

## physiology of Body Fluids

**Body fluids** are liquids originating from inside the bodies of living humans. They include fluids that are excreted or secreted from the body. Human blood, body fluids

- Total amount of fluids in the human body is approximately 70% of body weight
- Body fluid has been divided into two **compartments** –
  - **Intracellular fluid (ICF)**
- Inside the cells, 55% of total body water
- **Extracellular fluid**
- Outside the cells, 45% of total body water

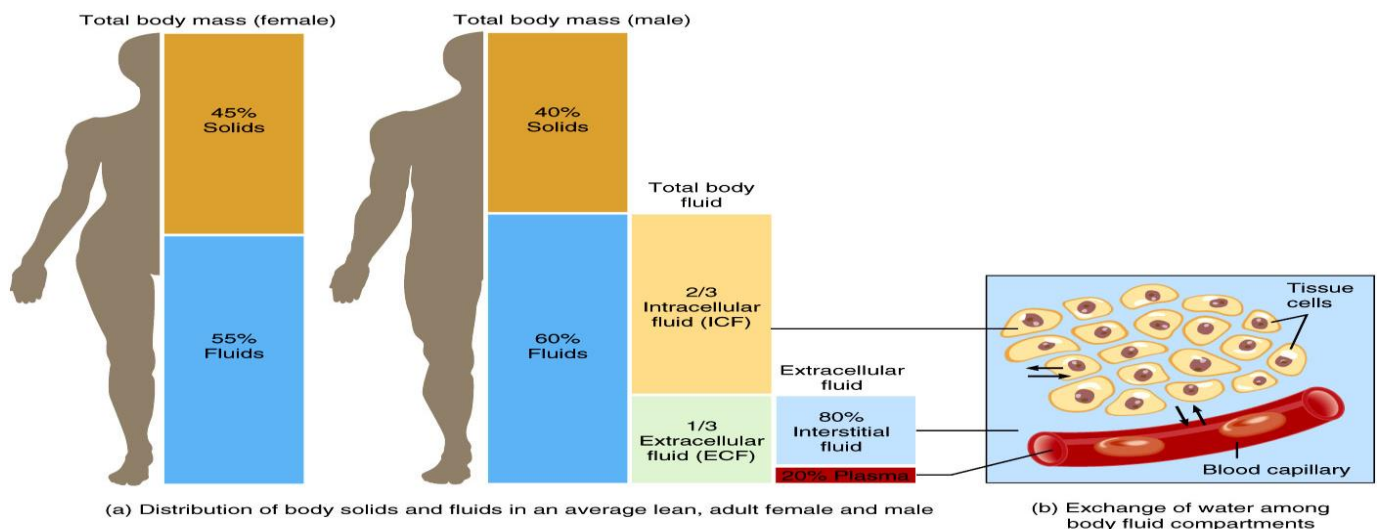


Figure 27.01 Tortora - PAP 12/e  
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## Composition of body fluids

### ● Organic substances

Glucose ,Amino acids ,Fatty acids ,Hormones ,Enzymes

### ● Inorganic substances

- Sodium
- Potassium
- Calcium
- Magnesium
- Chloride
- Phosphate
- Sulphate

## Extracellular fluid

### ● Interstitial fluid

Present between the cells, Approximately 80% of ECF

- **Plasma**

Present in blood ,Approximately 20% of ECF

- **Also includes**

Lymph

synovial fluid

cerebrospinal fluid

pleural, pericardial and peritoneal fluids

**1) Extracellular fluids:**

**Interstitial Fluid:**

Also known as intercellular fluid and tissue fluid is fluid between the cells of multi-cellular organisms which delivers materials to the cells, intercellular communication, and removal of metabolic waste.

- **it represents the largest portion of the ECF compartment.**
- Interstitial fluid **consists** of a water solvent containing **amino acids, sugars, fatty acids, coenzymes, hormones, neurotransmitters, salts, as well as waste products** from the cells.
- This fluid presents as gel-like extracellular matrix.
  - **The plasma and the interstitial fluid** integrate through pores in the blood capillaries which allow water and most dissolved substances except **protein to diffuse**
  - **oxygen, nutrients, and regulatory molecules** travelling in the blood must first pass into the interstitial fluid before reaching the body cells., waste products and hormone secretions from the cells must first pass into the interstitial fluid before reaching the blood plasma.

The exchange of material across the capillaries occurs at high rate by **diffusion** in both directions

- The composition of tissue fluid depends upon the exchanges between the cells in the biological tissue and the blood. **This means** that tissue fluid has a different composition in different tissues and in different areas of the body
- acting as a media for intercellular communication.

**Barriers separate ICF, interstitial fluid and plasma**

- **Plasma membrane**

- Separates ICF from surrounding interstitial fluid

- **Blood vessel wall**

- Separate interstitial fluid from plasma

***2)Blood plasma:***

It is the fluid portion of the blood.

- The blood transports oxygen from the lungs to the body cells and carbon dioxide from the body cells to the lungs.
- Blood also transports nutrients derived from food in the intestine to the body cells., other nutrients between organs

### 3) Lymph

- Clear and colorless fluid, 96% water and 4% solids, Solids
- **Proteins**
  - 2-6% of solids
  - albumin, globulin, fibrinogen, prothrombin, clotting factors, antibodies, enzymes
- **Lipids**
  - 5-15%
  - Chylomicrons
  - Lipoproteins
- **Carbohydrates**
  - Glucose mainly
- **NPN (Non protein Nitrogen)**
  - Urea and creatinine
- **Electrolytes**
  - Sodium, calcium, potassium, chloride, bicarbonates

#### Functions of Lymph:

- Return protein from tissue spaces into blood
- Removal of bacteria, toxins and other foreign bodies from tissues
- Maintain structural and functional integrity of tissue
- Route for intestinal fat absorption
- Transport lymphocytes

#### 2) Intracellular Fluid:

- The cytosol or intracellular fluid is the liquid found inside the cells .
- **Physiological Function :**
- The cytosol has no single function and instead it is the site of multiple cell processes including metabolic processes (such as glycolysis, gluconeogenesis , PPP) . It is also involved in signal transduction from the cell membrane to sites within the cell .

*The body fluid composition of tissue varies by*

- **Tissue type:** lean tissues have higher fluid content than fat tissues.
- **Gender:** males have more lean tissue and therefore more body fluid.
- **Age:** lean tissue is lost with age and body fluid is lost with it.

## Body fluid composition:

a) water

b) dissolved

solutes

*organic*

*inorganic*

*substances*

*substances*

*(e.g protein)*

*(e.g electrolytes)*

*e.g glucose*

*e.g Na<sup>+</sup>, K<sup>+</sup>*

- Since water passes freely across cell membrane, the volume of the various fluid compartments are determined by unique solutes that are confined to each space.
- For the total extracellular fluid compartment it is sodium and for the intracellular space, it is potassium.

## Electrolytes of the body fluids

Electrolytes are salts and minerals that can conduct electrical impulses in the body.

- Common human electrolytes are sodium, chloride, potassium, calcium, and bicarbonate.
- Electrolytes in body fluids are charged ,

It can be:

**Cation** - positively charged electrolyte, e.g .Na<sup>+</sup>, k<sup>+</sup>,Ca<sup>+2</sup>

**Anion** - negatively charged electrolyte, e.g, Cl<sup>-</sup> , HCO<sub>3</sub><sup>-</sup> po<sub>4</sub><sup>-3</sup>

The chief extracellular cation is **Na<sup>+</sup>**

The chief intracellular cations are **k<sup>+</sup>**

- **Cl<sup>-</sup>** is the predominant anion outside cells whereas **phosphates** constitute the bulk of intracellular anions.

- **Electrolytes:**

- Control the fluid balance of the body
- important
  - in muscle contraction
  - in energy generation - and almost every major biochemical reaction in the body

## Movement of body fluids:

- *Membrane transport processes:*
- **1) passive transport**

- it is the movement of substances across a membrane from higher to lower concentration (down a concentration gradient)
- - it does not require metabolic energy.

### Passive transport

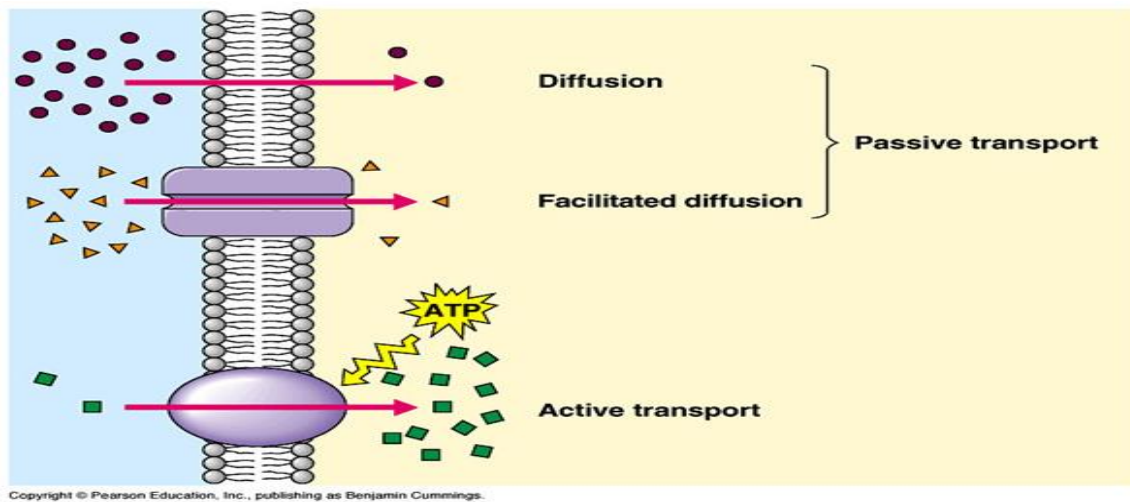
- **simple diffusion**

It is the movement of substances from a region of high concentration to a region of low concentration.

Generally, simple diffusion of water, gases, and other small uncharged molecules across plasma membranes can occur in the absence of transport proteins.

- **facilitated diffusion.**

It is a transport of substances across a biological membrane from an area of higher concentration to an area of lower concentration by a carrier proteins.



## 2) Active transport:

It is the movement of substances across a membrane against gradient (from low concentration to high concentration).

-Active transport requires energy and involves specific carrier proteins.

### Movement of fluids due to:

#### 1) Hydrostatic pressure:

It is physiological processes that regulate fluids intake & output as well as movement of water & substances dissolved in it between the body compartments

#### 2) osmotic pressure:

The pressure exerted by the flow of water through a semi-permeable membrane separating two solutions with different conc. of solute

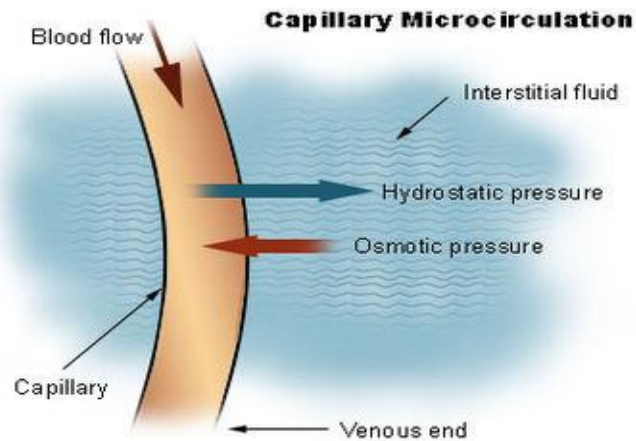
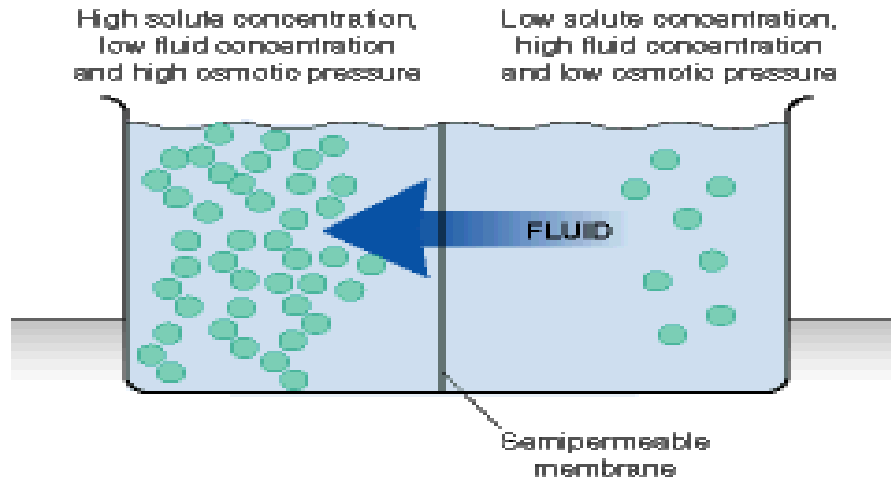
**Osmosis:** It is diffusion of a solvent (usually water molecules) through a semi-permeable membrane from an area of low solute concentration to an area of high solute concentration.

## Osmotic pressure:

It is pressure which forces the water to move from where there is little dissolved solute to where there is lots dissolved solutes.

- It is determined by the number of particles per unit volume of fluids
- The amount of osmotic pressure exerted by a solute is proportional to the number of molecules or ions.

**Osmoles** is the unit used to express the concentration in term of numbers of particles



Fluid intake and output are **balanced**

**Table 25–1**  
**Daily Intake and Output of Water (ml/day)**

	Normal
<b>Intake</b>	
Fluids ingested	2100
From metabolism	200
Total intake	<u>2300</u>
<b>Output</b>	
Insensible—skin	350
Insensible—lungs	350
Sweat	100
Feces	100
Urine	<u>1400</u>
Total output	<u>2300</u>

### **Water Balance:**

Water balance exists when water intake equals water output.

### **Water Intake:**

- The volume of water gained each day varies from one individual to the next.
- About 60% of daily water is gained from drinking, another 30% comes from moist foods, and 10% from the water of metabolism .

### **Regulation of Water Intake:**

- The **thirst** mechanism is the primary regulator of water intake.
- The thirst mechanism derives from the osmotic pressure of extracellular fluids and a thirst center in the hypothalamus.
- Once water is taken in, the resulting distention of the stomach will inhibit the thirst mechanism.

### **Water Output:**

Water is lost in urine, feces, perspiration, evaporation from skin (insensible perspiration), and from the lungs during breathing.

The route of water loss depends on temperature, relative humidity, and physical exercise

### **Regulation of Water Output:**

- The distal **convoluted tubules** and **collecting ducts of the nephrons** regulate water output.
- **Antidiuretic** hormone from the posterior pituitary causes a reduction in the amount of water lost in the urine.
- When drinking adequate water, the ADH mechanism is inhibited, and more water is expelled in urine.

### **Disorders of water balance:**

**Dehydration:** water loss exceeds water intake

- **Hypotonic hydration:** ECF is diluted (there is increase in water, causing ECF sodium levels to lower (hyponatremia), increase in osmosis occurs and tissue cells swell (**oedema**)).

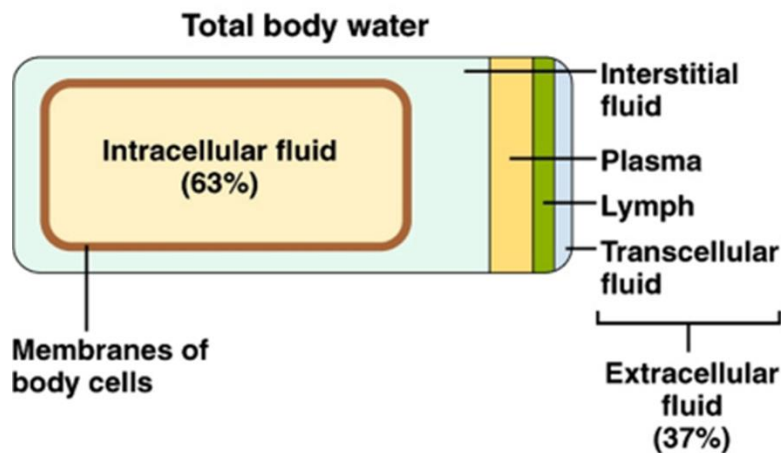
**Electrolytes** are important for

- Maintaining fluid balance.
- Contributing to acid–base regulation.
- Facilitating enzyme reactions.
- Transmitting neuromuscular reactions.

***Electrolyte Balance:***

An electrolyte balance exists when the quantities of electrolytes gained equals the amount lost.

- Electrolytes, **charged ions** capable of conducting electricity, are present in all body fluids and fluid compartments. Just as maintaining the fluid balance is vital to a normal body function, so is maintaining electrolyte balance.
- Although the concentration of specific electrolytes **differ** between fluid compartments, a balance of cations (positively charged ions) and anions (negatively charged ions) **always** exists.



**Regulation of fluid volume in body:**

- Antidiuretic Hormone
- Renin/angiotensin/aldosterone system
- Baroreceptors in carotid arteries and aorta
- Stretch receptors in atrium and juxtaglomerular apparatus
- Cortisol