REGULATION OF EXTRACELLULAR FLUID VOLUME

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Objectives

- Identify and describe the role of the sensors and effectors in the renal regulation of body fluid volume.
- Describe the role of the kidney in regulation of body fluid volume.
- Identify the site and describe the influence of aldosterone on reabsorption of Na^+ in the late distal tubules.

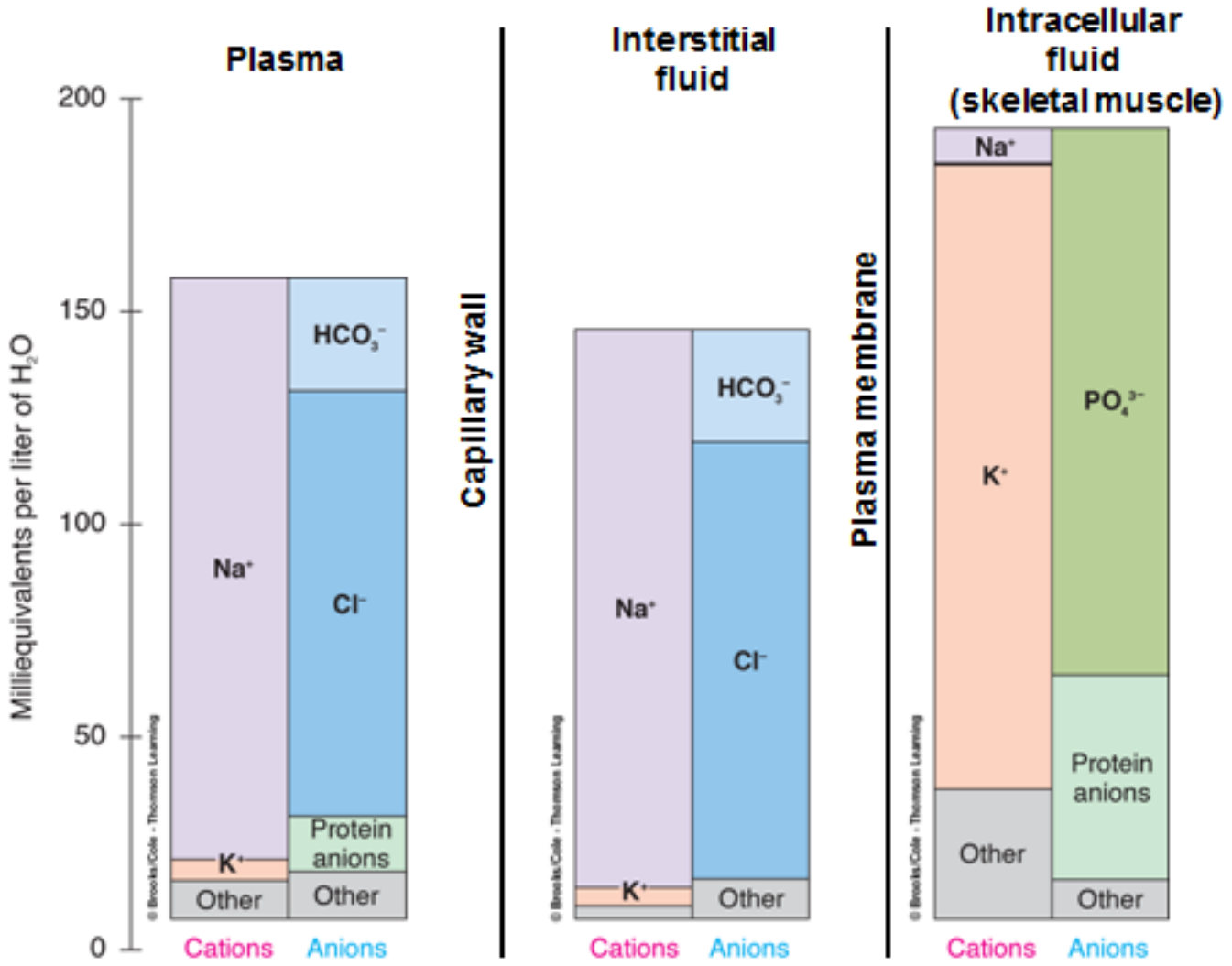
Introduction

- Maintaining normal ECF ***volume*** and ***osmolarity*** is crucial for the well-being of human beings.
- Normal ***ECF volume*** is important for maintenance of normal ABP which ensures adequate tissue perfusion.
- Normal ***ECF osmolarity*** is crucial for maintenance of normal cell volume & function.
- Two separate yet interrelated control systems regulate ECF volume & osmolarity.
- ***ECF volume*** is regulated through adjusting ***body NaCl content***.
- ***ECF osmolarity*** is regulated through adjusting ***body water content***.

Today we will focus on ECF volume regulation

Let's revise a few concepts!

Electrolyte Composition of Body Fluids



[Figure 15-2; Sherwood]

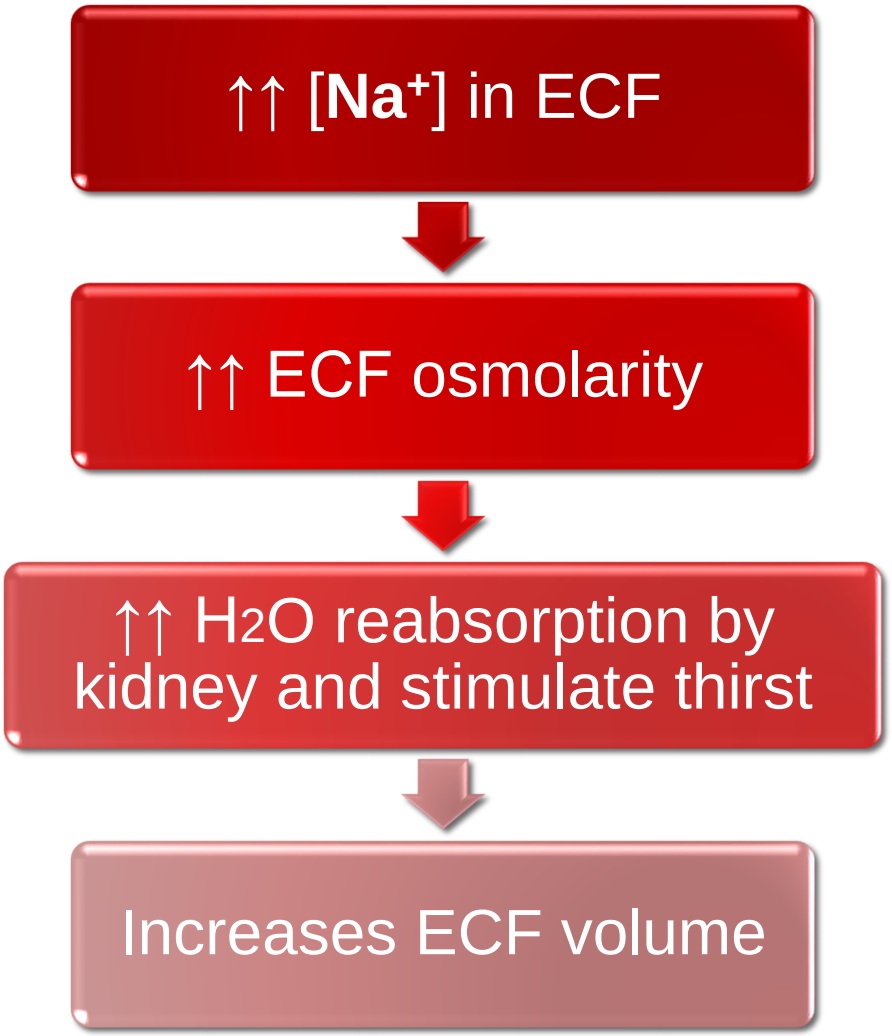
ECF Volume

- The most abundant cation in ECF is **Na^+**
- The most abundant anions in ECF are **Cl^-** and **$HCO3^-$**
- ***The body regulates ECF volume by monitoring and adjusting total body content of Na^+***
- ***ECF volume is closely linked to Na^+ balance.***
- ***To understand ECF volume regulation one must understand Na^+ regulation.***

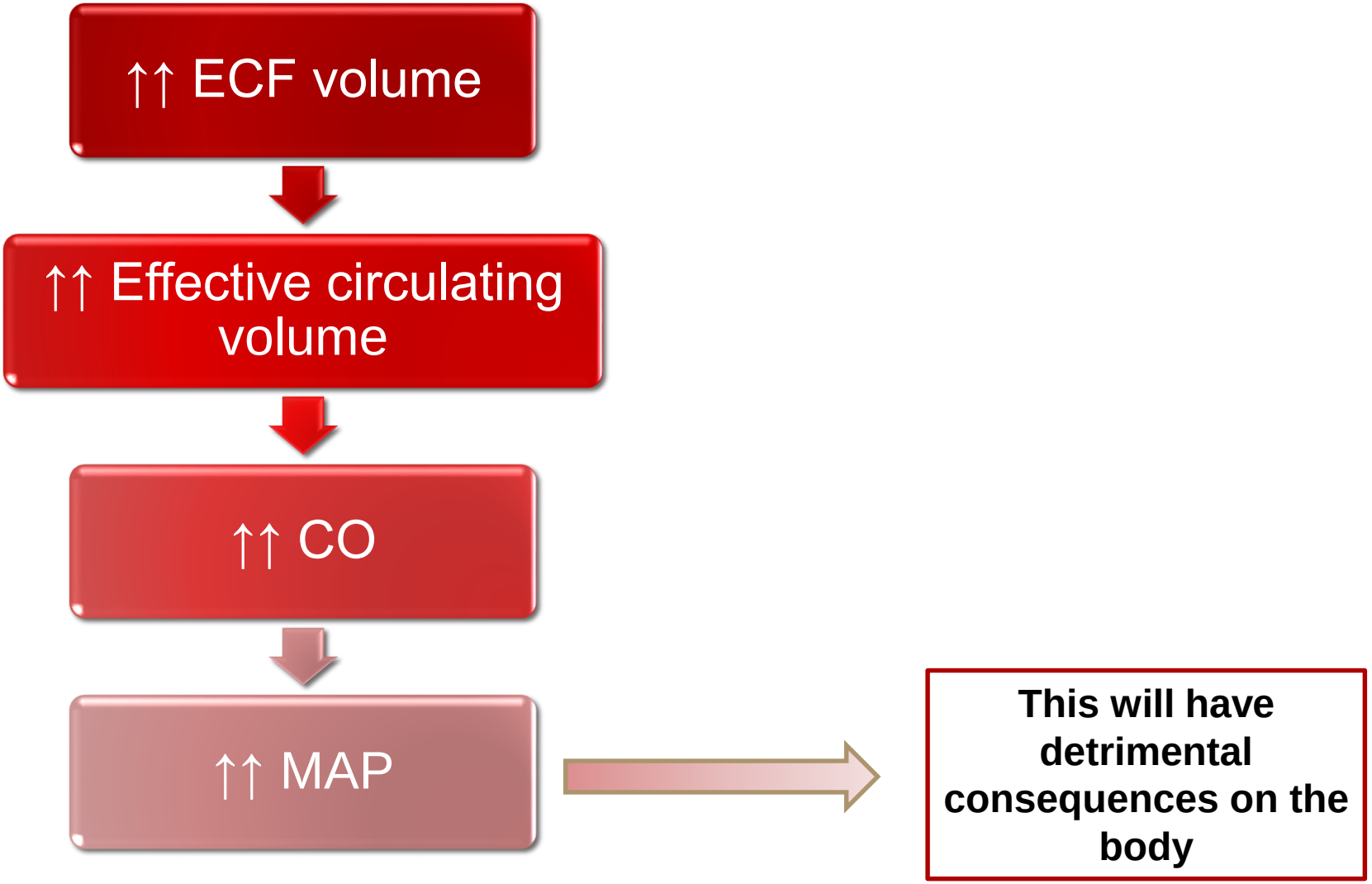
Why is Na^+ Content the Main Determinant of ECF Volume?

Na^+ and its associated anions are the main osmotic constituents of ECF volume.

When **Na^+** salts move, water must follow.



Why is it Important to Regulate ECF Volume?



Sodium Balance

Input

- Dietary intake;
  - RDA = 1.5-2.3 g/day
  - Actual content in western diet = 7g/day

Output

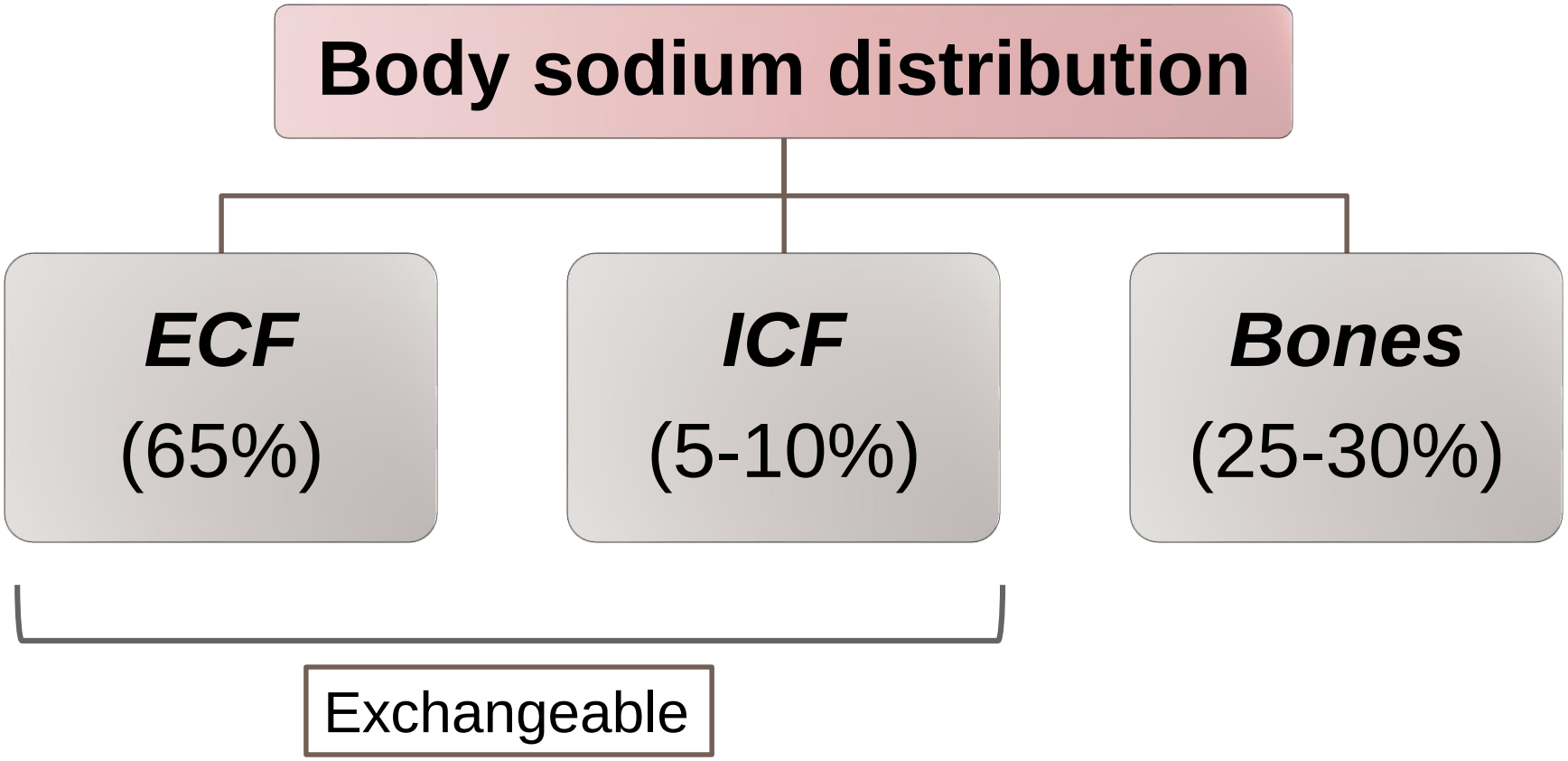
- Kidney (most important).

- GI loss
- Sweat

} Minor pathways under normal conditions

(Preston & Wilson. Lippincott's illustrated reviews Physiology)

Sodium Distribution in the Body



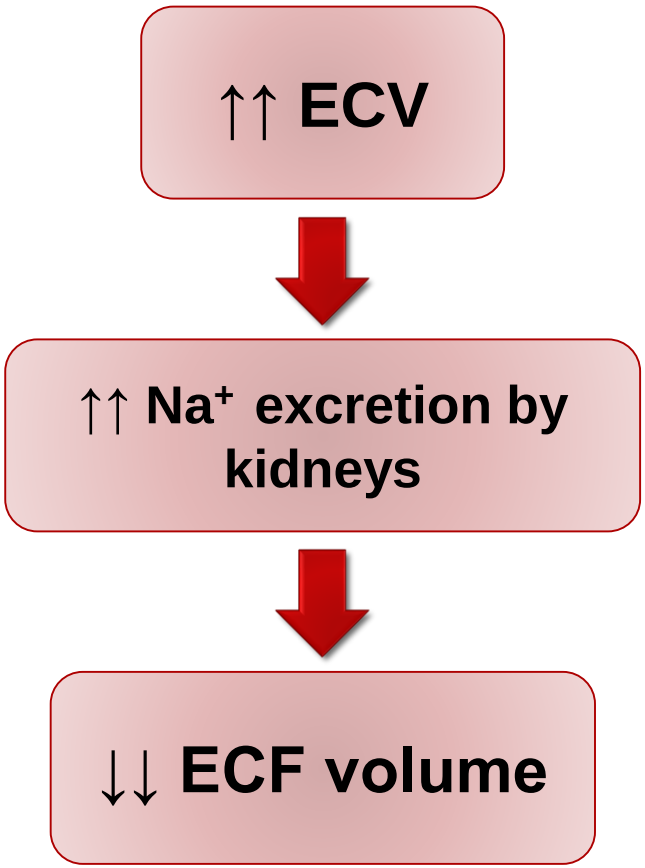
(Boron & Boulpaep. Medical Physiology)

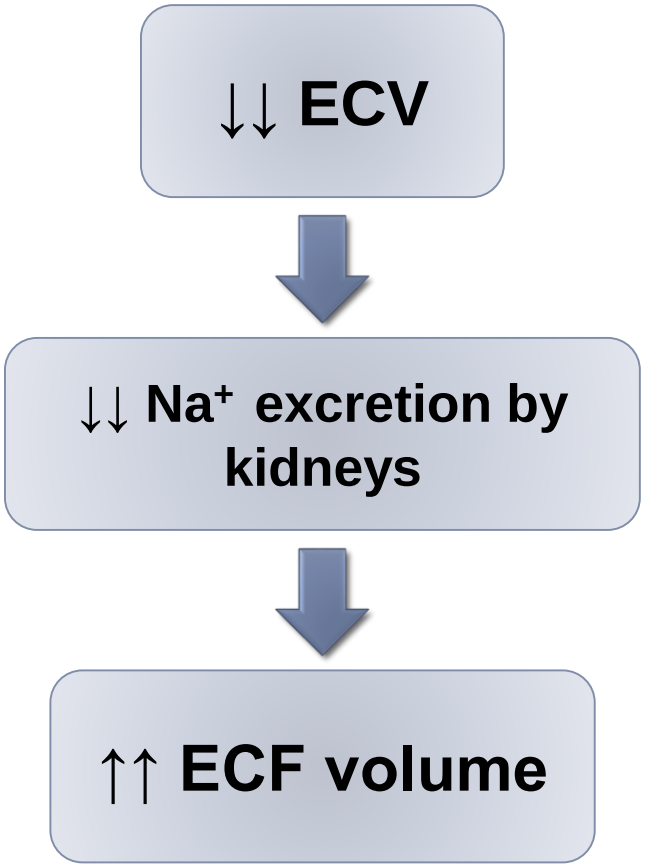
Regulation of Na^+ Excretion by the Kidney

- The kidney is the main route for the body to rid itself of excess **Na^+**
- The signal that triggers enhanced **Na^+** excretion by the kidney is actually the ***ECF volume*** specifically the ***effective circulating volume.***
- **Effective circulating volume (ECV)** = a functional blood volume that reflects the extent of tissue perfusion in specific regions, as evidenced by the pressure in their blood vessels.
- Usually changes in ECV parallels those of ECF volume.

(Boron & Boulpaep. Medical Physiology)

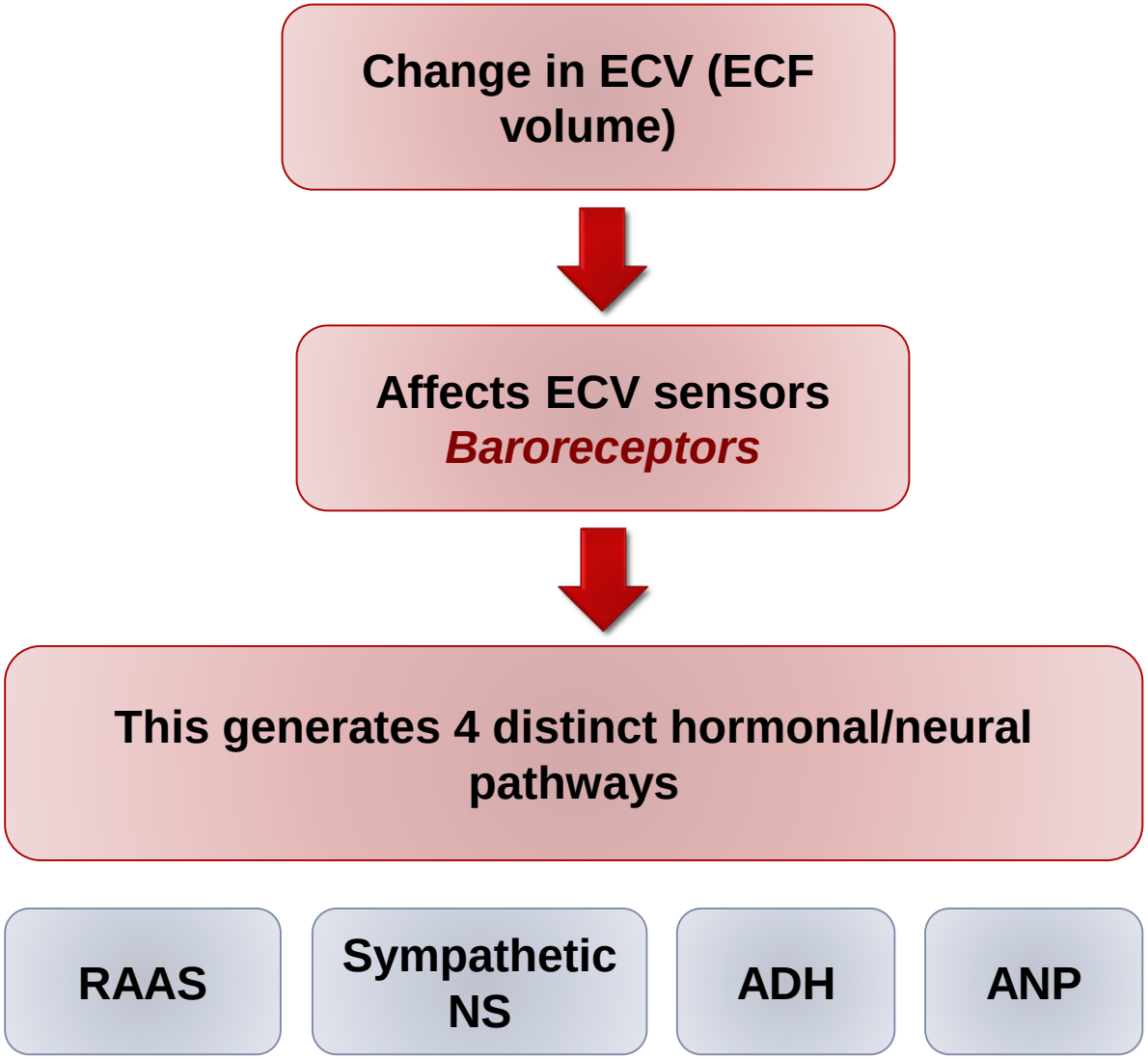
Regulation of ECF Volume (ECV)



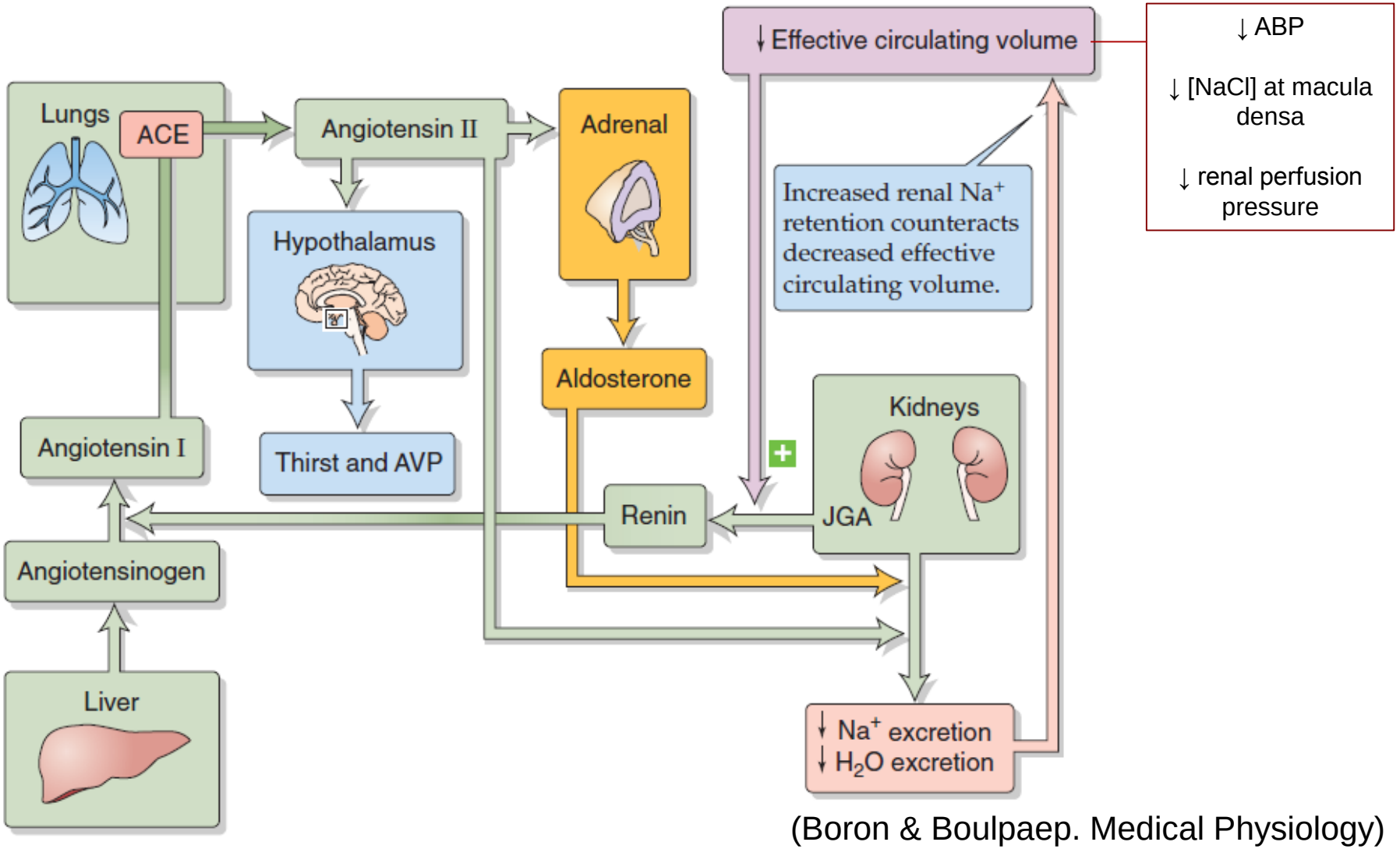


(Boron & Boulpaep. Medical Physiology)

Regulation of ECF Volume (ECV)



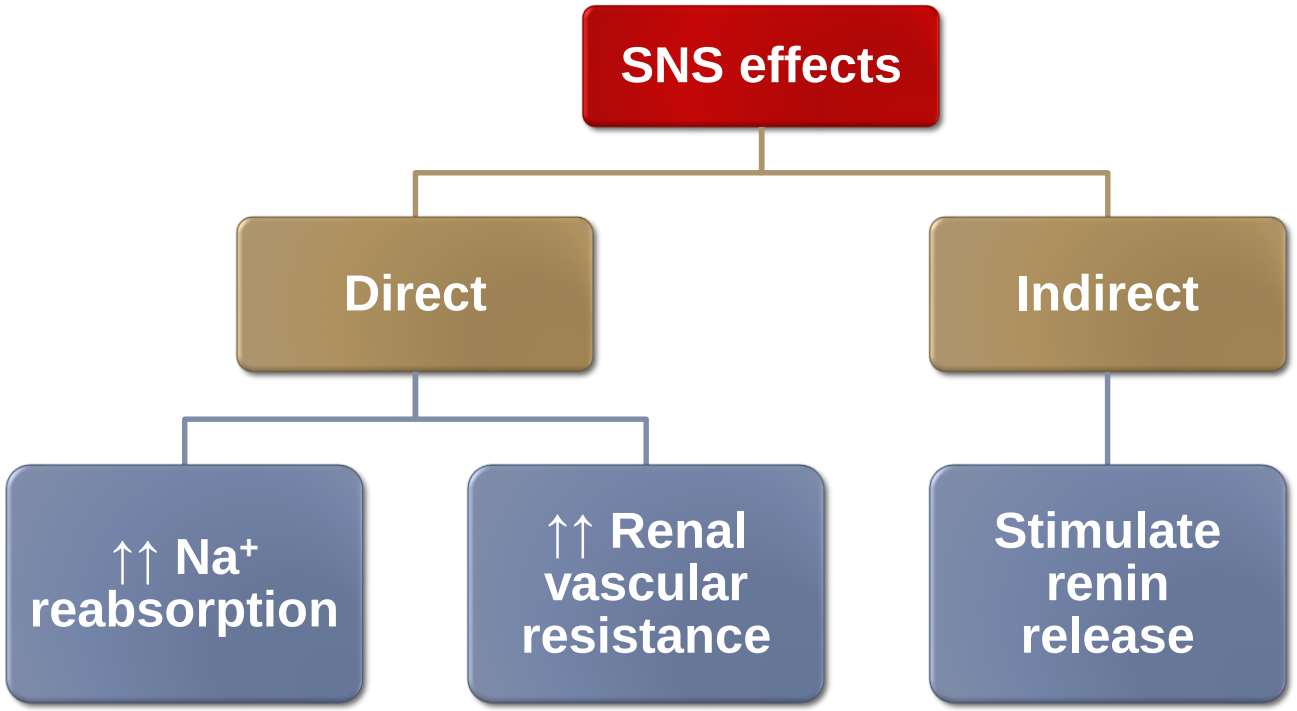
The Renin-Angiotensin-Aldosterone System (RAAS)



(Boron & Boulpaep. Medical Physiology)

Sympathetic Nervous System (SNS)

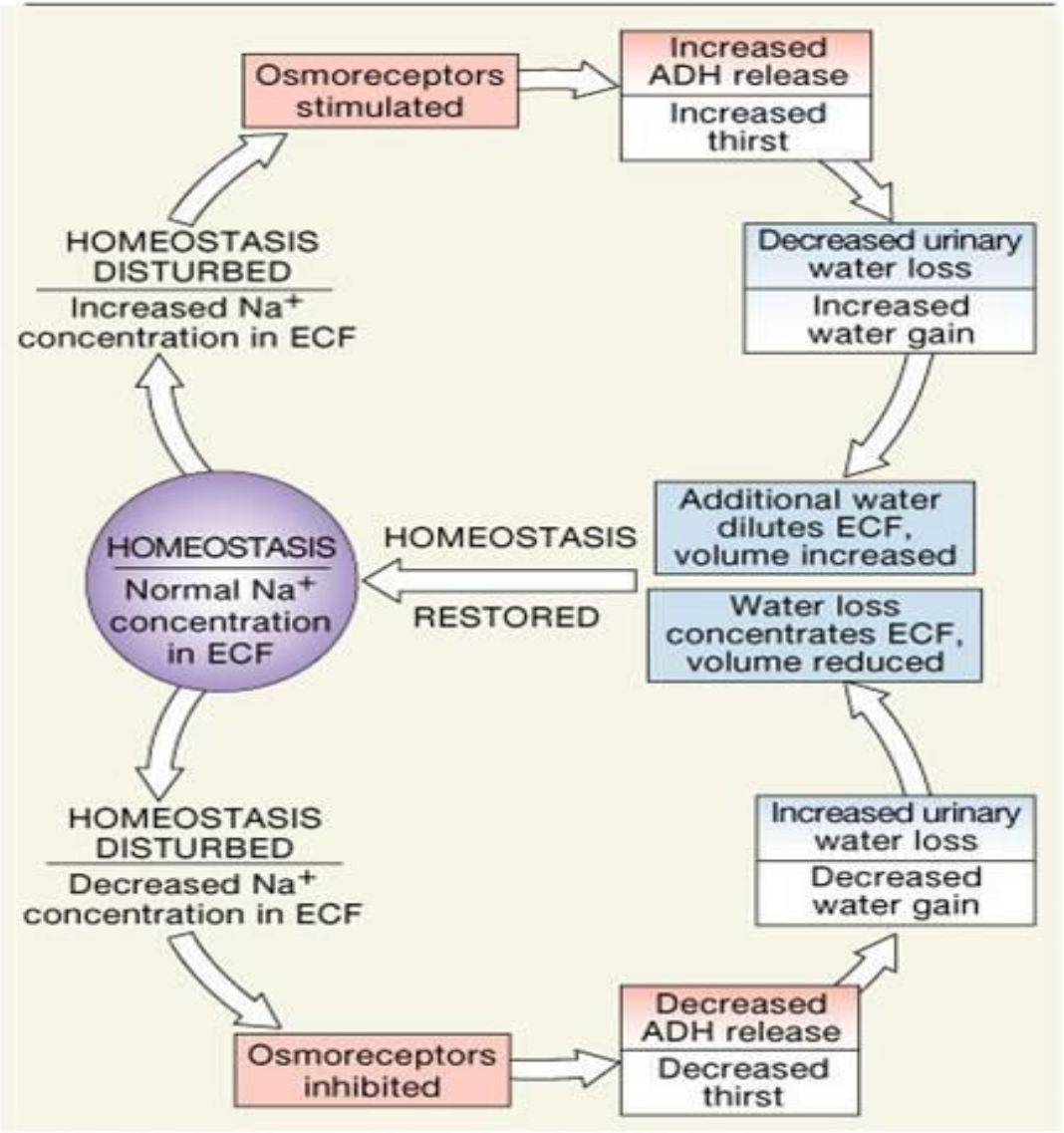
Its role is thought to be especially important during stressful conditions, e.g. hemorrhage.



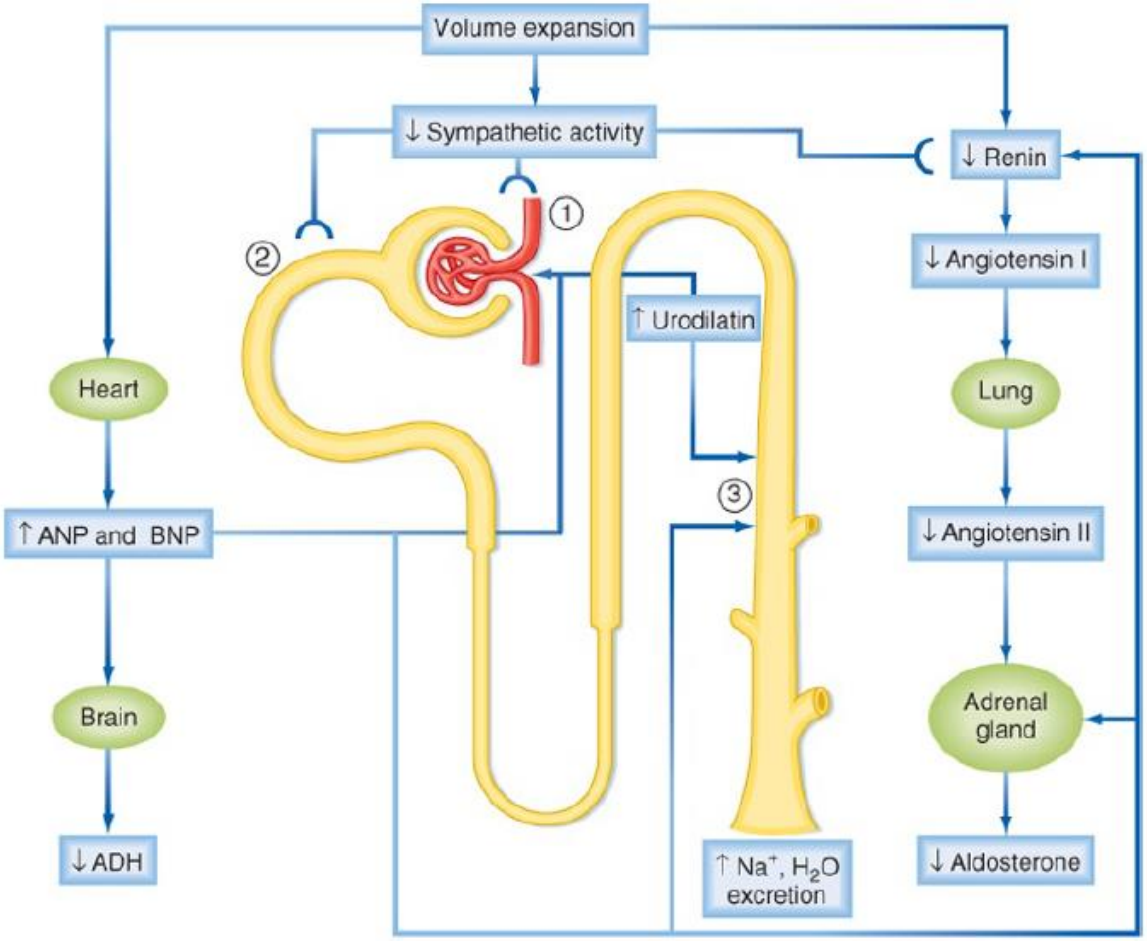
Atrial Natriuretic Peptide (ANP)

- ANP promotes ***natriuresis*** (Na^+ excretion).
- Secreted by atrial myocytes in response to stretch.

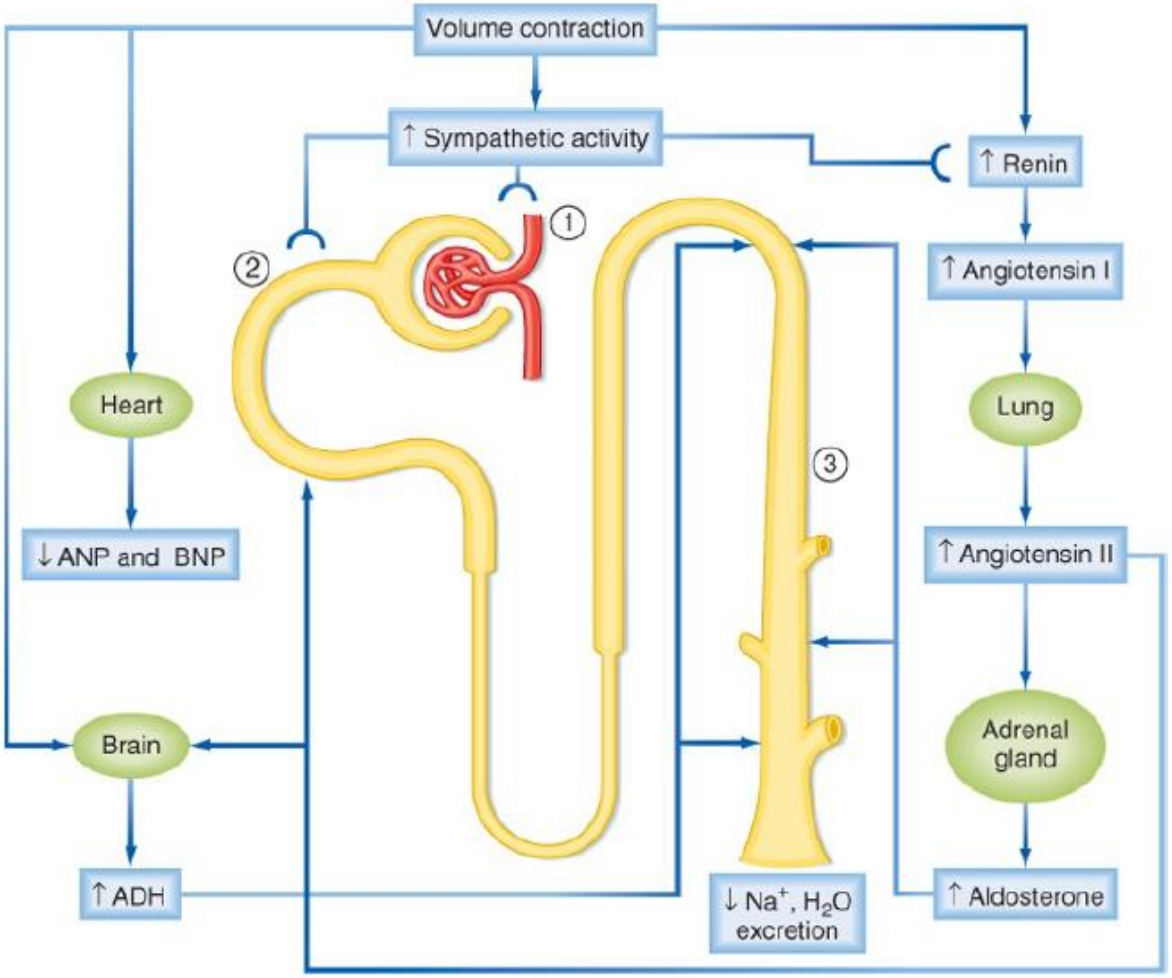
Antidiuretic Hormone (ADH)



Summary



Summary



Final Note

- Although, under physiologic conditions, the body regulates plasma volume & plasma osmolarity independently.

- Severe derangements in fluid & electrolyte balance may challenge the system by presenting two conflicting changes in osmolarity and volume.

- In general, ***the body defends volume at the expense of osmolarity***.

THANK YOU

Table 40-2 ECF Volume Receptors

"Central" Vascular Sensors *Low-Pressure Sensors (very important)* Cardiac atria Pulmonary vasculature *High-Pressure Sensors (less important)* Carotid sinus Aortic arch Juxtaglomerular apparatus (renal afferent arteriole)
Sensors in the CNS (*less important*)
Sensors in the Liver (*less important*)