{Na}^+$  کے بغیر  
 (  $\text{Na}^+$ -glucose co-transport )

electro-chemical gradients  
 الب دافق الخلية  
 داخل الخلية  
 خارج الخلية  
 فاعلانی في وجود الخلية  
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\* Pregnants may suffer of **toxemia** (الامني) \* oedema  
 (التي تصبى بالسكر في الدم) (Salt craving) \* hypertension  
 \* albuminuria

مع كثيره اقل كثيره ← يستغل بالماء ← يكبر حجم الدم ← زيادة في الدم ←

(Cortisol) -**Glucocorticoids** : -Weak Aldosterone like action on sodium reabsorption →  $\text{Na}^+$  & water retention & decrease  $\text{Na}^+$  excretion in urine.

-**Sex hormones (estrogens)**: Salt retention effect, so contraceptive pills that contain oestrogen → oedema in prolonged use. **منع بعد 35 سنة**

- **$\text{PGE}_2$** : Increase  $\text{Na}^+$  excretion in urine (natriuresis)

- This by inhibiting  $\text{Na}^+ \text{K}^+$  ATPase & by increase intracellular  $\text{Ca}^{++}$ , which inhibit  $\text{Na}^+$  transport across the channels.

- Endothelins causes natriuresis by increasing  $\text{PGE}_2$ .

-**Atrial natriuretic peptide (ANP)**: Decrease  $\text{Na}^+$  reabsorption & increase excretion

### 3- Glomerulo-tubular balance:

- Increase GFR → increase tubular load of any substance → increase its reabsorption to prevent overloading of the distal tubules with these solutes.

### 4- Effect of ABP:

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 • Increase ABP above 180mmHg → increase  $\text{Na}^+$  excretion & urine output