



Body Fluids and Body Fluid Compartments

Tissue Biology and Introduction to Human Embryology (MED 114)

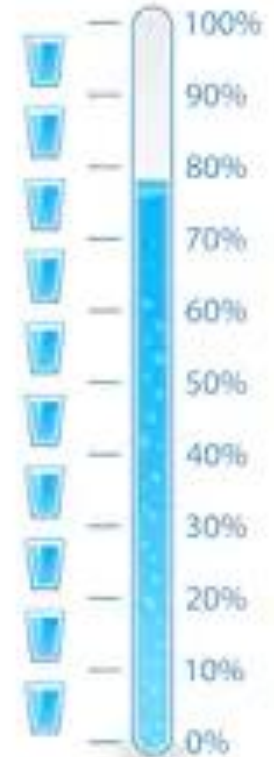
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Body fluid

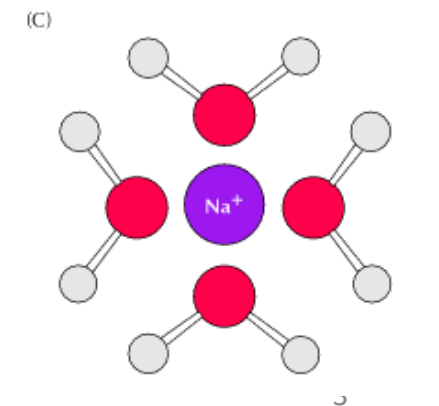
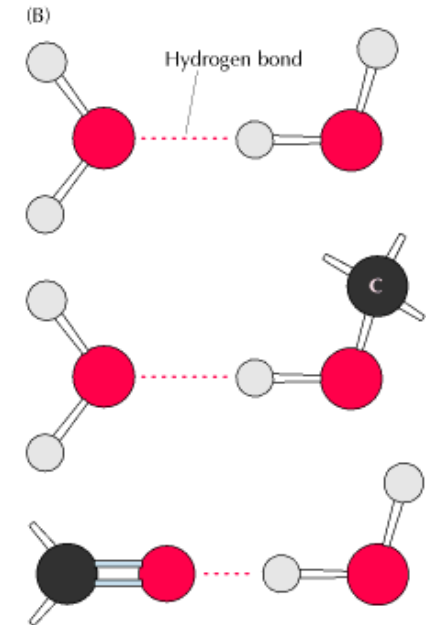
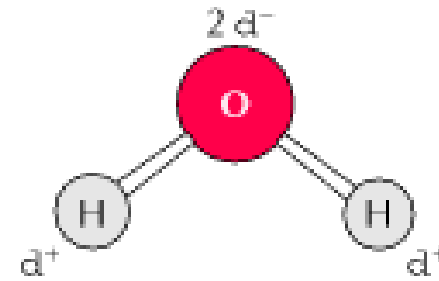
Watery solution of dissolved substances such as oxygen, nutrients, and wastes

- present within and around all cells of the body, and within blood vessels -*internal environment*



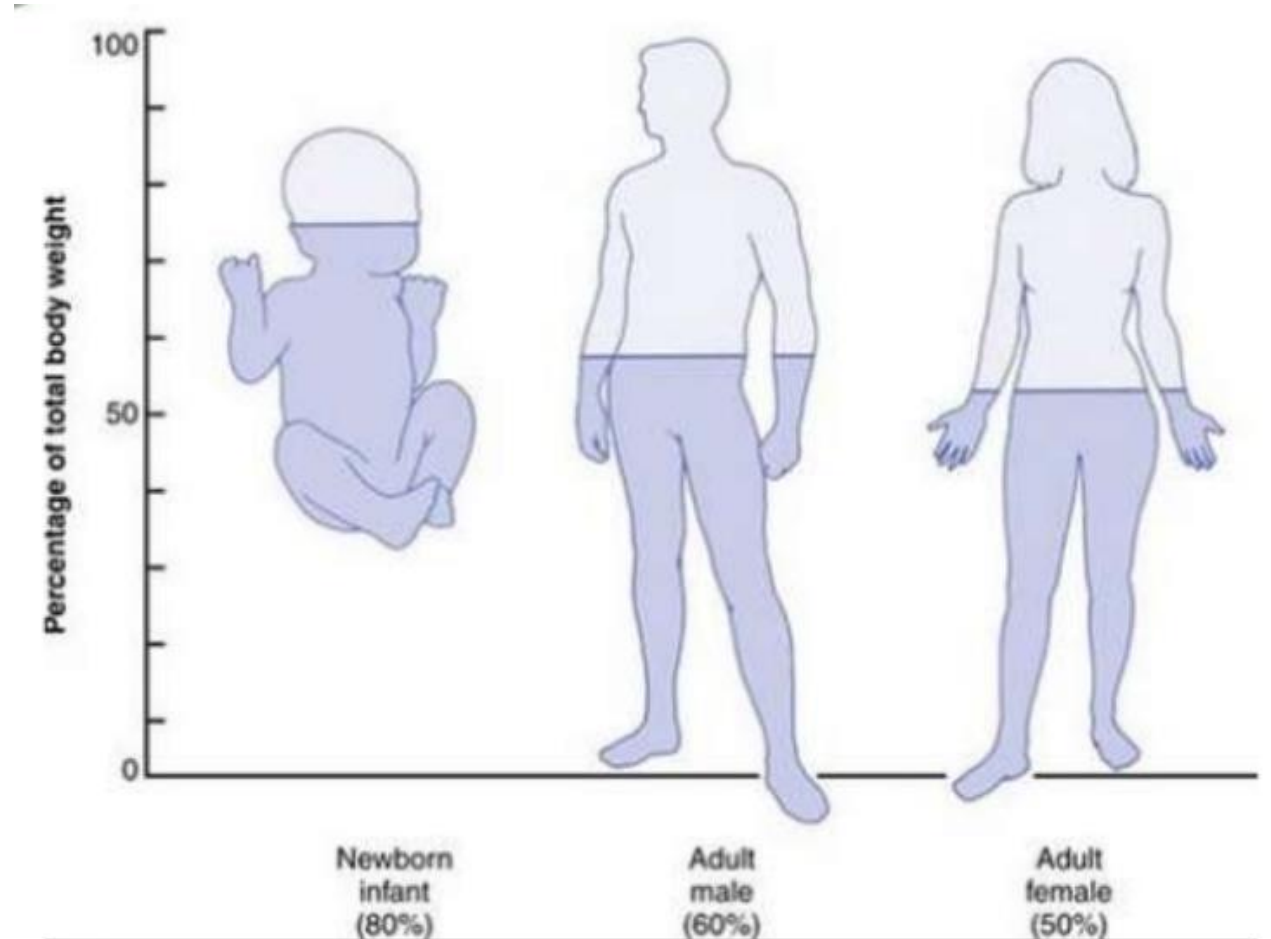
Body Fluids

- The chemical reactions of life take place in aqueous solutions.
- Human beings are **mostly water**, ranging from about 75% of body mass in infants to about 50–60% in adult men and women.



Water (H₂O)

- In the average young adult male, 18% of the body weight is protein and related substances, 7% is mineral, and 15% is fat.
- In a 70-kg adult man, the total body water is about
60% ~ 42 liters
- This percentage depends on **age** and **gender**.



The total body fluid is distributed mainly between two compartments

1- Intracellular fluid: ICF (inside the cell)

40 % body weight

= **28 liters**

2- Extracellular fluid: ECF (outside the cell)

20 % body weight

= **14 liters**

a) Interstitial fluid (Intercellular)

15 % body weight = 10.5 liters

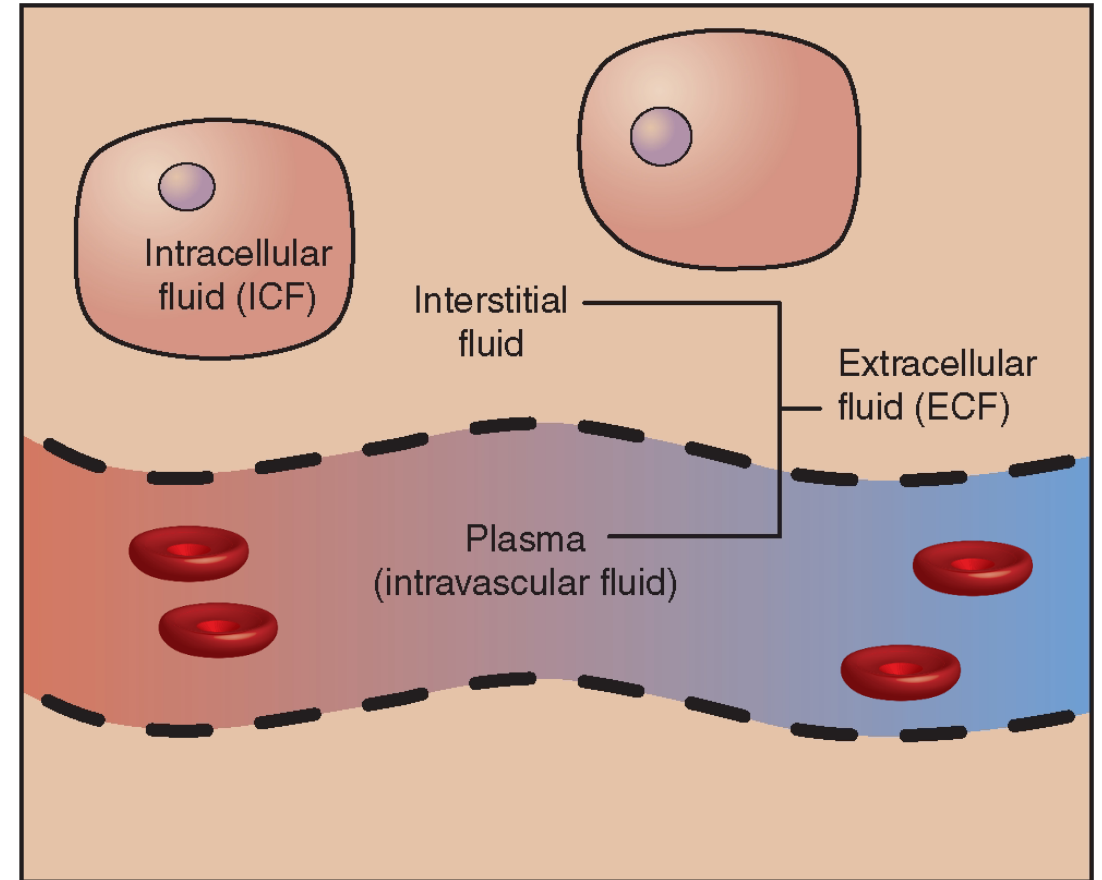
b) Intravascular fluid (Blood Plasma)

5 % body weight = 3.5 liters

c) Transcellular fluid (synovial, peritoneal, pericardial, CSF, intraocular spaces)

TOTAL BODY FLUID

60 % = 42 liters



Extracellular vs. Intracellular

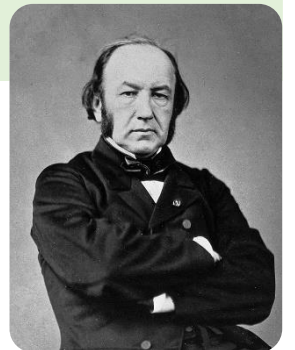
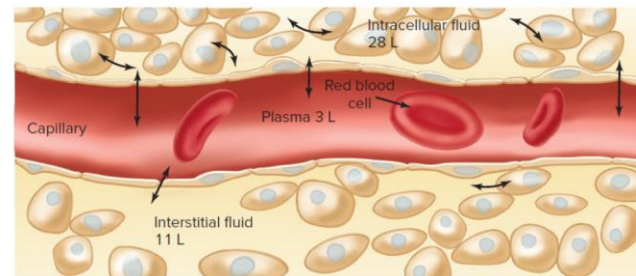
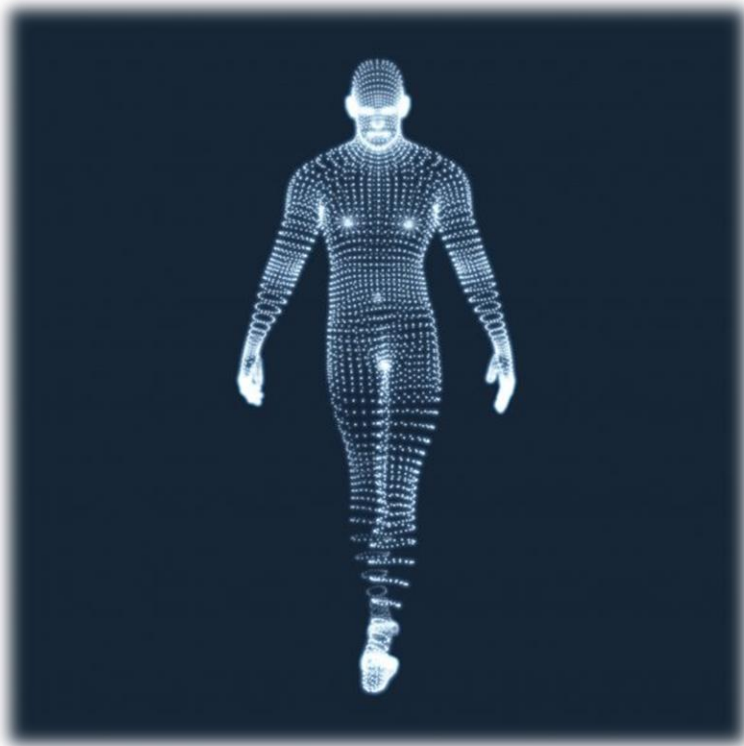
	EXTRACELLULAR FLUID	INTRACELLULAR FLUID
Na ⁺	142 mEq/L	10 mEq/L
K ⁺	4 mEq/L	140 mEq/L
Ca ⁺⁺	2.4 mEq/L	0.0001 mEq/L
Mg ⁺⁺	1.2 mEq/L	58 mEq/L
Cl ⁻	103 mEq/L	4 mEq/L
HCO ₃ ⁻	28 mEq/L	10 mEq/L
Phosphates	4 mEq/L	75 mEq/L
SO ₄ ⁻	1 mEq/L	2 mEq/L
Glucose	90 mg/dl	0 to 20 mg/dl
Amino acids	30 mg/dl	200 mg/dl ?
Cholesterol	0.5 g/dl	2 to 95 g/dl
Phospholipids		
Neutral fat		
PO ₂	35 mm Hg	20 mm Hg ?
PCO ₂	46 mm Hg	50 mm Hg ?
pH	7.4	7.0
Proteins	2 g/dl (5 mEq/L)	16 g/dl (40 mEq/L)



In the extracellular fluid are the **ions and nutrients** needed by the cells to maintain cell life.

The extracellular fluid is also called the “*internal environment of the body*” (the *milieu intérieur*).

The internal environment is made up of the ECF.



The maintenance of a relatively constant volume and a stable composition of the body fluids is essential for homeostasis.

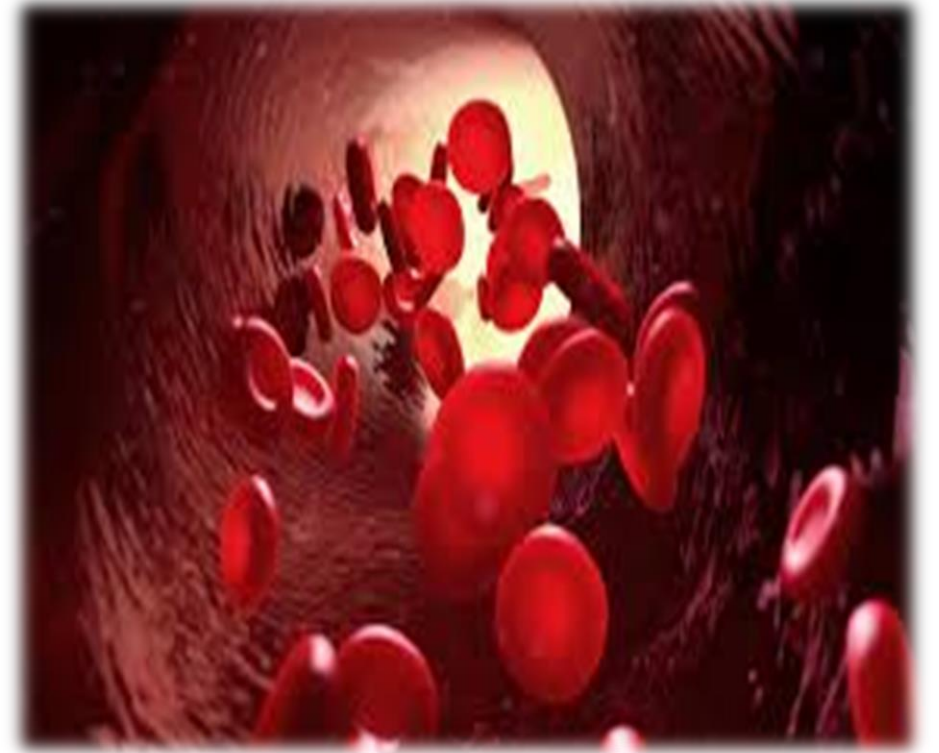
Some of the most common and important problems in clinical medicine arise because of abnormalities in the control systems that maintain this relative constancy of the body fluids.

Homeostasis

- **Homeostasis** is the maintenance of constant conditions in fluid surrounding cells (extracellular fluid) or internal environment by the integrated actions of various organs within the organism
- **Homeo**: the same; **Stasis**: standing still
- The term “*homeostasis*” is used by physiologists to explain **maintenance of nearly constant conditions in the internal environment** even though the outside world is continuously changing.
- Essentially all organs and tissues of the body perform functions that help maintain these constant (steady state) conditions.
- Dynamic

BLOOD

- Blood contains both
 - extracellular fluid (the fluid in **plasma**)
 - intracellular fluid (the fluid in the blood cells)
- Blood is considered to be a separate fluid compartment because it is contained in a chamber of its own: the circulatory system
- Especially important in the control of cardiovascular dynamics.



Total body weight x **0.08** = (~**5.5 Liters**)

Functions of Blood

- ✓ Transportation of nutrients, gases, wastes, hormones
- ✓ Regulation of pH
- ✓ Restriction of fluid loss during injury
- ✓ Defense against pathogens and toxins
- ✓ Regulation of body temperature

Components of the Blood

- 60% plasma
- 40% red blood cells (i.e., erythrocytes)

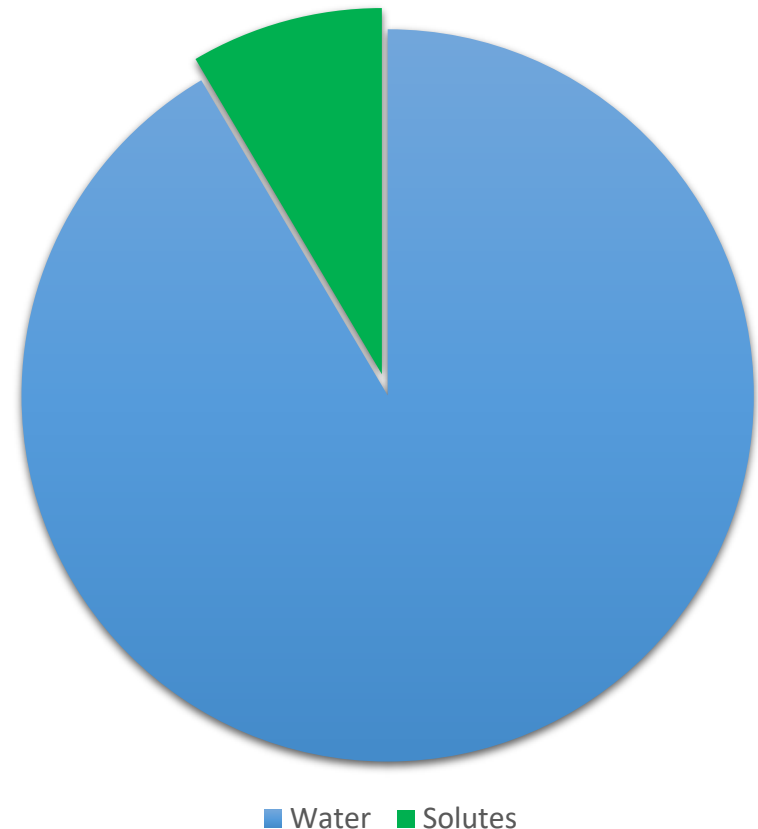
These percentages can vary considerably in different people, depending on **gender, weight, and other factors.**

Hematocrit: Packed Red Blood Cell Volume

- ✓ The percentage of blood volume that is erythrocytes (i.e. ratio of the volume of red blood cells to the volume of whole blood).
- ✓ ~3 to 4 % of the plasma remains entrapped among the cells
- ✓ **True hematocrit** is only about 96% of the measured hematocrit.

Composition of the Plasma

- 91.5 % water
 - Provides a **solvent** environment to facilitate the transport of molecules
- 8.5 % **solutes**

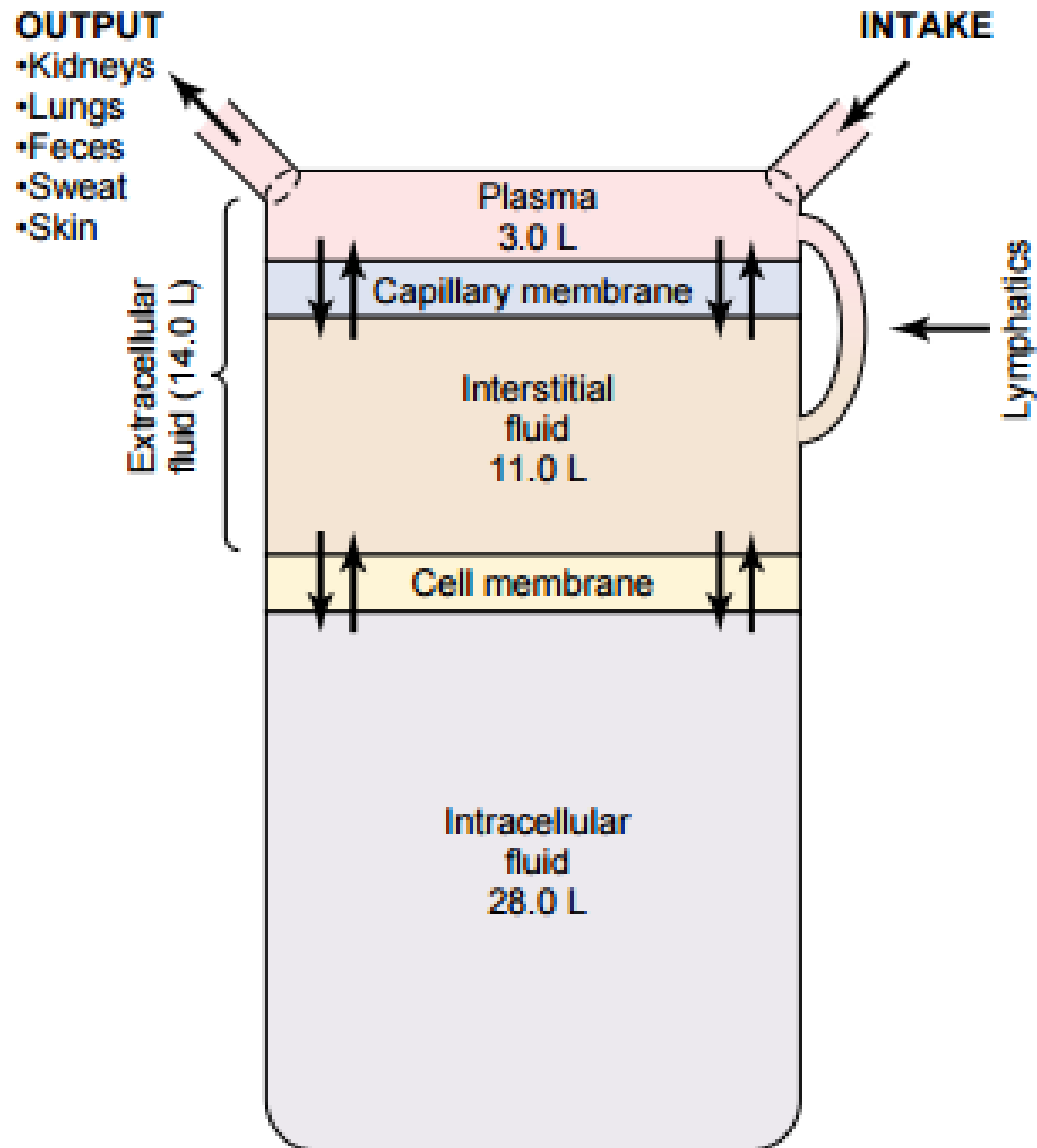


Components of the Plasma: **Solutes**

- **Proteins**

- Electrolytes (Ions): Na^+ , K^+ , Cl^- , Ca^{++} , Mg^{++}
- Food substances: Amino acids, Glucose, Minerals, Vitamins
- Waste products: Waste nitrogen \rightarrow Ammonia \rightarrow Urea, Metabolites
- Hormones: Glucagon, Insulin, TSH,...
- Gases: O_2 , CO_2
- Lipoproteins: Lipids do not directly dissolved in the plasma. They are carried by carrier proteins.

Ionic composition of plasma and interstitial fluid is similar



	Plasma (mOsm/L H ₂ O)	Interstitial (mOsm/L H ₂ O)	Intracellular (mOsm/L H ₂ O)
Na ⁺	142	139	14
K ⁺	4.2	4.0	140
Ca ⁺⁺	1.3	1.2	0
Mg ⁺⁺	0.8	0.7	20
Cl ⁻	106	108	4
HCO ₃ ⁻	24	28.3	10
HPO ₄ ⁻ , H ₂ PO 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	299.8	300.8	301.2
Corrected osmolar activity (mOsm/L)	282.0	281.0	281.0
Total osmotic pressure at 37°C (mm Hg)	5441	5423	5423

The relative constancy of the body fluids is remarkable

There is continuous exchange of fluid and solutes with the external environment, as well as within the different body compartments.

	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