Renal Reabsorption (Lecture 5)

Renal threshold			
HIGH threshold	medium threshold	LOW threshold	NO threshold
- Glucose - Amino acids - vitamins. *Note :* "Completely Reabsorbed"	- K+ - Urea *Note:* "Some of the substance will be reabsorbed and the remaining will be excreted in the urine "	- Phosphate - Uric acid *Note :* "Only small amount will be reabsorbed but the majority of substance will be excreted"	- Creatinine - mannitol - inulin. *Note:* "Completely excreted"

- *The threshold refers to the filtered load at which the substance first begins to be excreted in the urine.*
- *Assume that the plasma conc. of a certain substance is 120 {Glucose} , above this level the kidney will start to excrete the substance.*

Glucose as example of tubular transport maximum :

- Normal plasma conc. of glucose = 120 mg/dl *(180 in some references)*
  (Normally, glucose molecules do not exist in urine because they are completely reabsorbed "because your body need glucose").
- T-max of glucose = 375 mg/dl (more than this level, glucose start to appear in urine).

فلنفترض أن لدينا خمس أماكن فارغة (Carriers) ، بالمقابل لدينا سبع جزيئات جلوكوز بالتالي خمسة منها سوف ترتبط بالناقل الخاص بها وعندها يحصل تشبع لأنه تم شغر جميع الأماكن ، والجزيئين المتبقيين يتم إخراجهما مع البول.

لذلك نقول : (Transport maximum is reached when carriers are fully SATURATED)

- Plasma glucose up to 180 mg/dl, all will be **reabsorbed**. **Beyond this level** of plasma [glucose], *it appears in the urine = Renal plasma threshold for glucose.*

عند وصول تركيز الجلوكوز في البلازما إلى نقطة أعلى مما ذكر مسبقاً، سيتم إخراجه مع البول وهذا يوضح لنا مفهوم الـ threshold والذي يمثل بداية ظهور أو إخراج المادة مع البول.

- **The regulation of blood glucose is not the function of the kidney ! its regulation is done by the pancreas(Hormonal).**

- The appearance of glucose in the urine of diabetic patients = **glycosuria**, is due to *failure of insulin, NOT, the kidney.*

Transport precess (mainly, 2 major parts)

1. Tubular Reabsorption.
2. Tubular Secretion

1- Tubular Reabsorption :

- **Transported substances move through three membranes :**
  1. Luminal membrane (Apical)
  2. Basolateral membrane.
  3. Endothelium of peritubular capillaries

- Ca^{2+}, Mg^{2+}, K^{+}, and some Na^{+} can be reabsorbed via **paracellular pathways.**

  ***paracellular pathways :** transfer of substances across an epithelium by passing through the intercellular space *between* the cells.

  ***Transcellular transport :** substances travel *through* the cell, passing through both the apical membrane and basolateral membrane.

- Reabsorption may be an **active** (requiring ATP) or **passive** process.

Substance	Measure	Filtered*	Excreted	Reabsorbed	% Filtered Load Reabsorbed
Water	L/day	180	1.5	178.5	99.2
Na^{+}	mEq/day	25,200	150	25,050	99.4
K^{+}	mEq/day	720	100	620	86.1
Ca^{++}	mEq/day	540	10	530	98.2
HCO_3^{-}	mEq/day	4320	2	4318	99.9+
Cl^{-}	mEq/day	18,000	150	17,850	99.2
Glucose	mmol/day	800	0	800	100.0
Urea	g/day	56	28	28	50.0

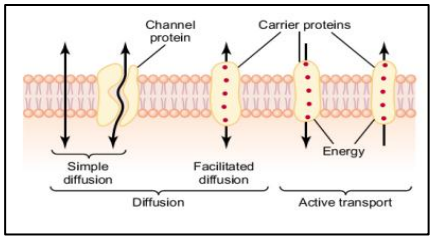
نستنتج من الجدول السابق مدى إعادة امتصاص المادة وأعلاها الجلوكوز حيث يتم امتصاصه بالكامل

كيف نحسب النسبة المئوية ؟

$$\left\{ \frac{\text{Reabsorbed} \times 100}{\text{Filtered}} \right\}$$

Mechanisms of tubular absorption and secretion :

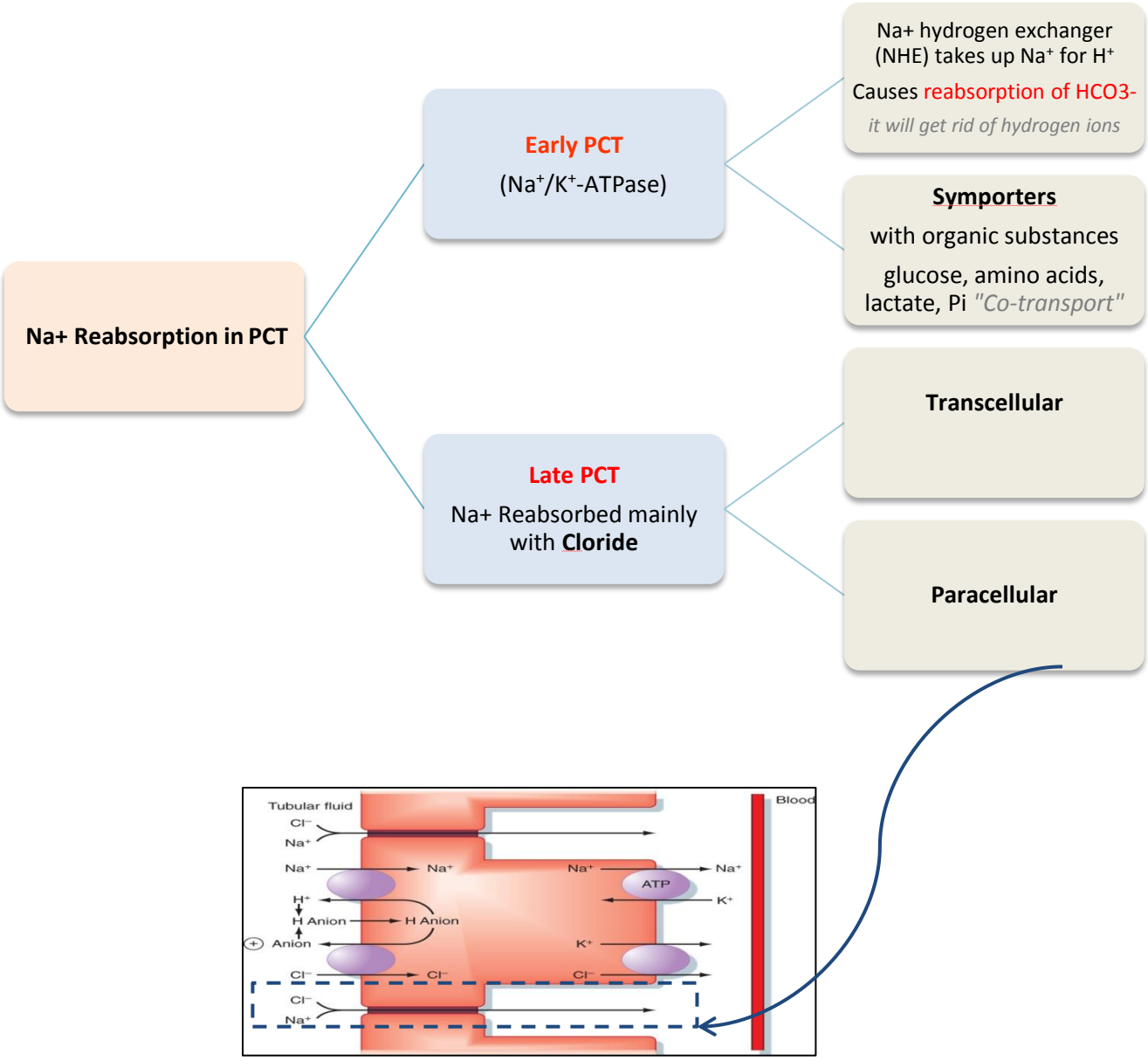
1. **Diffusion** *(Passive / requires no energy)* :
   - I. facilitated diffusion.
   - II. Simple diffusion.
2. **Active transport** *(Needs ATP)*



Reabsorption

Na+	- Always *Actively transported* - Actively transported out of the tubules by *a Na+-k+ pump*. - Na^+ enters the tubule cells at the luminal membrane **Proximal convoluted tubule Na+ Reabsorption :** - 70% of Na+, Cl-, K+, water absorbed by **PCT**. *"see next page"*
Glucose	**From tubular lumen to tubular cell:** *Sodium co-transporter (Carrier-mediated secondary **active** transport)* **From tubular cell to peritubular capillary:** *Facilitated diffusion* (*Carrier-mediated **passive** transport*)
Urea	**-About 40-70% of filtered load of urea is reabsorbed in:** 1) Second half of PCT. 2) Medullary CT(collecting tubules) & CD (collecting ducts) *(ADH dependent)* Due to water reabsorption in the first half of PCT, the conc. of urea is increased in the second half and urea is *reabsorbed by simple diffusion* (downhill).
Water	- PCT cells permeable to water - PCT Reabsorbs 67% of filtered water **Transtubular Passive (osmosis),** due to osmotic active substances that are absorbed e.g. **Na+**, glucose, HCO3-, Cl- ⇒ ↓ tubule osmolality / ↑ intracellular osmolality. **Solvent drag:** K+, Ca2+, carried with water & hence reabsorbed The accumulation of fluid and solutes within the lateral intercellular space increases hydrostatic pressure in this compartment ,*the increased hydrostatic pressure forces fluid and solutes into the capillaries*. Thus, water reabsorption follows solutes. **The proximal tubule reabsorption is isosmotic "imp"**
Protein	- Peptide hormones, small proteins & amino acids *reabsorbed in PCT* - Undergo *Endocytosis into PCT*, either intact or after being partially degraded by enzymes. - Once protein inside the cell, enzyme digest them into amino acids, which leave the cell to blood. - **Has a maximum capacity : too much protein filtered = proteinuria**
HCO_3^-	- The renal tubules are *poorly-permeable to HCO_3^-*. However, it is still *reabsorbed but in the form of CO_2* (to which the tubules are very highly permeable). **This occurs through the following steps:** **1)** H^+ is formed inside the cells then secreted in the tubular fluid. **2)** H^+ combines with HCO_3^- in the tubular fluid forming H_2CO_3. **3)** By activity of the carbonic anhydrase enzyme (C.A.) in the tubular cells, H_2CO_3 dissociates into CO_2 & H_2O.

	4) CO_2 diffuses into the cells where it combines with H_2O (by activity of an intracellular C.A.), forming H_2CO_3 which dissociates into HCO_3^- & H^+. **5)** HCO_3^- passively diffuses into the interstitial fluid (then to the blood) while H^+ is secreted into the tubular fluid to help more reabsorption of HCO_3^-. **Factors affecting HCO_3^- reabsorption:** Arterial Pco_2 / Plasma[K^+] / Plasma Aldosterone / Plasma [cl^-] Video



Done by : *Khawla Alammari*