
بسم الله الرحمن الرحيم


رب اشرح لي صدري ويسر لي أمري

Renal physiology

Body Fluids

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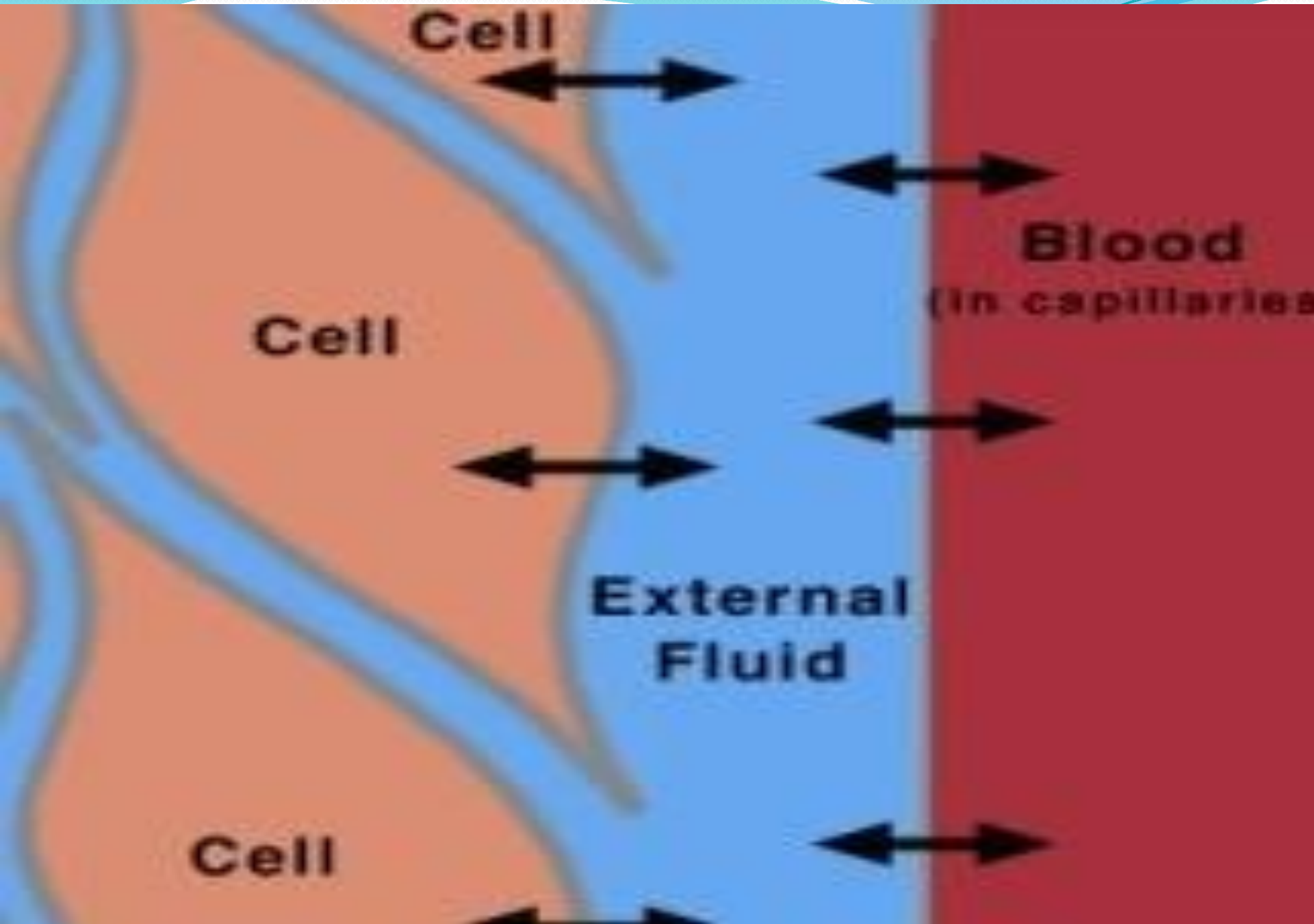
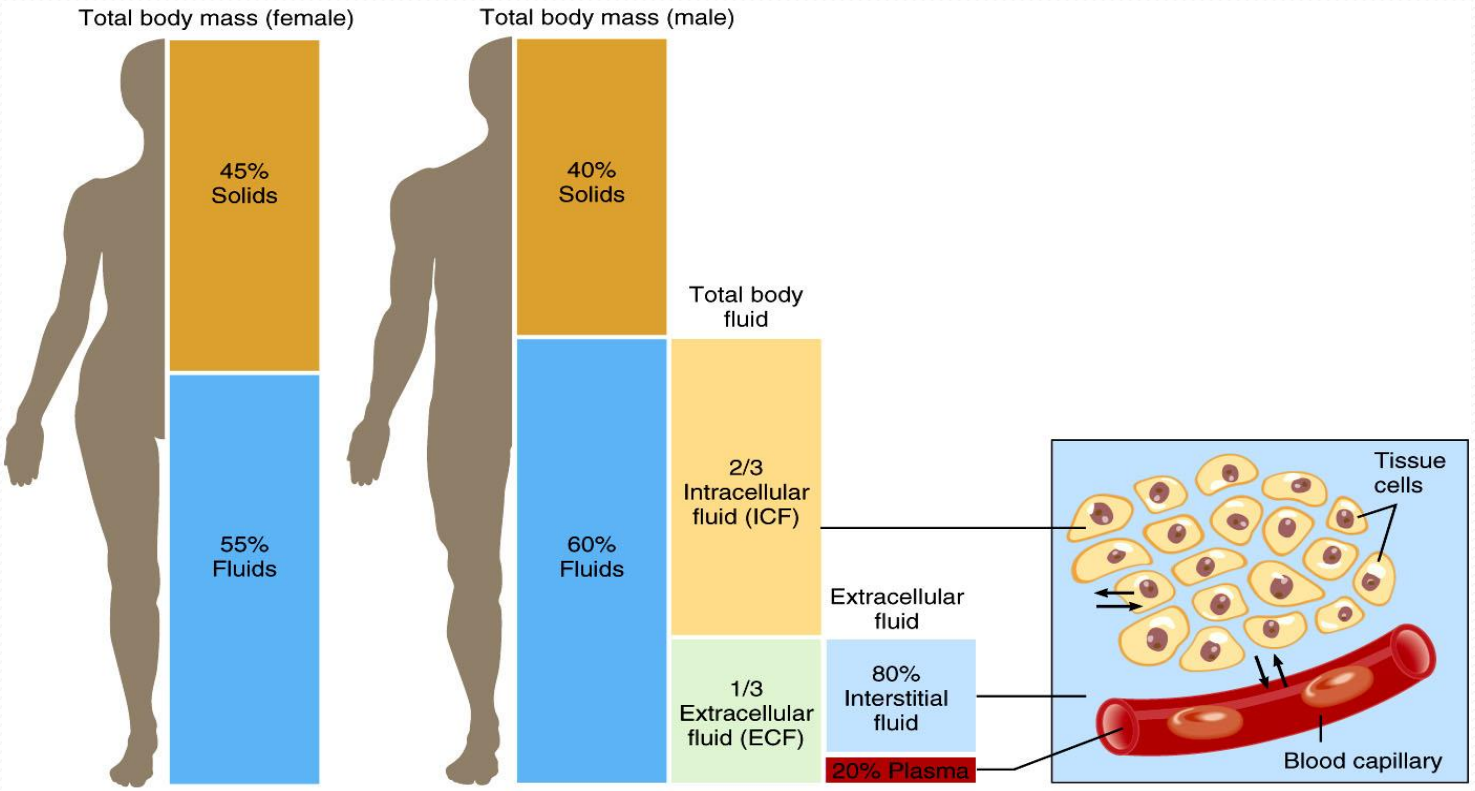
Body Fluids

- **Total amount of fluid 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**


Cell
Blood
(In capillaries
Cell
External
Fluid
Cell

Body Fluid Compartments



(a) Distribution of body solids and fluids in an average lean, adult female and male

(b) Exchange of water among body fluid compartments

Composition of body fluids

- Organic substances
  - Glucose
  - Amino acids
  - Fatty acids
  - Hormones
  - Enzymes
- Inorganic substances
  - Sodium
  - Potassium
  - Calcium
  - Magnesium
  - Chloride
  - Phophate
  - Sulphate

Extracellular fluid

Interstitial fluid

Present between the cells

80% of ECF حوالي Approximately

Plasma

Present in blood

Approximately 20% of ECF

Also includes

Lymph

synovial fluid

cerebrospinal fluid

ECF من ٪ 80

ECF من

alsaayil alkhilaliu

- **pleural, pericardial and peritoneal fluids**

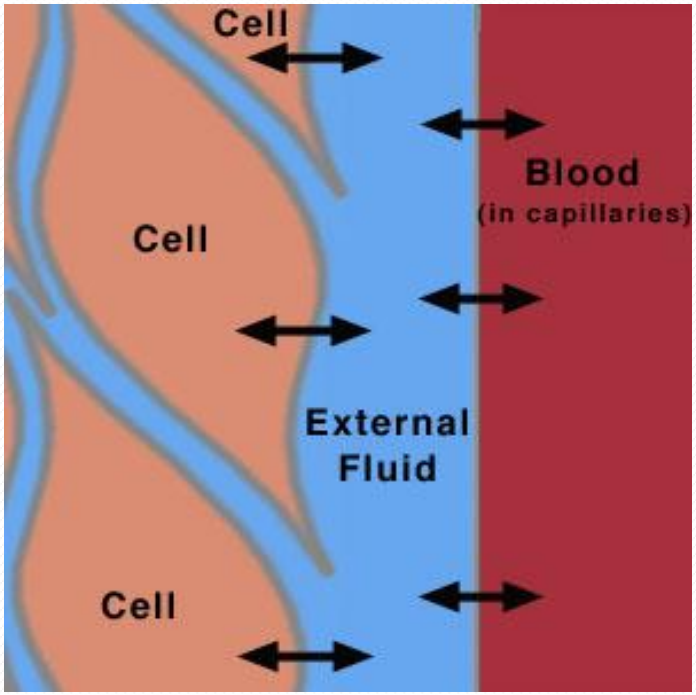
1) Extracellular fluids:

a) 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.

‹ICF 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 solute**
  - ***organic substances (e.g protein)*** — ***e.g glucose***
  - ***inorganic substances (e.g electrolytes)*** — ***e.g Na^+, K^+***

- ***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.***

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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^{+}, k^{+},Ca^{+2}

Anion - negatively charged electrolyte, e.g, Cl^{-} , HCO_3^{-} po_4^{-3}

The chief extracellular cation is **Na^+**

The chief intracellular cations are **k^+**

Cl^- 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

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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
- facilitated diffusion.

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.

1) passive transport:

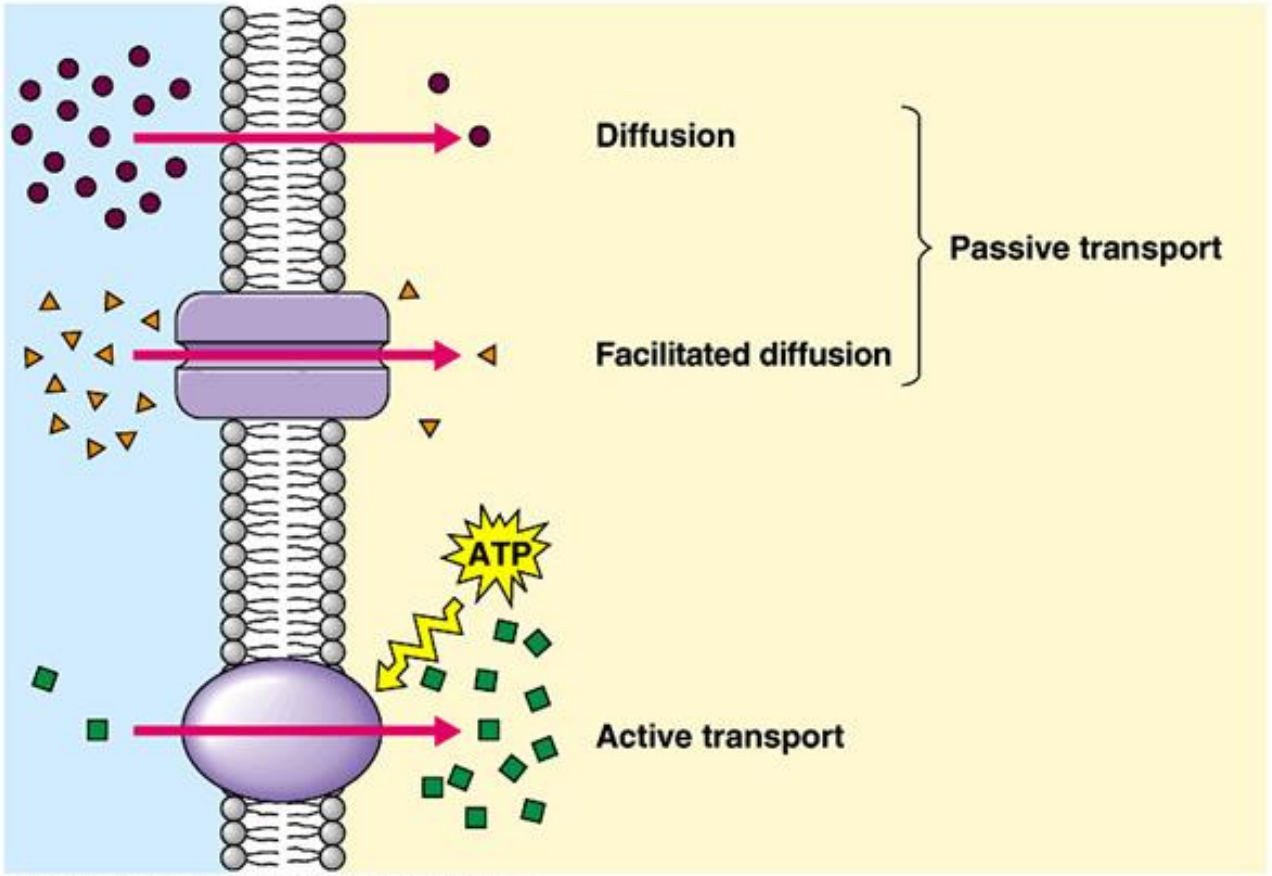
a) simple diffusion:

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.

b) 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.



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

conc.

Osmosis:

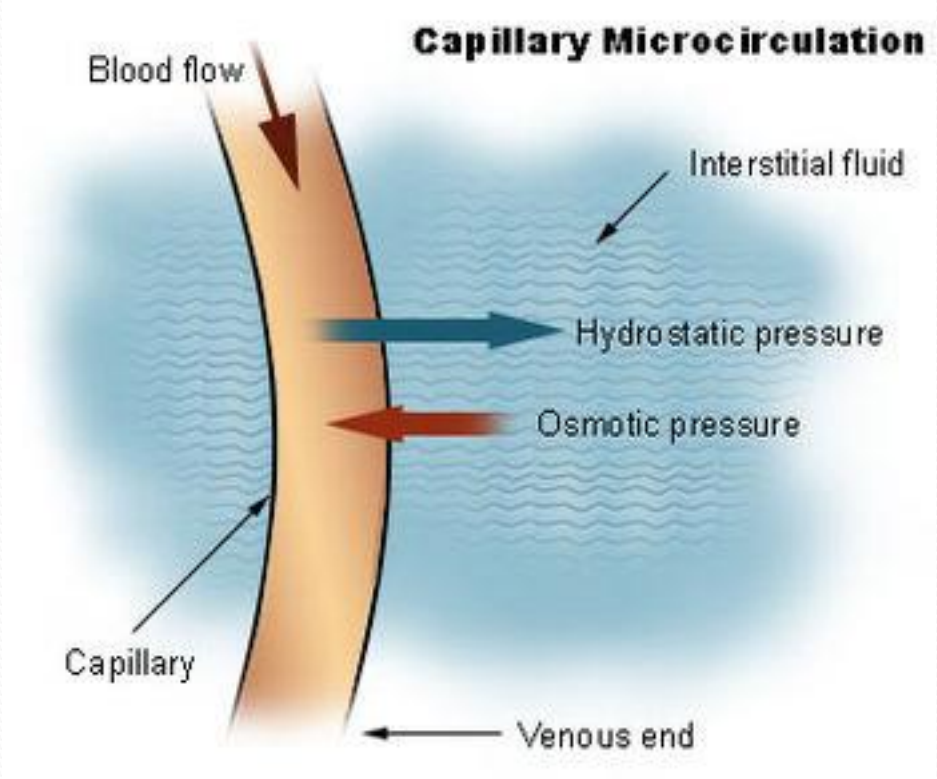
It is diffusion of a solvent (usually water molecules) through a semi-permeable membrane from an area of low solute concentration to an area of high solute concentration.

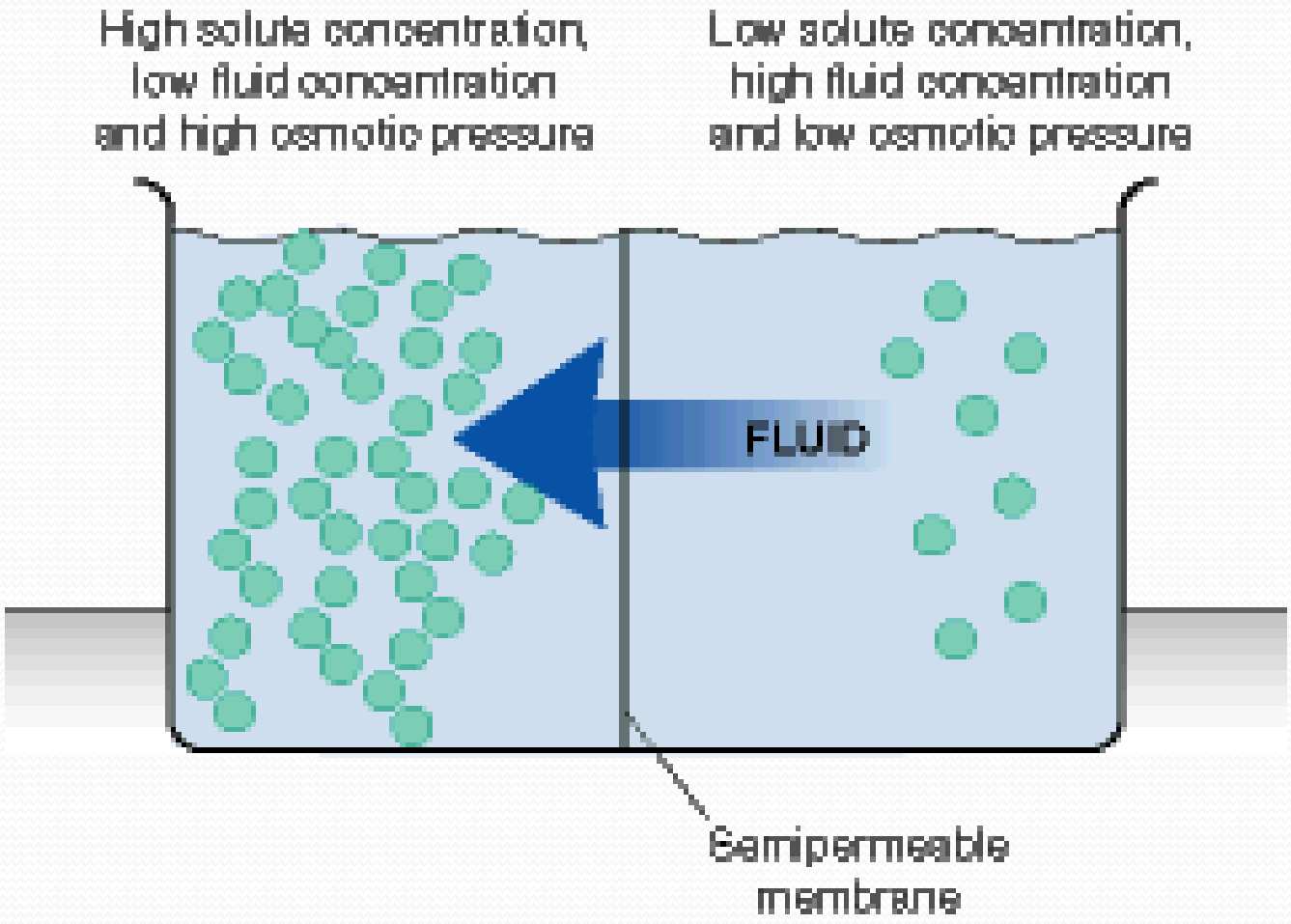
Osmotic pressure:

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 exereted 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

Osmoles


Capillary Microcirculation
Blood flow
Interstitial fluid
Hydrostatic pressure
Osmotic pressure
Capillary
Venous end


High solute concentration, low fluid concentration and high osmotic pressure
Low solute concentration, high fluid concentration and low osmotic pressure
FLUID
Semipermeable membrane

Regulation of body fluids and electrolytes

- fluid intake and output are **balanced.**

Table 25–1

Daily Intake and Output of Water (ml/day)

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

Regulation of body fluids and electrolytes:

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**)

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Electrolytes

Electrolytes

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

- 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 Electrolyte Intake:

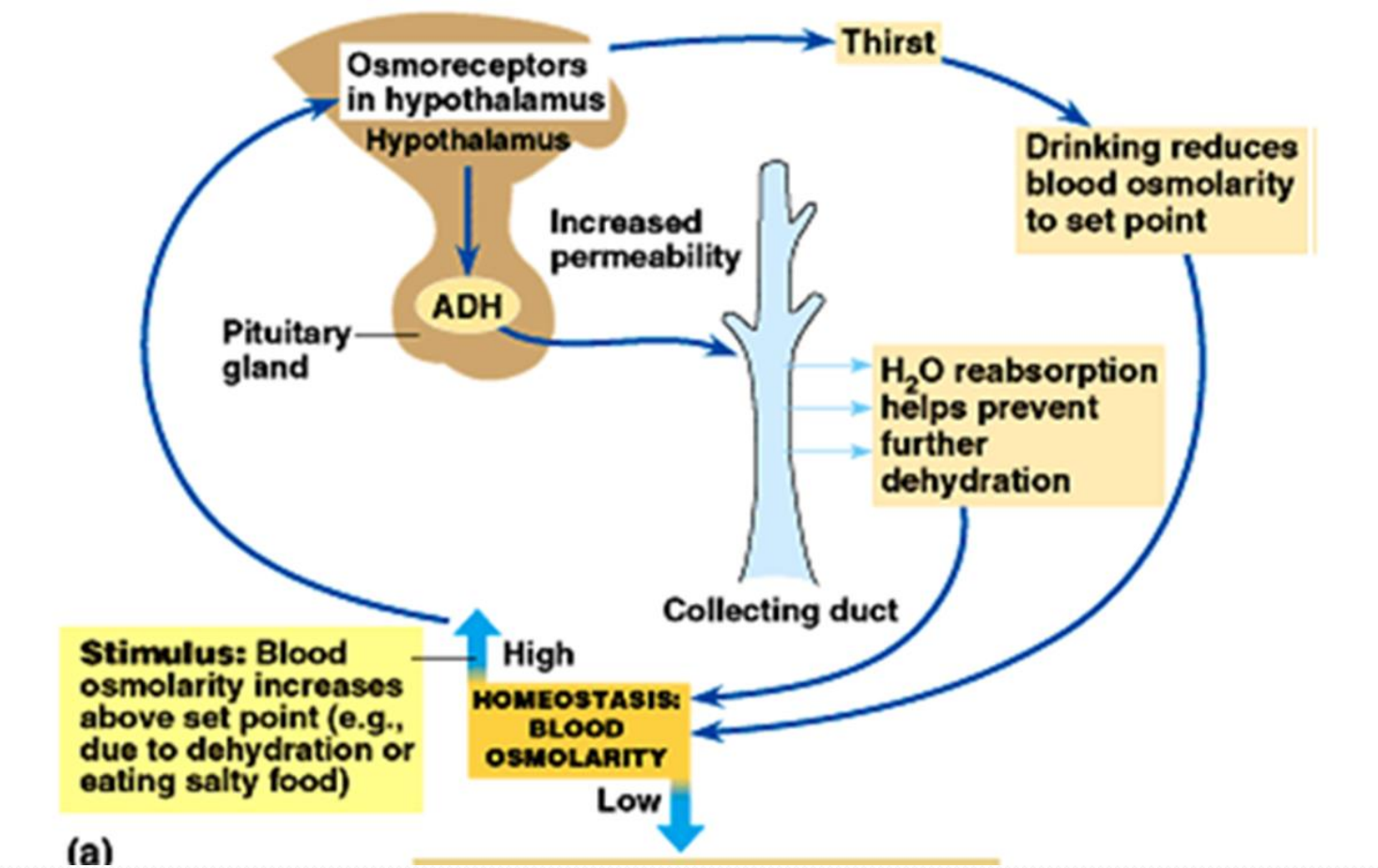
A person ordinarily obtains sufficient electrolytes from food eaten.

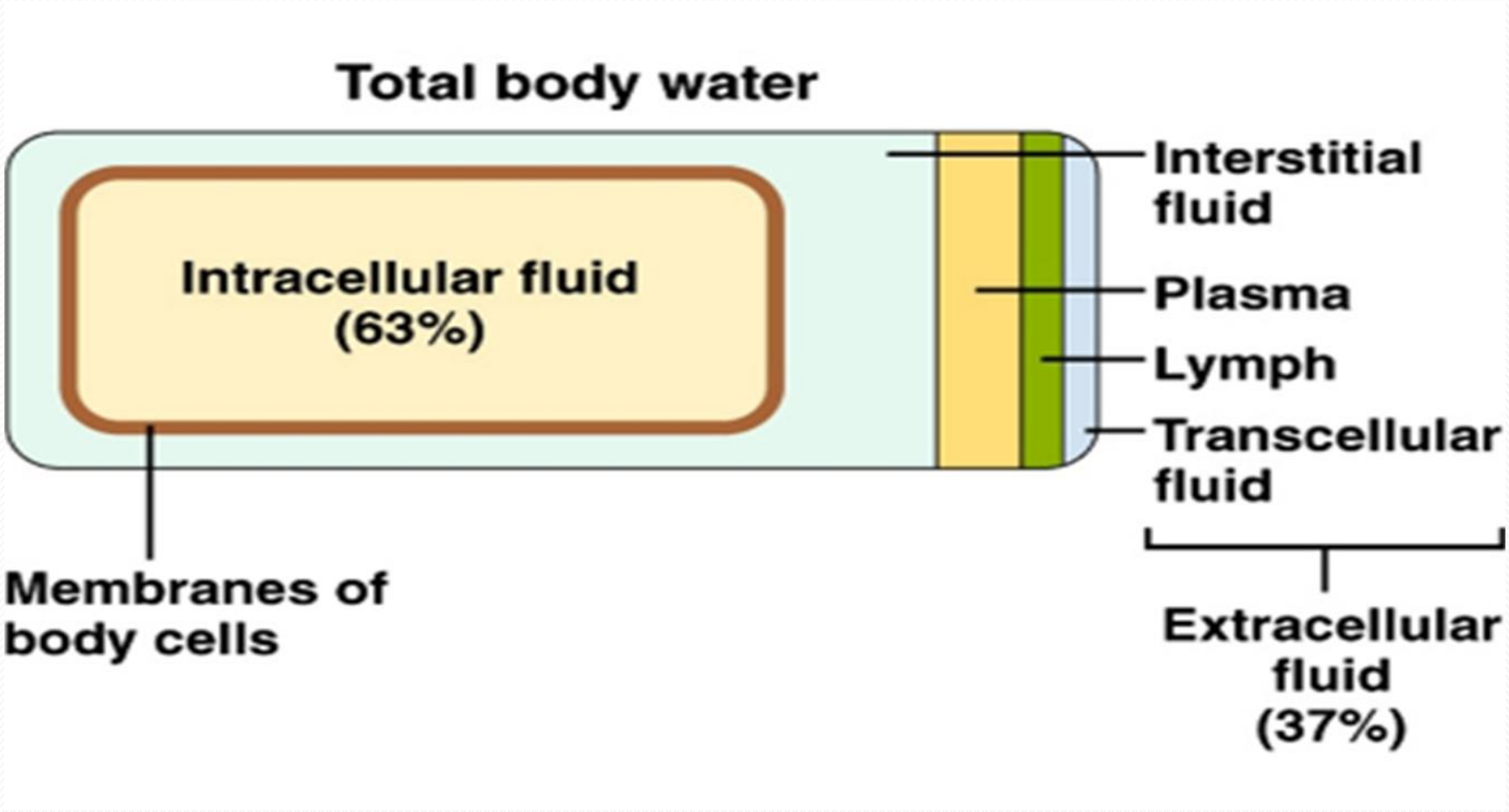
A salt craving may indicate an electrolyte deficiency.

Electrolyte Output:

Losses of electrolytes occur through sweating, in the feces, and in urine.

Hormonal role




Total body water
Intracellular fluid
(63%)
Membranes of
body cells
Interstitial
fluid
Plasma
Lymph
Transcellular
fluid
Extracellular
fluid
(37%)