SODIUM IMBALANCE

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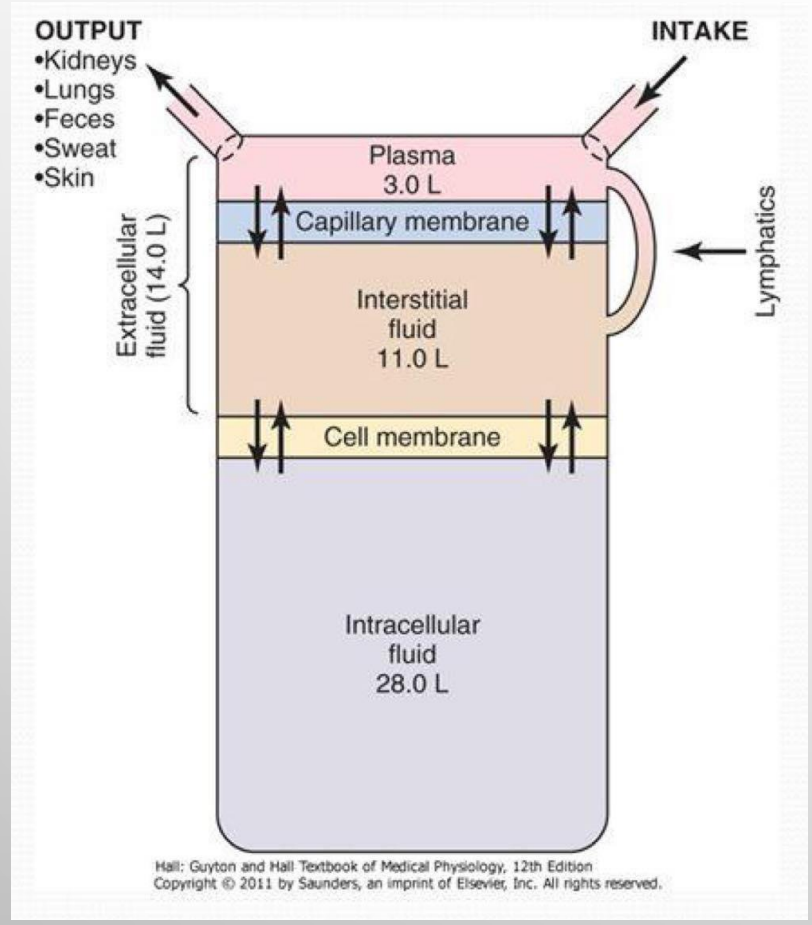
INTRODUCTION

- Body fluid compartment :



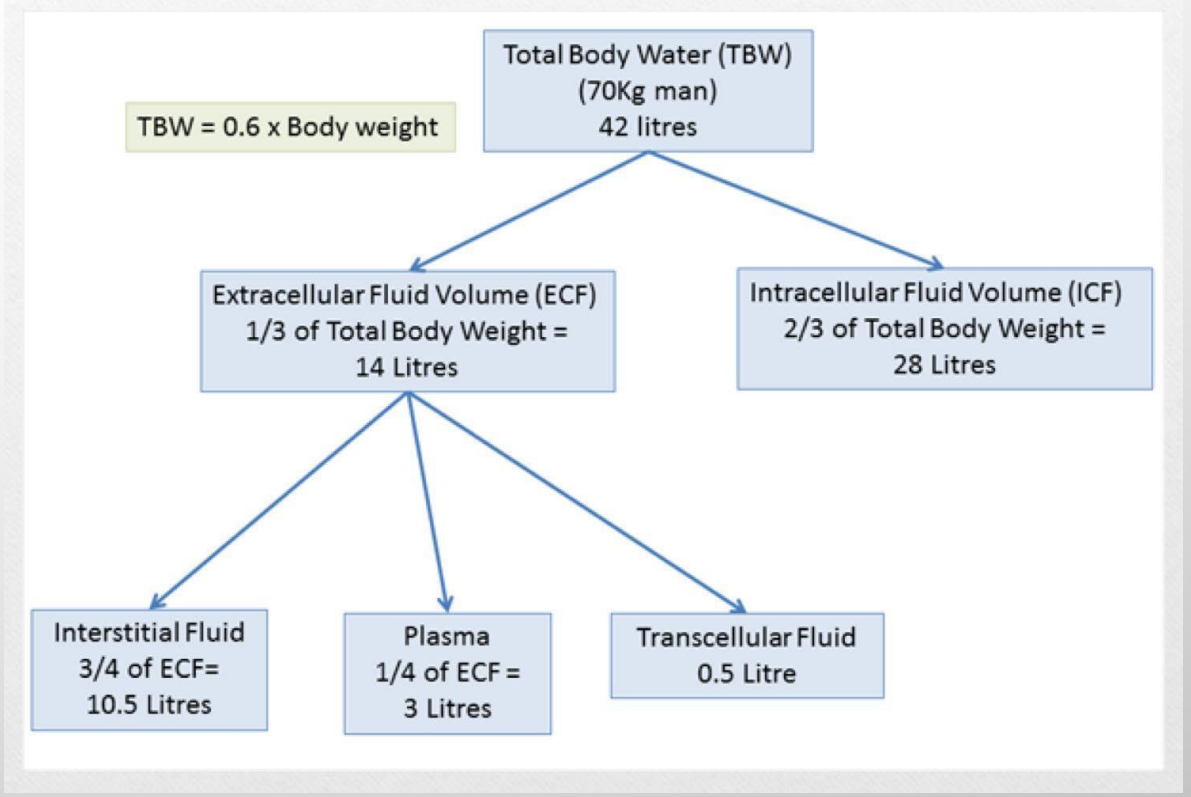
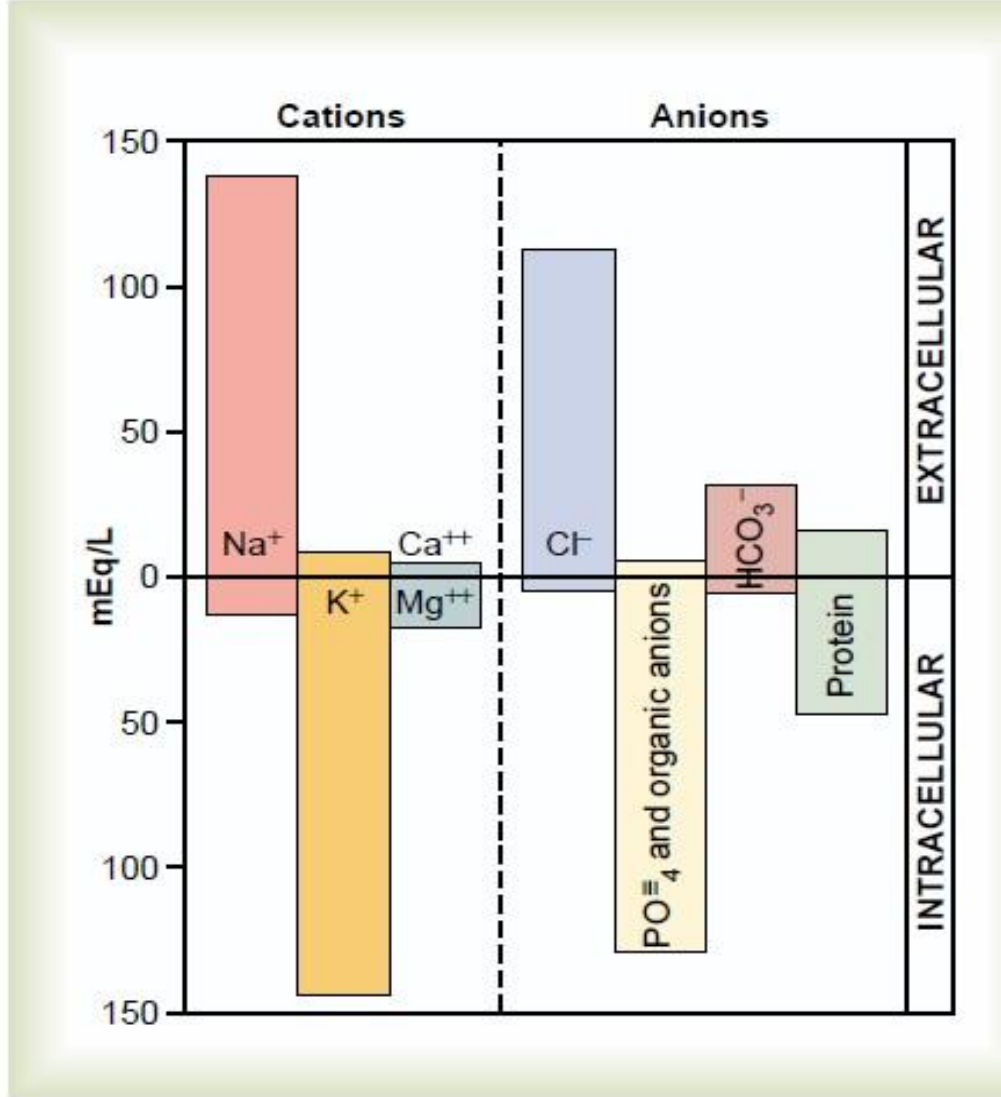


Table 25–1

Daily Intake and Output of Water (ml/day)

	Normal	Prolonged, Heavy Exercise
Intake		
Fluids ingested	2100	?
From metabolism	200	200
Total intake	2300	?
Output		
Insensible—skin	350	350
Insensible—lungs	350	650
Sweat	100	5000
Feces	100	100
Urine	1400	500
Total output	2300	6600

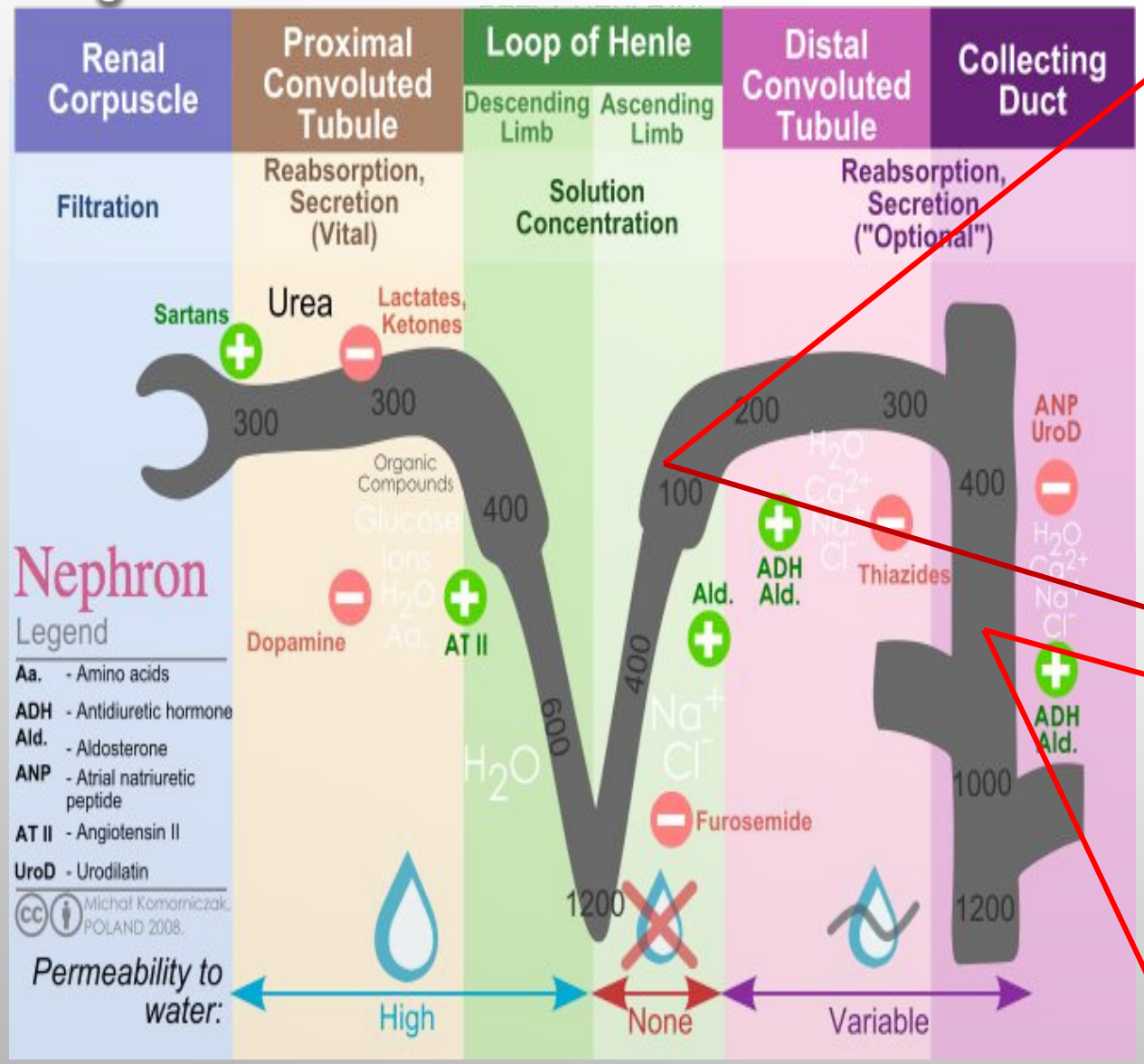
cations and anions of extracellular and intracellular fluid

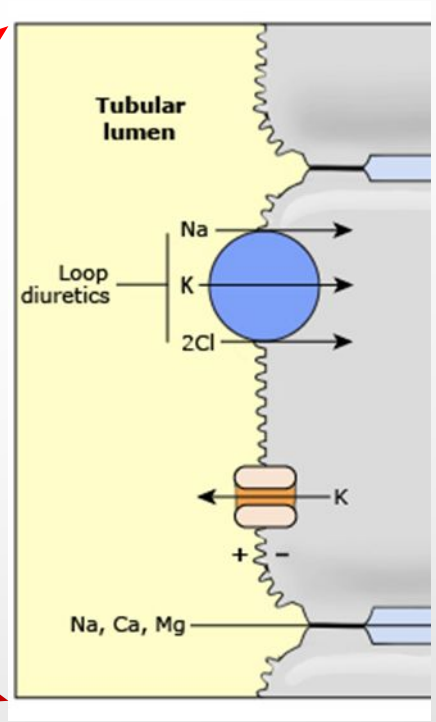


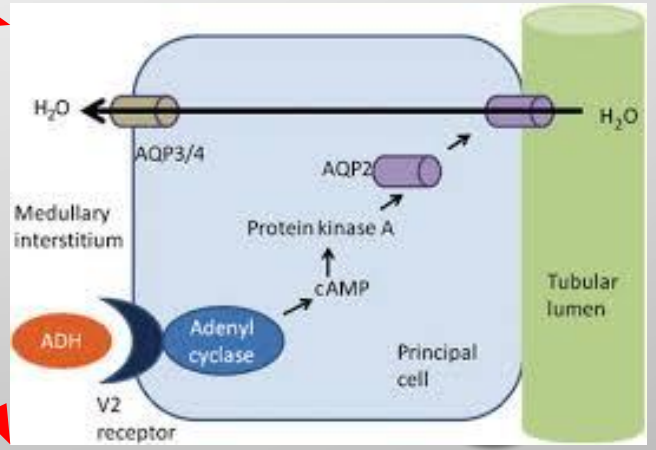
$$\text{Serum Osmolarity} = 2[Na+] + \frac{\text{Glucose}}{18} + \frac{\text{BUN}}{2.8}$$

$$\text{Normal Osmolarity} = 280 - 290\ \text{mOsm/L}$$

RENAL TUBULAR PROCESSING







ADH :
-act on collecting duct
- Water – reabsorbtion

Aldosterone :
- act on distal convoluted tubules
- Na – reabsorbtion

HYPONATREMIA

- **causes and classification (based on serum osmolality) :**

1- Hyper-Osmolar (Factitious hyponatremia)

2- Iso- Osmolar (pseudohyponatremia)

3- **Hypo- Osmoar (true hyponatremia)**

↳ categorized by volume status :

- Hypervolemic
- Euvolemic
- Hypovolemic

$$\text{Serum Osmolarity} = 2\,[Na+] + \frac{\text{Glucose}}{18} + \frac{\text{BUN}}{2.8}$$

$$\text{Normal Osmolarity} = 280 - 290\ \text{mOsm/L}$$

Hypertonic hyponatremia

- caused by the presence of osmotic substances that cause an **osmotic shift of water out of cells**. These substances cannot cross the cell membrane and therefore create osmotic gradients.
- These substances include:

- Glucose—hyperglycemia increases osmotic pressure, and water shifts from cells into ECF leading to a dilutional hyponatremia.

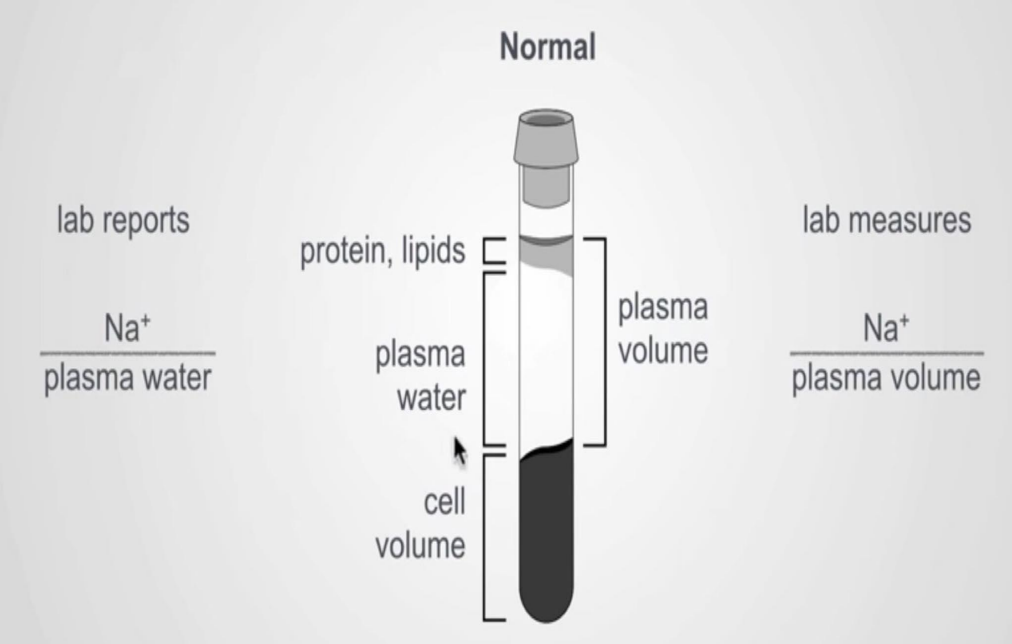
- mannitol, sorbitol, glycerol, maltose.

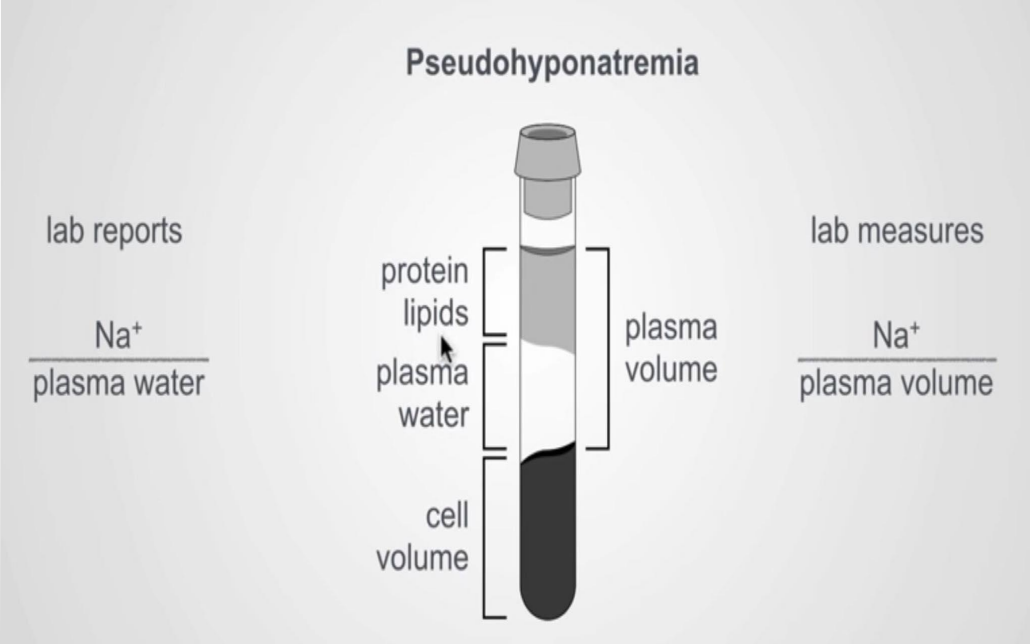
- radiocontrast agents.

Isotonic hyponatremia (pseudohyponatremia)

- Lab measurement error

- This can be caused by any condition that leads to **elevated** **protein or lipid levels**

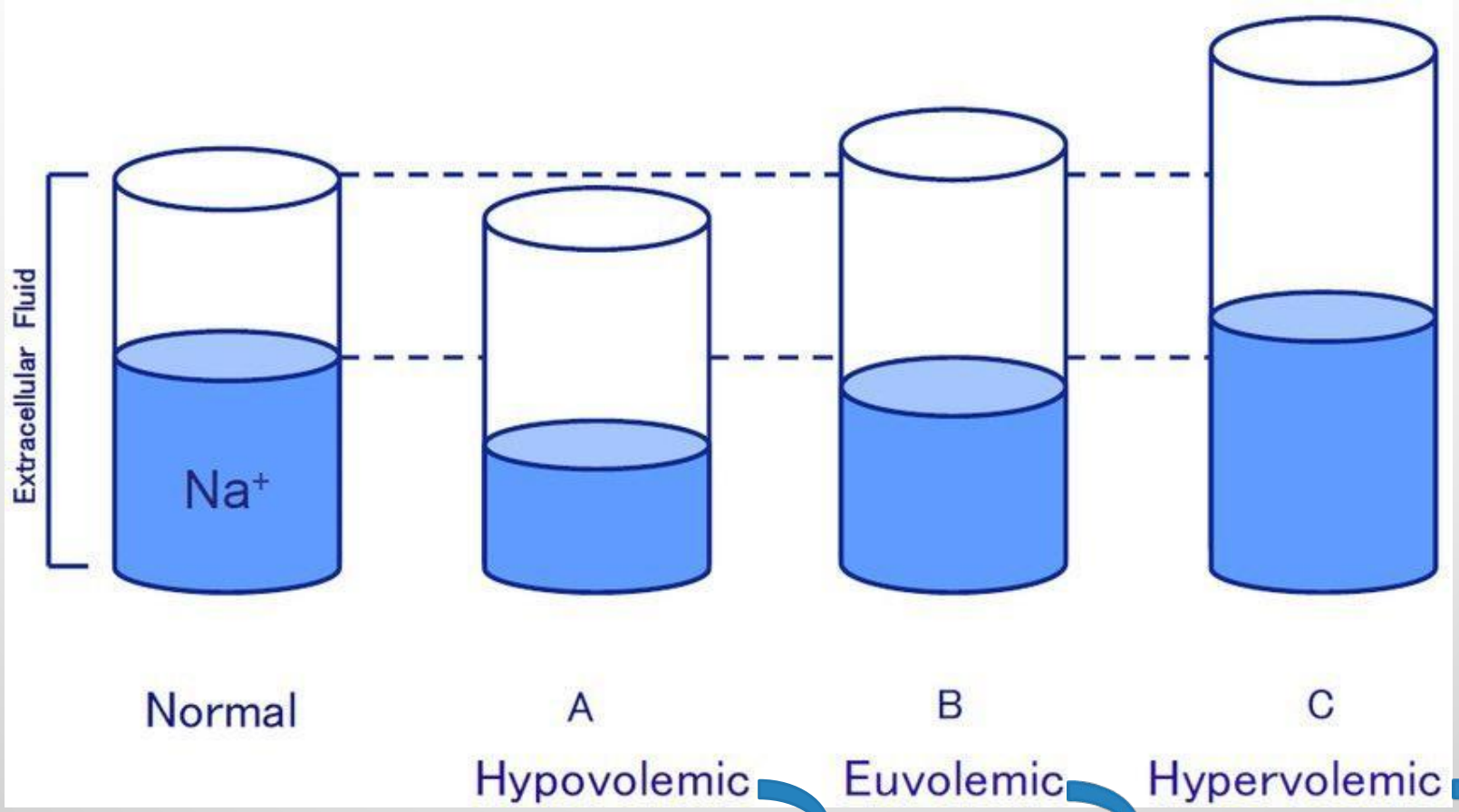




Hypotonic hyponatremia (true hyponatremia)

Water disorder :
Na – concentration

Volume disorder :
Total Na in the body
Hypervolemia– total Na is high .
Hypovolemia – total Na is low .
Euvolemia – total Na is not change .



Decrease in total body water and the total body sodium **but decrease is sodium more** .

Total body sodium is actually normal , **but you have an increase in total body water.**

Increase in both total body water and total body sodium **, but increase in total body water is more .**

Hypervolemic (low urine sodium)—this is due to water-retaining states. the relative excess of water in relation to sodium results in hyponatremia.

- CHF
- Liver disease (cirrhosis)
- Advanced renal failure)
- Pregnancy

Euvolemic - no evidence of ecf expansion or contraction on clinical grounds.

- **U osm < 100**

SIADH , adrenal insufficiency , hypothyroidism

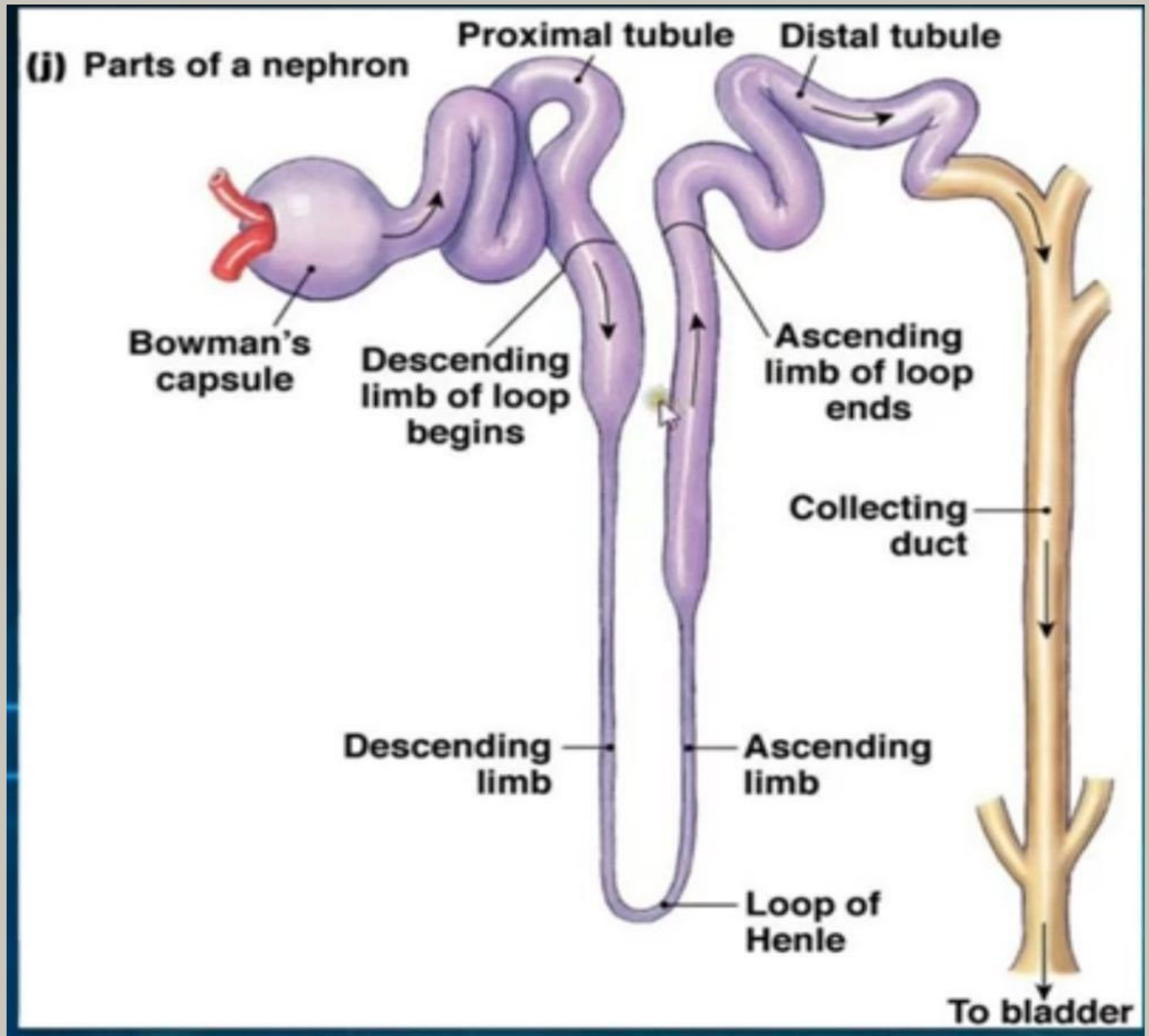
- **Uosm > 100**

Psychogenic polydipsia , special diet (beer potomania , tea and toast)

Hypovolemic

- **low urine sodium (<10 meq/l)—**implies increased sodium retention by the kidneys to compensate for **extra renal losses** (e.g., diarrhea, vomiting, nasogastric suction, diaphoresis, third-spacing, burns, pancreatitis) of sodium-containing fluid .

- **high urine sodium (>20 meq/l)—**renal salt loss is likely—for example, diuretic excess, decreased aldosterone (ACE inhibitors), SLN (salt – losing nephropathy)


(j) Parts of a nephron
Proximal tubule
Distal tubule
Bowman's capsule
Descending limb of loop begins
Ascending limb of loop ends
Collecting duct
Descending limb
Ascending limb
Loop of Henle
To bladder

General characteristics of hyponatremia

- 1. this refers to too much water in relation to sodium in the serum.
- 2. it is typically defined as a plasma na+ concentration <135 mmol/l.
- 3. symptoms usually begin when the na+ level falls to <120 meq/l. an important exception is increased intracranial pressure (ICP) (e.g., after head injury). as ECF osmolality decreases, water shifts into brain cells, further increasing ICP. (therefore, it is critical to keep serum sodium normal or slightly high in such patients.)

clinical features

1- Neurologic symptoms predominate—caused by “water intoxication”—osmotic water shifts, which leads to increased ICF volume, specifically brain cell swelling or cerebral edema

- A. headache, delirium, irritability
- B. muscle twitching, weakness
- C. hyperactive deep tendon reflexes

- 2- increased ICP , seizures, coma
- 3- GI —nausea, vomiting, ileus, watery diarrhea
- 4- cardiovascular—hypertension due to increased ICP
- 5- increased salivation and lacrimation
- 6- oliguria progressing to anuria—may not be reversible if therapy is delayed