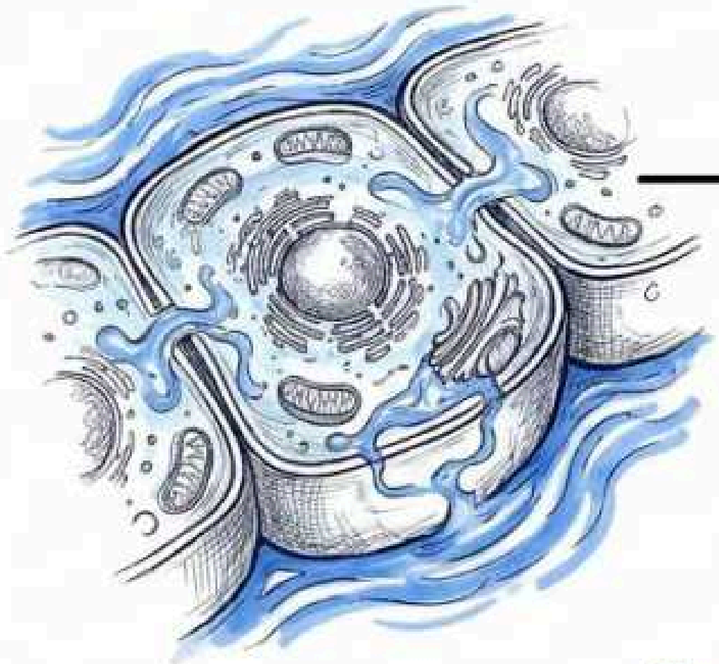
The Architecture of Body Fluid

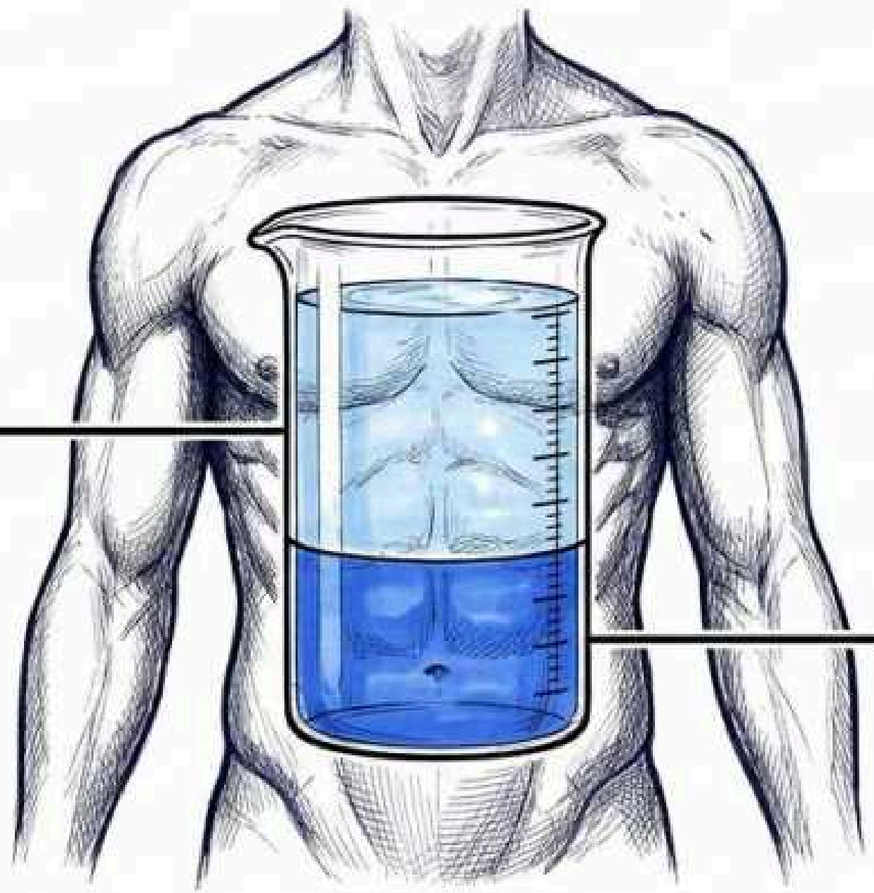
¶ 2.1

Total Body Water (TBW) ≈ 60% Body Weight

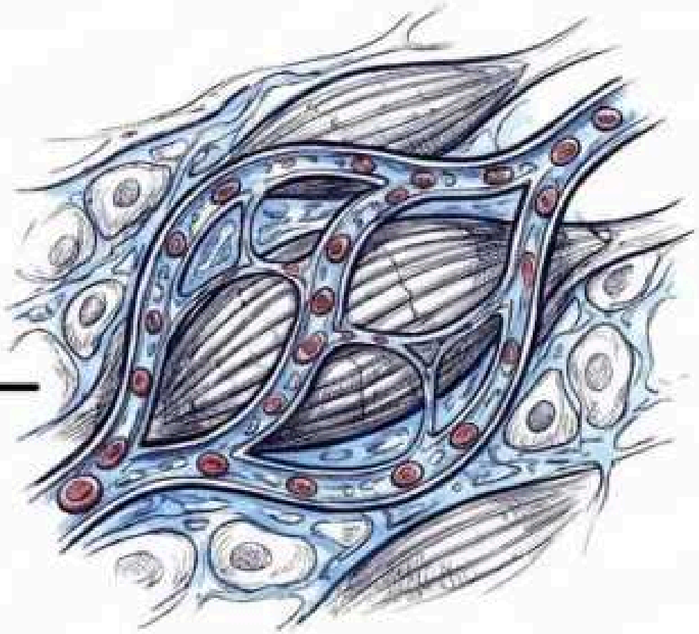
Slightly <60% in women and older people

Intracellular Fluid (2/3)
Inside the cells





Extracellular Fluid (1/3)
Plasma + Interstitial Fluid



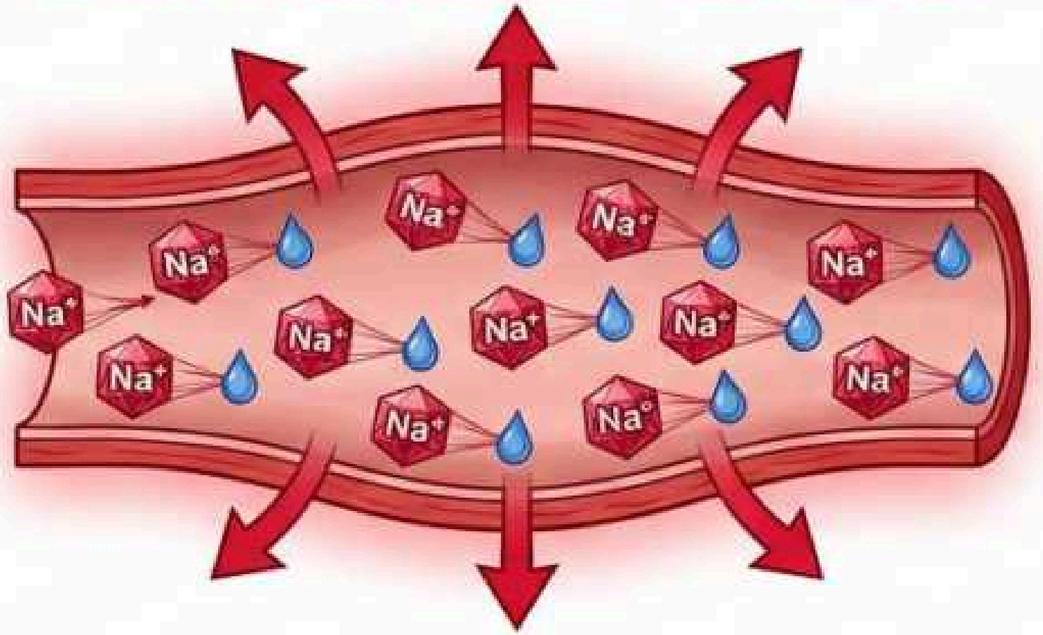
Keeping the exact right amount of fluid in each compartment is essential to life.

Gemini Notebook

Two Separate Clinical Questions

¶ 2.2

Extracellular Volume



$$Volume \propto Total\ Na^+$$

Water follows Sodium.

Fluid Concentration



$$[Na^+] = \frac{Na^+}{Water}$$

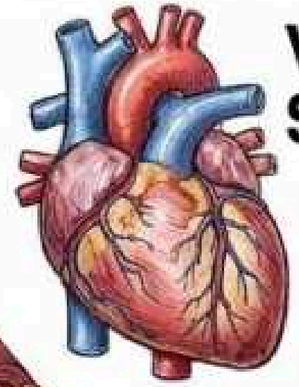
Measured by blood sodium concentration; depends on water balance.

These two parameters must be evaluated and managed independently

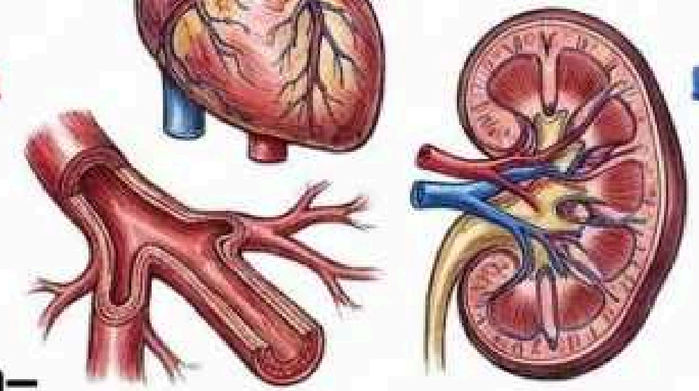
Gemini Notebook

Sensing and Controlling Volume

¶ 2.3



Volume Sensors

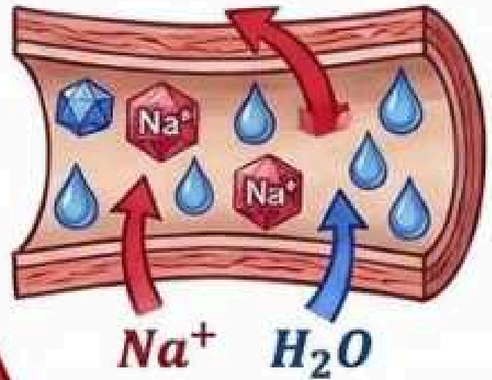


Volume Sensors

Trigger:
Hemorrhage /
Severe Diarrhoea

Mechanism:
Activates Renin–Angiotensin–Aldosterone System (RAAS) + Sympathetic Nervous System

Action: Retains Na^+ and H_2O

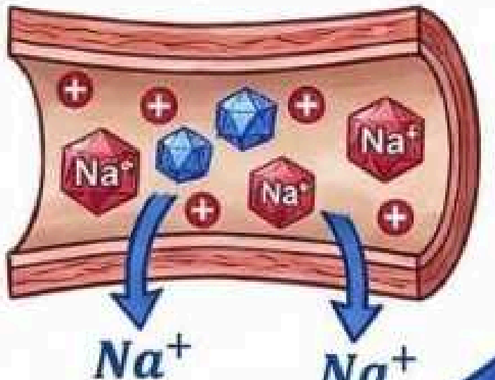


Result: Supports Blood Pressure

Trigger:
High volume
(Heart stretch)

Mechanism:
Heart releases Natriuretic Peptides

Action: Kidney excretes Na^+



The body defends extracellular volume primarily by regulating Sodium.

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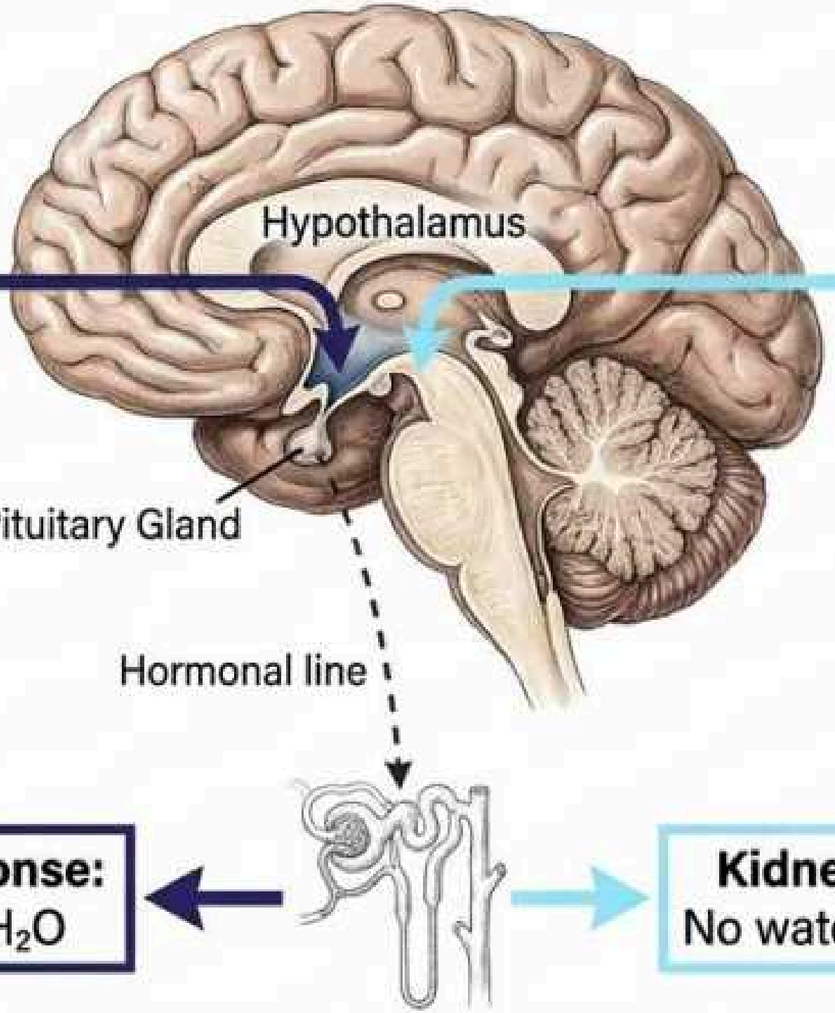
Sensing and Controlling Concentration

¶ 2.4

Sensors: Hypothalamus cells trigger

Action:
Triggers Thirst + releases Antidiuretic Hormone (ADH) from pituitary

Result: Concentrated urine produced



Kidney Response:
Reabsorbs H_2O

Sensors: Hypothalamus cells switch off

Action:
ADH is switched off

Kidney Response:
No water reabsorption

Result: Passes large amounts of dilute urine

The body defends concentration primarily by regulating Water.

Gemini Notebook

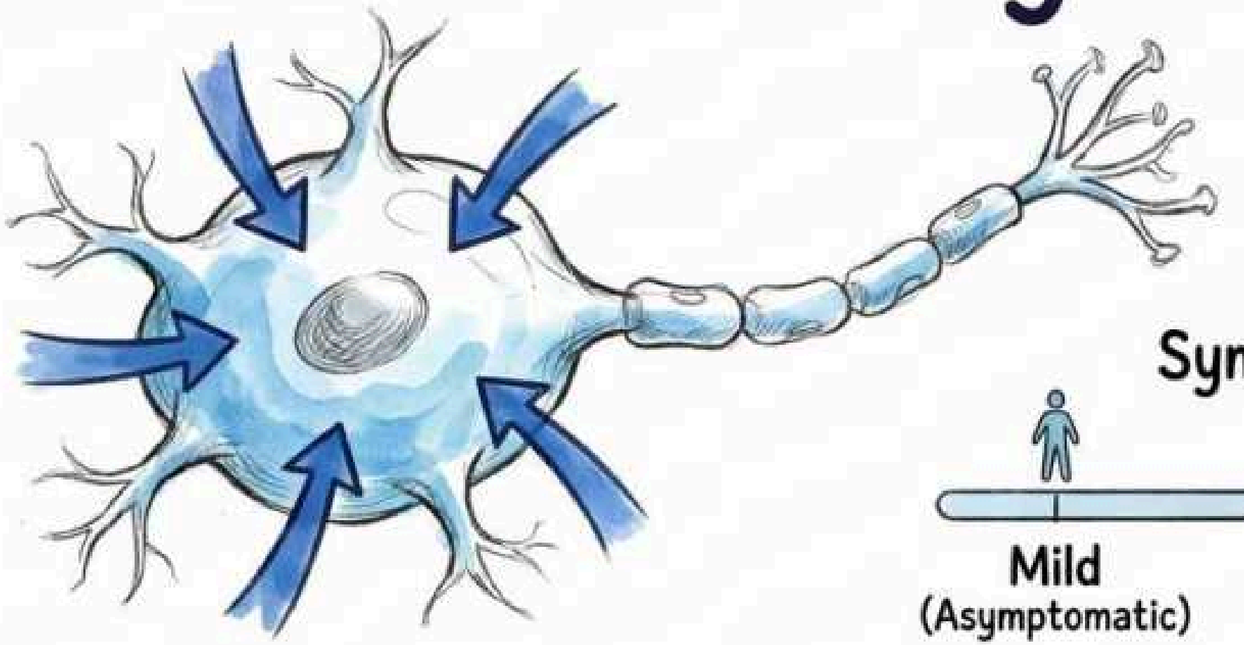
Hyponatraemia: The Water Excess

¶ 2.5

$$\downarrow [Na^+] = \frac{\text{Normal } Na^+}{\uparrow\uparrow \text{Total Body Water}}$$

Causes

Excess ADH	Diuretics	Heart Failure
Liver Disease	Polydipsia (excessive water drinking)	



Symptoms

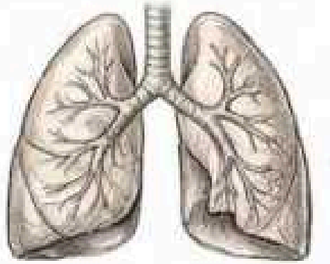
Mild (Asymptomatic)

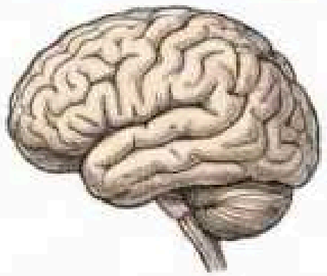
Severe/Rapid Confusion, Seizures, Brain Swelling

The commonest salt disturbance in hospital patients.
It means too much water relative to sodium, not too little sodium.

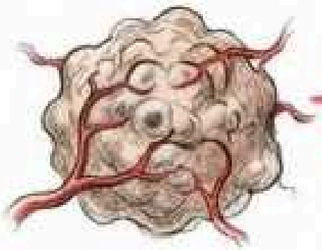
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SIADH: The Broken Feedback Loop









ADH

ADH

ADH

ADH

Brain
(Hypothalamus)

Pituitary Gland

ADH release

Kidney
(Water Reabsorption)

Feedback:
Dilute Body Fluids Switch Off ADH



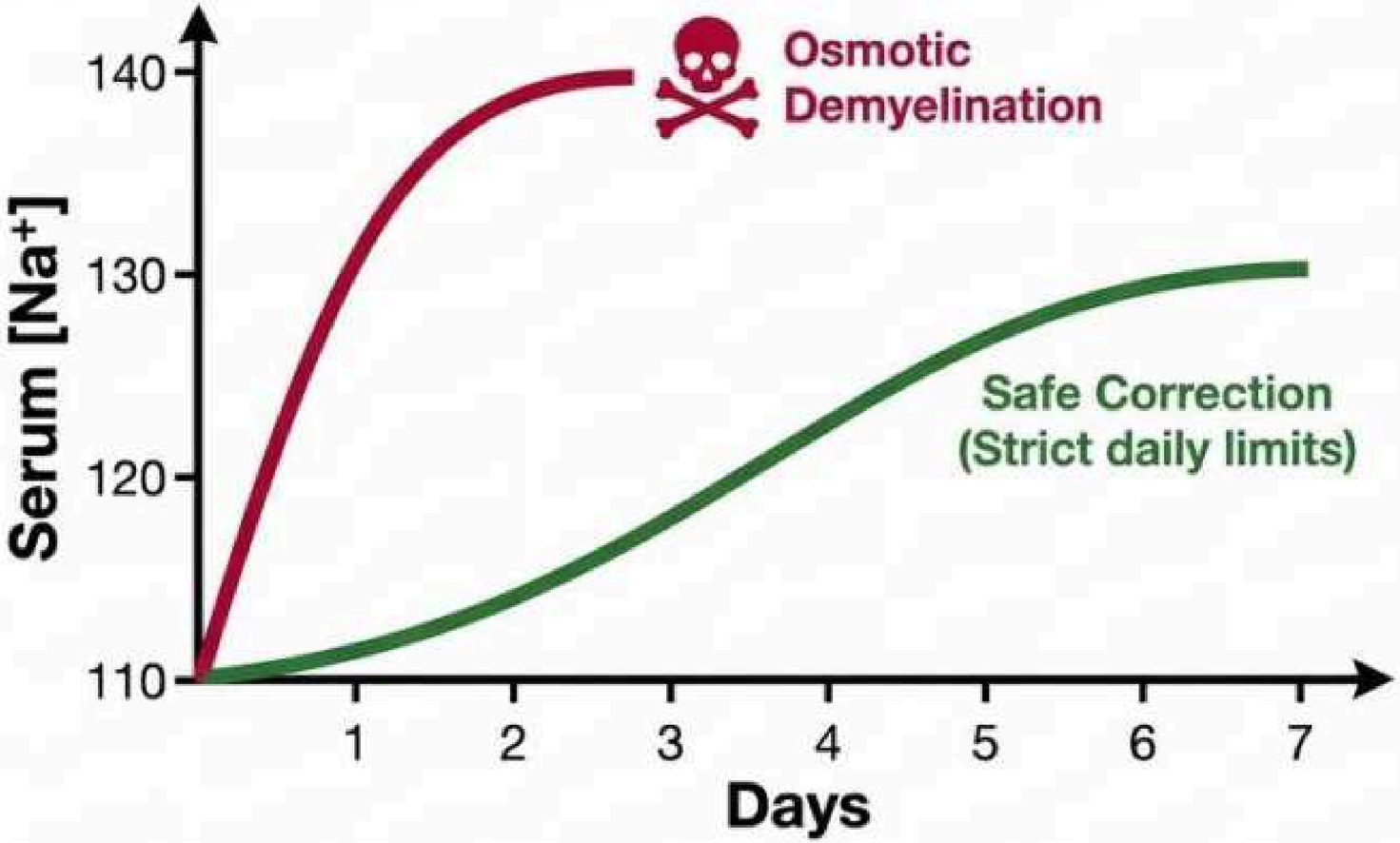
Mechanism: ADH is released inappropriately, even though body fluids are already dilute. Water is retained, and sodium concentration falls.

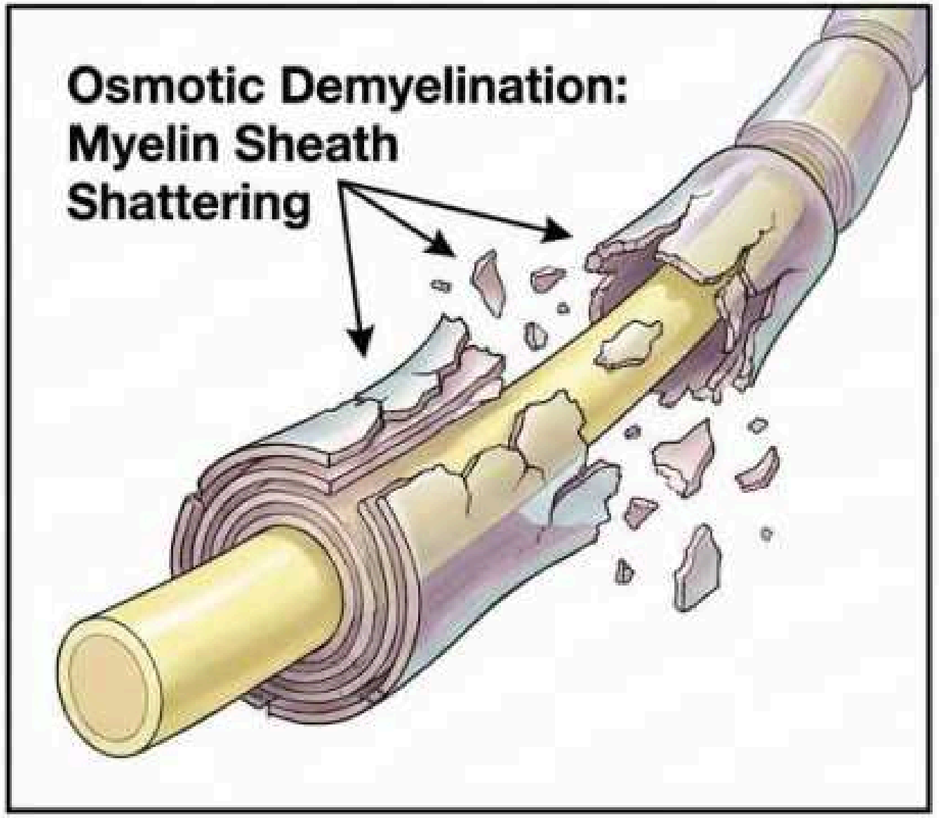
Common Culprits: Lung disease, brain disorders, certain medicines, cancers.

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The Danger Zone: Correcting Low Sodium

¶ 2.7





Clinical Warning: If a long-standing low sodium is raised too quickly, brain cells that adapted to the dilute enenvironment are damaged.

Protocol: Doctors must raise sodium slowly, bound by strict daily limits.

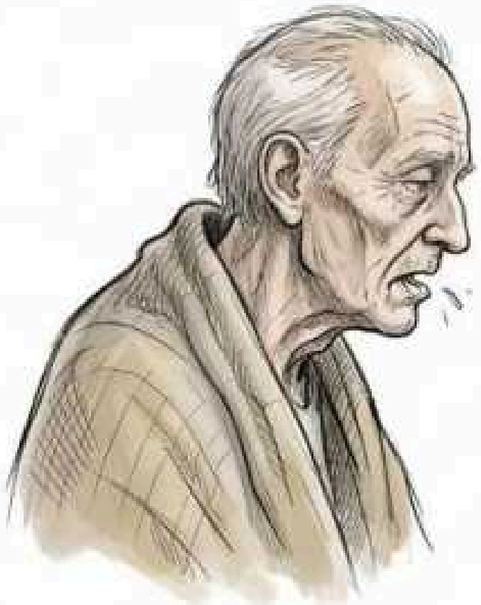
Gemini Notebook

Hypernatraemia: The Water Deficit

¶ 2.8

$$\uparrow[Na^+] = \frac{\text{Normal } Na^+}{\downarrow\downarrow \text{Total Body Water}}$$

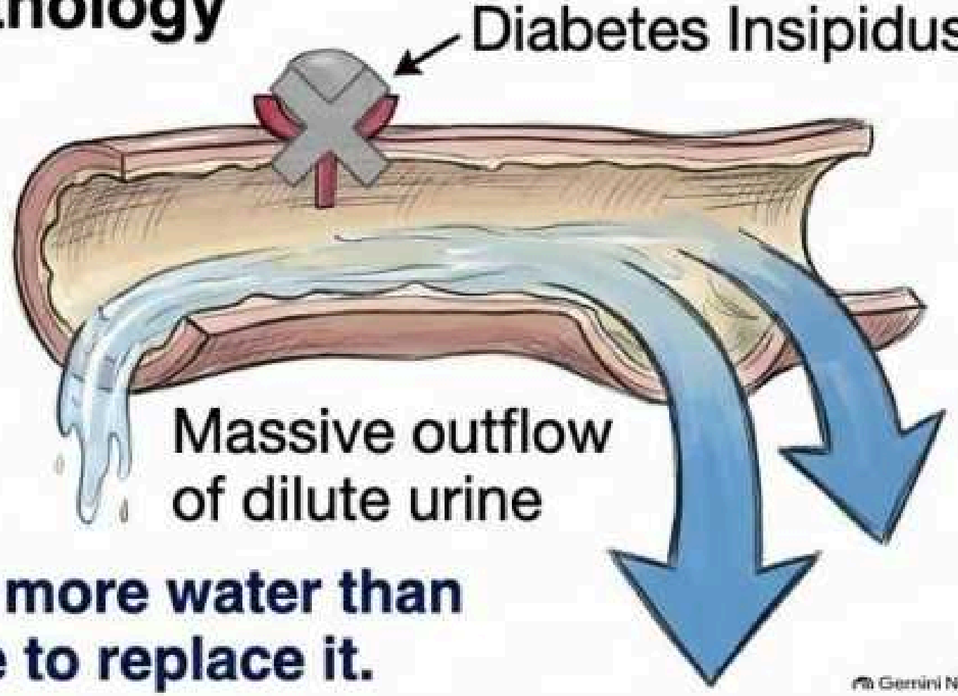
Demographics



Populations who cannot easily reach water or sense thirst.



Pathology

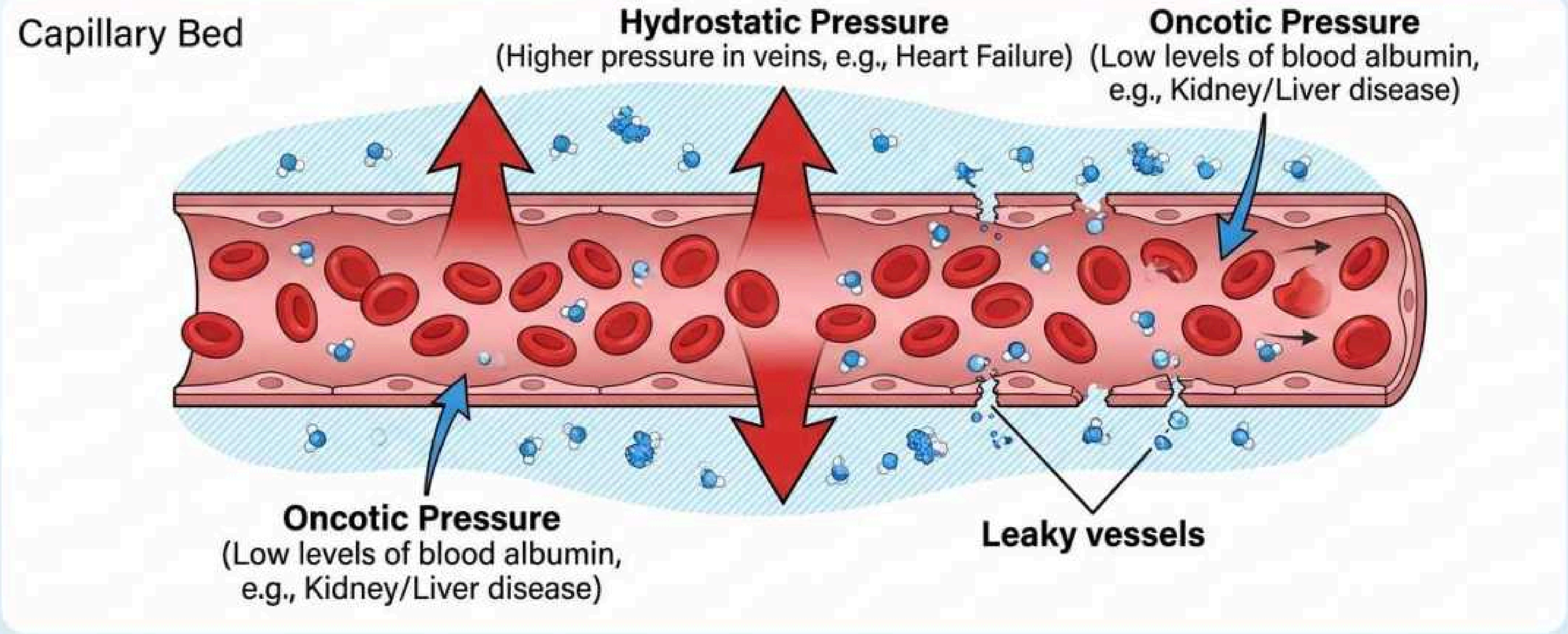


Usually means the body has lost more water than sodium and has not been able to replace it.

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Oedema: The Mechanics of Swelling

¶ 2.9

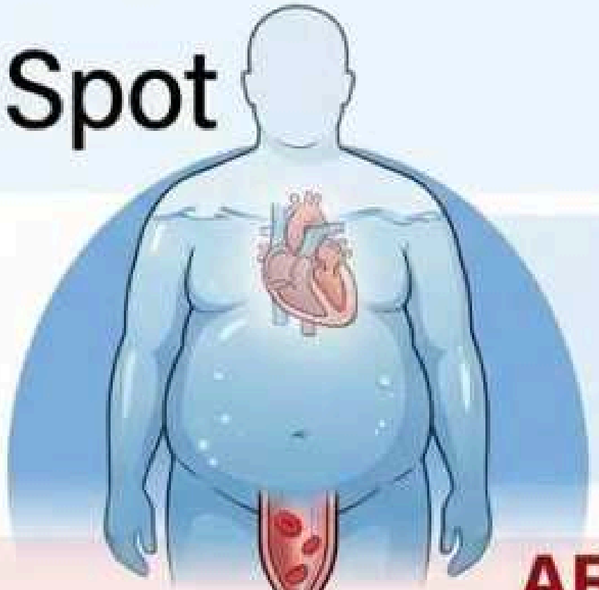


Definition: Swelling caused by excess fluid in the tissues. Occurs when forces across small blood vessel walls favour fluid leaving the vessels.

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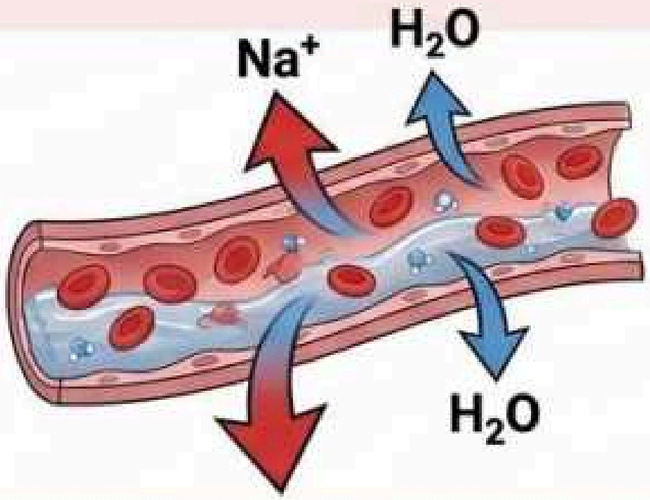
The Kidney's Blind Spot

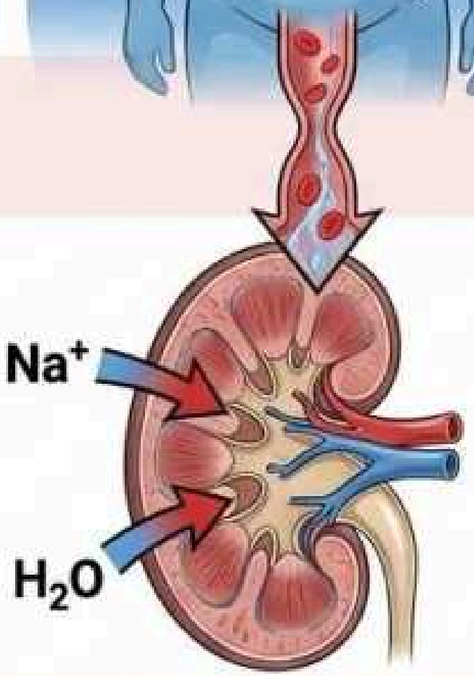
¶ 2.10



TOTAL BODY WATER = HIGH

ARTERIAL VOLUME = LOW





Treatment

Treatment = [↓ Salt Intake] + [Diuretics at tubule]





In heart failure, liver cirrhosis, and nephrotic syndrome, the kidney senses under-filled arteries and retains even more sodium and water, worsening the overall swelling.

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Synthesis: The Volume-Concentration Paradigm ¶ 2.11

VOLUME	CONCENTRATION
Regulated by: Sodium	Regulated by: Water
Primary Sensors: Heart, Arteries, Kidney	Primary Sensors: Hypothalamus
Key Hormones: RAAS, Natriuretic Peptides	Key Hormones: Antidiuretic Hormone (ADH)

The Golden Rule:
Disturbances of sodium concentration are usually problems of water.

Coming Next: Potassium and Acidity Control.

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