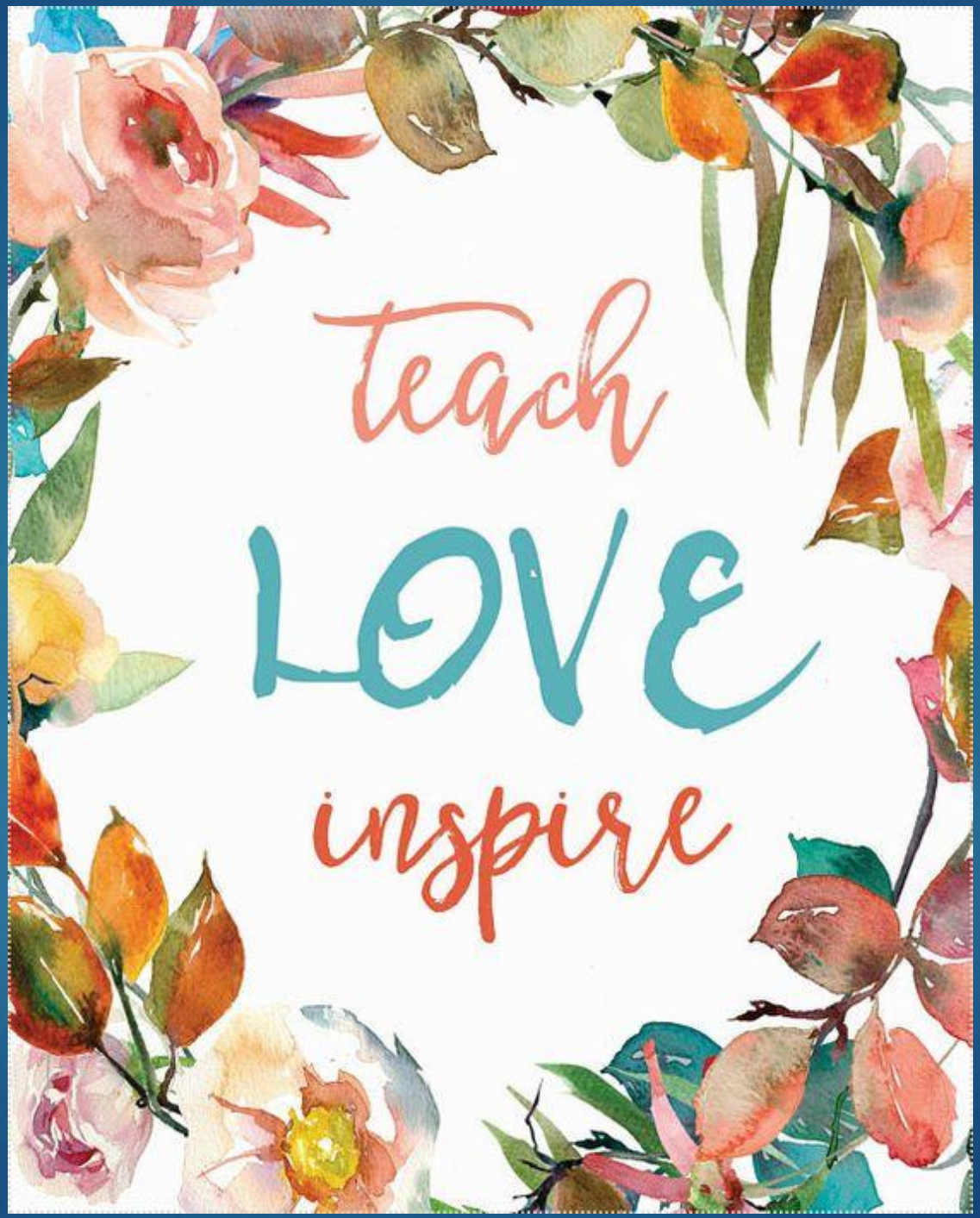
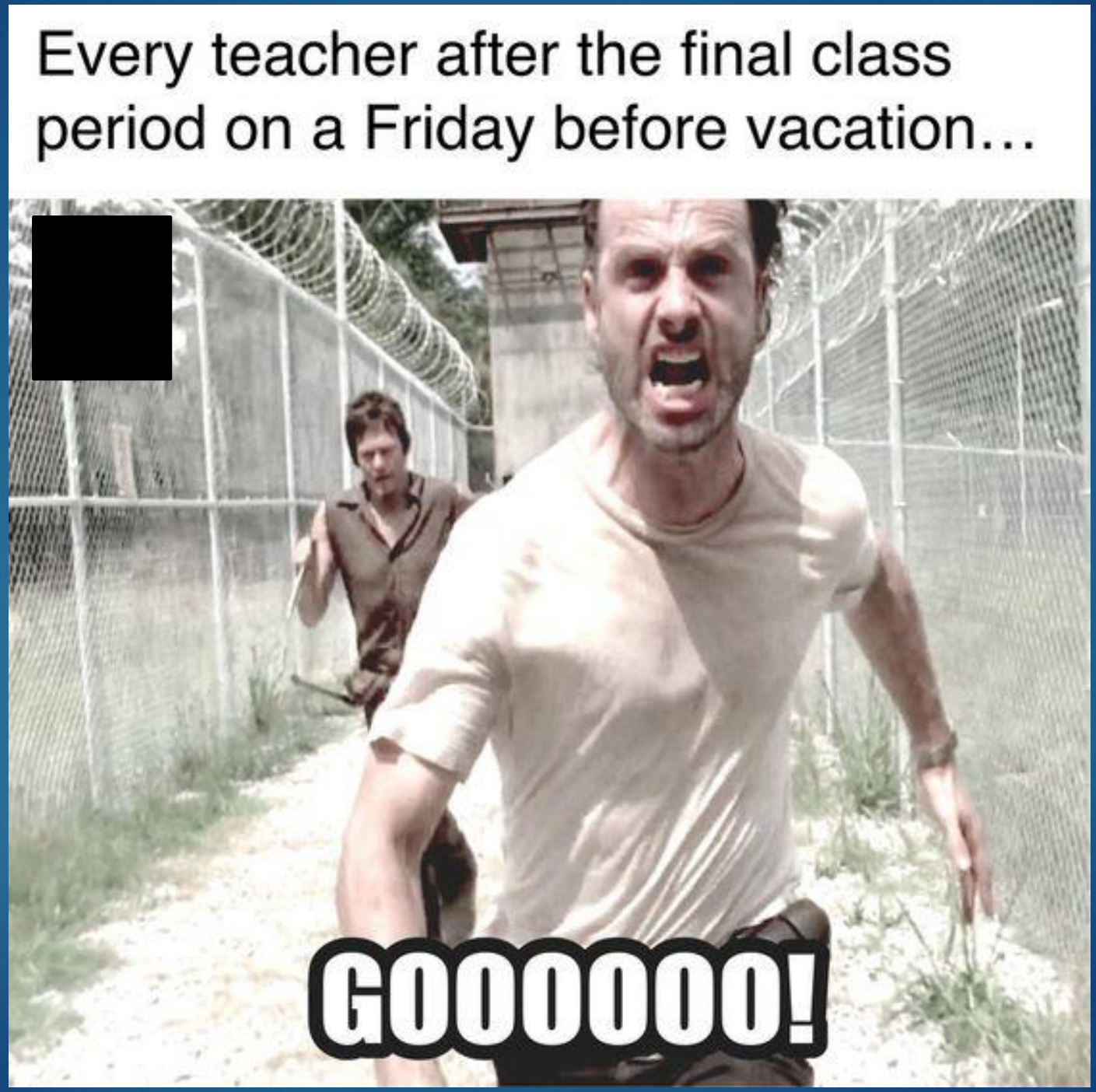

teach
LOVE
inspire

Every Student's Dream 😂


Every teacher after the final class period on a Friday before vacation…
GOOOOOO!

Renal Tubular Absorbtion & Secretion

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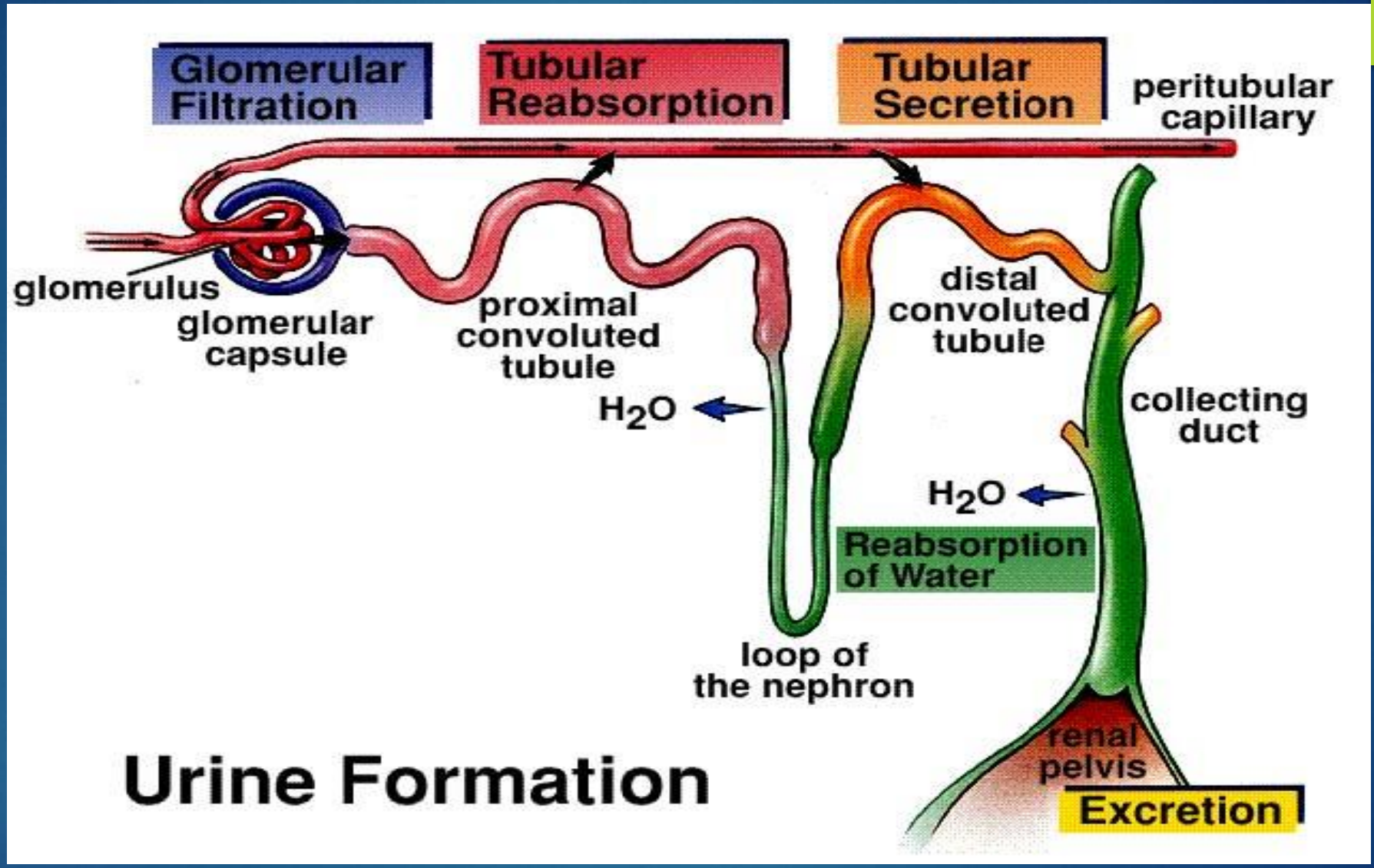
PHYSIOLOGY


إن الله وَمَلَائِكَتَهُ يُصَلُّونَ عَلَى النَّبِيِّ
يَا أَيُّهَا الَّذِينَ آمَنُوا صَلُّوا عَلَيْهِ وَسَلِّمُوا تَسْلِيمًا
@SOMY_332


Glomerular Filtration
Tubular Reabsorption
Tubular Secretion
peritubular capillary
glomerulus
glomerular capsule
proximal convoluted tubule
distal convoluted tubule
collecting duct
H_2O
H_2O
Reabsorption of Water
loop of the nephron
renal pelvis
Excretion
Urine Formation

- As glomerular filtrate enters the renal tubules it flows sequentially through the successive parts of the tubule the proximal, the loop of henle , the distal tubule, collecting tubule and finally the collecting duct before it is excreted as urine.
- Along this course a few substances are reabsorbed and few are secreted.

- unlike glomerular filtration , tubular reabsorption is very selective.
- Some substances such as glucose and amino acids are almost completley reabsorbed from the tubules.
- Na, Cl, HCO3 are highly reabsorbed.
- Waste products such as urea and craetinine are poorly reabsorbed from the te tubules and are excreted in relatively large amount.

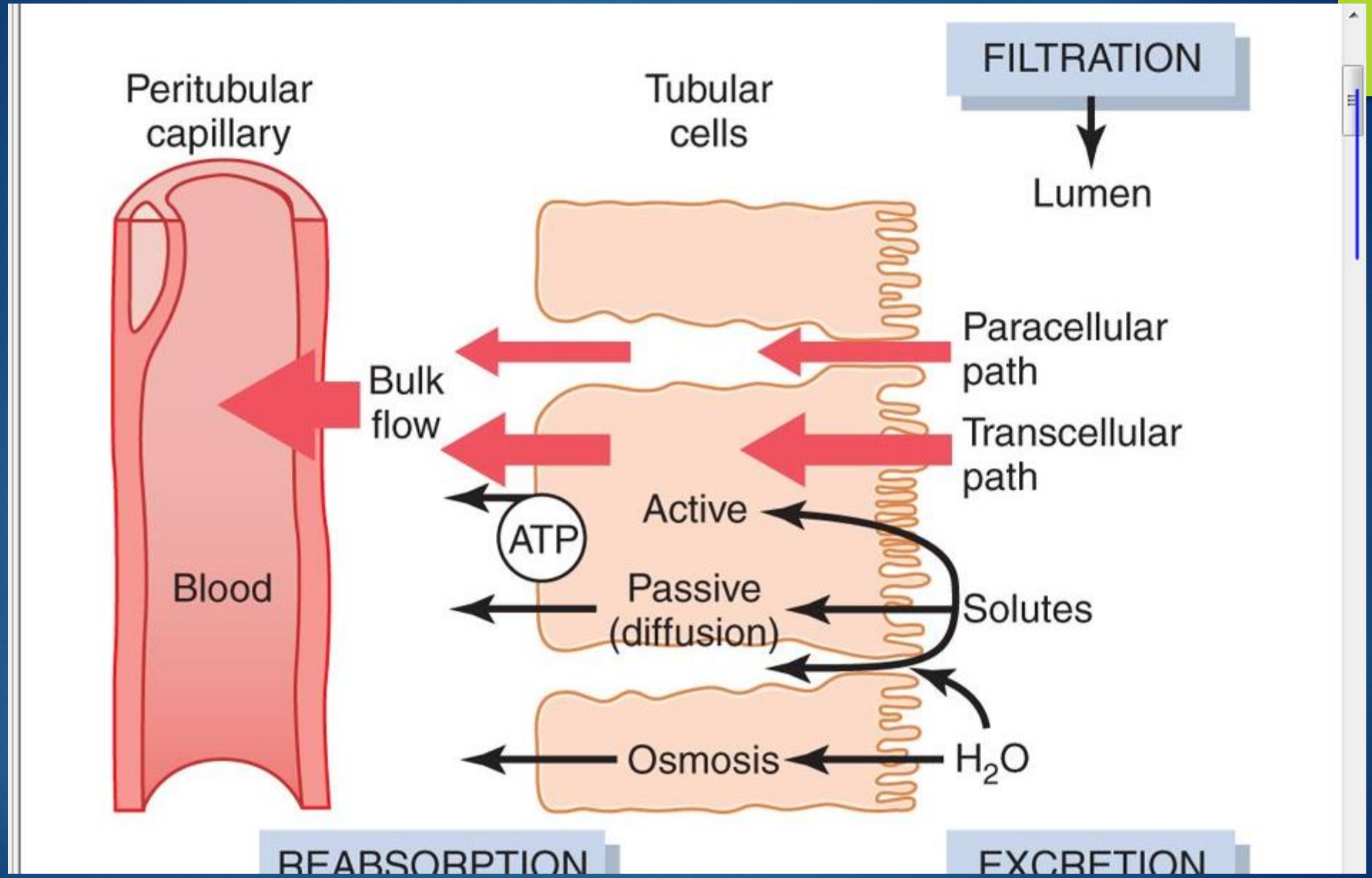
TUBULAR REABSORPTION INCLUDES PASSIVE AND ACTIVE MECHANISM

For a substance to be reabsorbed, it must first be transported

- (1) across the tubular epithelial membranes into the renal interstitial fluid and then
- (2) through the peritubular capillary membrane back into the blood

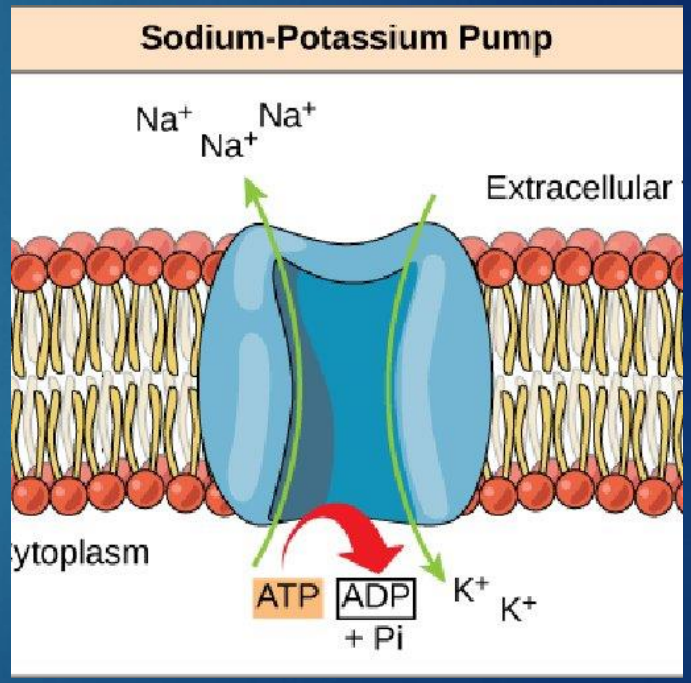
Water and solutes can be transported through

- the cell membranes themselves ***(transcellular route)*** or
- through the spaces between the cell junctions (***paracellular route***)


FILTRATION
Peritubular capillary
Tubular cells
Lumen
Paracellular path
Transcellular path
Bulk flow
ATP
Active
Passive (diffusion)
Solutes
Blood
Osmosis
H_2O
REABSORPTION
EXCRETION

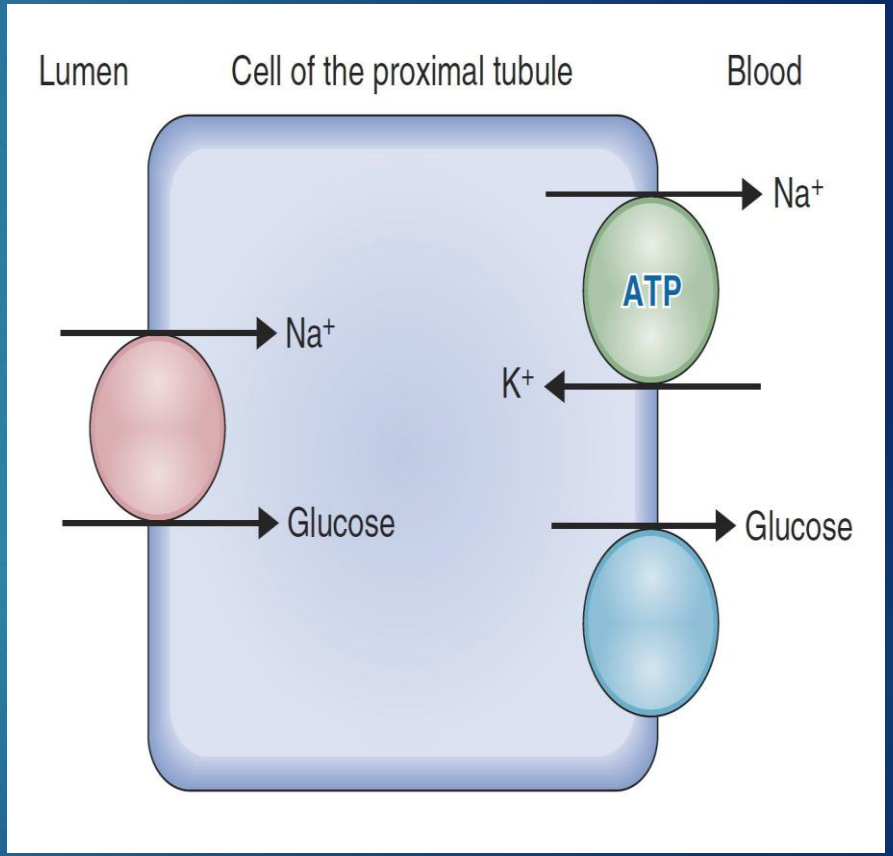
ACTIVE TRANSPORT

- Active transport can move a solute against an electrochemical gradient and requires energy derived from metabolism.
- Transport that is coupled directly to an energy source, such as the hydrolysis of adenosine triphosphate (ATP), is termed ***primary active transport***.
- A good example of this is the sodium-potassium ATPase pump that functions throughout most parts of the renal tubule.



Secondary active transport

- Transport that is coupled *indirectly* to an energy source, such as that due to an ion gradient, is referred to as ***secondary active transport***
- Reabsorption of glucose by the renal tubule is an example of secondary active transport



Osmosis

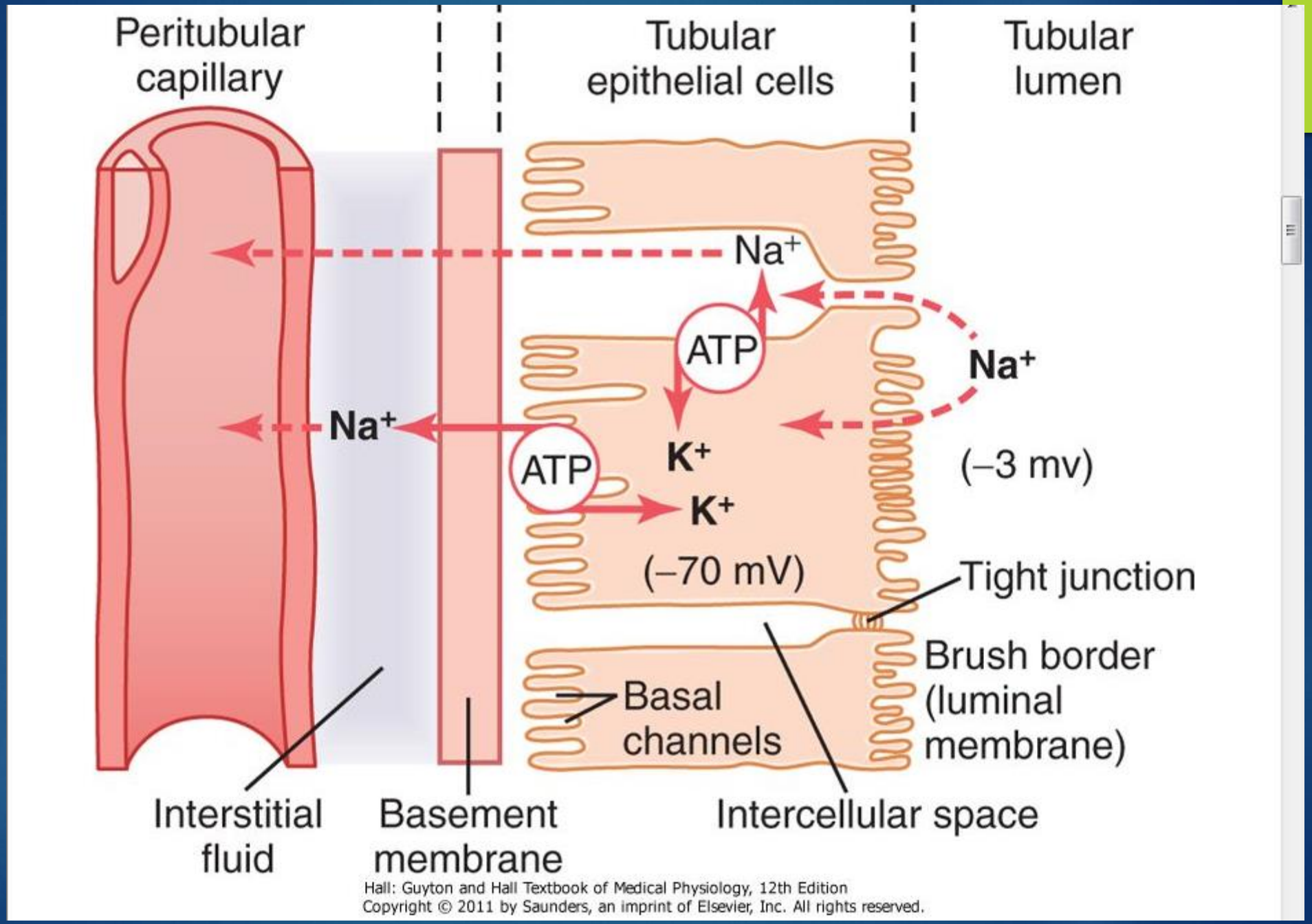
- Although solutes can be reabsorbed by active and/or passive mechanisms by the tubule, water is always reabsorbed by a passive (nonactive) physical mechanism called ***osmosis,*** which means water diffusion from a **region of low solute concentration** (high water concentration) **to one of high solute** concentration (low water concentration).

SOLUTES CAN BE TRANSPORTED THROUGH EPITHELIAL CELLS OR BETWEEN CELLS

- **Solutes can be reabsorbed or secreted across the cells through the *transcellular pathway* or between the cells by moving across the tight junctions and intercellular spaces by way of the *paracellular pathway*.**
- Sodium is a substance that moves through both routes, although most of the sodium is transported through the transcellular pathway.

Primary Active Transport Through the Tubular Membrane Is Linked to Hydrolysis of ATP

- *The special importance of primary active transport is that it can move solutes against an electrochemical gradient.*
- The energy for this active transport comes from the hydrolysis of ATP by way of membrane-bound ATPase.
- The primary active transporters in the kidneys that are known include *sodium-potassium ATPase, hydrogen ATPase, hydrogen-potassium ATPase,* and *calcium ATPase.*



The net reabsorption of sodium ions from the tubular lumen back into the blood involves at least three steps:

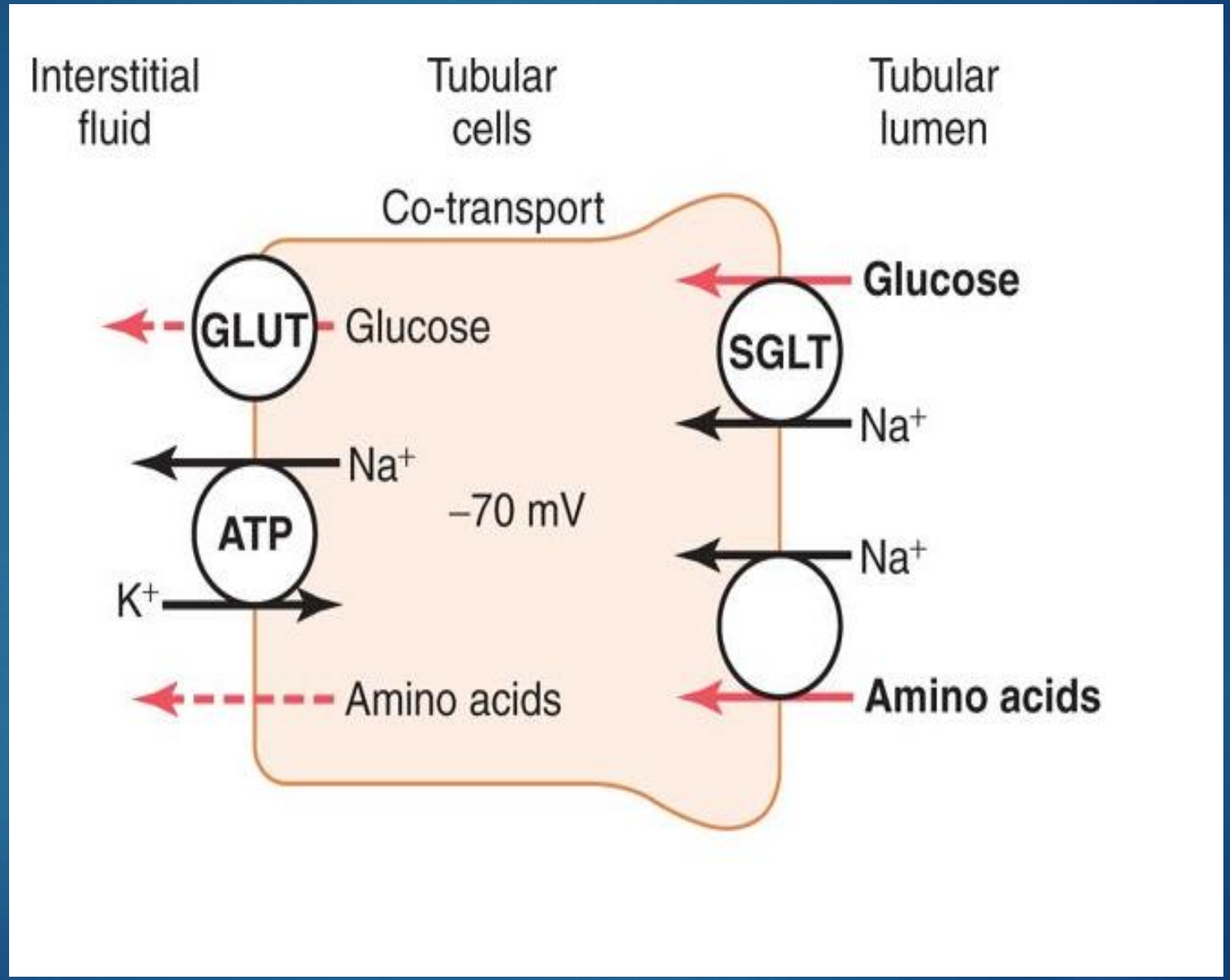
- 1. Sodium diffuses across the luminal membrane (also called the *apical membrane*) into the cell down an electrochemical gradient established by the sodium-potassium ATPase pump on the basolateral side of the membrane.
- 2. Sodium is transported across the basolateral membrane against an electrochemical gradient by the sodium-potassium ATPase pump.
- 3. Sodium, water, and other substances are reabsorbed from the interstitial fluid into the peritubular capillaries by ultrafiltration, a passive process driven by the hydrostatic and colloid osmotic pressure gradients

Secondary Active Reabsorption Through the Tubular Membrane

- In secondary active transport, two or more substances interact with a specific membrane protein (a carrier molecule) and are transported together across the membrane.
- As one of the substances (for instance, sodium) diffuses down its electrochemical gradient, the energy released is used to drive another substance (for instance, glucose) against its electrochemical gradient.

secondary active transport of glucose and amino acids in the proximal tubule.

- In both instances, specific carrier proteins in the brush border combine with a sodium ion and an amino acid or a glucose molecule at the same time.
- These transport mechanisms are so efficient that they remove virtually all the glucose and amino acids from the tubular lumen.
- After entry into the cell, glucose and amino acids exit across the basolateral membranes by diffusion.


Interstitial fluid
Tubular cells
Tubular lumen
Co-transport
GLUT
Glucose
Na+
ATP
K+
−70 mV
Amino acids
Glucose
SGLT
Na+
Na+
Amino acids

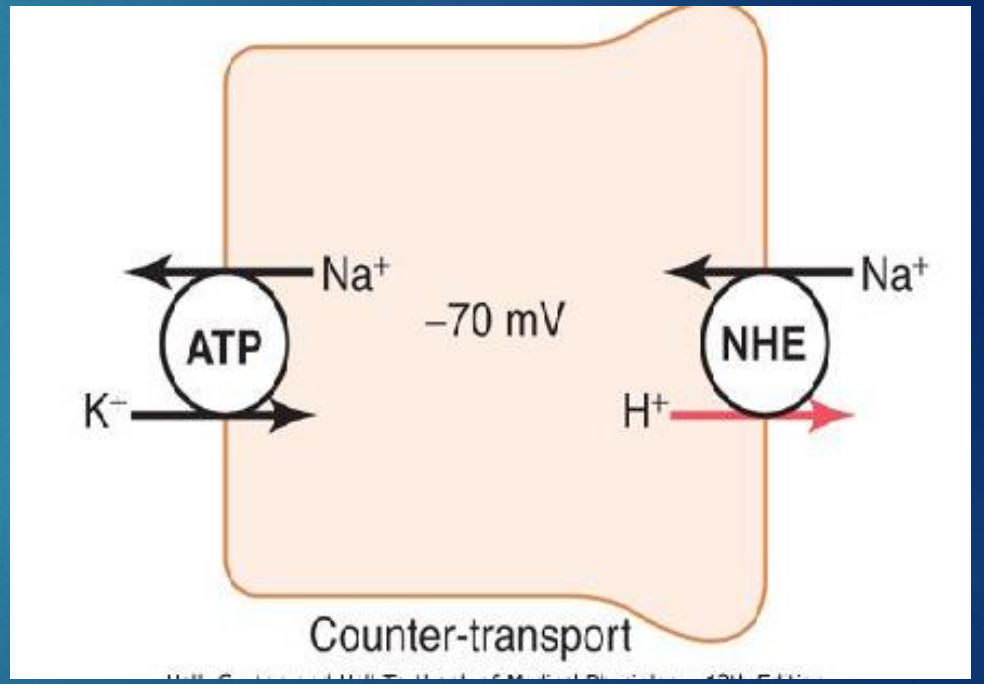
CO-TRANPORT

- ***Sodium glucose co-transporters (SGLT2 and SGLT1)***
- are located on the brush border of proximal tubular cells and carry glucose into the cell cytoplasm against a concentration gradient, as described previously. Approximately 90 percent of the filtered glucose is reabsorbed by SGLT2 in the early part of the proximal tubule
- the residual 10 percent is transported by SGLT1 in the latter segments of the proximal tubule.
- On the basolateral side of the membrane, glucose diffuses out of the cell into the interstitial spaces with the help of ***glucose transporters-GLUT2,*** **in the S1 segment and *GLUT1* in the latter part (S3 segment) of the proximal tubule.**

Secondary Active Secretion into the Tubules- COUNTER-TRANSPORT

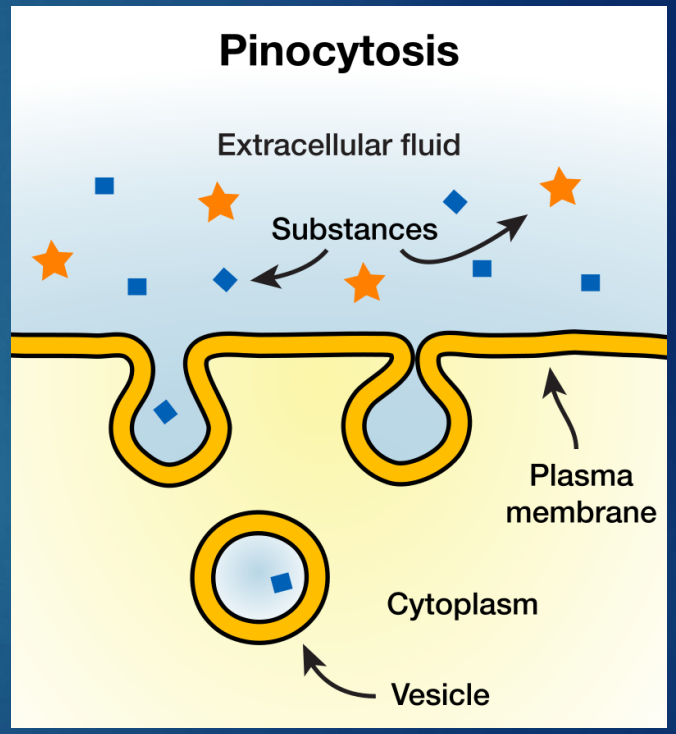
- Some substances are secreted into the tubules by secondary active transport. This often involves *counter-transport* of the substance with sodium ions.
- In counter-transport, the energy liberated from the downhill movement of one of the substances (e.g., sodium ions) enables uphill movement of a second substance in the opposite direction.

- One example of counter-transport, shown in Figure , is the active secretion of hydrogen ions coupled to sodium reabsorption in the luminal membrane of the proximal tubule.
- In this case, sodium entry into the cell is coupled with hydrogen extrusion from the cell by sodium-hydrogen counter-transport. This transport is mediated by a specific protein (*sodium-hydrogen exchanger*) in the brush border of the luminal membrane.
- As sodium is carried to the interior of the cell, hydrogen ions are forced outward in the opposite direction into the tubular lumen



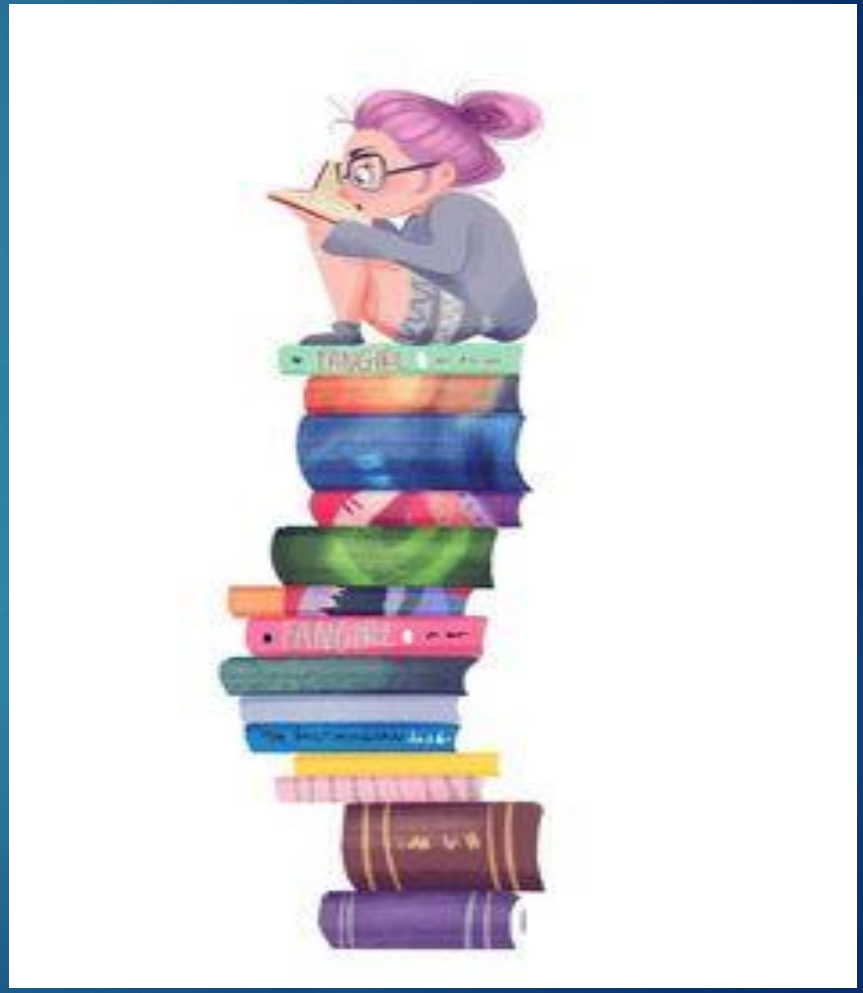
Pinocytosis-An Active Transport Mechanism for Reabsorption of Proteins

- The proximal tubule, reabsorb large molecules such as proteins by *pinocytosis*.
- In this process the protein attaches to the brush border of the luminal membrane, and this portion of the membrane then invaginates to the interior of the cell until it is completely pinched off and a vesicle is formed containing the protein.
- Inside the cell, the protein is digested into its constituent amino acids→ reabsorbed through the basolateral membrane into the interstitial fluid.
- Pinocytosis requires energy, it is considered a form of active transport



Recommended Books & links

- Guyton & Hall
- Sherwood
- Sembalingum
- https://www.youtube.com/watch?v=rwZIT_N75Bs
- https://www.youtube.com/watch?v=vD1n3-Z6Ec8




That's all Folks!