

Tubular Reabsorption

Guyton

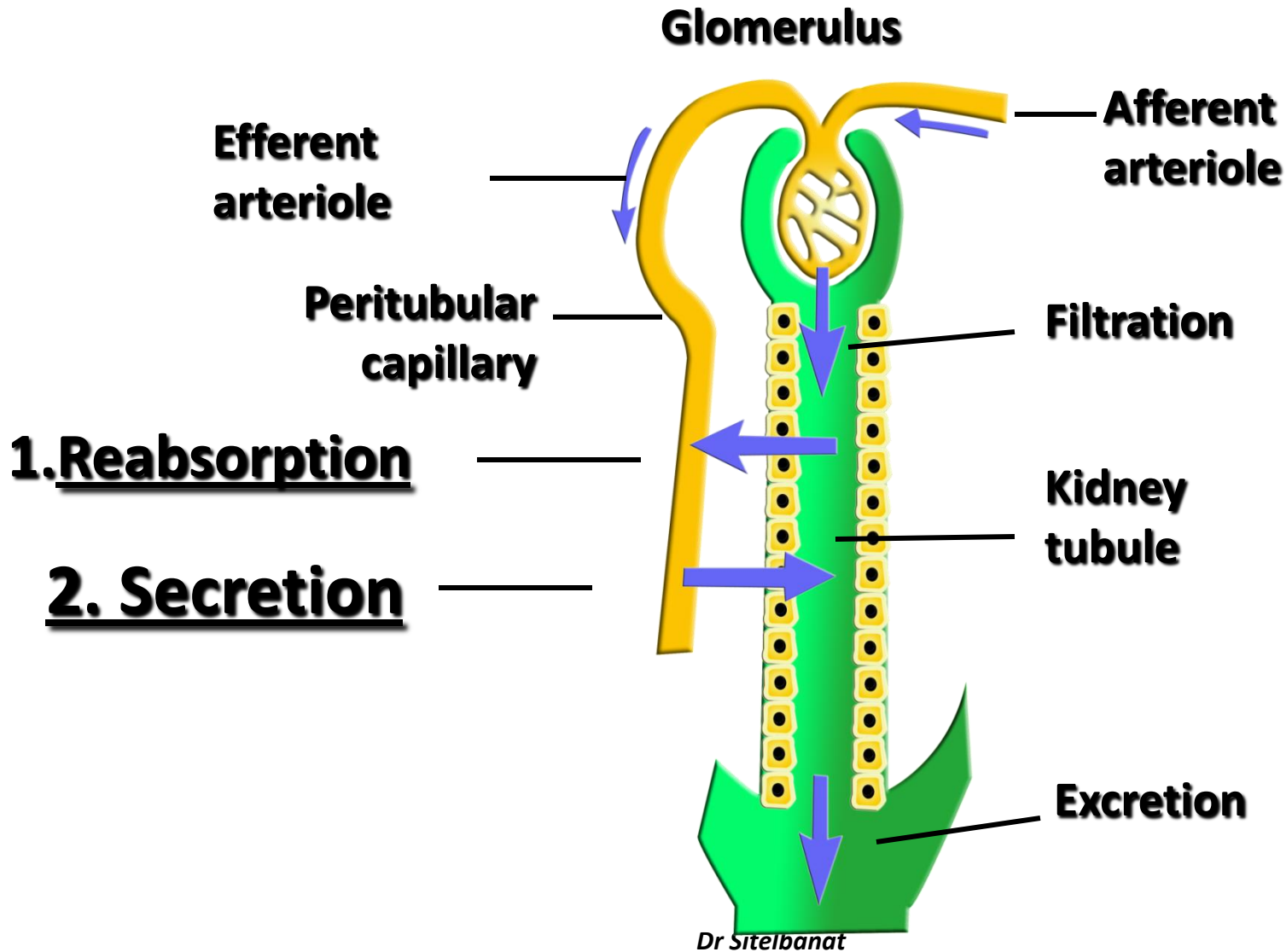
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Objectives

At the end of this lecture student should be able to describe:

- **Mechanism of urine formation**
- **Renal tubular transport**
- **Nacl re-absorption in PCT**
- **Water re-absorption in PCT**
- **Glucose and amino acid re-absorption in PCT**

Tubular Function



Filtration, Reabsorption and excretion rate

	Filtered	Absorb.	Excreted	A/F %
Glucose (g/d)	180	180	0	100
HCO ₃ (meq/d)	4320	4318	2	99.98
Na (meq/d)	25560	25410	150	99.4
Cl (meq/d)	19440	19260	180	99.1
K (meq/d)	756	664	92	87.7
Urea (g/d)	46.8	23.4	23.4	50
creatinine (meq/d)	1.8	0	1.8	0

Calculation of tubular reabsorption or secretion from renal clearances

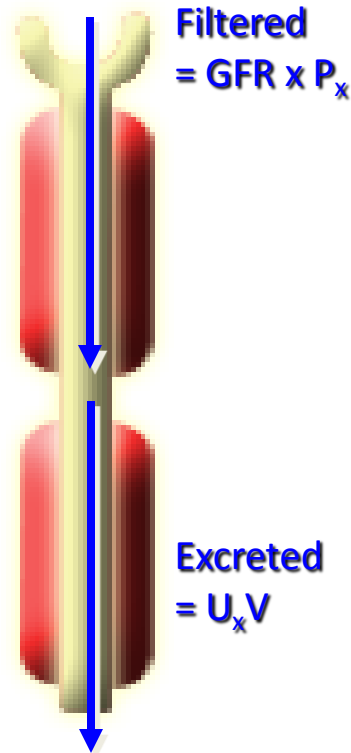
**Reabsorption or secretion =
Quantity Filtrated – Quantity excreted**

Quantity Filtrated = $P_x \times \text{GFR}$

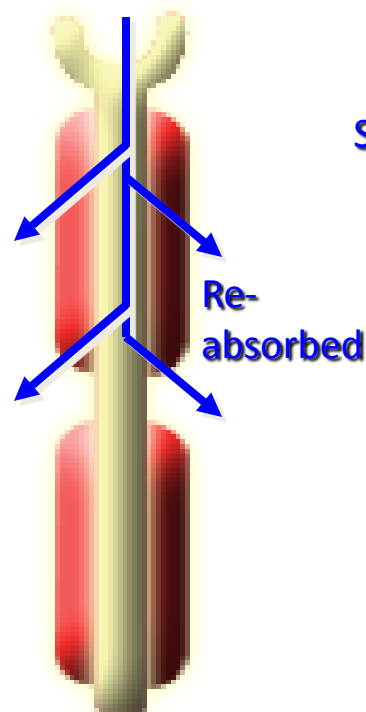
Quantity Excreted = $U_x \times V$

Calculation of renal transport (Tx)

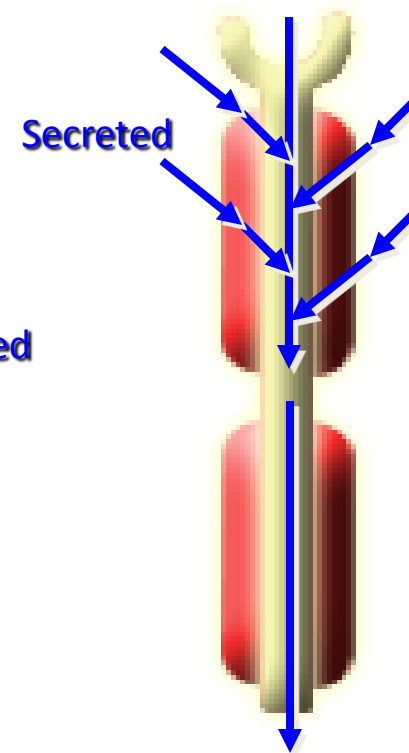
$$T_x = GFR \times P_x - U_x V$$



$T_x = 0$
 $GFR \times P_x = U_x V$
e.g. Inulin



$T_x = \text{positive}$
 $GFR \times P_x > U_x V$
e.g. glucose



$T_x = \text{negative}$
 $GFR \times P_x < U_x V$
e.g. PAH

Calculation of Na reabsorption

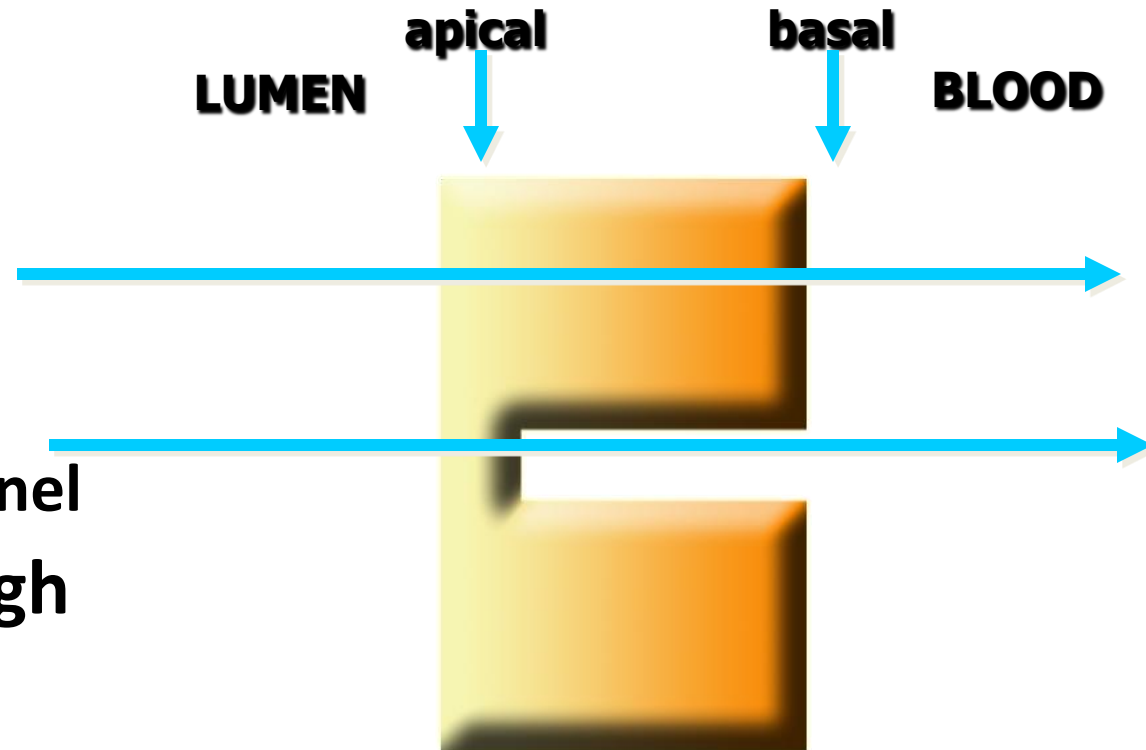
Example

- **Plasma Na concentration = 140 mEq/L**
- **GFR (inulin clearance) = 125 ml/min**
- **Urine flow rate = 1 ml/min**
- **Urine concentration of Na = 70 mEq/L**

Calculate the amount of Na transported

Types of transport

- **Transcellular: Across renal cell**
 - Primary active transport
 - Secondary active transport
 - Passive: ion channel
- **Paracellular: Through tight junction**
 - Passive diffusion

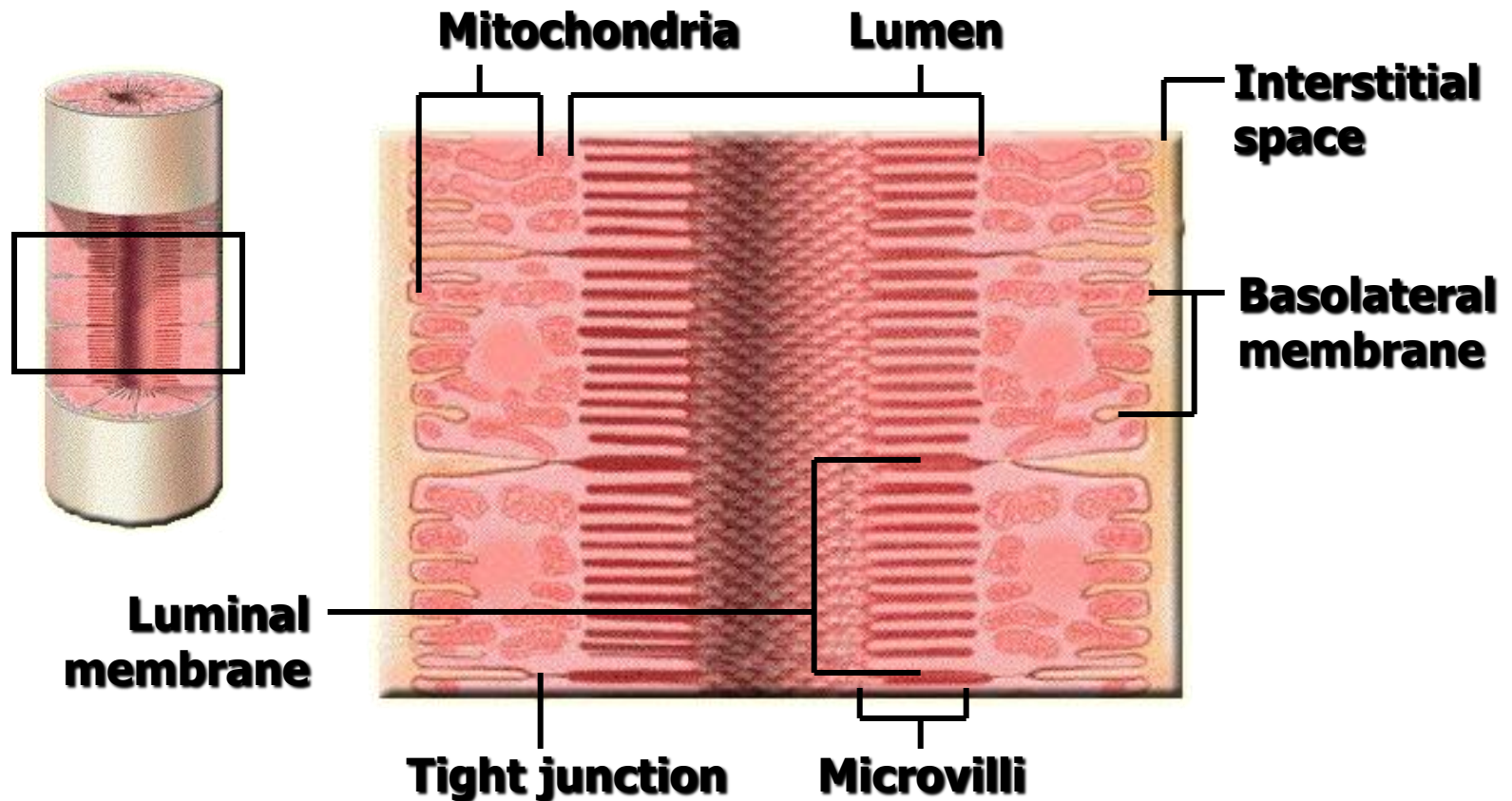


Proximal convoluted tubule

- **High capacity for reabsorption**
 - **Special tubular epithelial cell**
 - **Metabolically active (lot of mitochondria)**
 - **Brush border (surface area)**
 - **Tight junction is not so tight**
 - **Contain a lot of carrier protein**

Cells of the Proximal Convoluted Tubule (PCT)

Simple cuboidal cells with brush border **Highly permeable to water and many solutes.**



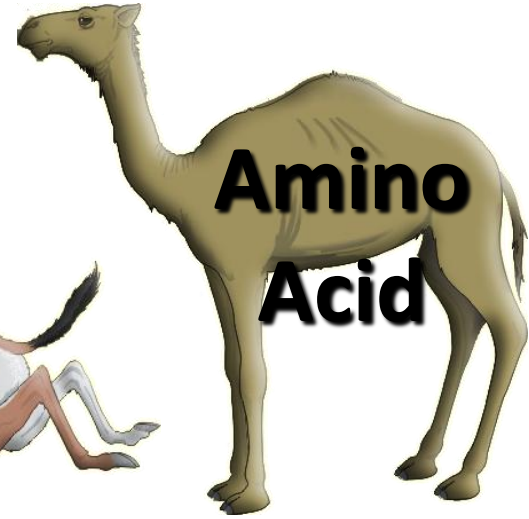
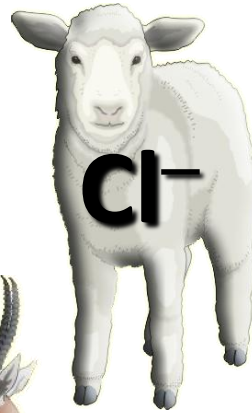
Substances absorbed in PCT

- **Tubular absorption**

- Sodium
- Chloride
- Glucose
- Water
- Amino acid
- Bicarbonate
- Phosphate
- Urea

- **Secretion**

- PAH
- H⁺
- K



Sodium reabsorption in PCT

- **65-70% of filtered sodium is reabsorbed in PCT**
- **Followed by water & chloride**
- **Iso-osmotic absorption (equal quantity of solute & water)**
- **Important for the absorption of**
 - **Glucose**
 - **Amino acids**
 - **phosphates**

Passage of sodium absorption

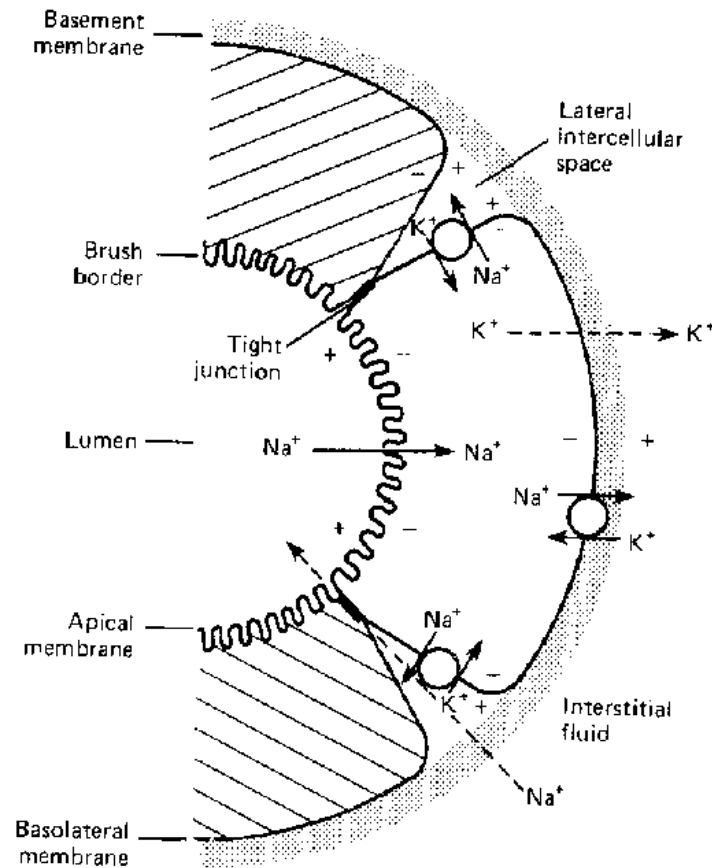


Figure 28.6 Mechanism of sodium absorption in an epithelial cell.

Mechanism of sodium reabsorption

- **Basolateral membrane**

- **Na⁺/K⁺ Atpase**

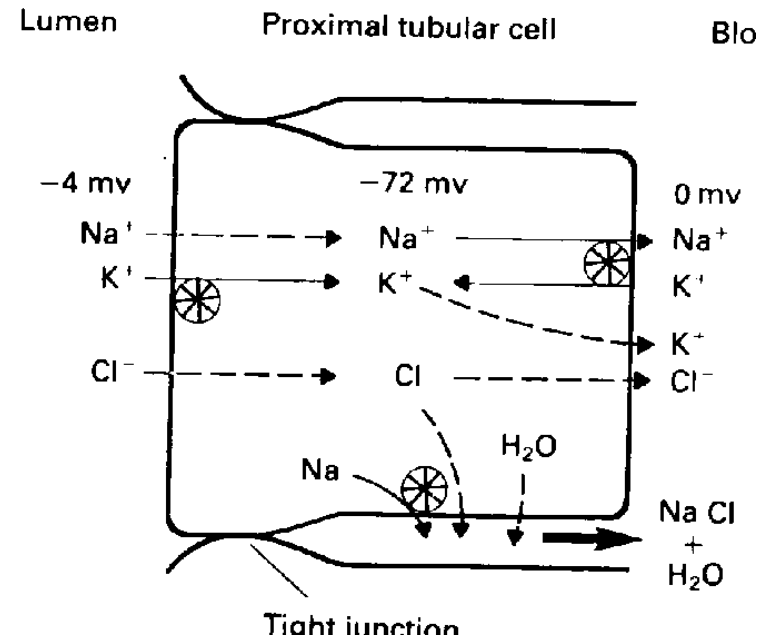
- 3 Na / 2 K

- K leak out of the cell

Results in

- **Low intracellular Na Concentration**

- **high peritubular osmolality**



Mechanism of sodium reabsorption

- **Na enter the cell passively following**
 - **Electrical difference (inside the cell -70mv, lumen -4mv)**
 - **Na concentration differences (140 mEq/L to 12mEq/L)**
- **Na enter the cell across the luminal membrane:**
 - **Cotransport with glucose, amino acids**
 - **Na in exchange H (counter transport)**
 - **Na channel**

Chloride reabsorption

- **Cl reabsorbed down concentration gradient following the positively charge Na**

Water reabsorption

- **60-70% of filtered water is reabsorped in PCT**
 - **Active pump of Na from renal cell to peritubular space results in increases the osmolality of peritubular space**
 - **Drag water by osmosis**
- **Filterate remain iso-osmotic (~equal quantity of water & solute are absorbed)**

Glomerulo-tubular balance

- **Feed back mechanism to keep a fixed percentage of reabsorbed glomerular filtrate**
- **The higher the filtration in the glomerulus → the higher oncotic pressure in efferent & peritubular capillaries → ↑ reabsorption in PCT**

Glucose reabsorption

- In healthy adult all filtered glucose is reabsorbed and no glucose will appear in urine
- If plasma glucose (P_G) reach 200 mg/dl, glucose appear in the urine – this level is the “Renal threshold”
 - 200mg/dl in arterial; 180 mg/dl in venous

Glucose reabsorption

- The amount of reabsorped glucose at very high filtered glucose, remains constant, this is called tubular transport maximum for glucose (Tm_G)= 375 mg/min (female 300mg/min)
- At this maximum transport, all the glucose carriers are saturated and no more glucose can be transported

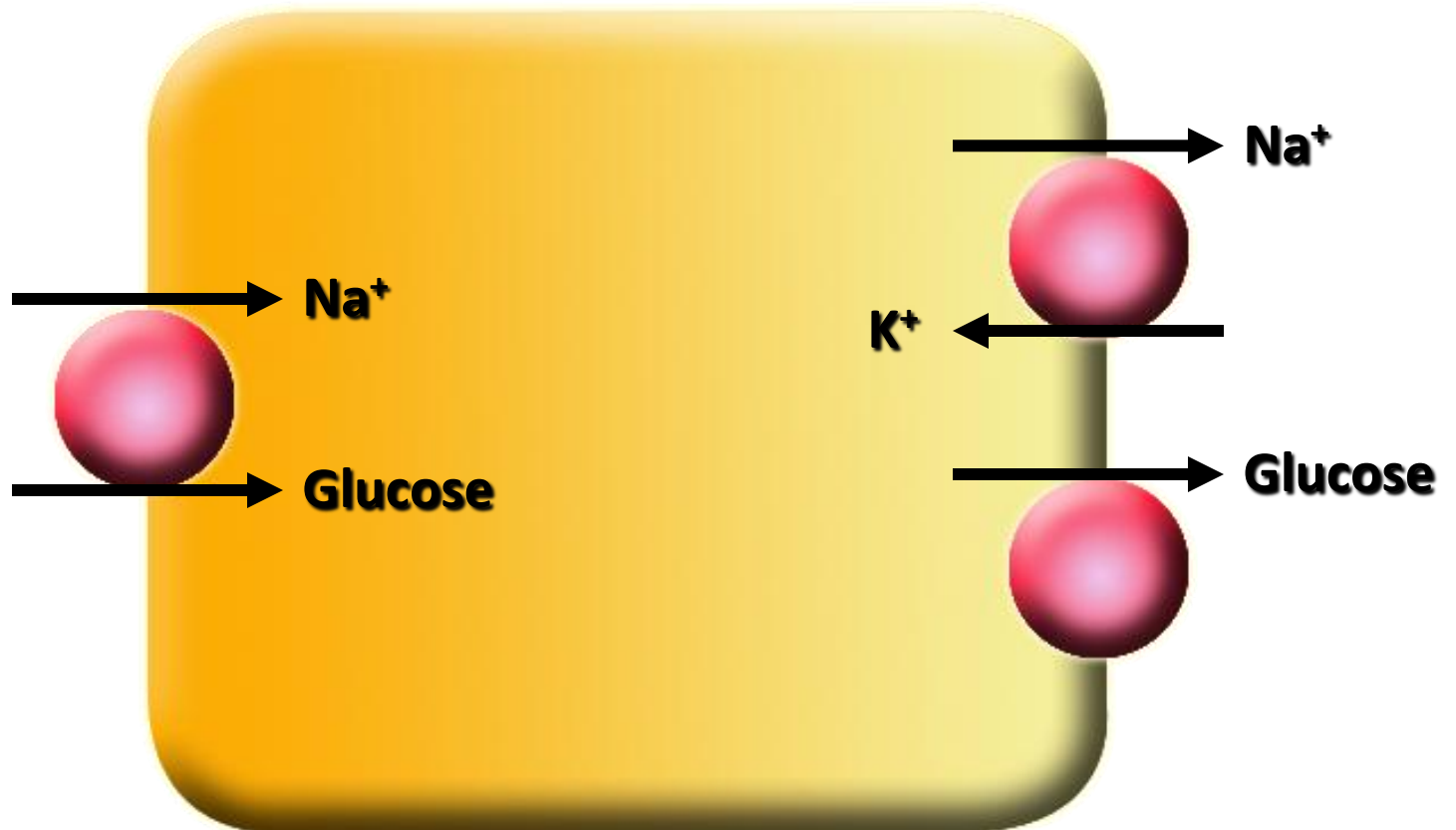
Mechanism of Glucose reabsorption

- **Secondary active transport**
- **Luminal membrane**
 - Cotransport with Na
- **Basolateral membrane**
 - GLUT 1 & 2

LUMEN

Cell of the proximal tubule

BLOOD



Cellular Mechanism for Glucose Reabsorption

Amino acid reabsorption

- **All filtered AAs are reabsorbed in PCT**
- **Luminal membrane**
 - **Cotransport with Na**
- **Basolateral membrane**
 - **diffusion**