UNIT V

Textbook of Medical Physiology, 11th Edition

Body fluids and electrolytes

Dr Mohammed Alotaibi, MRes, Ph.D.

GUYTON & HALL

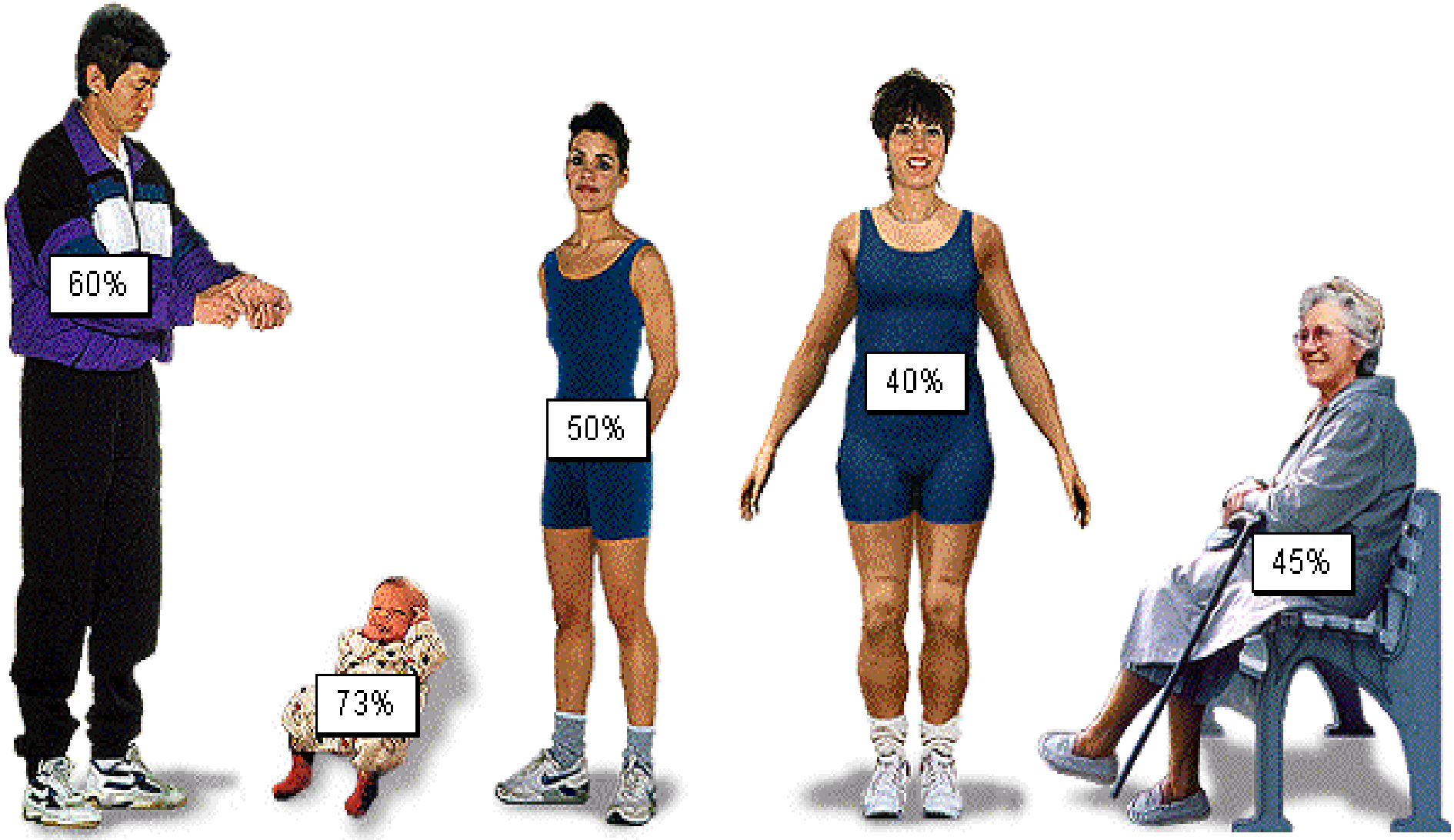
Objectives

- **<u>At the end of this session, the students should be able to:</u>**
- Identify and describe daily intake and output of water and maintenance of water balance.
- List and describe of body fluid compartments as intra-cellular fluid (ICF), Extra-cellular fluid (ECF), interstitial fluid, trans-cellular fluid, and total body water (TBW).
- Describe the composition of each fluid compartment, in terms of volume and ions and represent them in graphic forms.
- Describe the physiological and pathological factors influencing the body fluid.

Body fluids

- Human body contains **50-70%** water = **60%**
- **Example:**
- 70 kg man has 42 L of water.
- Kg of water = L of water.
- **Factors affecting (Age):**
- Infant: **73%**
- Male adult: **60%**
- Female adult: **40-50%**
- Obesity
- Old age ↓ **45%**

Percentage of Water in the Body

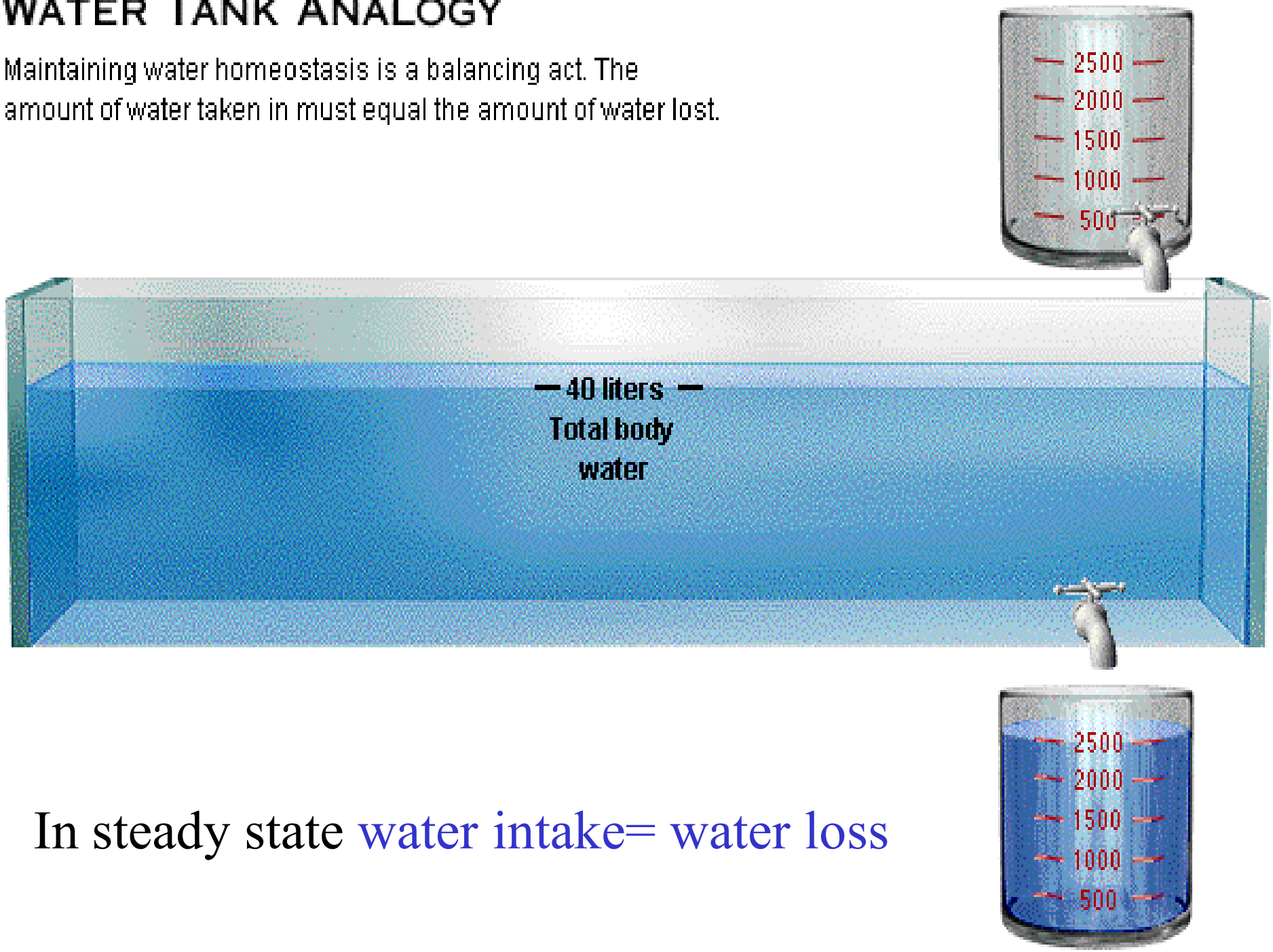


Body Water Content

- **Infants** have low body fat, low bone mass, and are **73%** or more water
- **Healthy males** are about **60%** water; **healthy females** are around **50%**
- This difference reflects females':
  - Higher body fat
  - Smaller amount of skeletal muscle
- In **old age**, only about **45%** of body weight is water

Water Tank Analogy

Maintaining water homeostasis is a balancing act. The amount of water taken in must equal the amount of water lost.

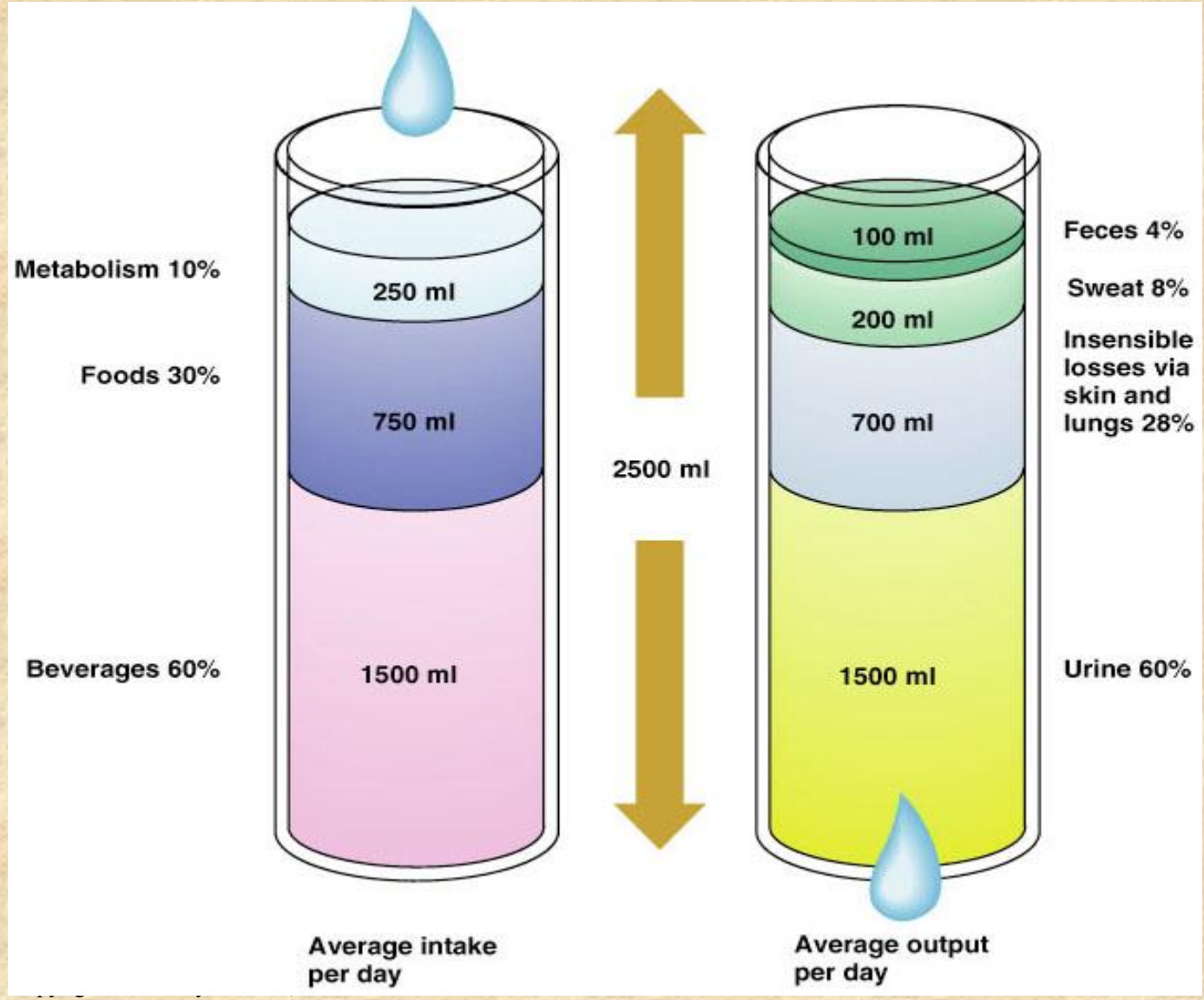


In steady state water intake= water loss

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

Daily Intake and output of Water (ml/day)

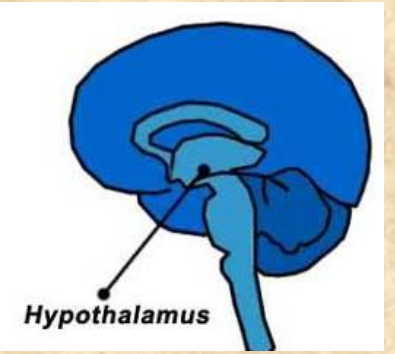


Regulation of Water Intake

- Climate
- Habits
- Level of physical activity

➢ **The hypothalamic thirst centre is stimulated:**

- By a decline in plasma volume of 10% – 15%
- By increases in plasma osmolality of 1 – 2%



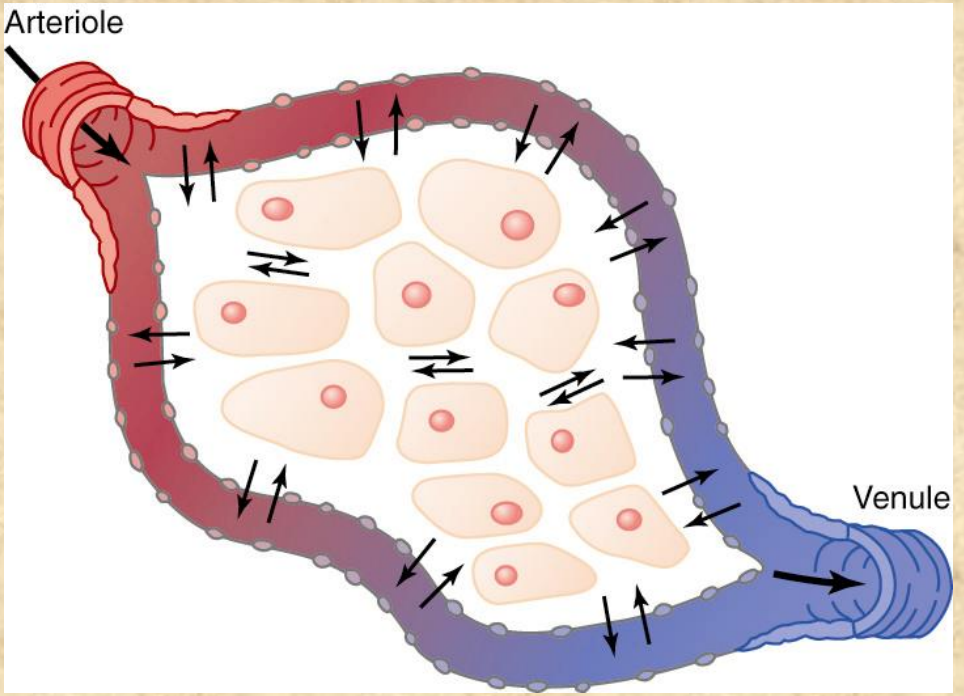
Factors that Affect the TBW

- **Physiological factors**
  - Age
  - Sex
  - Body fat
  - Climate and habit
  - Physical activity
- **Pathological factors**
  - Vomiting
  - Diarrhea
  - Diseases with excessive loss of water (DM, excessive sweating)
  - Blood loss

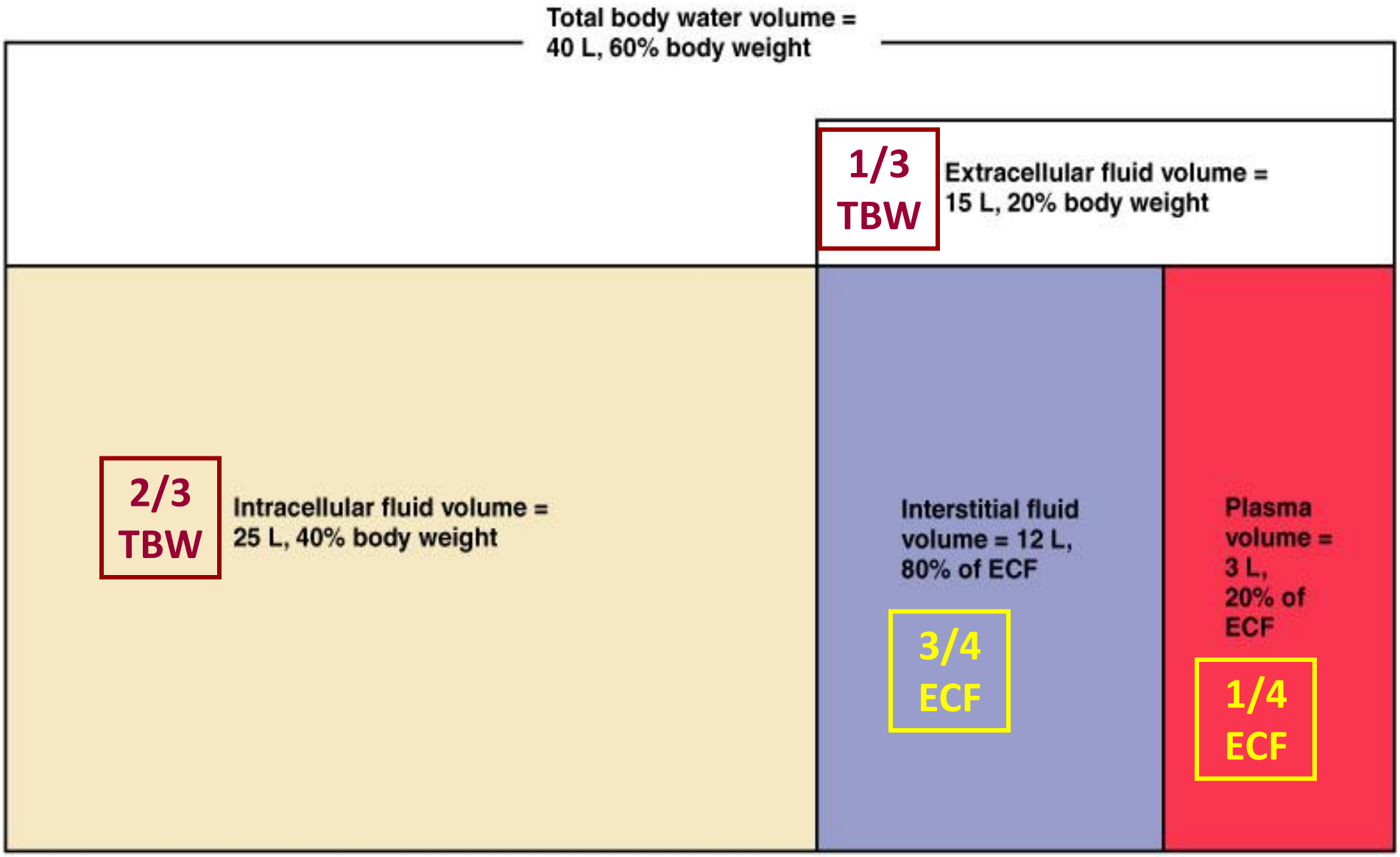
Fluid Compartments

- Water occupies **two** main fluid compartments:

- Intracellular fluid (ICF)
- Extracellular fluid (ECF)
  - Interstitial Fluid (IF)
  - Plasma
  - Transcellular Fluid



Fluid Compartments



FLUID COMPARTMENTS

EXTRA CELLUAR FLUID

INTRA CELLULAR FLUID

PLASMA

INTERSTITIAL FLUID

TRANSCELLULAR FLUID

CSF
Intraocular
intrapleural
intraperitoneal
Synovial
Digestive Secretions

Small amount

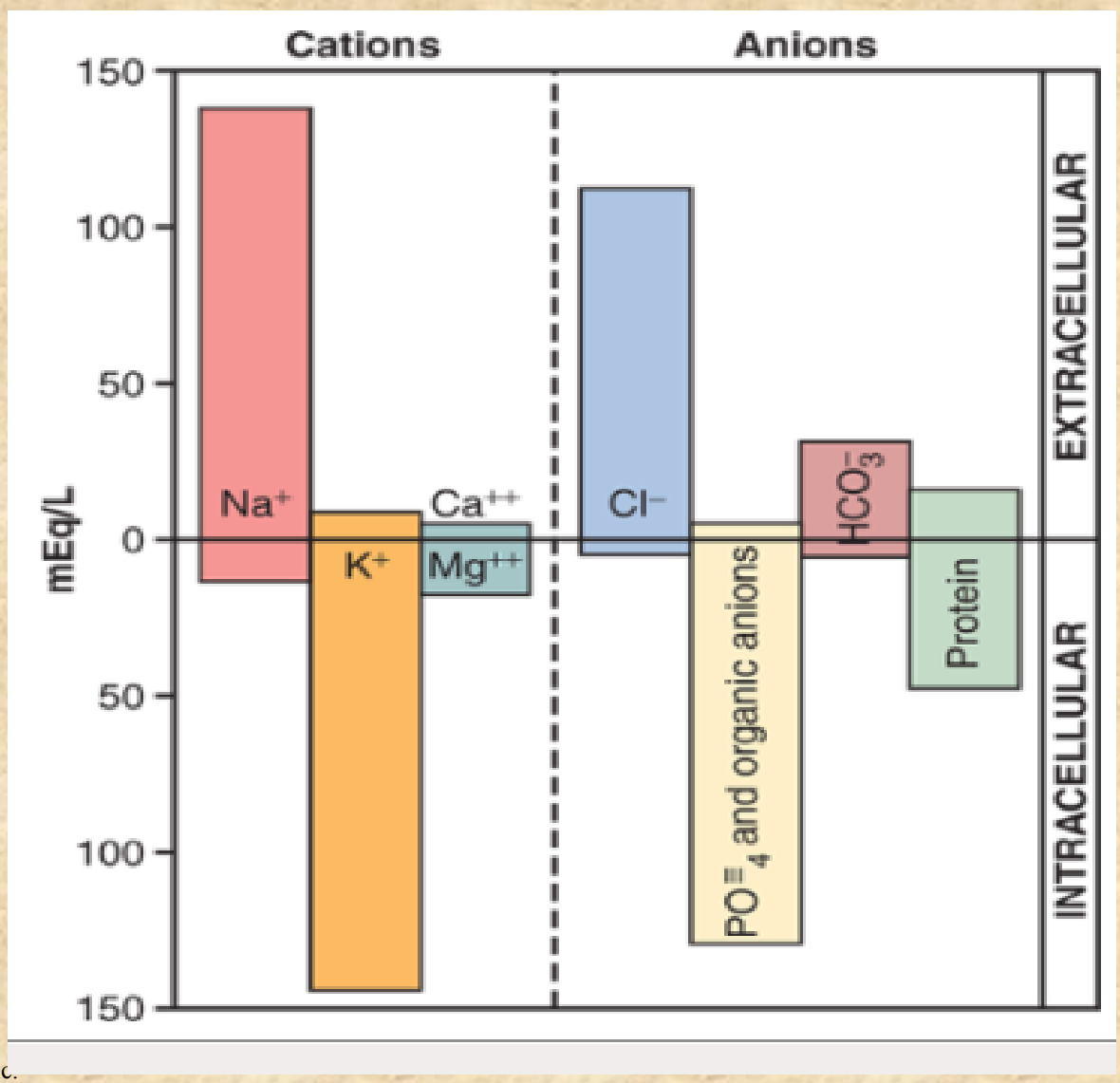
Fluid Compartments

- **Intracellular fluids (ICF):**
  - Inside the cell.
  - 2/3 of TBW.
  - High concentration of protein.
- **Extracellular fluids (ECF):**
  - Outside the cell.
  - 1/3 of TBW.
  - **Plasma:**
    - Fluid circulating in the blood vessels.
    - 1/4 of ECF
  - **Interstitial fluid:**
    - Fluid bathing the cell.
    - Ultra filtration of plasma.
    - 3/4 of ECF

Plasma and interstitial fluids are almost having the same composition except for high protein concentration in plasma

- **Composition of body fluid**
- Water is the universal solvent
- **Solutes are broadly classified into:**
- **Electrolytes** – inorganic salts, all acids and bases, and some proteins
- **Nonelectrolytes** – examples include glucose, lipids, creatinine, and urea
- **Amount** = in moles, osmoles.
- **Concentration**
- **Molarity** = moles/liter M/L.
- **Osmolarity** = osmoles/liter Osm/L.
- **Osmolality** = osmoles/kg Osm/kg.
- **In biological solution**
- Millimoles per liter (mM/L)
- Milliosmoles per (mOsm/L)
- 1mM=1/1000 M
- 1mOsm=1/1000 Osm

Constituents of Extracellular and Intracellular Fluids

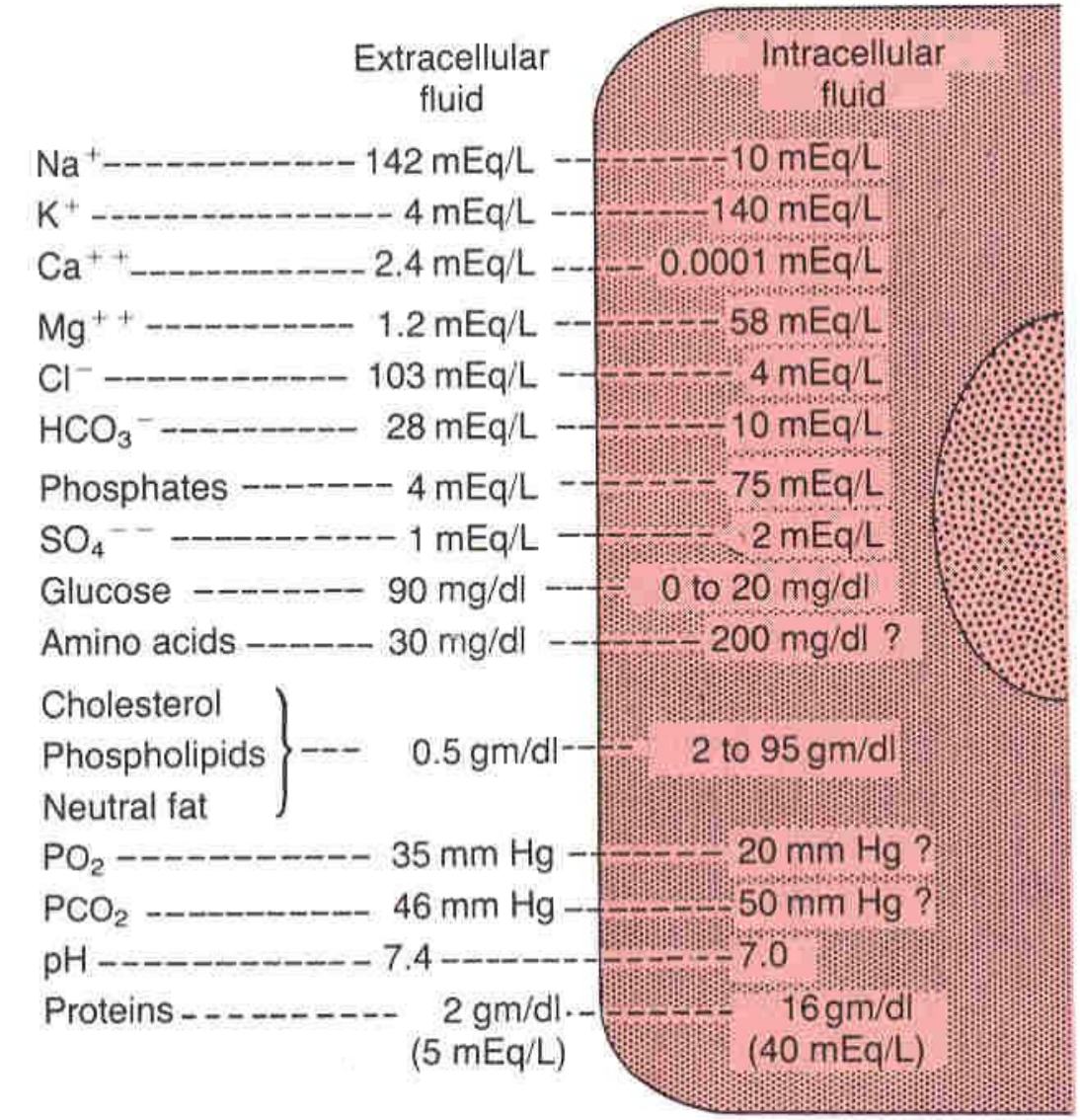


Osmolar substances in extracellular and intracellular fluids

	Plasma (mOsm/L H_2O)	Interstitial (mOsm/L H_2O)	Intracellular (mOsm/L H_2O)
Na^+	142	139	14
K^+	4.2	4.0	140
Ca^{++}	1.3	1.2	0
Mg^{++}	0.8	0.7	20
Cl^-	108	108	4
HCO_3^-	24	28.3	10
$HPO_4^=$, $H_2PO_4^-$	2	2	11
$SO_4^=$	0.5	0.5	1
Phosphocreatine			45
Carnosine			14
Amino acids	2	2	8
Creatine	0.2	0.2	9
Lactate	1.2	1.2	1.5
Adenosine triphosphate			5
Hexose monophosphate			3.7
Glucose	5.6	5.6	
Protein	1.2	0.2	4
Urea	4	4	4
Others	4.8	3.9	10
Total mOsm/L	301.8	300.8	301.2
Corrected osmolar activity (mOsm/L)	282.0	281.0	281.0
Total osmotic pressure at 37 °C (mm Hg)	5443	5423	5423

Extracellular and Intracellular Fluids

- Each fluid compartment of the body has a distinctive pattern of electrolytes
- **Extracellular fluids** are similar (except for the high protein content of plasma)
  - Sodium is the chief cation
  - Chloride is the chief anion
- **Intracellular fluids** have low sodium and chloride
  - Potassium is the chief cation
  - Phosphate is the chief anion
- Each compartment must have almost the same concentration of positive charge (cations) as of negative charge (anion) **(Electroneutrality)**



Potassium Ion

Hypokalemia: decrease in K concentration in the ECF. 1-2 mEq/L

- **Hyperkalemia:** increase in K 60-100% a above normal

Sodium Ion

- **Hypernatremia:** increase in Na concentration in ECF
- **Hyponatremia:** decrease in Na concentration in the ECF

The End

Thank You