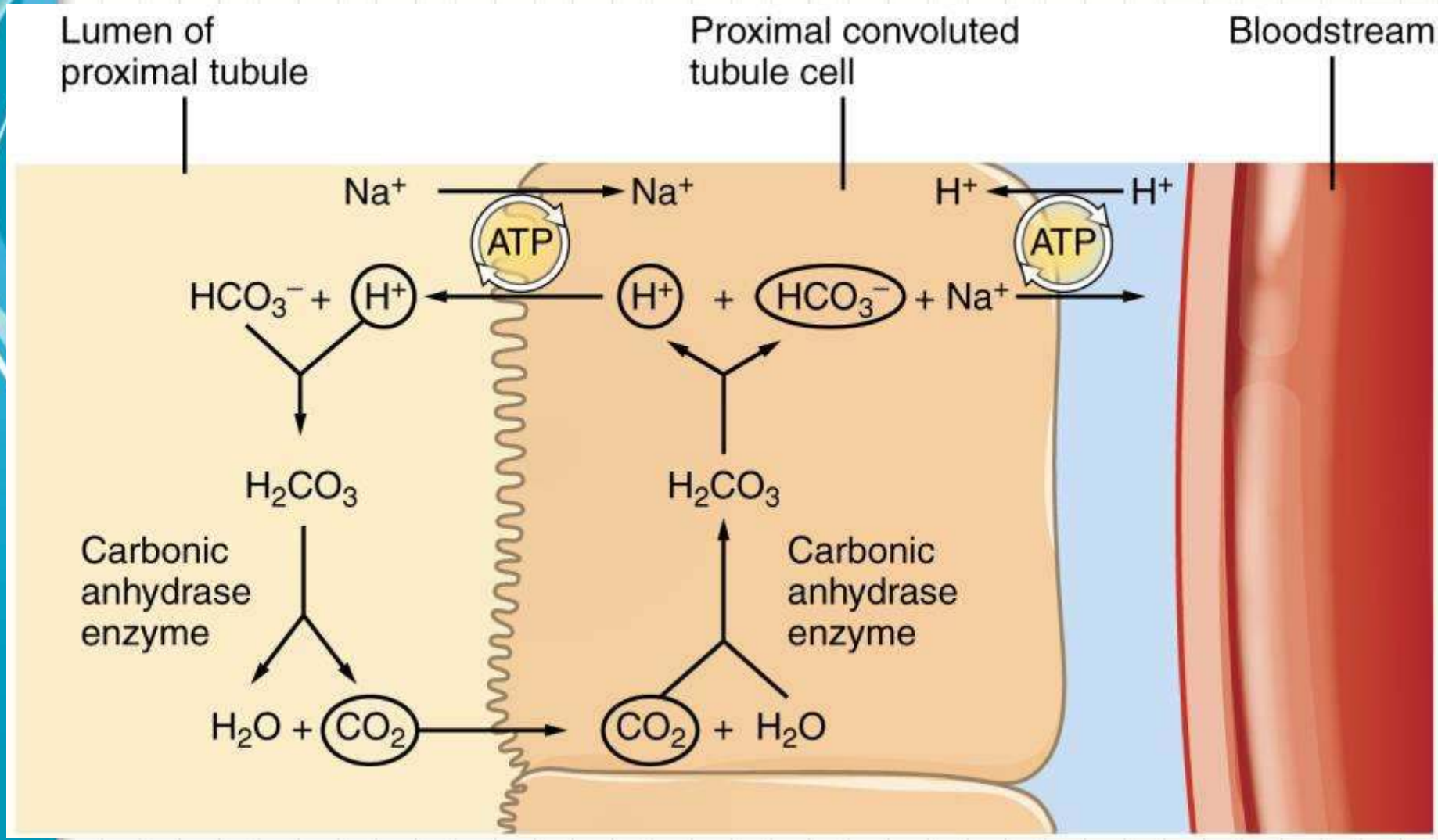
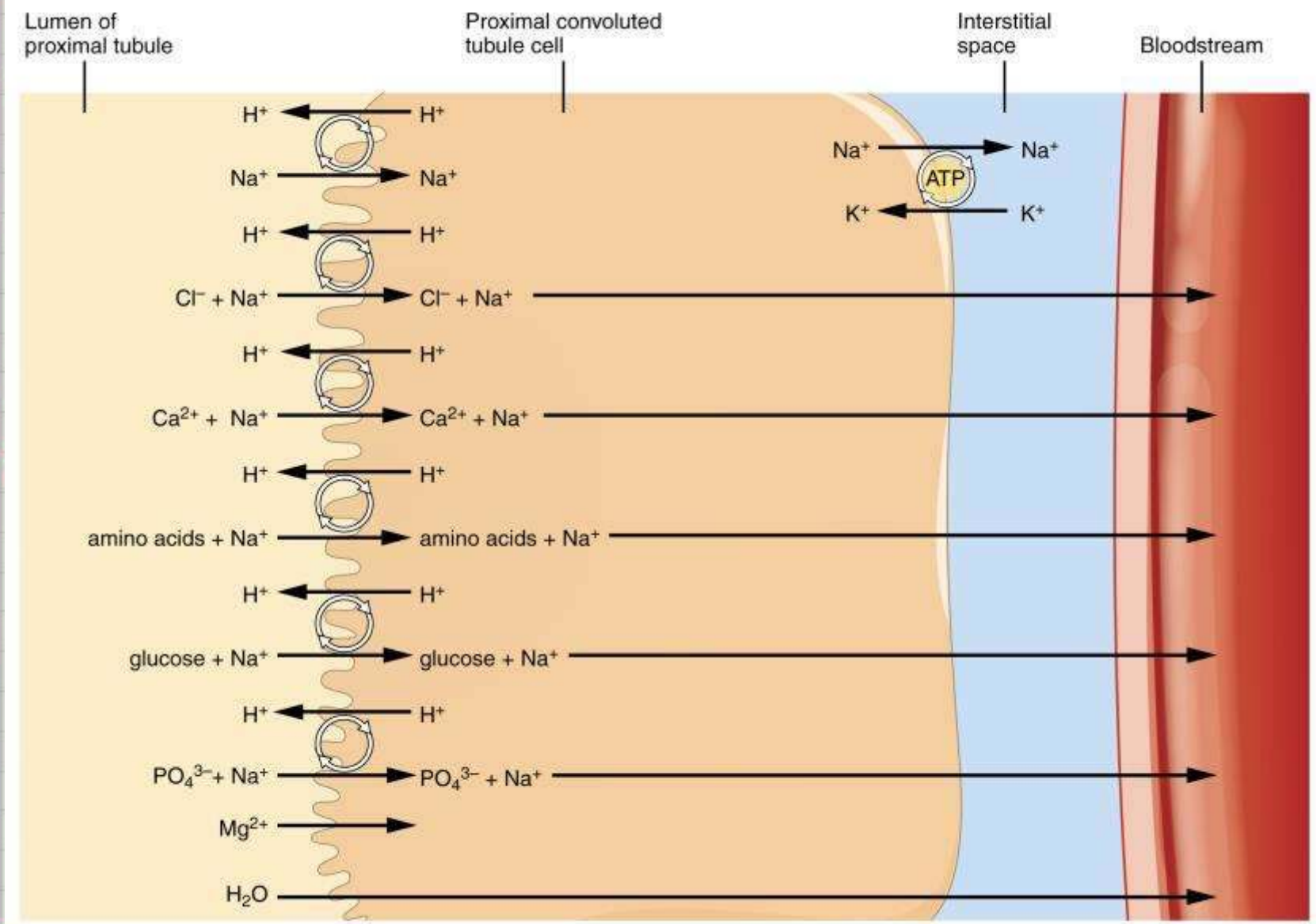
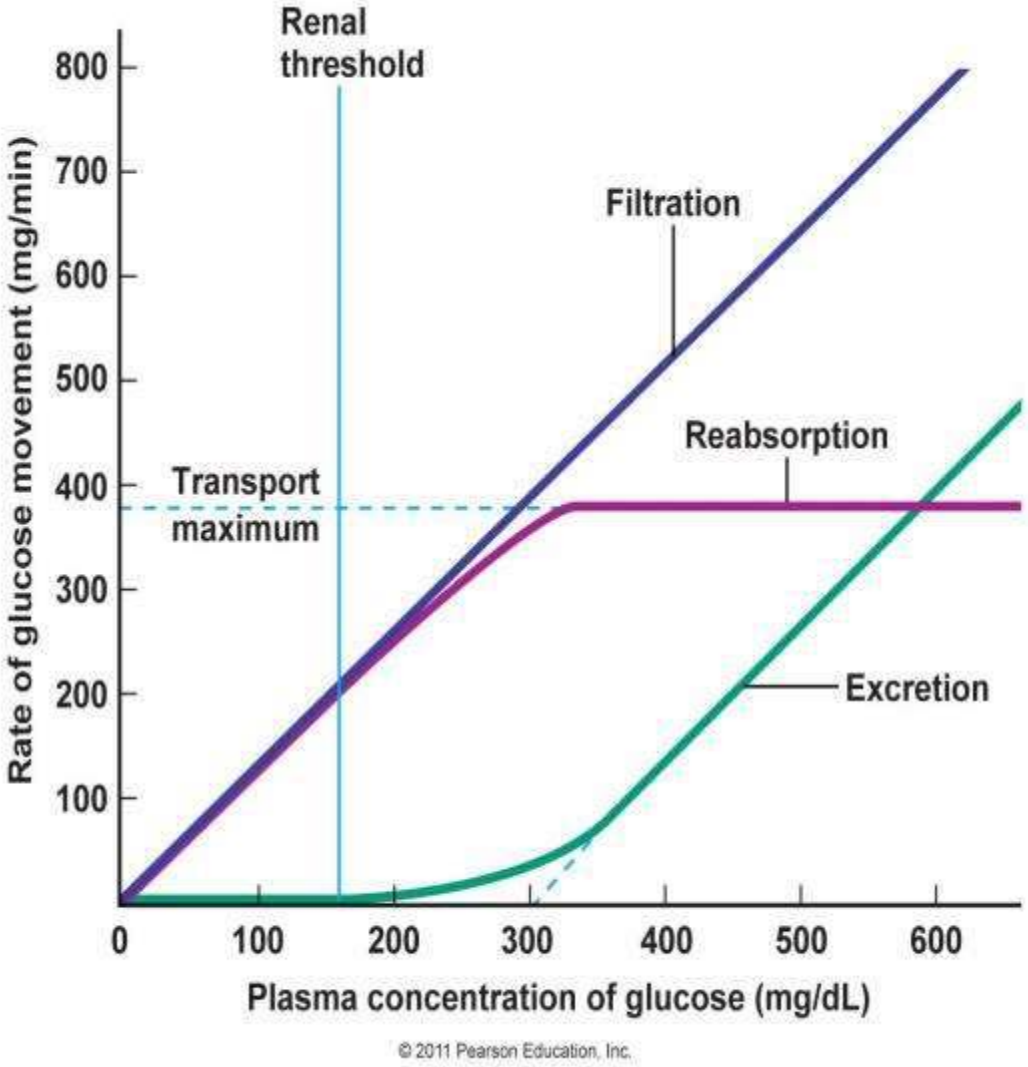
Transport Systems :H+ transport driven by Na+ transport



Transport Systems: Na+ Transport



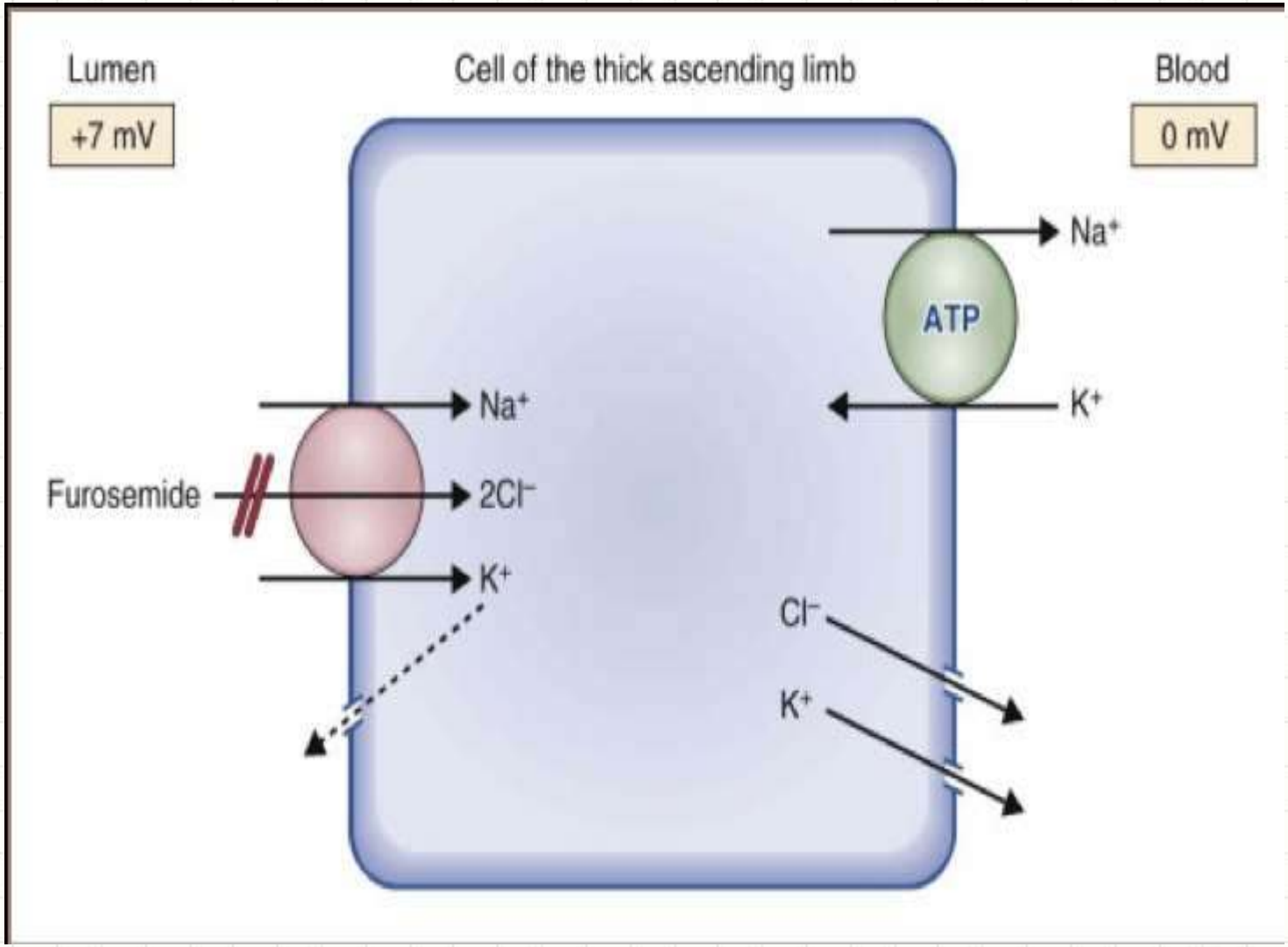
Example; Glucose Regulation



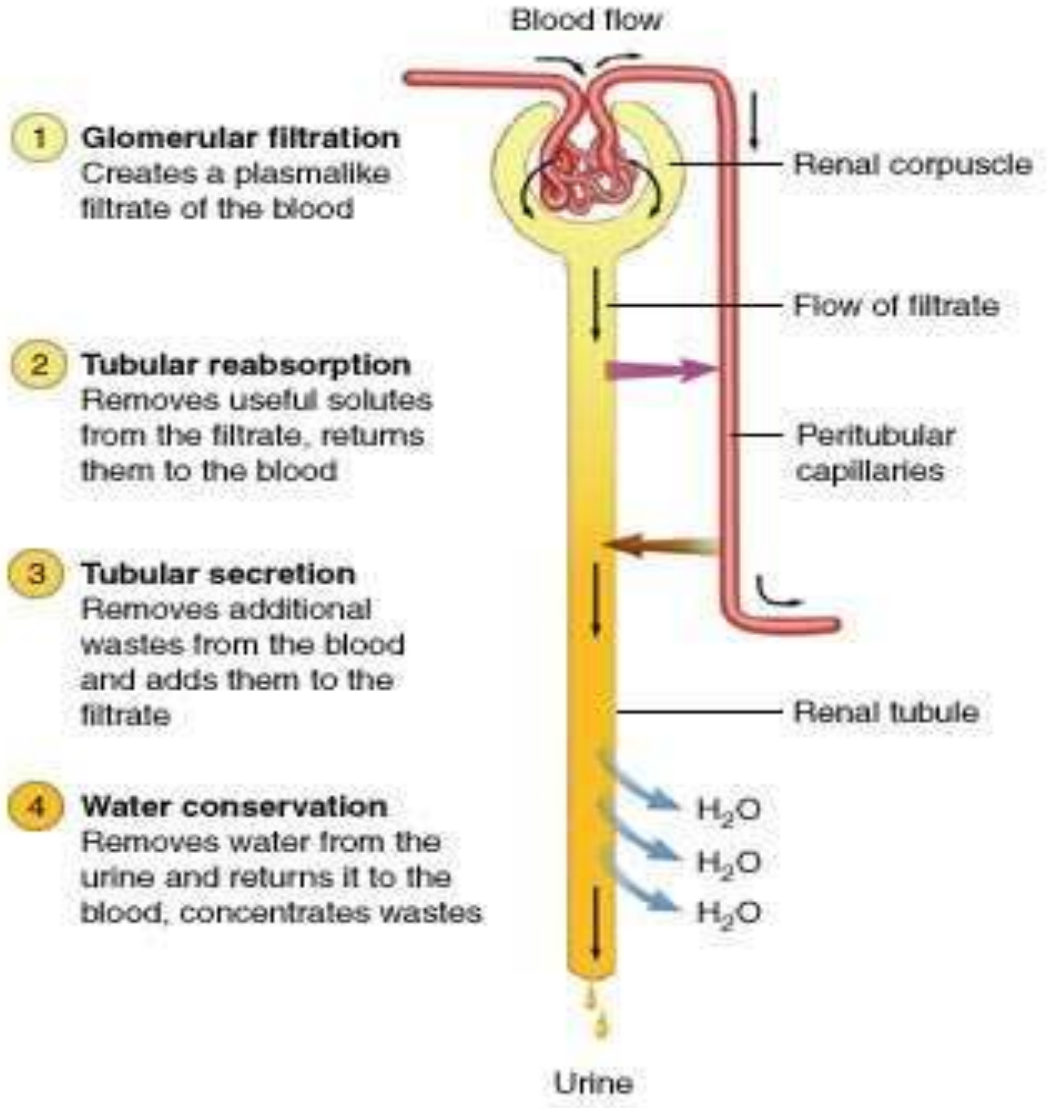
Normal glucose clearance is zero (i.e., no net loss)

- Filtration is complete
- Reabsorption complete (to a limit of about 320 mg/ min)
- Clearance increases for excess plasma glucose
- Diabetics have low reabsorption and can accumulate glucose in urine

Transport Systems: Na+ Transport at Loop of Henle (Furosemide)



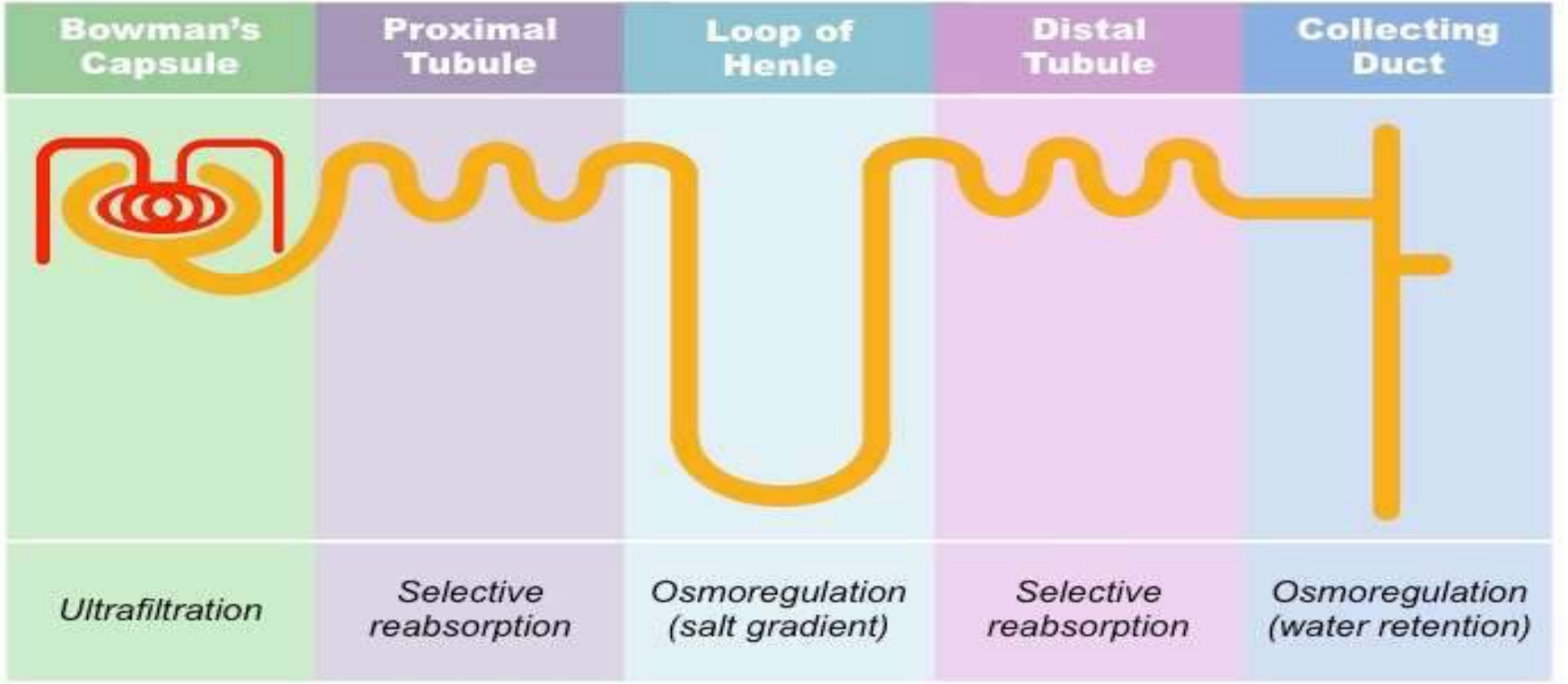
Nephron Functional Overview

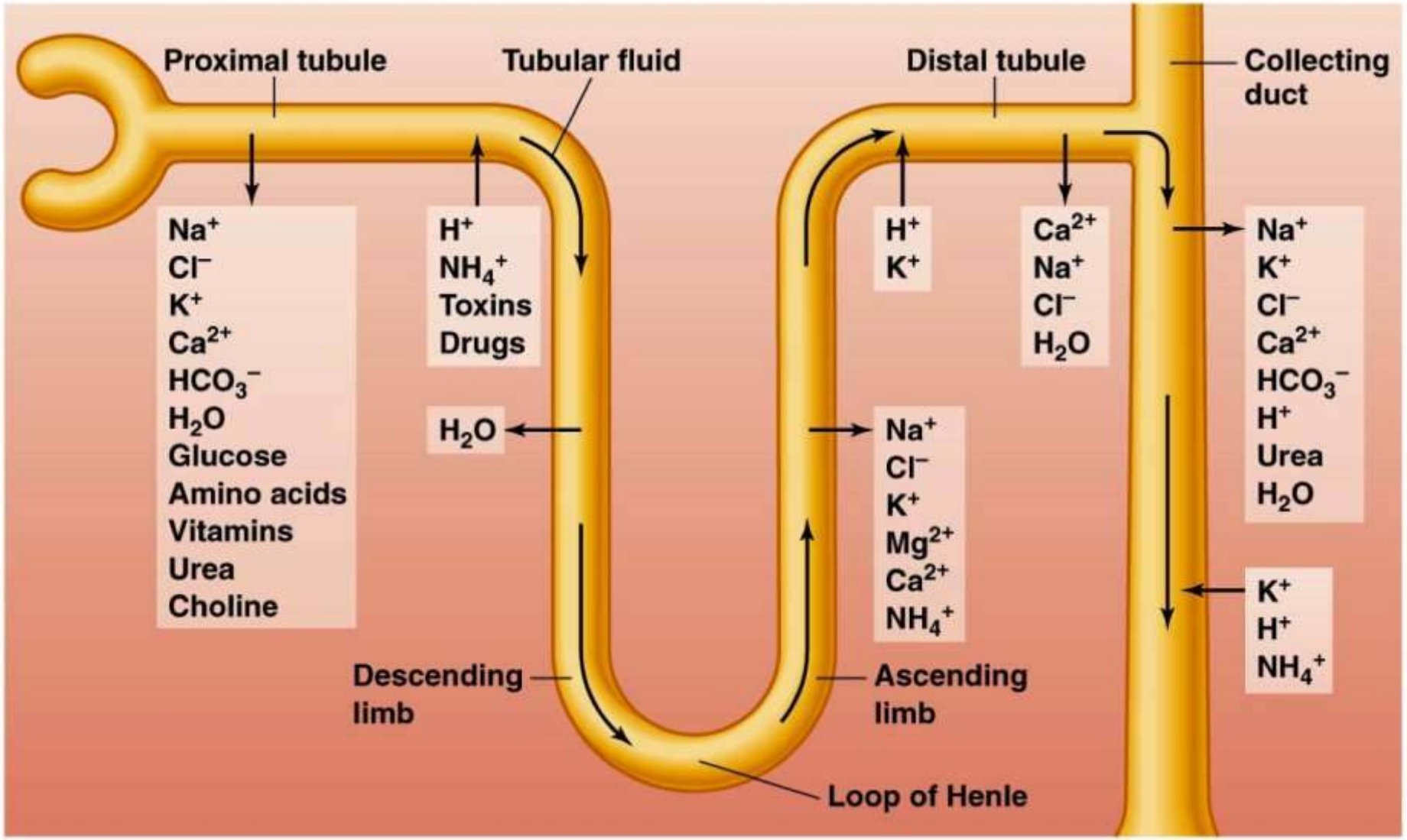


Nephron Functional Overview

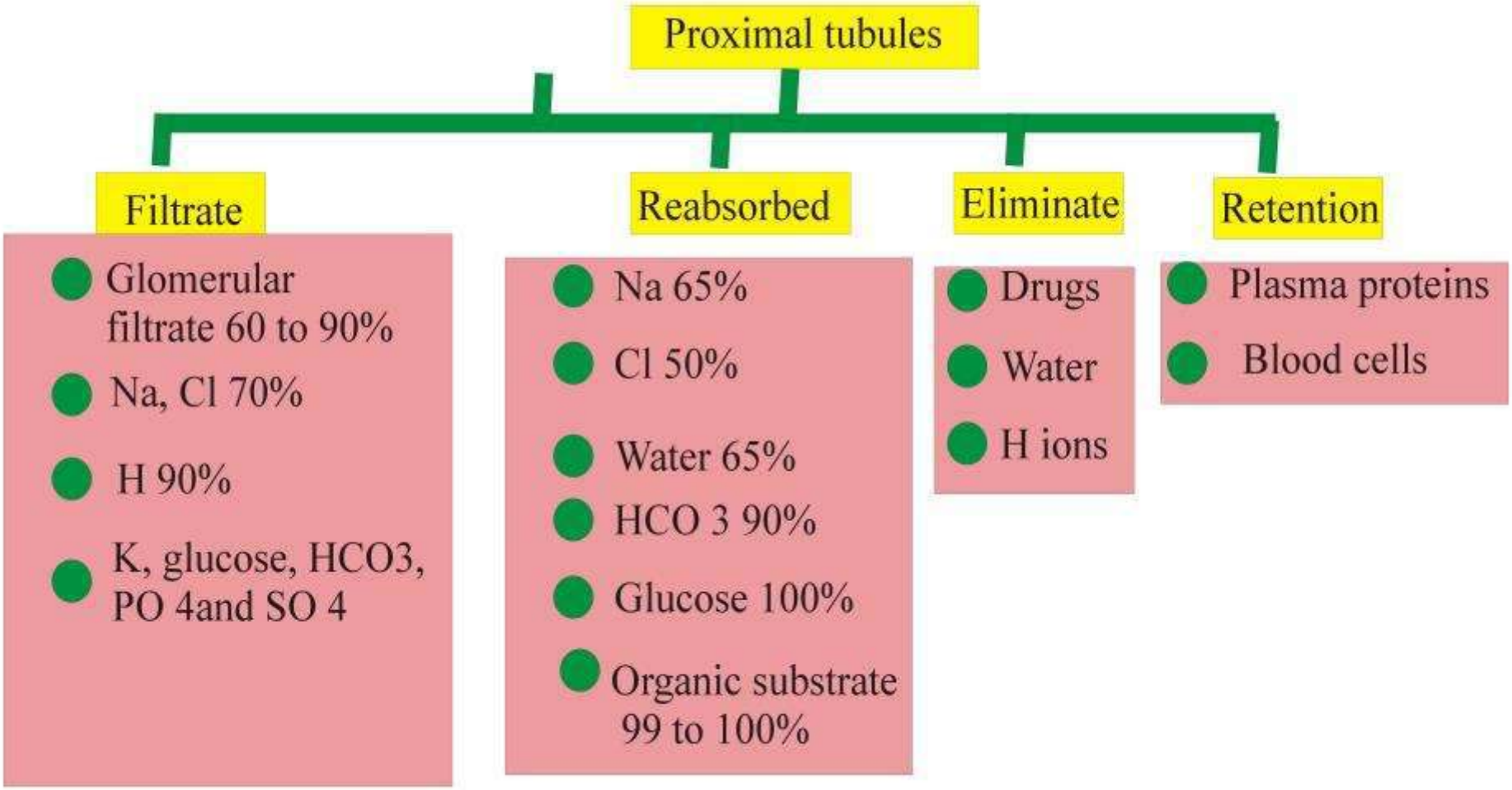
- Most water and minerals taken out of the filtrate
- Each region of tubule has different function
- “Renal clearance” ;Amount of plasma from which a substance is completely removed from the body [ml/min]

Function of filtration, reabsorption, and secretion




Proximal tubule
Tubular fluid
Distal tubule
Collecting duct
Na^+
Cl^-
K^+
Ca^{2+}
HCO_3^-
H_2O
Glucose
Amino acids
Vitamins
Urea
Choline
H^+
NH_4^+
Toxins
Drugs
H_2O
H^+
K^+
Ca^{2+}
Na^+
Cl^-
H_2O
Na^+
Cl^-
K^+
Mg^{2+}
Ca^{2+}
NH_4^+
Na^+
K^+
Cl^-
Ca^{2+}
HCO_3^-
H^+
Urea
H_2O
K^+
H^+
NH_4^+
Descending limb
Ascending limb
Loop of Henle

Proximal tubules functions



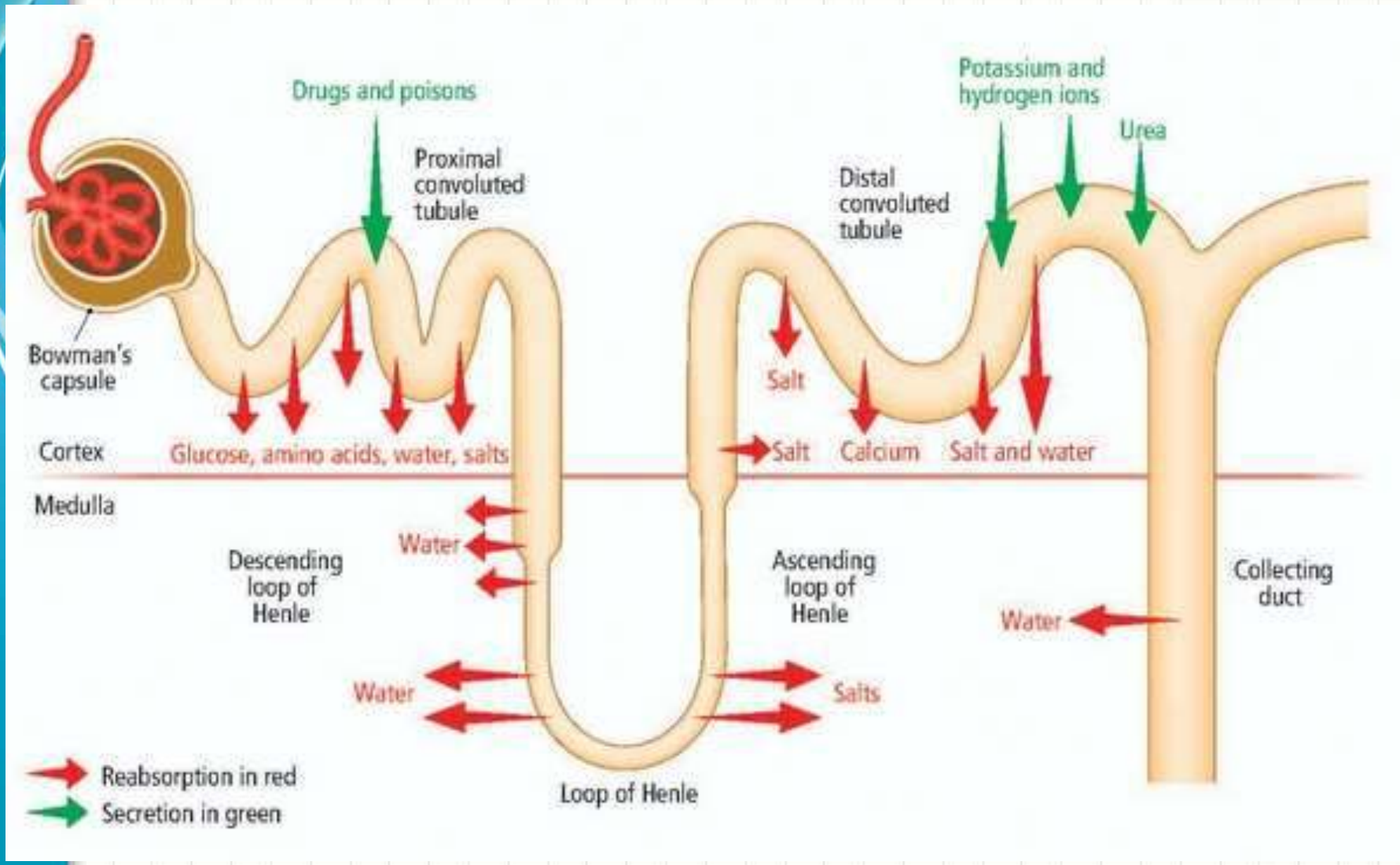
Loop of Henle ; Concentration of Urine

- Descending limb
– High passive H2O transport
– Interstitial osmolarity climbs
– Thin cells
– Almost no active salt transport, low salt permeability

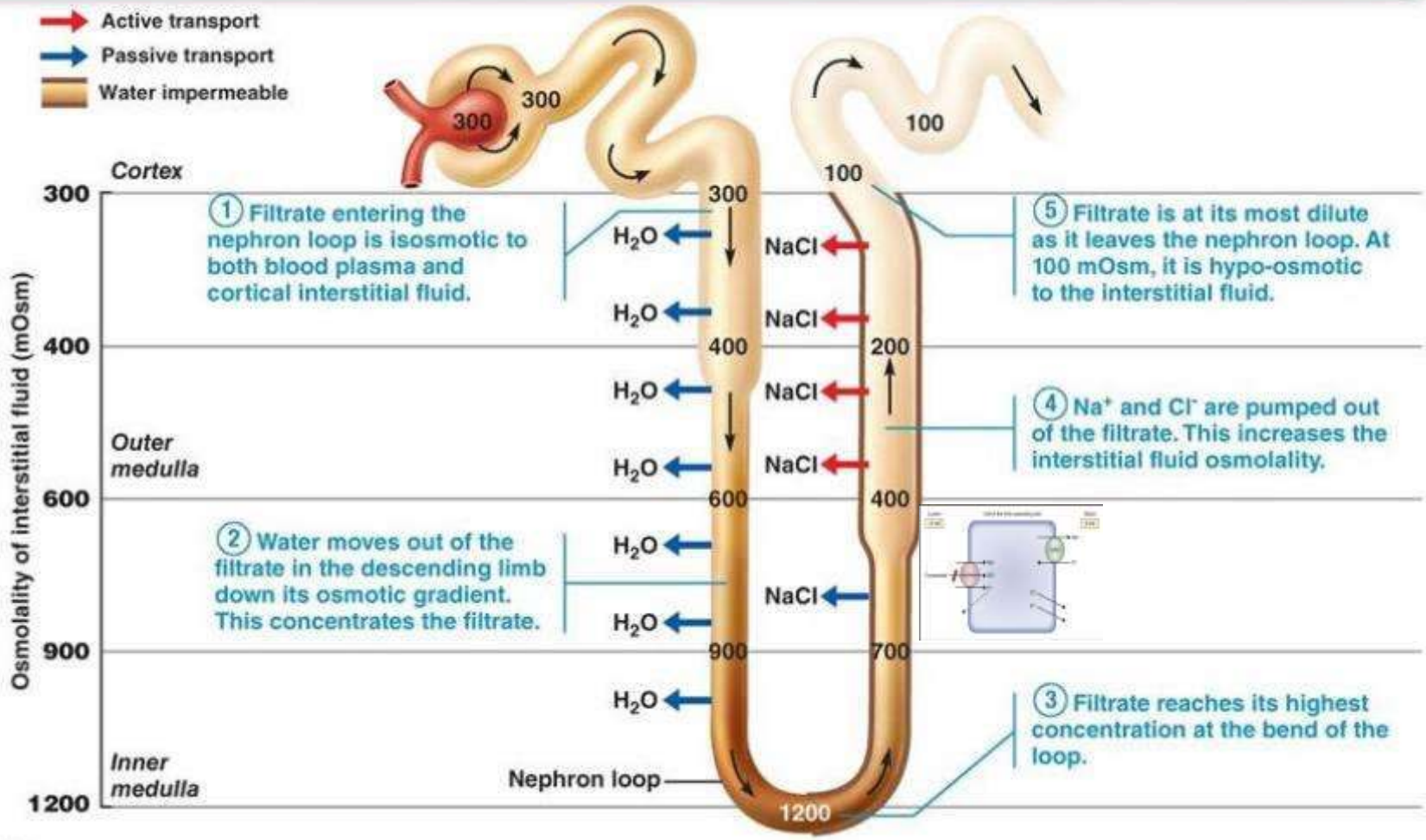
- Thin ascending segments
– Highly permeable to NaCl
– Very low permeability to H2O
– No active salt transport

- Thick ascending limb
– Active transport of NaCl
– Low H2O permeability
– Reduces osmolarity Concentration of Urine Kidney

Loop of Henle ; Concentration of Urine



(a) *(continued)* As water and solutes are reabsorbed, the loop first concentrates the filtrate, then dilutes it.



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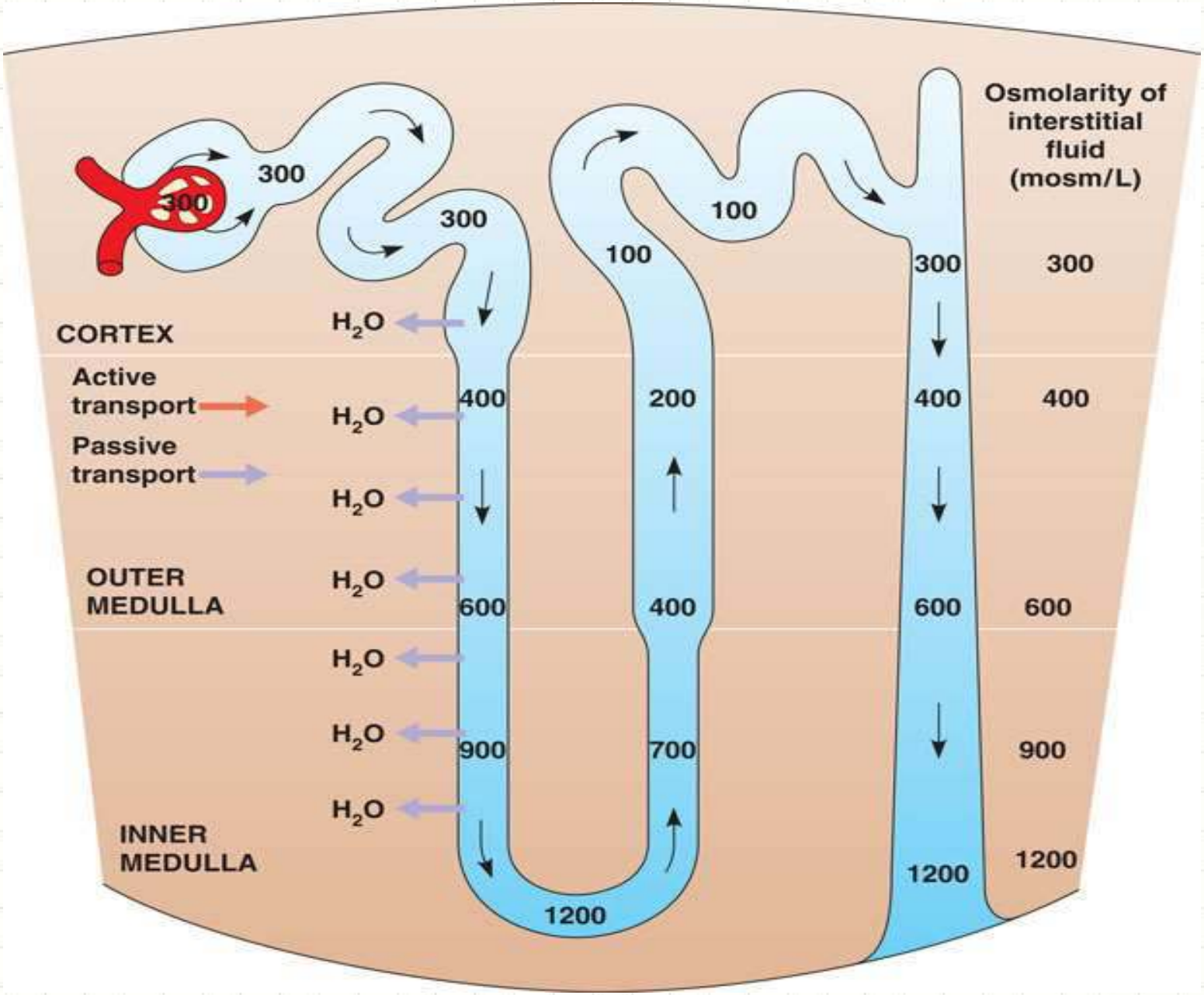
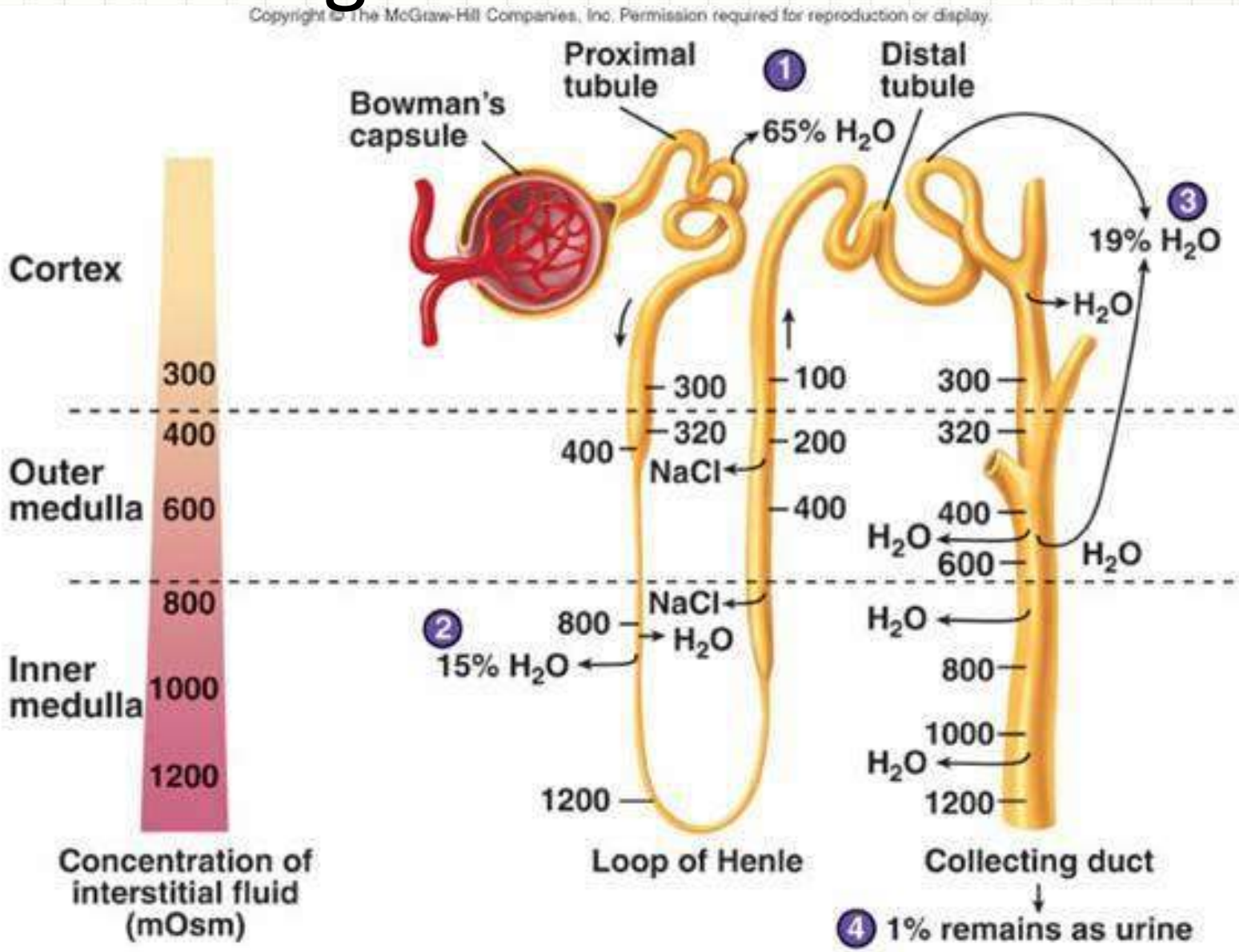
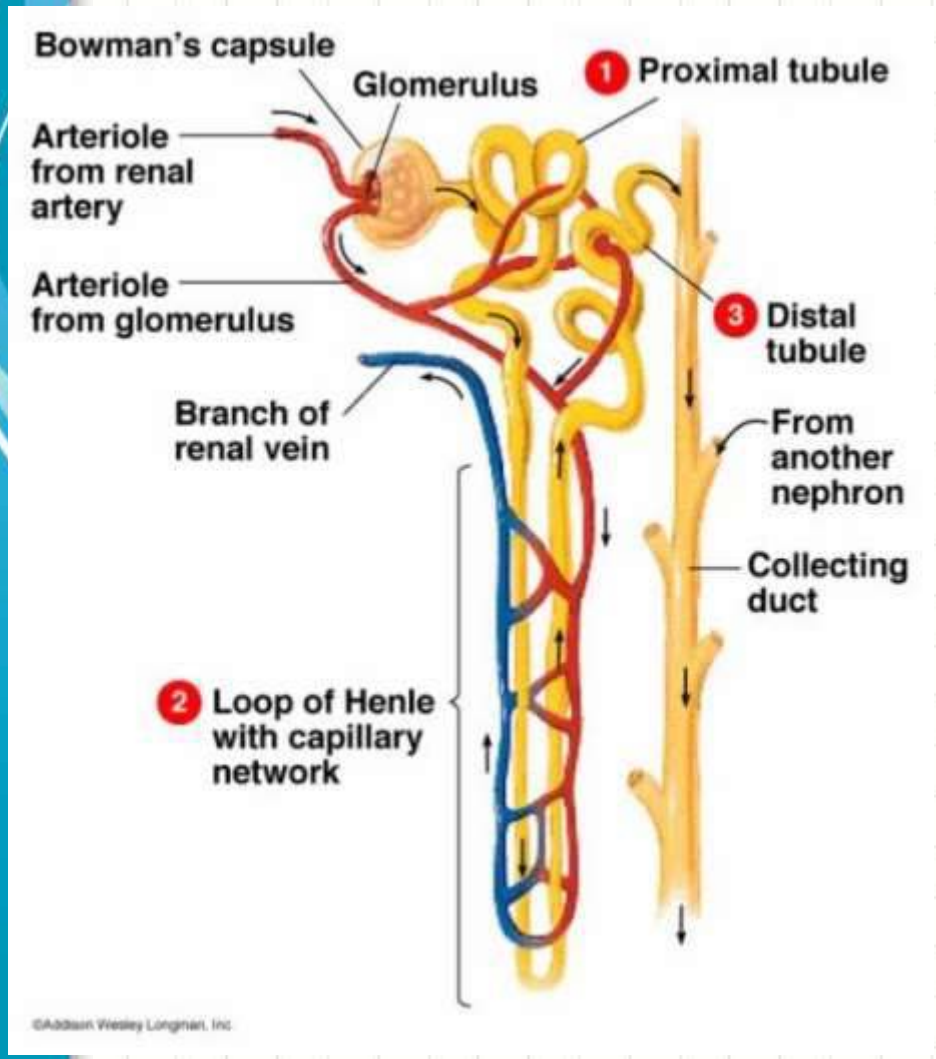
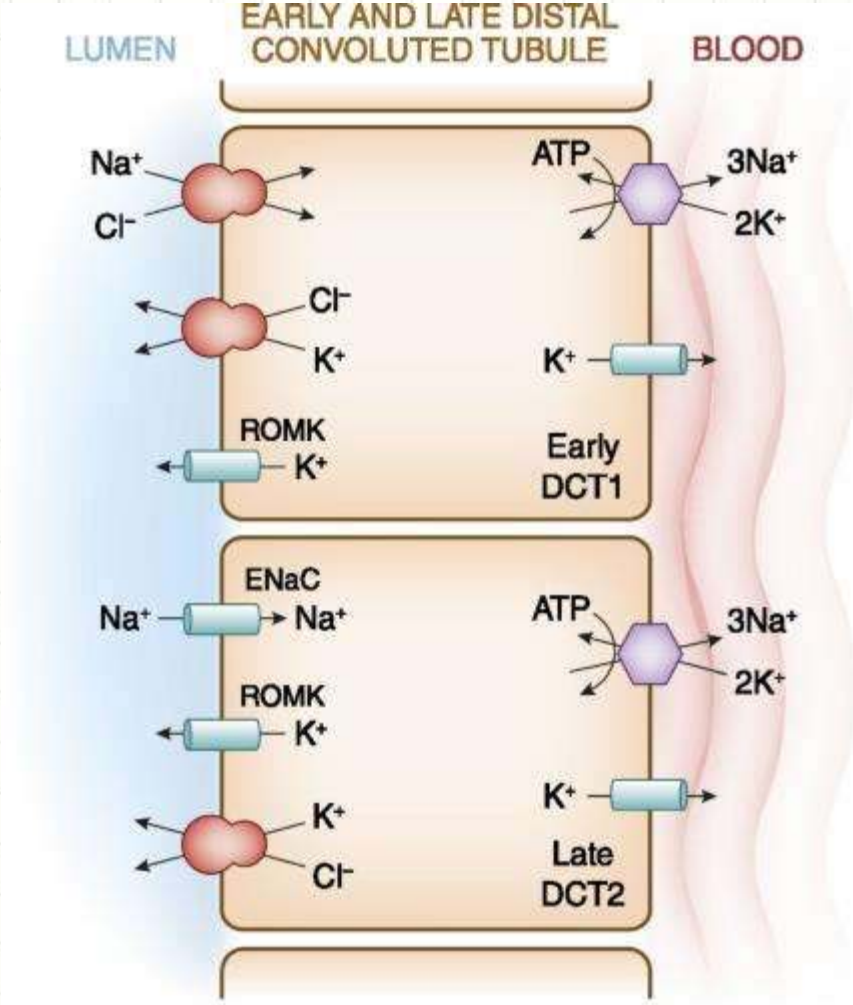

Osmolarity of interstitial fluid (mosm/L)
300
300
300
100
100
300
300
CORTEX
H_2O
Active transport
Passive transport
400
200
400
400
H_2O
H_2O
OUTER MEDULLA
H_2O
600
400
600
600
H_2O
H_2O
900
700
900
H_2O
INNER MEDULLA
1200
1200
1200

Water regulation



Distal tubule; Adjustment of urine content





Distal tubule; Adjustment of urine content

- Reabsorption:
  - – Na+, Cl - , HCO3-
  - – Active transport of NaCl
  - **– Water follows salts (permeability controlled by ADH)**
- Secretion:
  - **– H+, NH3, K+**
  - **– K+**

    Occurs when elevated in the body

    Na/K pumps into tubular cells, leaks into tubule through channels
- Regulation/Feedback :
  - – Distal tubule is close to glomerulus so regulation based on osmolarity in tubule
  - – Concentrates urine
  - – Salt transport under endocrine control
  - – Aldosterone: enhanced Na+ reabsorption and K+ secretion

Collecting Duct; **Final concentrating of urine**

- Water permeable
  – Permeability controlled by ADH through cAMP signaling that increases aquaporin formation
  – Interstitial space is hypertonic (mostly from NaCl and urea)
- Secretion of K+, H+, NH3
- Reabsorption of Na+, Cl- , HCO3 –
  – Na+ by active transport
  – Regulated by aldosterone
  – **Determines water movement and urine concentration**
- Reabsorption of urea

– End of duct very permeable to urea
– Regulated by ADH by increase in urea transporters

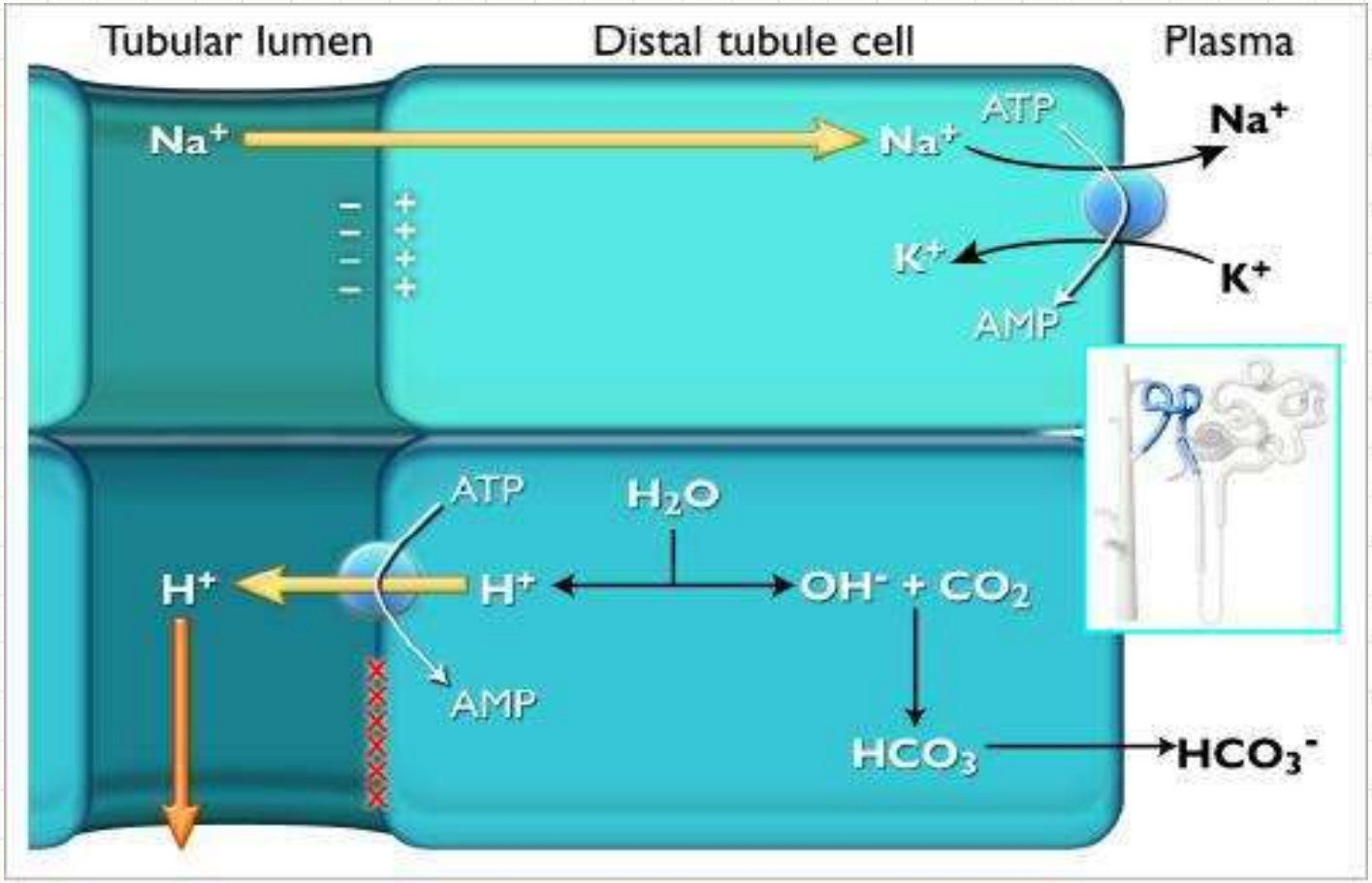


Figure 4. Passive diffusion of sodium into the principal cell creates a negative charge in the lumen, which aids intercalculated cells in H^+ excretion via an H^+-ATPase pump. The tubular wall is impermeable to H^+, thereby preventing its passive diffusion back into the cells. The dissociation of water within the intercalculated cell creates H^+ (which is pumped into the lumen) and OH . OH combines with CO_2 to form bicarbonate, which diffuses into the plasma. (Illustration by Felicia Paras)

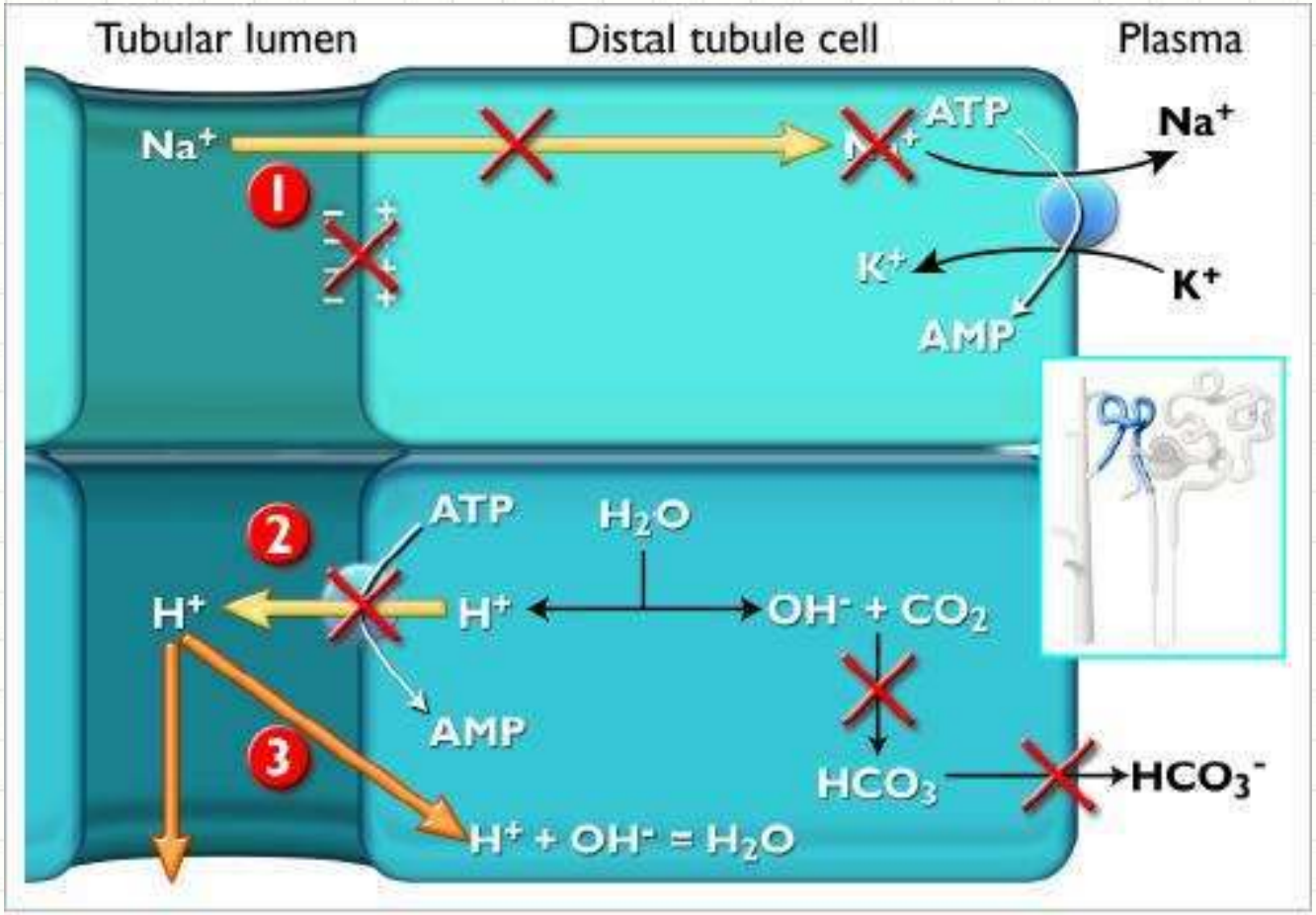


Figure 6. Causes of distal RTA. All three of these mechanisms can prevent HCO_3 production and reabsorption in the distal tubule. (Illustration by Felicia Paras)

1. **Voltage dependence:** Loss of Na^+ reabsorption prevents formation of a negative charge in the tubule.
2. **Impaired H^+-ATPase pump:** Failure of the H^+ pump prevents secretion of H^+.
3. **Increased tubule membrane permeability:** The leaky tubule membrane allows H^+ backflow and formation of water.

the kidneys perform many crucial functions, including:

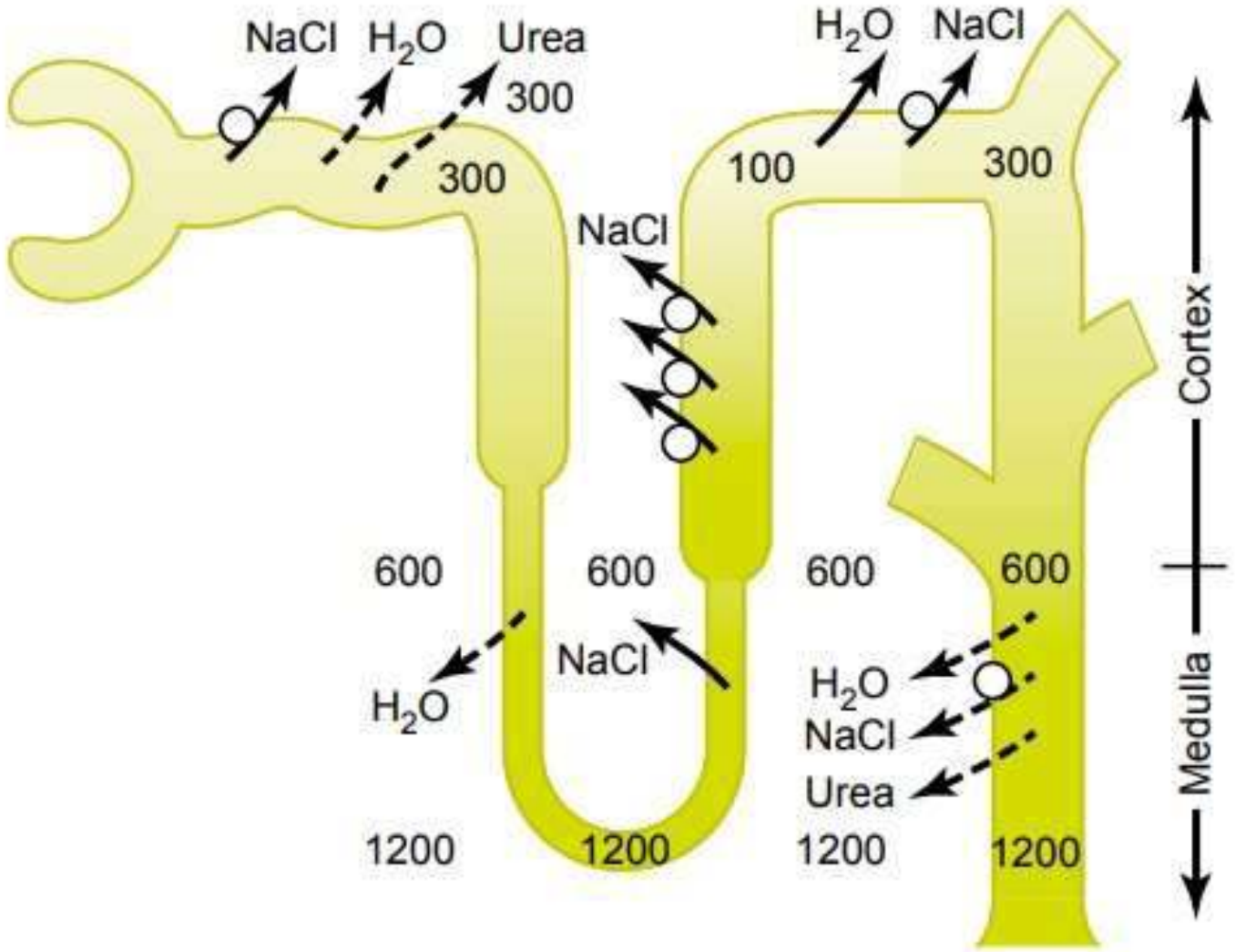
maintaining overall fluid balance.

regulating and filtering **minerals** from blood.

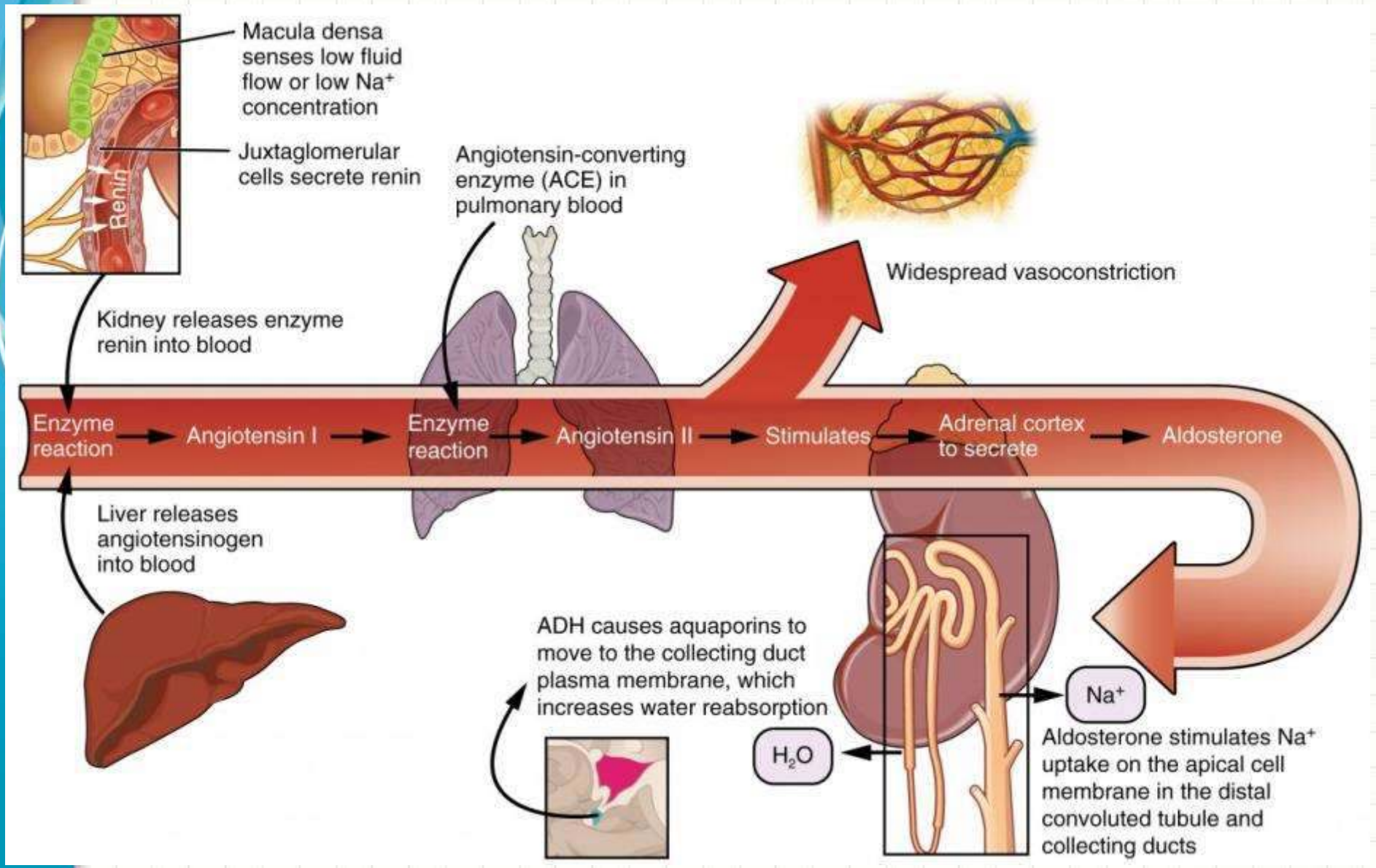
filtering waste materials from food, medications, and toxic substances.

creating **hormones** that help produce red blood cells, promote bone health, and regulate blood pressure.

Conclusion Nephron functions

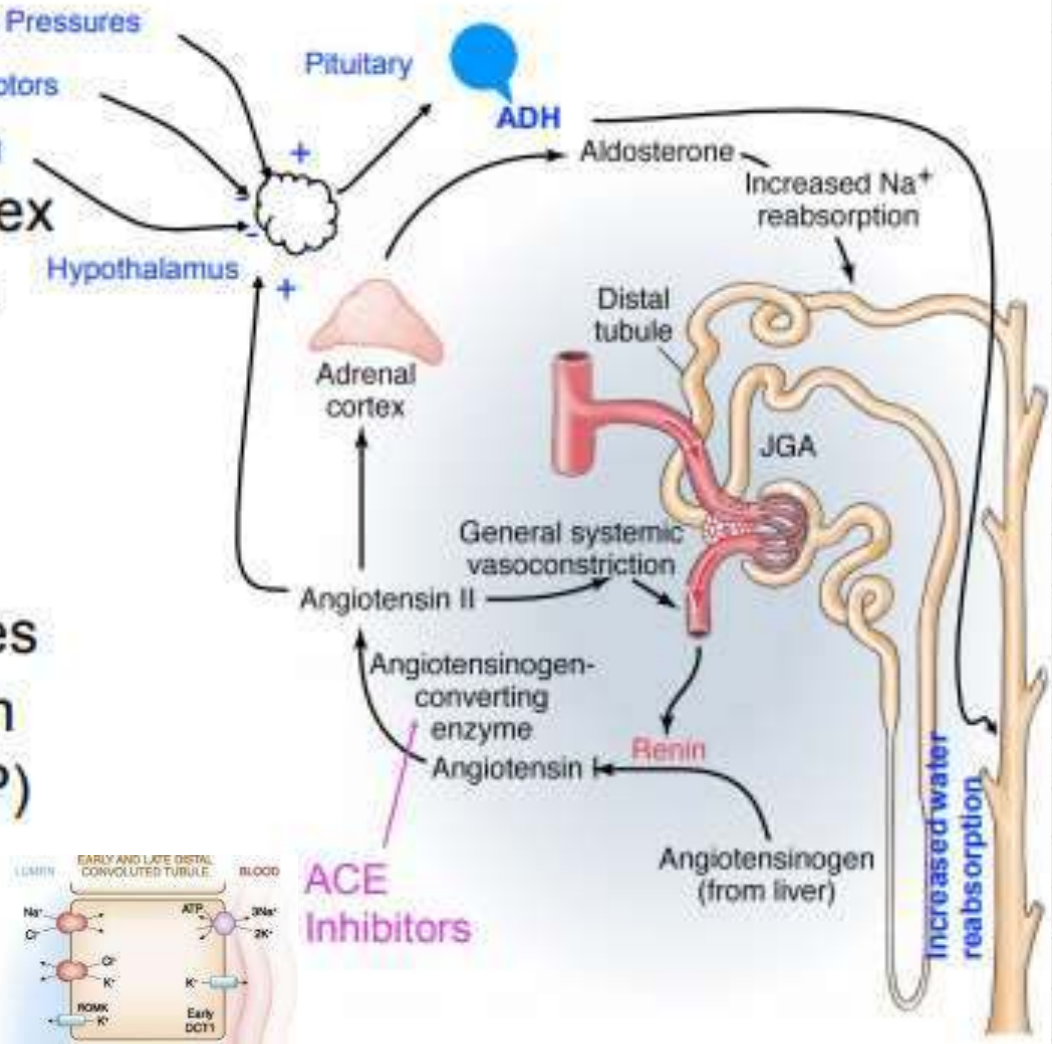


Regulation of Filtration and Renin-Angiotensin System

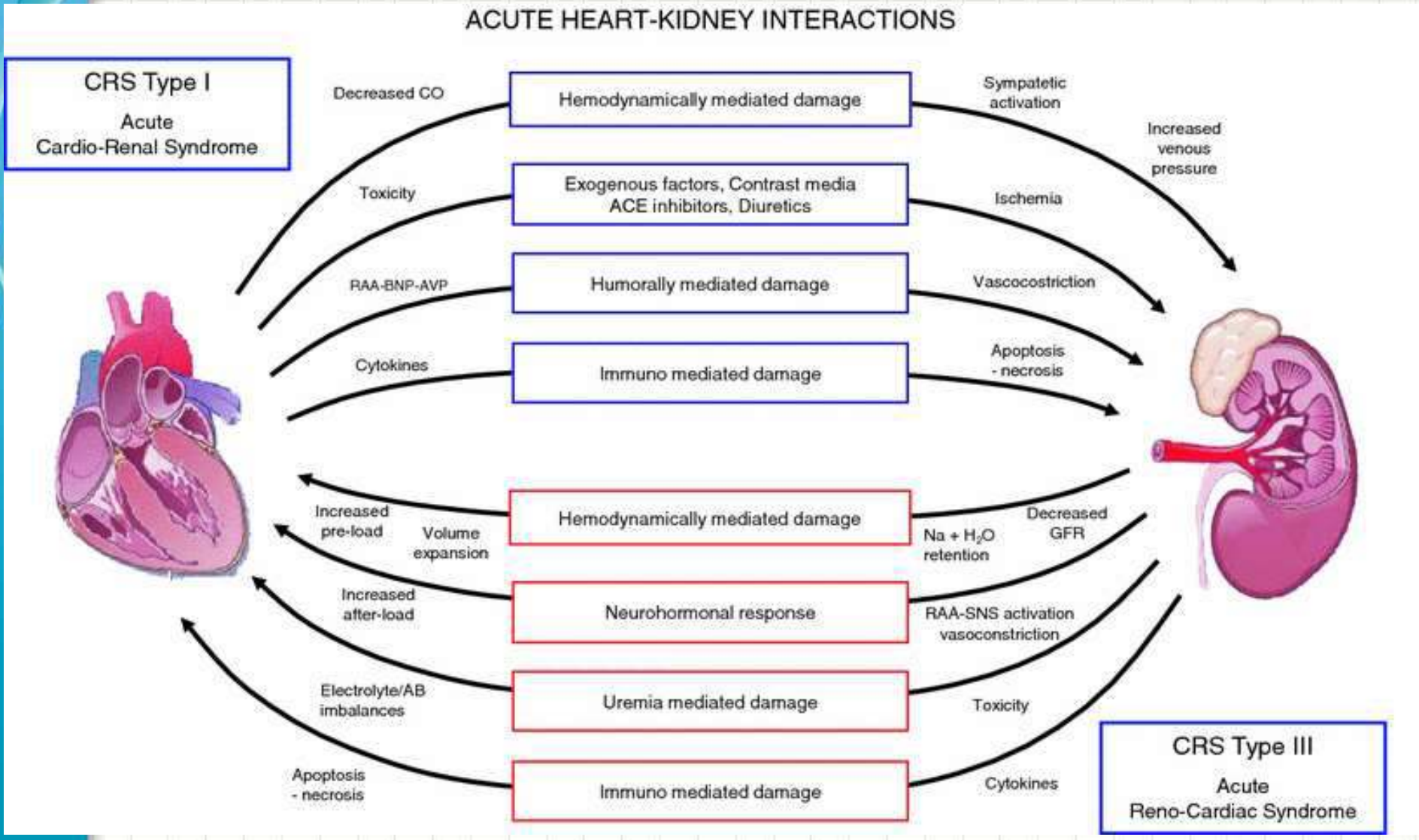


Aldosterone and ADH

- Aldosterone:
  - Releases from adrenal cortex
  - Increases Na^+ reabsorption
- Antidiuretic Hormone (ADH)
  - Also called vasopressin
  - Released from pituitary in response to angiotensin II, osmotic and blood pressures
  - Increase water reabsorption
- Atrial Natriuretic peptide (ANP)
  - Released from atrium in response to pressure
  - Inhibits release of renin and ADH to increase urine production



Cardio-Renal Syndrome



Endocrine links in kidney

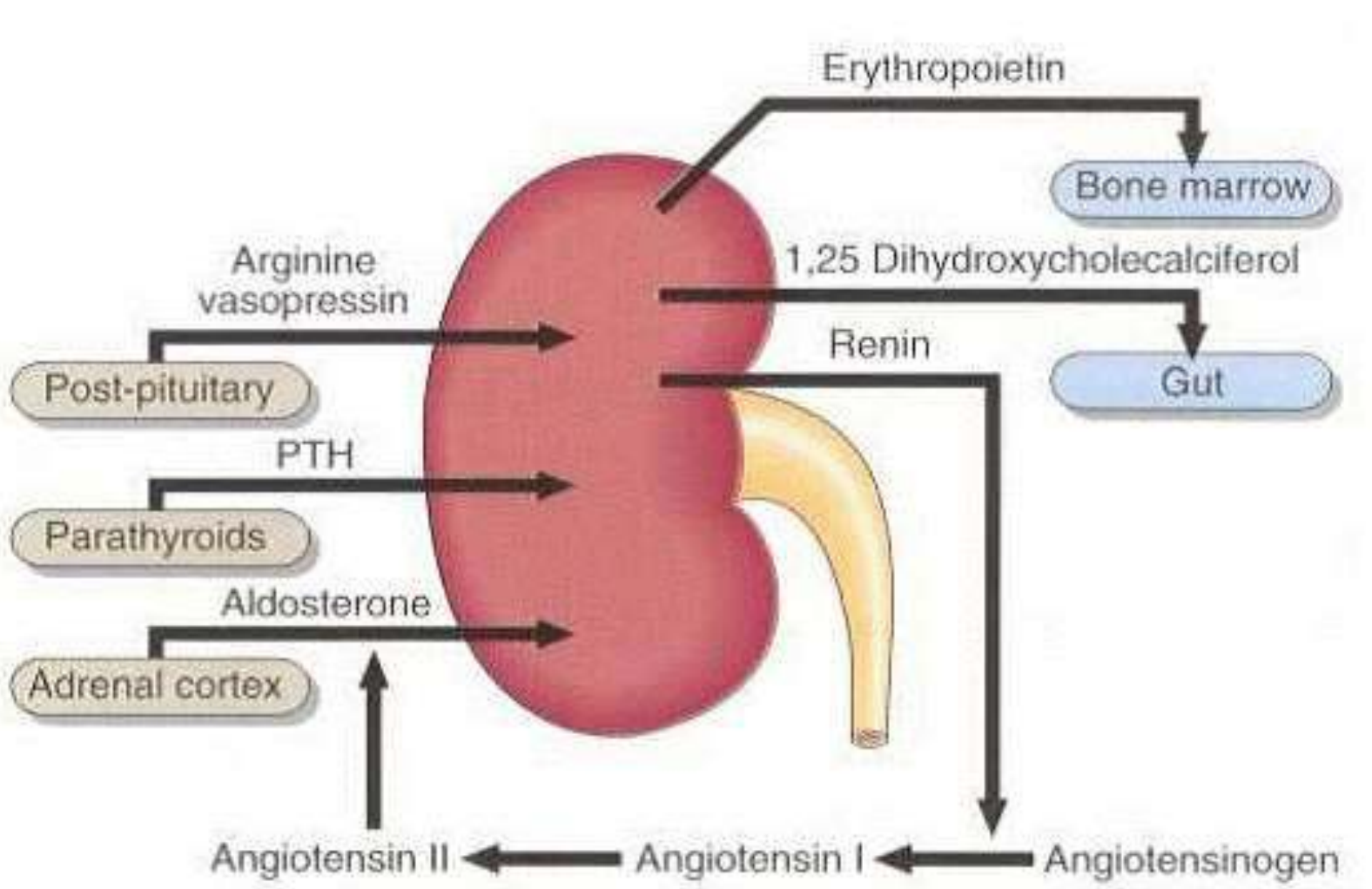
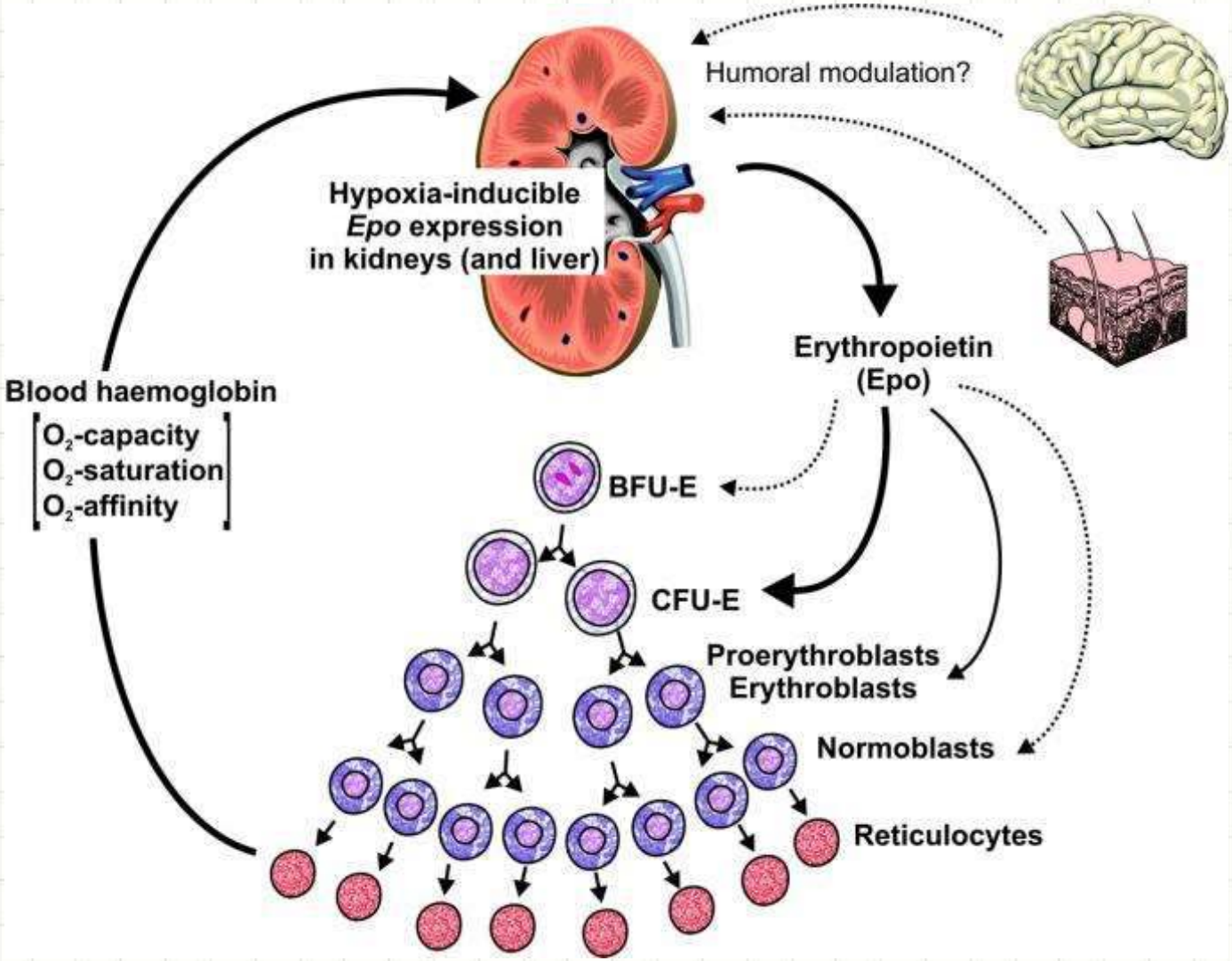


Fig. 2 **Endocrine links in the kidney.**

Erythropoietin (Epo)



Vitamin D metabolism