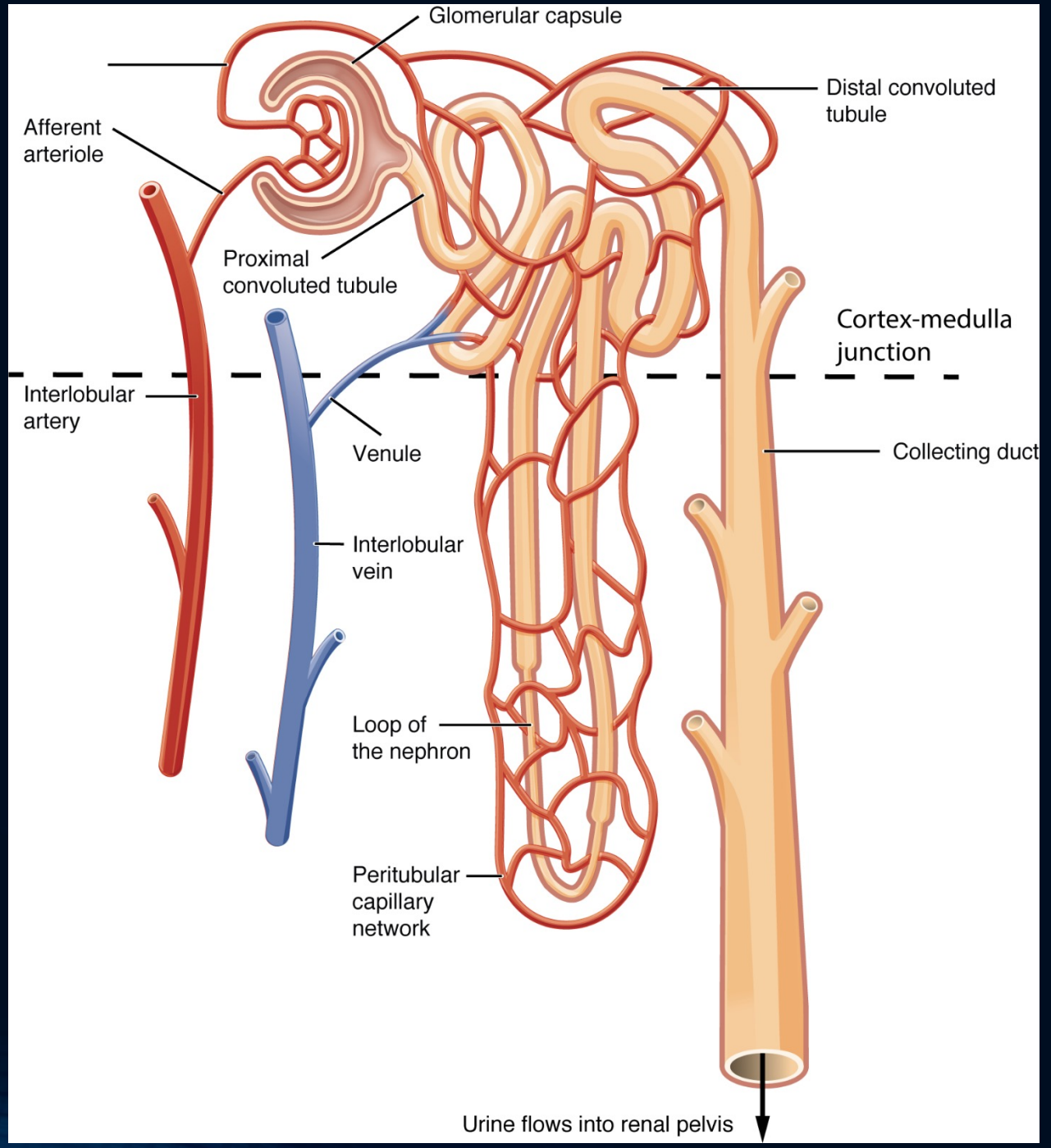
# Renal Physiology

RENAL PHYSIOLOGY 4 REABSORPTION LOOP OF HENLE

# Loop of Henle

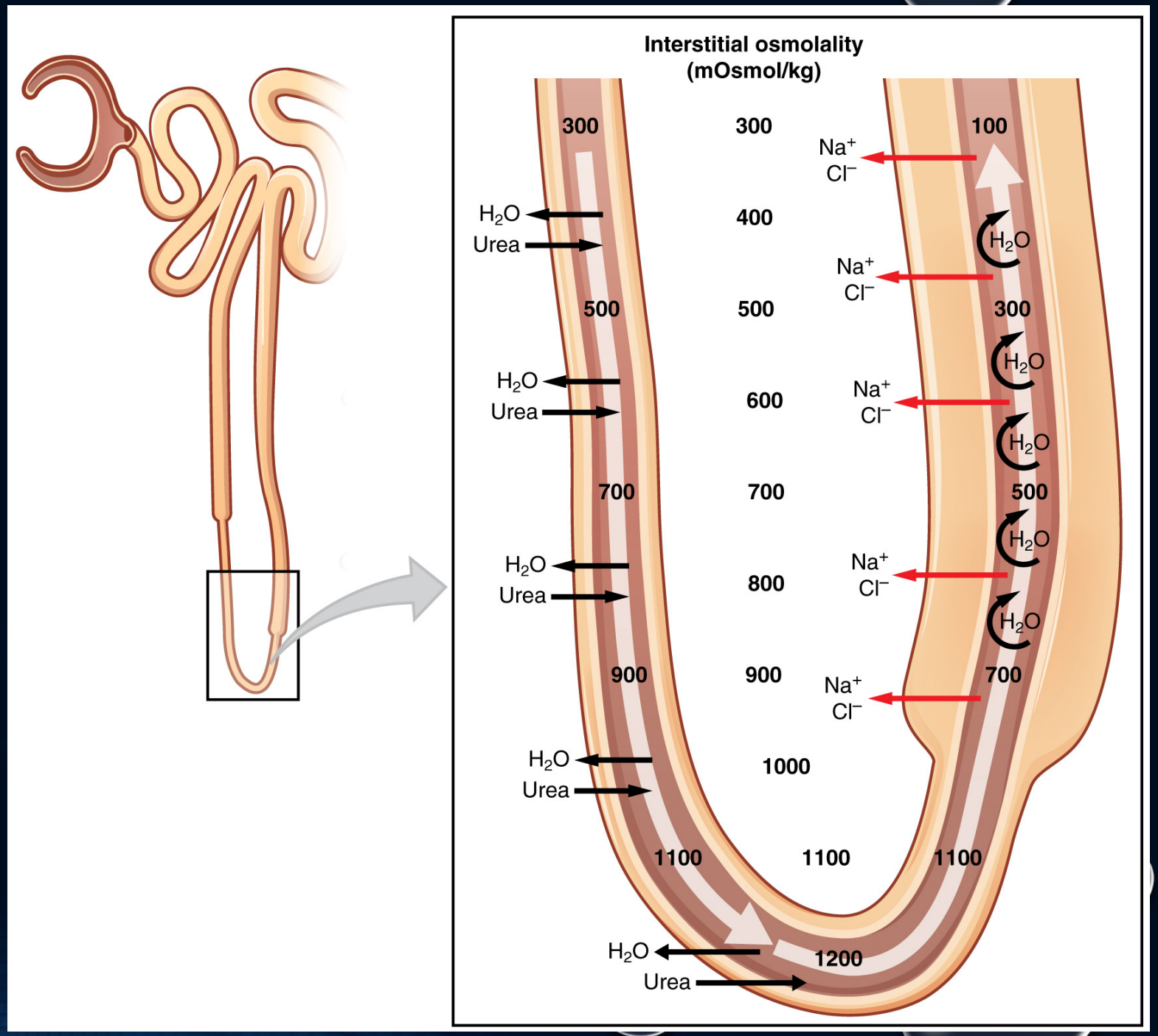
- Site of reabsorption of approximately 20% of solutes like Na+ and approximately 15% of water
- Descending loop is permeable to water and impermeable to Na+
- Ascending limb is permeable to Na+ but not to water
- In approximately 20% of nephrons, loop dips deep into the medulla
- Interstitial fluid becomes more concentrated as loop descends further into medulla
- Capillaries surrounding medullary loop are sometime called "vasa recta"

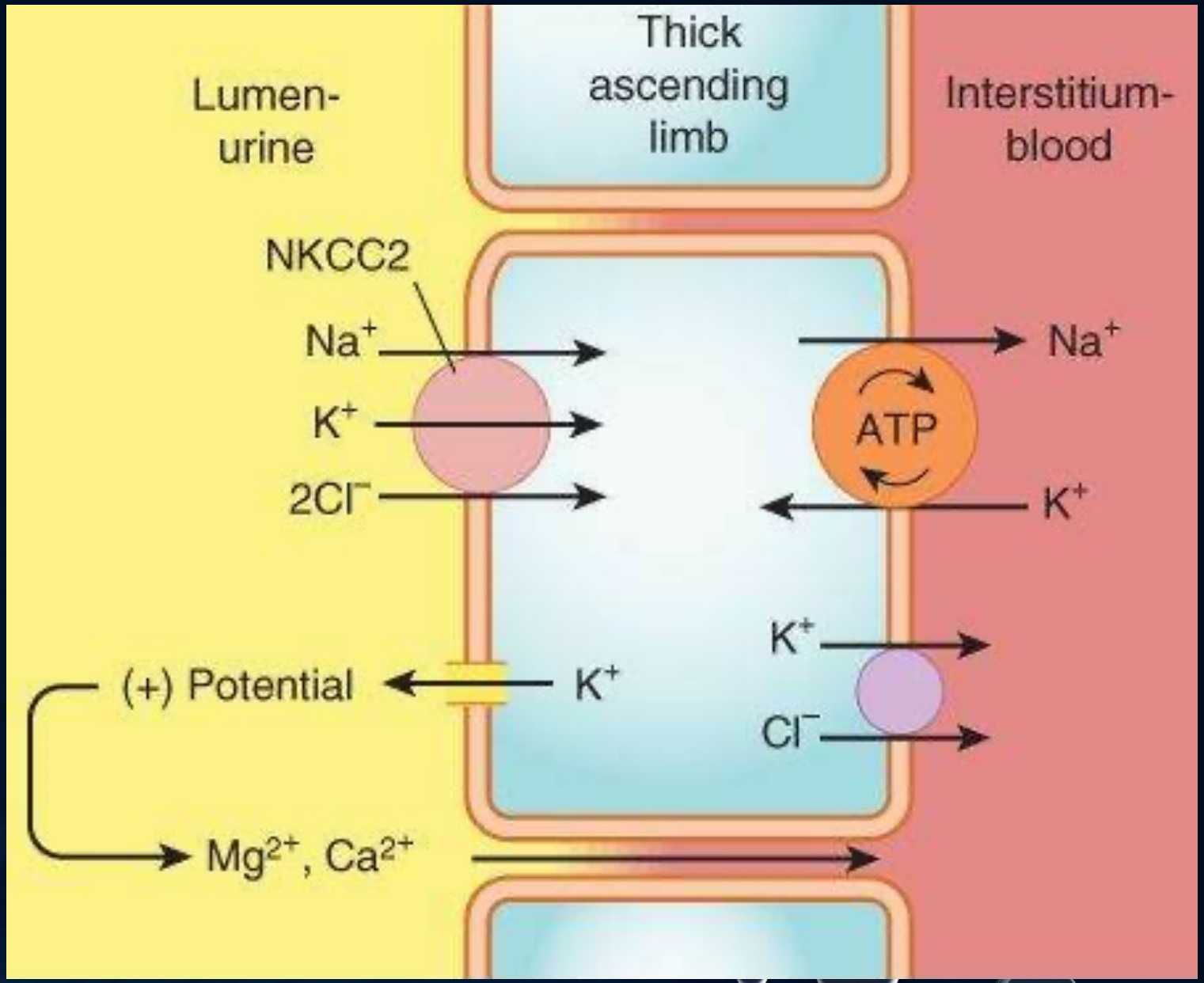


# Loop of Henle

- As filtrate goes through descending loop, H2O leaves nephron down its concentration gradient
- Filtrate becomes more concentrated as H2O but not solute leaves the loop
- Vasa recta have high osmotic pressure of capillary so water is drawn into capillaries
- Enters loop at 300 mosm/L; at bottom of loop, filtrate can be 1200 mosm/L

- As filtrate goes through ascending loop, Na+ and Cl- are reabsorbed through secondary active transport mechanisms similar to PCT
- With solute leaving, but H2O remaining, filtrate becomes diluted to ~100 mosm/L




Lumen-
urine
Thick
ascending
limb
Interstitium-
blood
NKCC2
Na+
K+
2Cl−
ATP
Na+
K+
(+) Potential
K+
K+
Cl−
Mg2+, Ca2+

# Renal Physiology

RENAL PHYSIOLOGY 5 REABSORPTION DCT AND CD

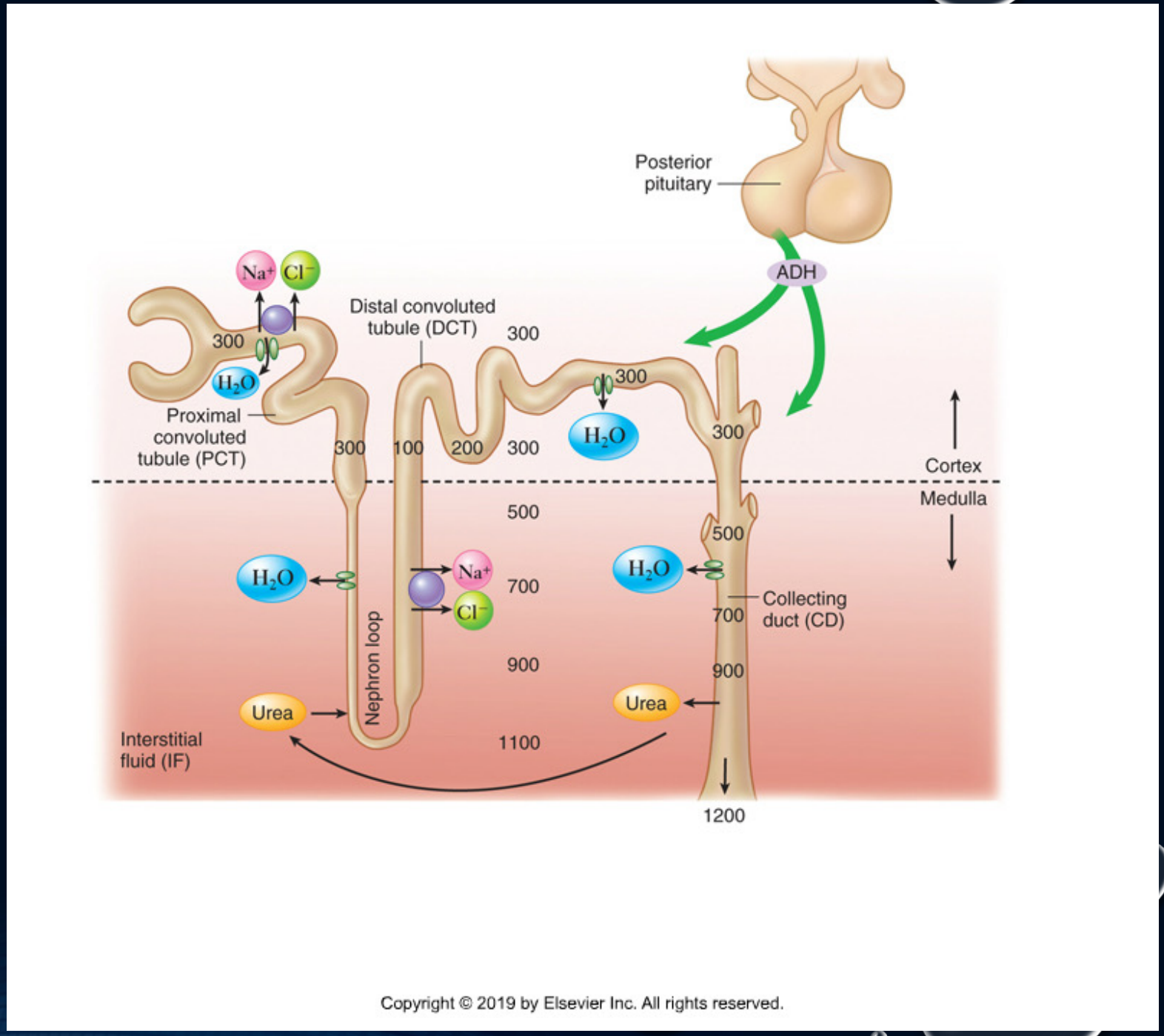
# Distal Convoluted Tubule and Collecting Duct

- Filtrate that reaches DCT from ascending loop of Henle is hypo-osmotic (~100 mosm/L)
- DCT and CD are locations where urine can remain dilute or can be concentrated depending on the fluid needs of the body
  - If we are dehydrated, more water is reabsorbed, urine is more concentrated
  - If we are overhydrated, less water is reabsorbed, urine is more dilute
- Hormones influence these actions
  - Antidiuretic hormone (ADH)
  - Aldosterone (ALDO)
  - Atrial natriuretic factor / peptide / hormone

# Producing concentrated urine ADH

Associated with increased action of ADH and aldosterone

- ADH increases the expression of aquaporin channels on DCT and CD



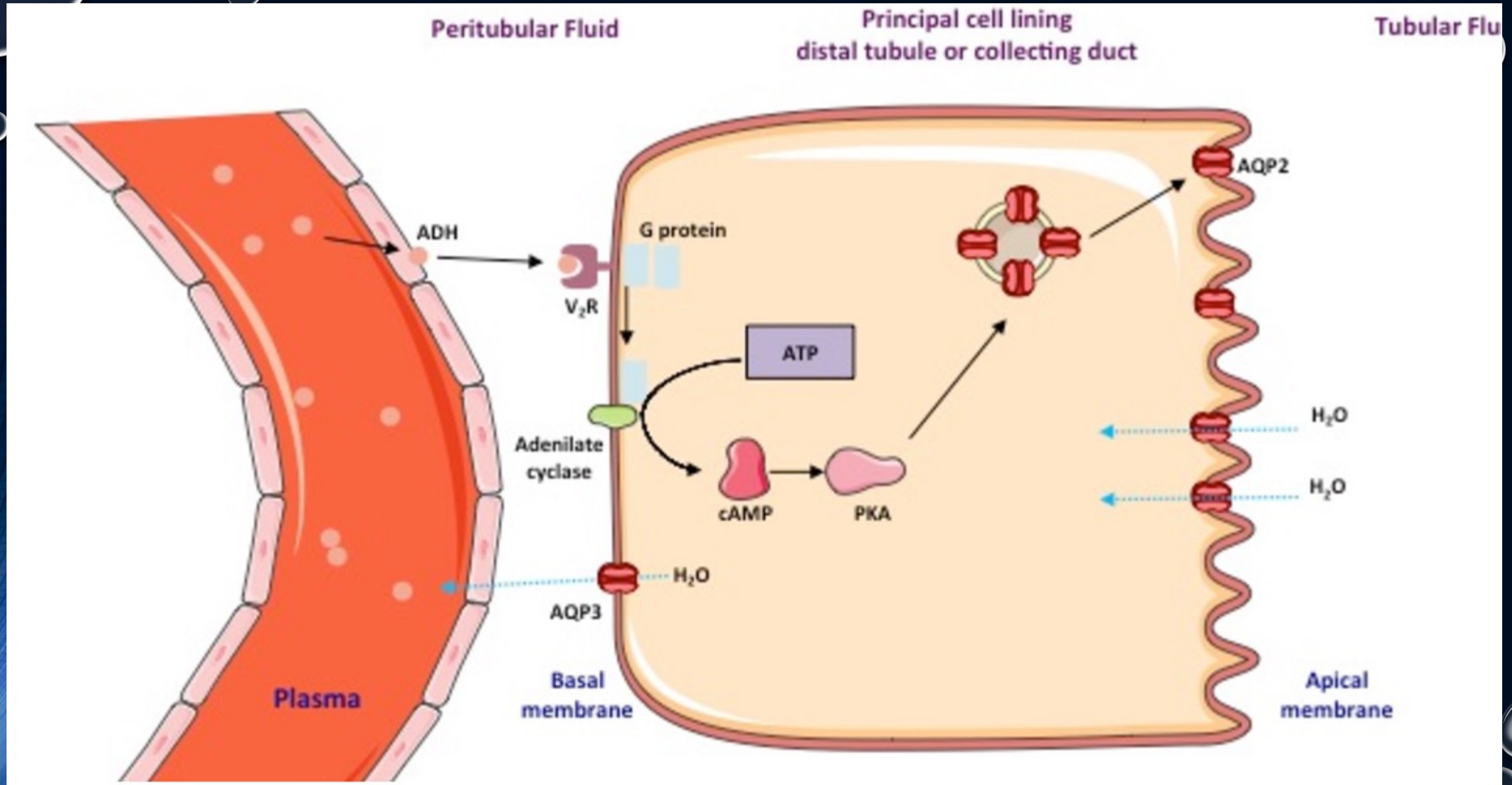
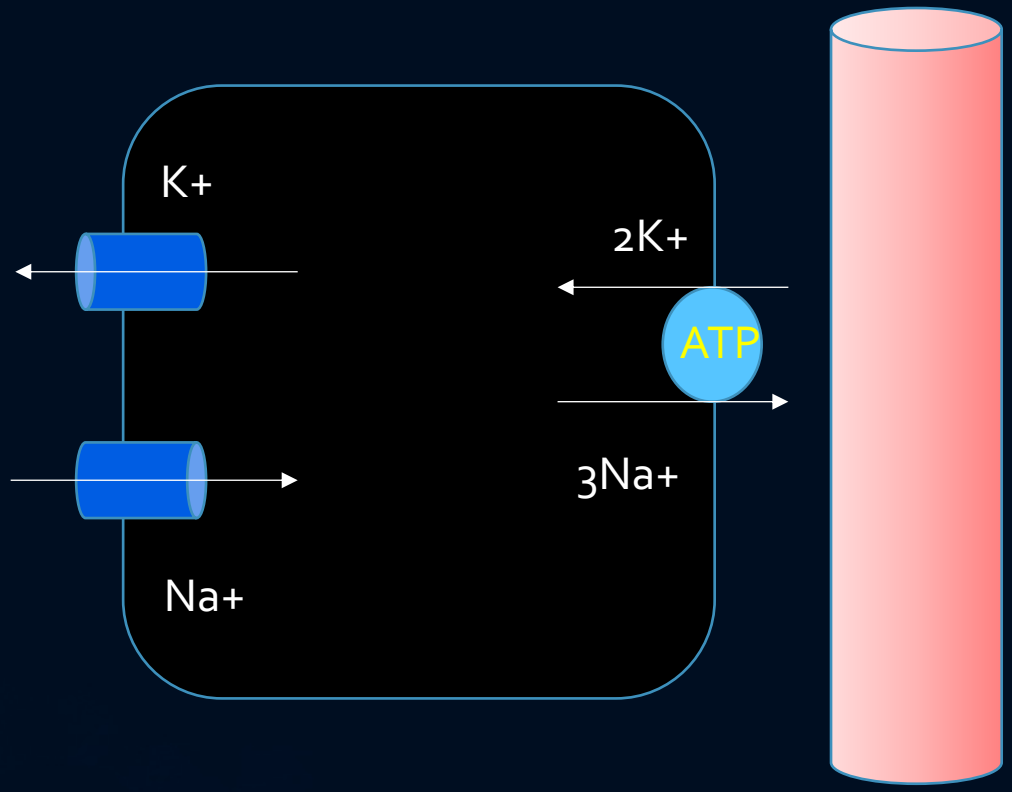


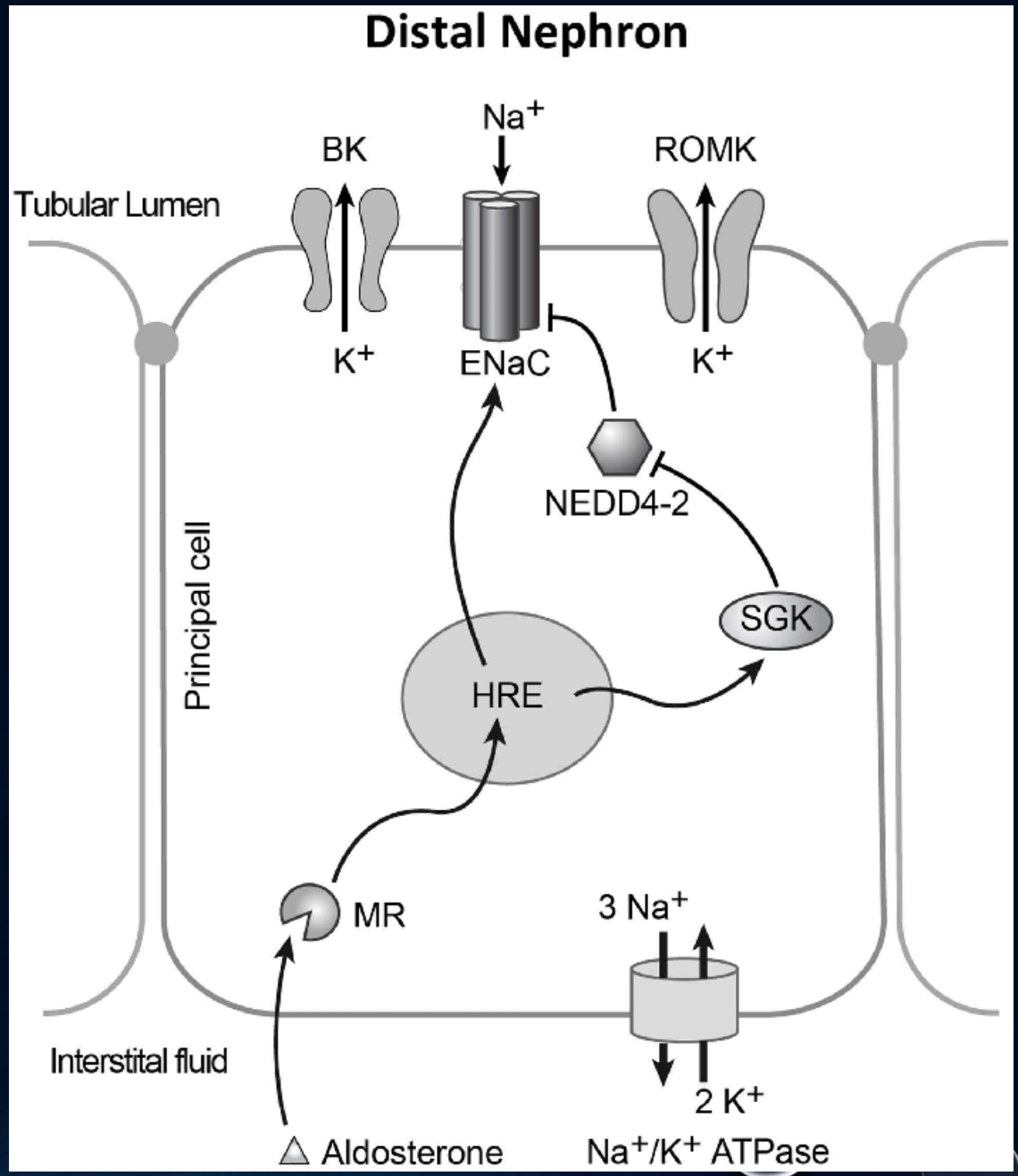

**Figure 4.** Mechanism of action of antidiuretic hormone (ADH) in the distal convoluted tubule and collecting duc

# Producing concentrated urine Aldosterone & ADH

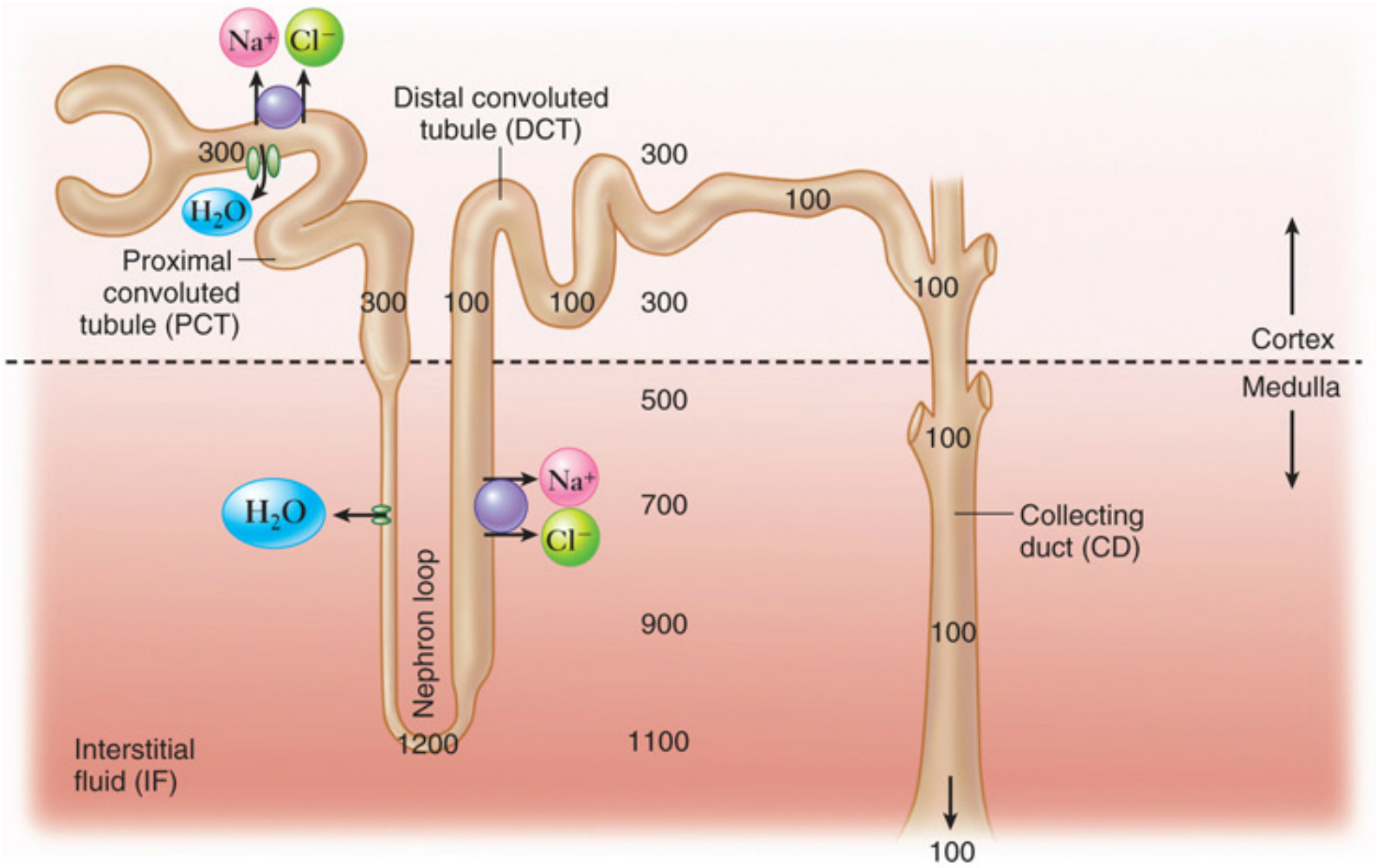



Associated with increased action of ADH and aldosterone

- Aldosterone increases expression of the following:
  - Apical Na+ channels
  - Apical K+ channels
  - Basal Na+ / K+ pump
- Aldosterone also increases the probability that Na+ and K+ channels will be open
- Aldosterone also increase the rate of activity of the Na+/K+ pump


Distal Nephron
Na+
BK
ROMK
Tubular Lumen
K+
ENaC
K+
NEDD4-2
Principal cell
SGK
HRE
MR
3 Na+
Interstital fluid
2 K+
Aldosterone
Na+/K+ ATPase

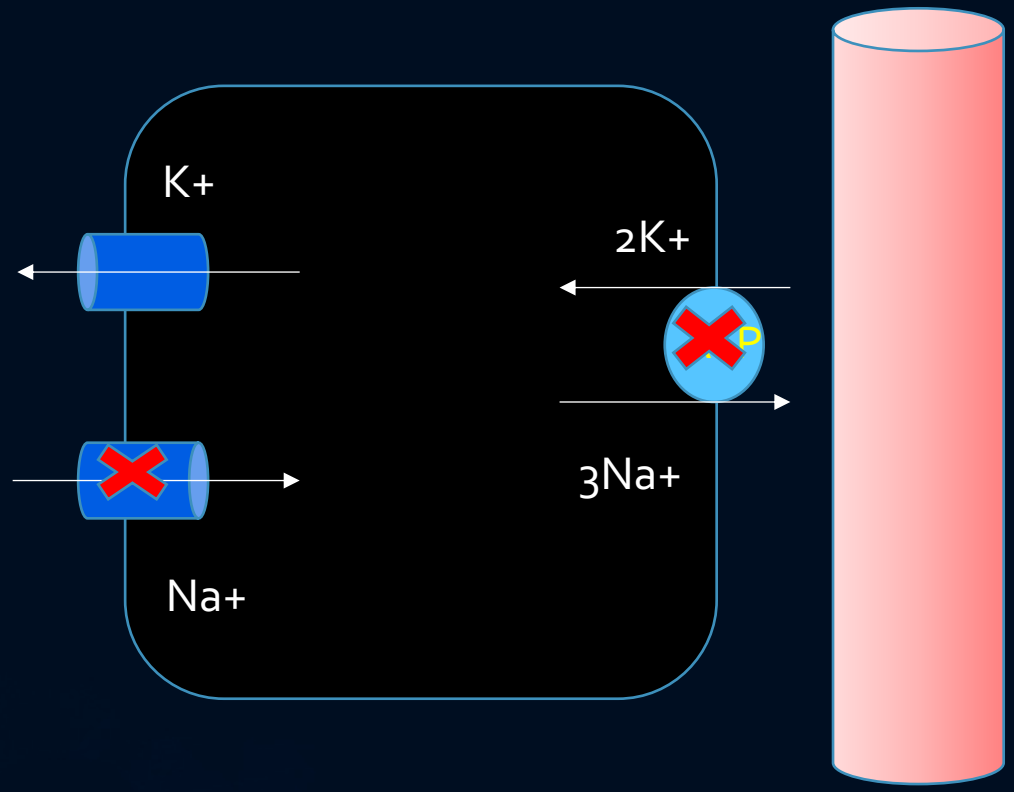
# Producing dilute urine



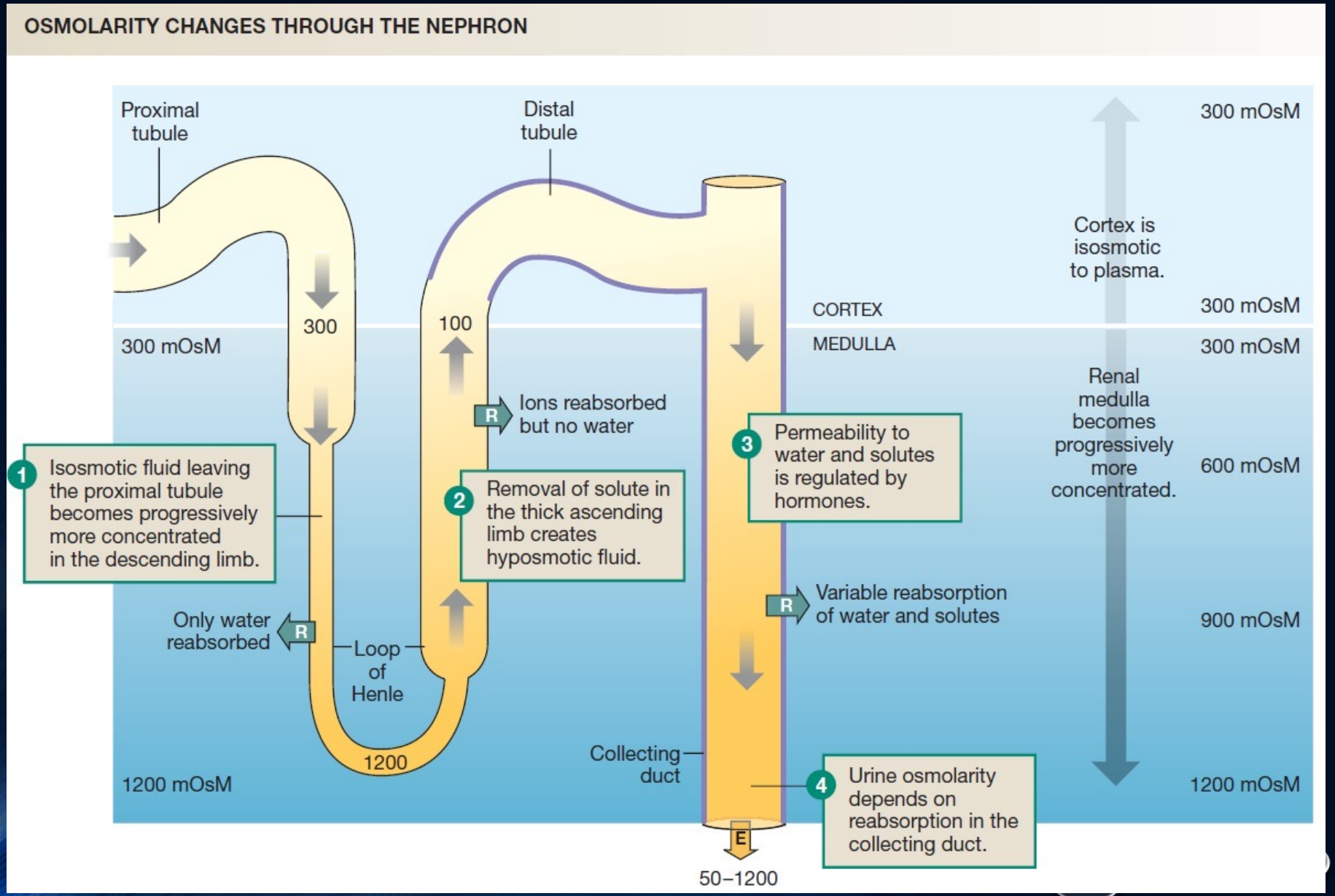
# Producing a dilute urine ANH

ANH inhibits the actions of aldosterone thus

- Decreased probability of opening of apical Na+ channels
- Decreased activity of basal Na+ / K+ pump



# Osmolarity Changes



# Renal Physiology

RENAL PHYSIOLOGY 6 SECRETION & EXCRETION

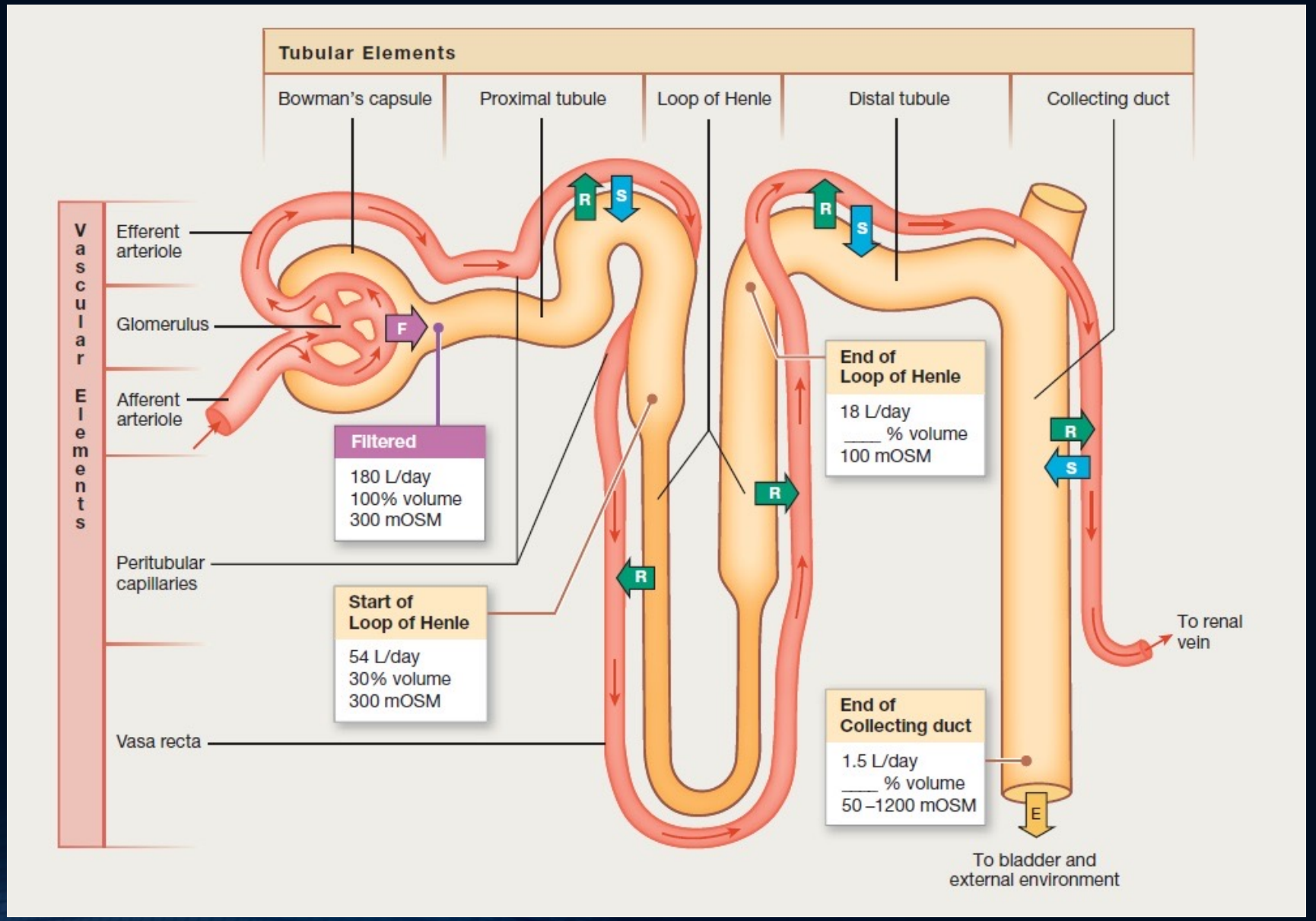
# Nephron Key Functions

Filtration
- Glom → BC

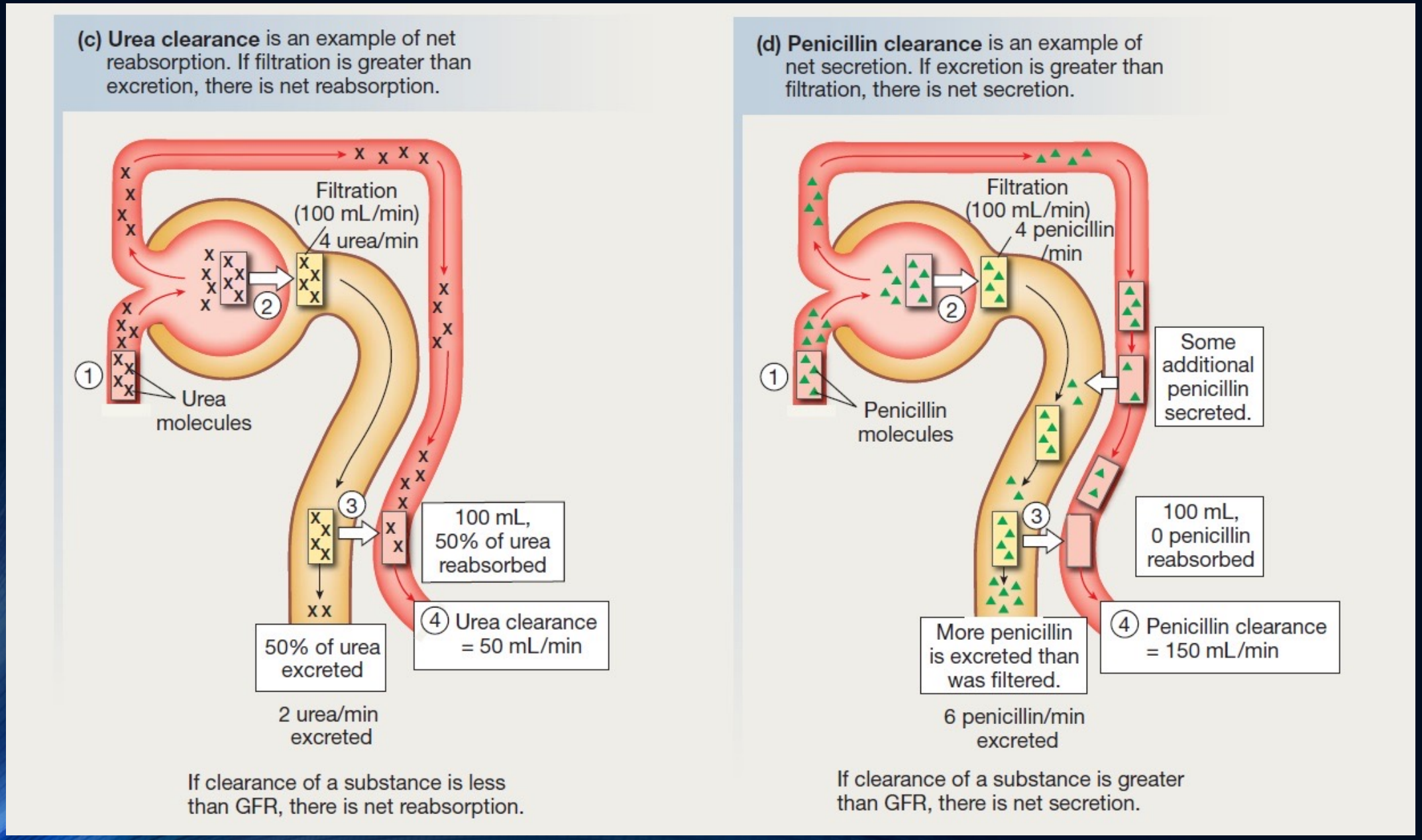
Reabsorption
- Tubule → PTC

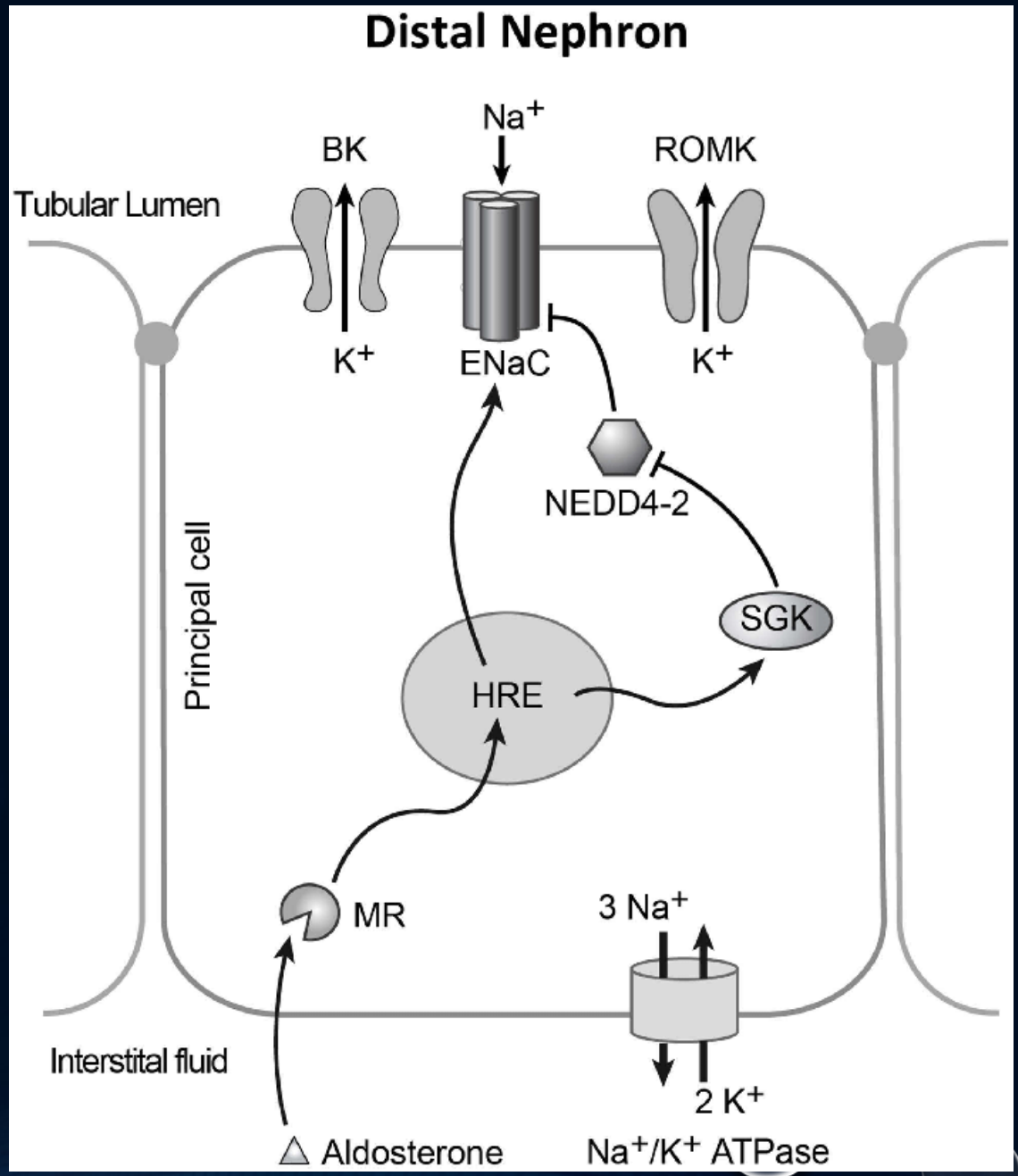
Secretion
- PTC → Tubule

Excretion
- E = F – R + S



# Reabsorption vs Secretion

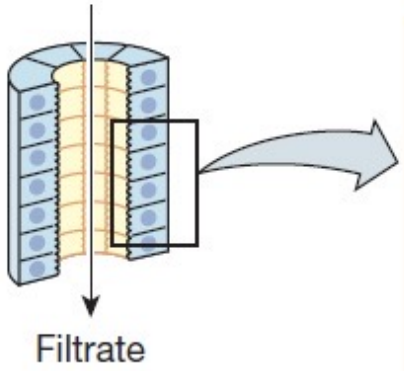


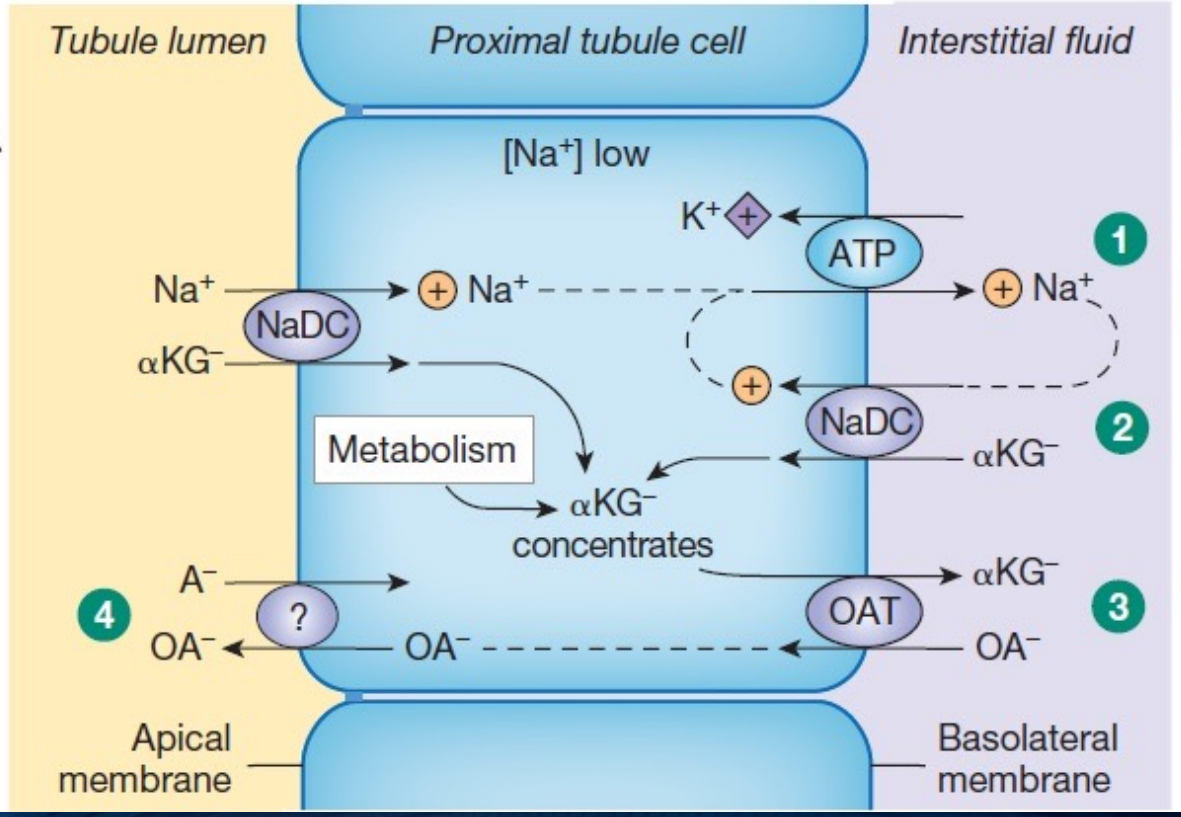

Distal Nephron
Na+
BK
ROMK
Tubular Lumen
K+
ENaC
K+
NEDD4-2
Principal cell
SGK
HRE
MR
3 Na+
Interstital fluid
2 K+
Aldosterone
Na+/K+ ATPase

# Secretion of Organic Anions (many drugs)

## ORGANIC ANION SECRETION

Proximal tubule secretion of organic anions by the organic anion transporter (OAT) is an example of tertiary active transport.




4 Organic anions enter the lumen by facilitated diffusion.

1 **Direct active transport**. The $Na^+$-$K^+$-ATPase keeps intracellular [$Na^+$] low.

2 **Secondary indirect active transport**. The $Na^+$-dicarboxylate cotransporter (NaDC) concentrates a dicarboxylate inside the cell using energy stored in the [$Na^+$] gradient.

3 **Tertiary indirect active transport**. The basolateral organic anion transporter (OAT) concentrates organic anions ($OA^-$) inside the cell, using the energy stored in the dicarboxylate gradient.

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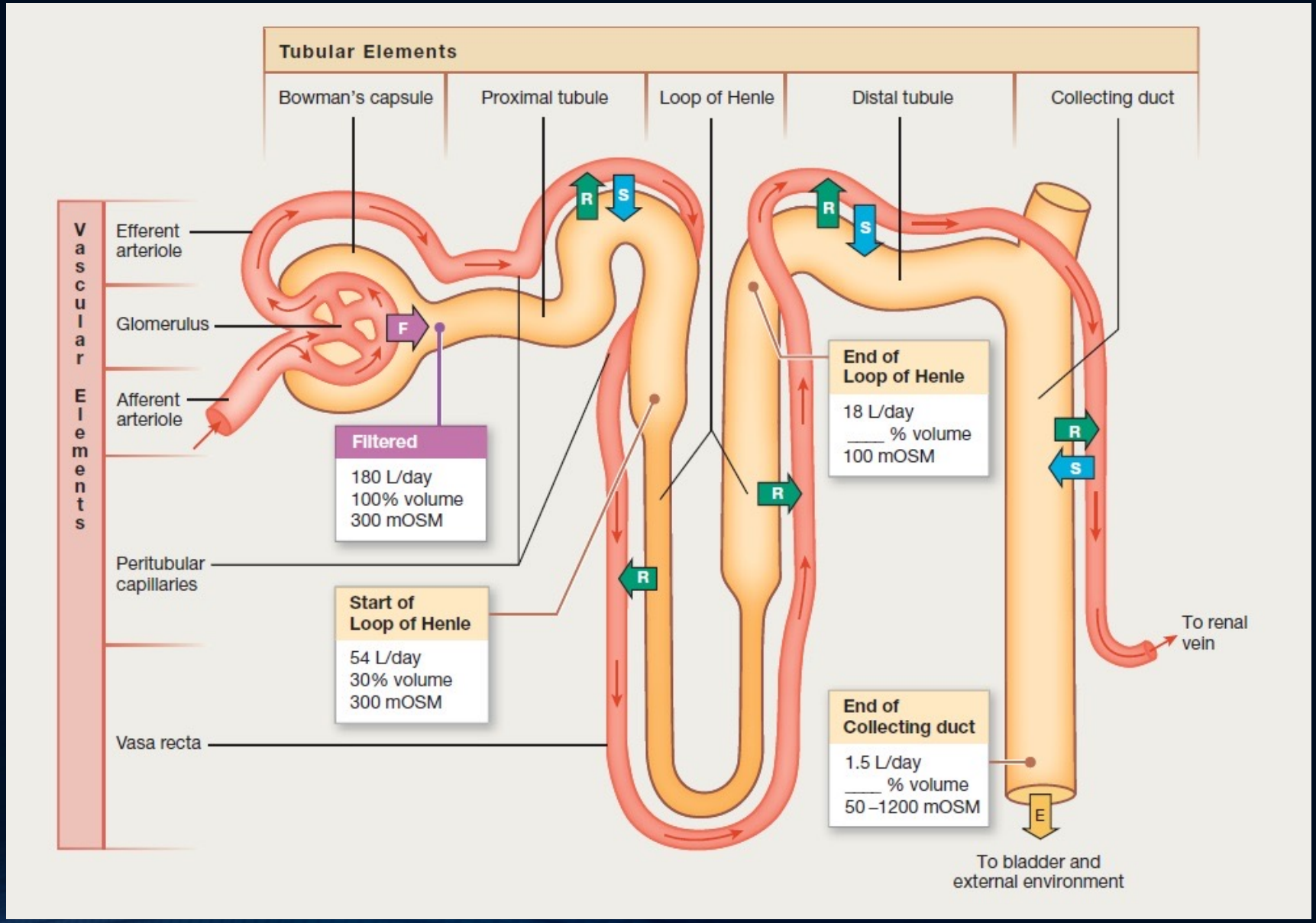

# Excretion

- Quantified is two ways
  - Clearance
    - Rate at which a substance is removed from the plasma (mL / min) through excretion and / or metabolism
    - $clearance\ \ (mL/\min) = \frac{excretion\ rate\ of\ A\ (mg/min)}{concentration\ of\ A\ in\ plasma\ mg/mL}$
    - Experimentally measured using inulin
      - Freely filtered, not reabsorbed, not secreted
      - Clearance of inulin is used to measure GFR
    - Clinically measured using creatinine
      - Freely filtered, not reabsorbed, slightly secreted
      - Creatinine clearance is estimate of GFR
  - Excretion rate
    - Amount of a substance excreted per min (mg / min)

# Reabsorption vs Secretion