

# Physiology



## Properties of The Body Fluid

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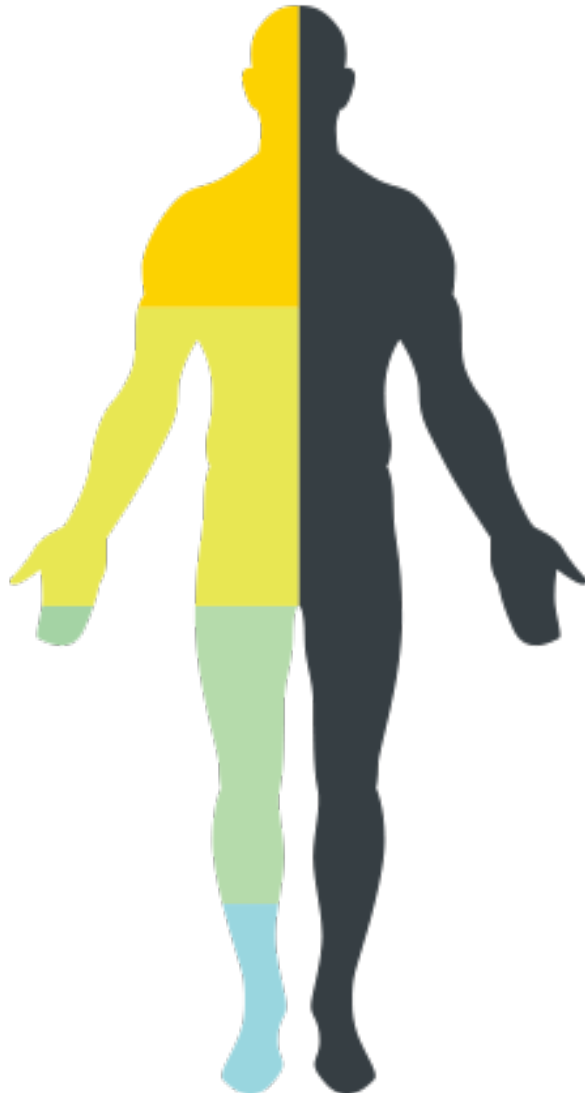
# Outline

- ① **Volumes & Compartments of Body Fluids**
- ② **Composition of Body Fluids**
- ③ **Fluid Movement between Compartments**

## **Reading Assignment**

Guyton And Hall Textbook Of Medical Physiology, 13 Edition, Chapter 25,  
pg; 305-308 , 316

# Body Composition



**SEE  
WHAT  
YOU  
ARE  
MADE  
OF**

In average young adult male:

<b>Protein</b>
<b>Minerals</b>
<b>Body fat mass</b>
<b>Total body water</b>

**% of body weight**

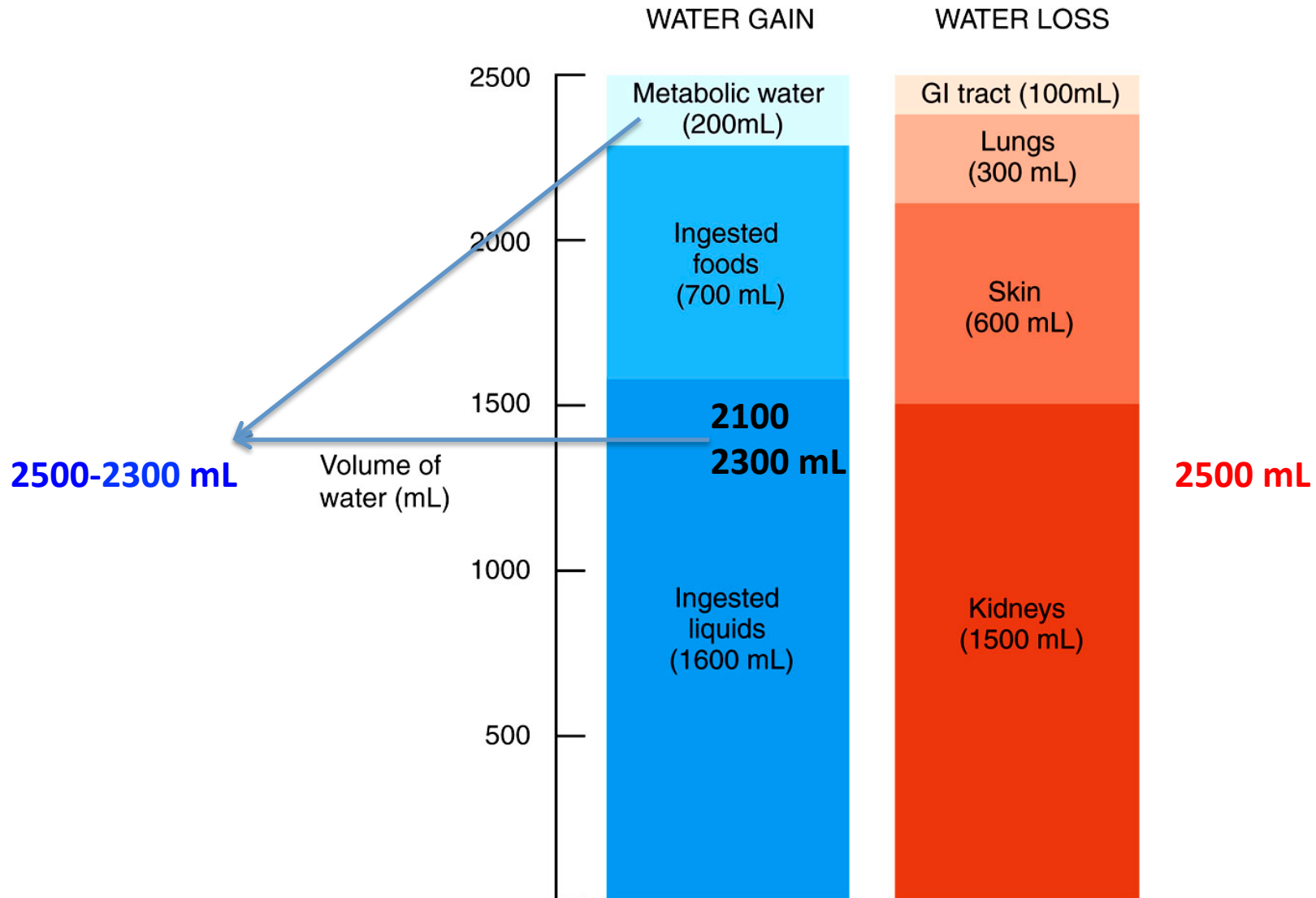
**%18**

**%7**

**%15**

**%60**

# Daily Water Gain and Loss



## FLUID INTAKE AND OUTPUT ARE BALANCED DURING STEADY-STATE CONDITIONS

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

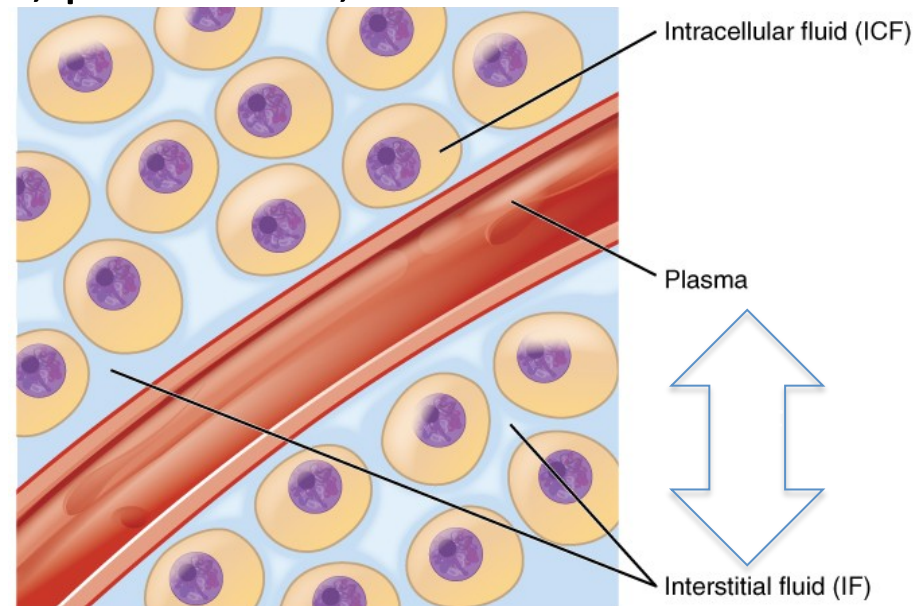
**The kidneys** are faced with the task of adjusting the excretion rate of water and electrolytes to match precisely the intake of these substances.

# Body Fluid Compartments

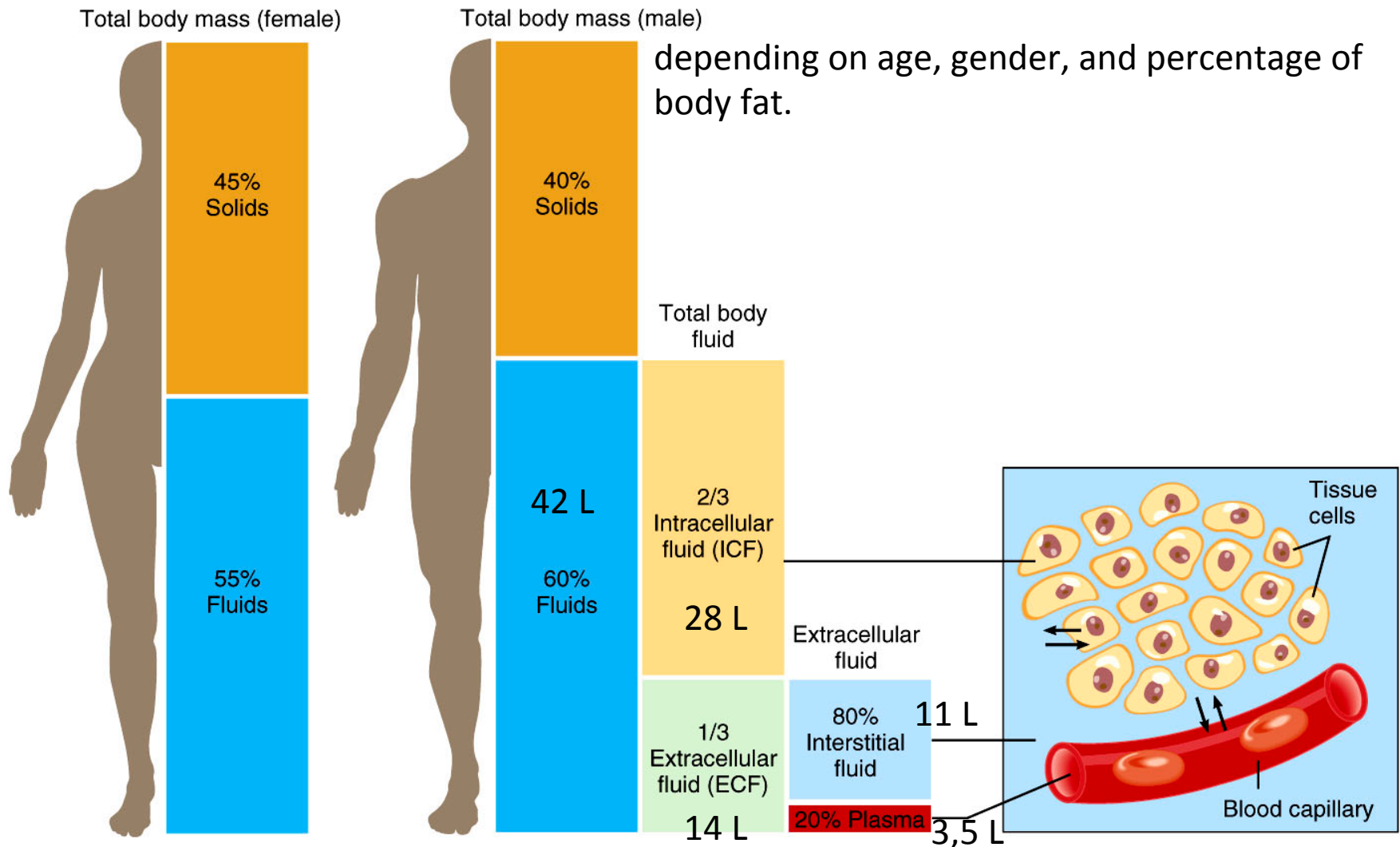
- **Intracellular fluid (ICF)** —nucleoplasm and cytosol
- **Extracellular fluid (ECF)** —fluid on the exterior of the cell
  - I. Interstitial Fluid (IF): Fluid between the cells
  - II. Plasma: Fluid portion of blood
  - III. Transcellular fluid: peritoneal, pericardial, CSF...

## Barriers separate ICF, Interstitial fluid and Plasma

- Plasma membrane
- Separates ICF from surrounding interstitial fluid
- Blood vessel wall
- Separate interstitial fluid from plasma



# 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

Body fluids contain water and solids. Solids are organic and inorganic substances.

## Organic substances

- Glucose
- Amino acids
- Fatty acids
- Hormones
- Enzymes

## Inorganic substances

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

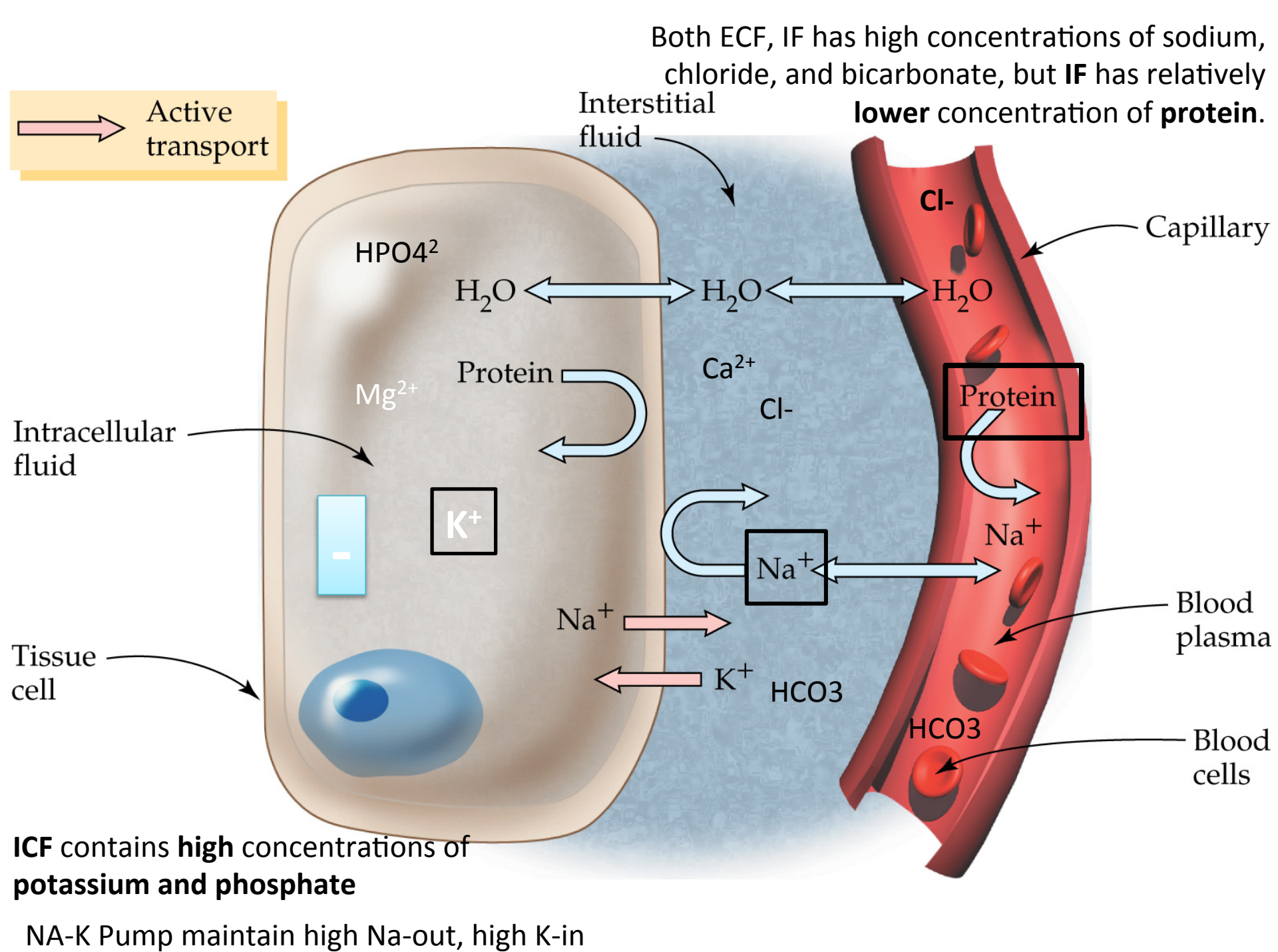


# Composition of Intracellular Fluid and Extracellular Fluid

**TABLE 11–1 A Comparison of Inorganic Ion Concentrations Inside and Outside a Typical Mammalian Cell\***

Component	Cytoplasmic concentration (mM)	Extracellular concentration (mM)
<b>Cations</b>		
Na <sup>+</sup>	5–15	145
K <sup>+</sup>	140	5
Mg <sup>2+</sup>	0.5	1–2
Ca <sup>2+</sup>	10 <sup>-4</sup>	1–2
H <sup>+</sup>	7 × 10 <sup>-5</sup> (10 <sup>-7.2</sup> M or pH 7.2)	4 × 10 <sup>-5</sup> (10 <sup>-7.4</sup> M or pH 7.4)
<b>Anions</b>		
Cl <sup>-</sup>	5–15	110

**water flows freely      membranes are not freely permeable      ICF is more acidic**



# Difference

## ECF

- **Most abundant cation  $\text{Na}^+$ ,**
  - muscle contraction
  - Impulse transmission
  - fluid and electrolyte balance
- **Most abundant anion  $\text{Cl}^-$** 
  - Regulates osmotic pressure
  - Forms  $\text{HCl}$  in gastric acid

## ICF

- **Most abundant cation  $\text{K}^+$** 
  - Resting membrane potential
  - Action potentials
  - Maintains intracellular volume
  - Regulation of pH
- **Anion are proteins and phosphates ( $\text{HPO}_4^{2-}$ )**

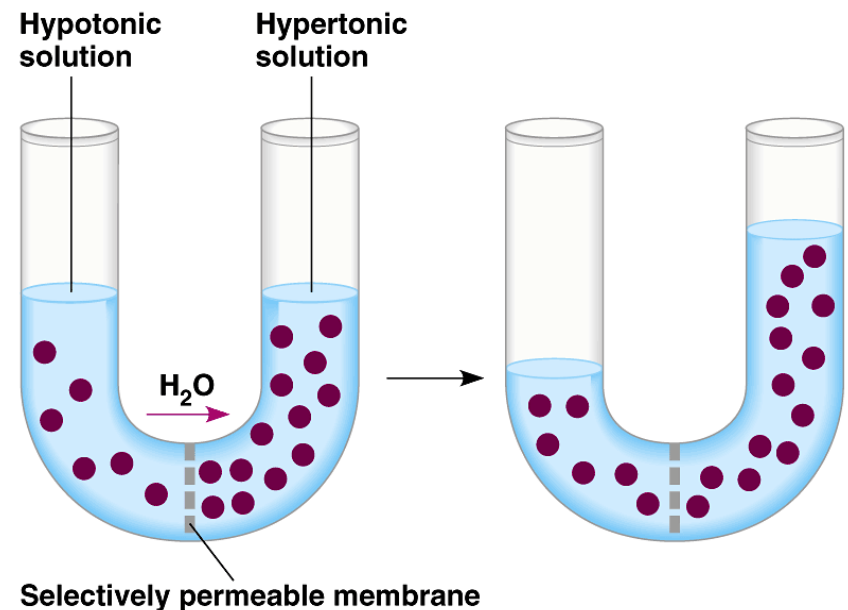
- $\text{Na}^+ / \text{K}^+$  pumps play major role in keeping  $\text{K}^+$  high inside cells and  $\text{Na}^+$  high outside cell

# Fluid Movement between Compartments

- **Hydrostatic pressure**, causes movement of fluid between compartments. (by pumping of the heart)
- Fluid also moves between compartments along an **osmotic gradient**. (kidney)
- **Active transport** processes require ATP to move some solutes against their concentration gradients between compartments.
- **Passive transport** of a molecule or ion depends on its ability to pass easily through the membrane, as well as the existence of a high to low concentration gradient.

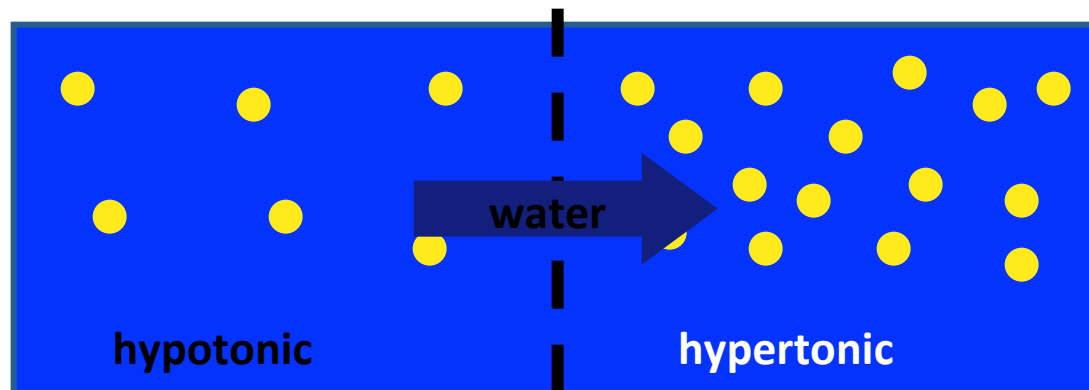
# Osmosis is Diffusion of Water

- Water is very important to life
- Diffusion of water from **high concentration** of water to **low concentration** of water across a semi-permeable membrane
- Osmosis is the diffusion of water through a selectively permeable membrane like the cell membrane



# Concentration of Water

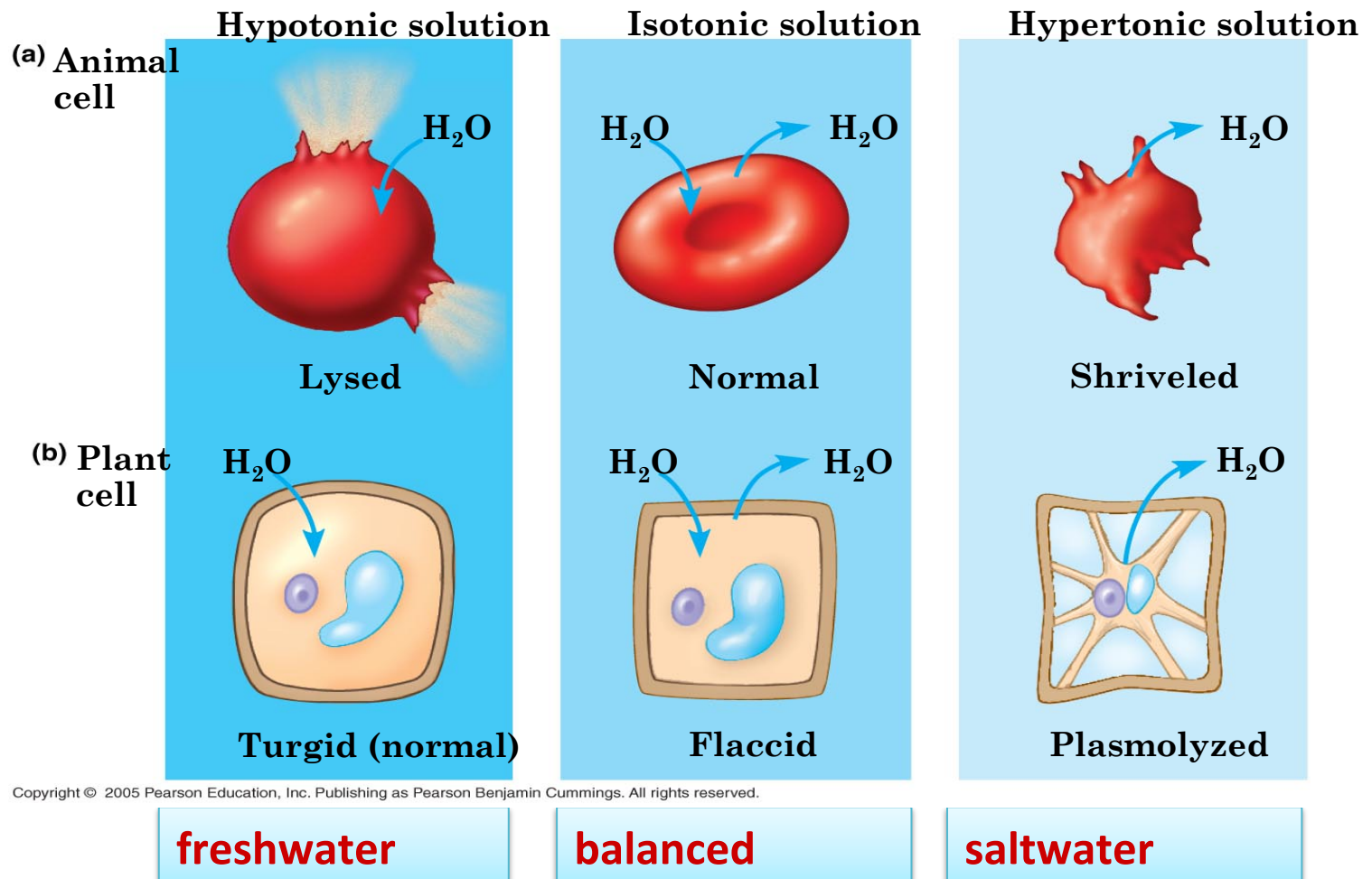
- Direction of osmosis is determined by comparing total solute concentrations
  - Hypertonic - more solute, less water
  - Hypotonic - less solute, more water
  - Isotonic - equal solute, equal water



net movement of water

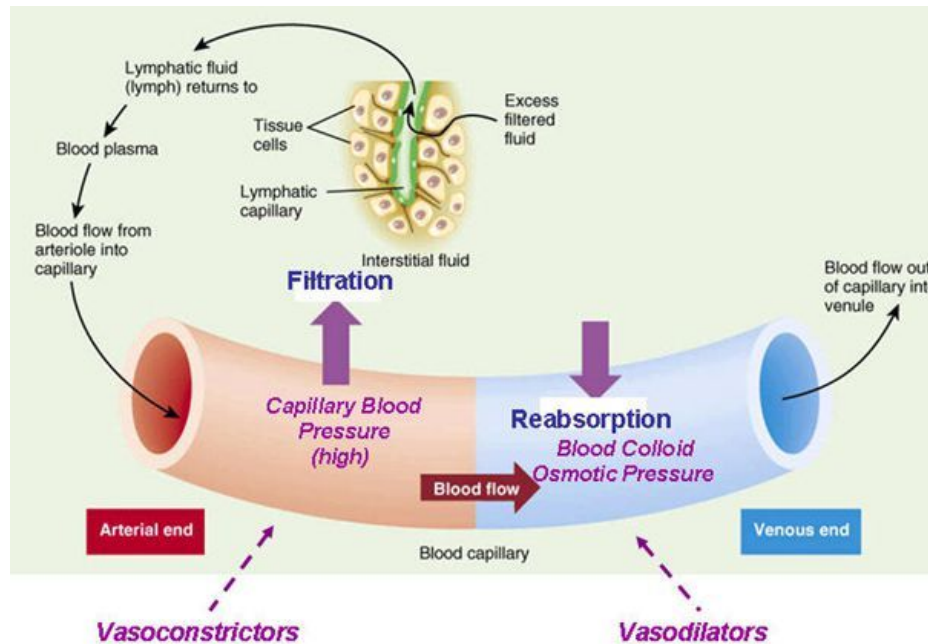
# Managing Water Balance

- Cell survival depends on balancing water uptake & loss

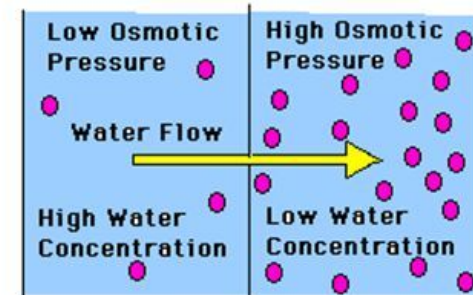




# Fluid Movement between Compartments



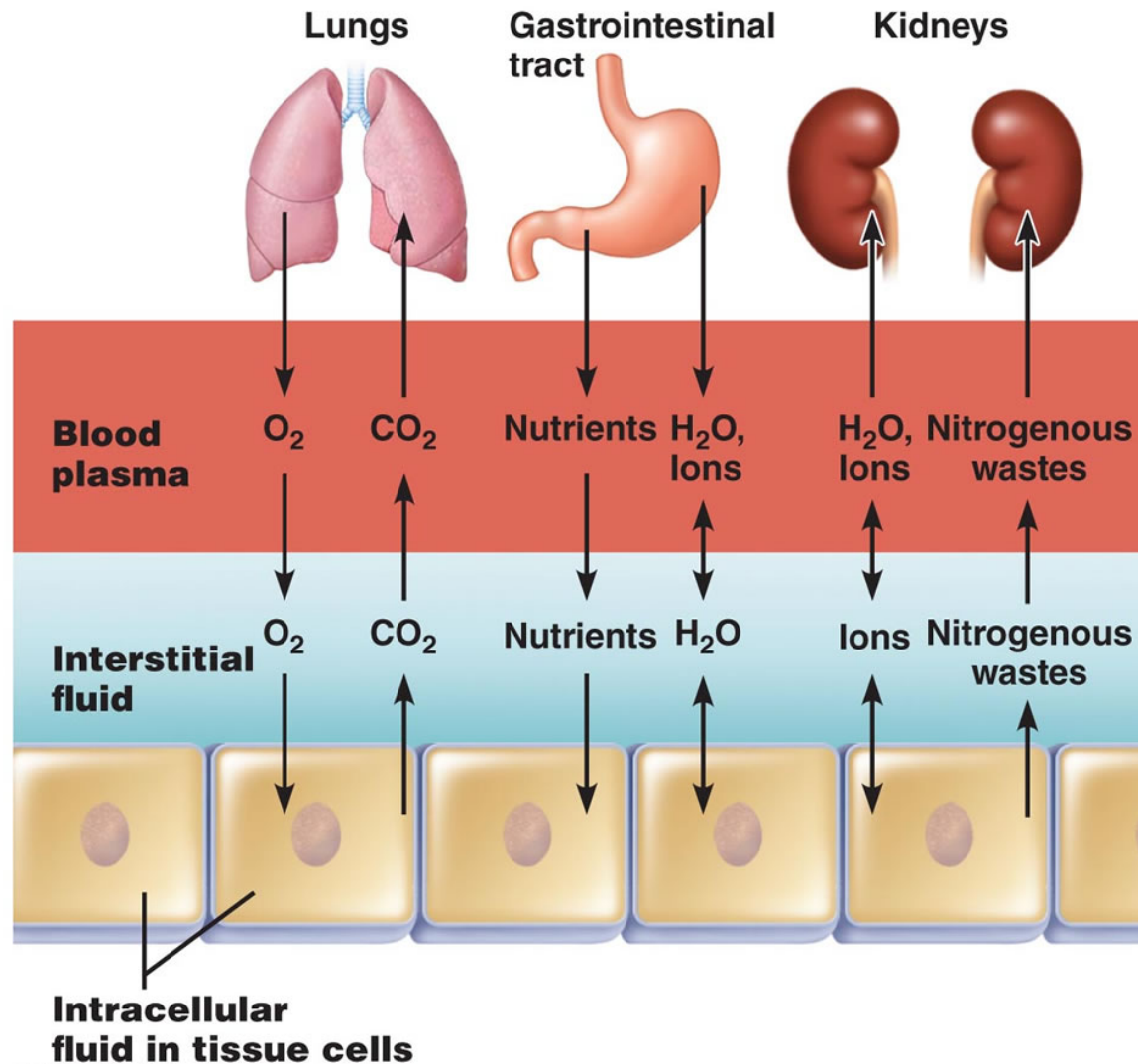
## BULK FLOW: Osmotic & Hydrostatic Pressure



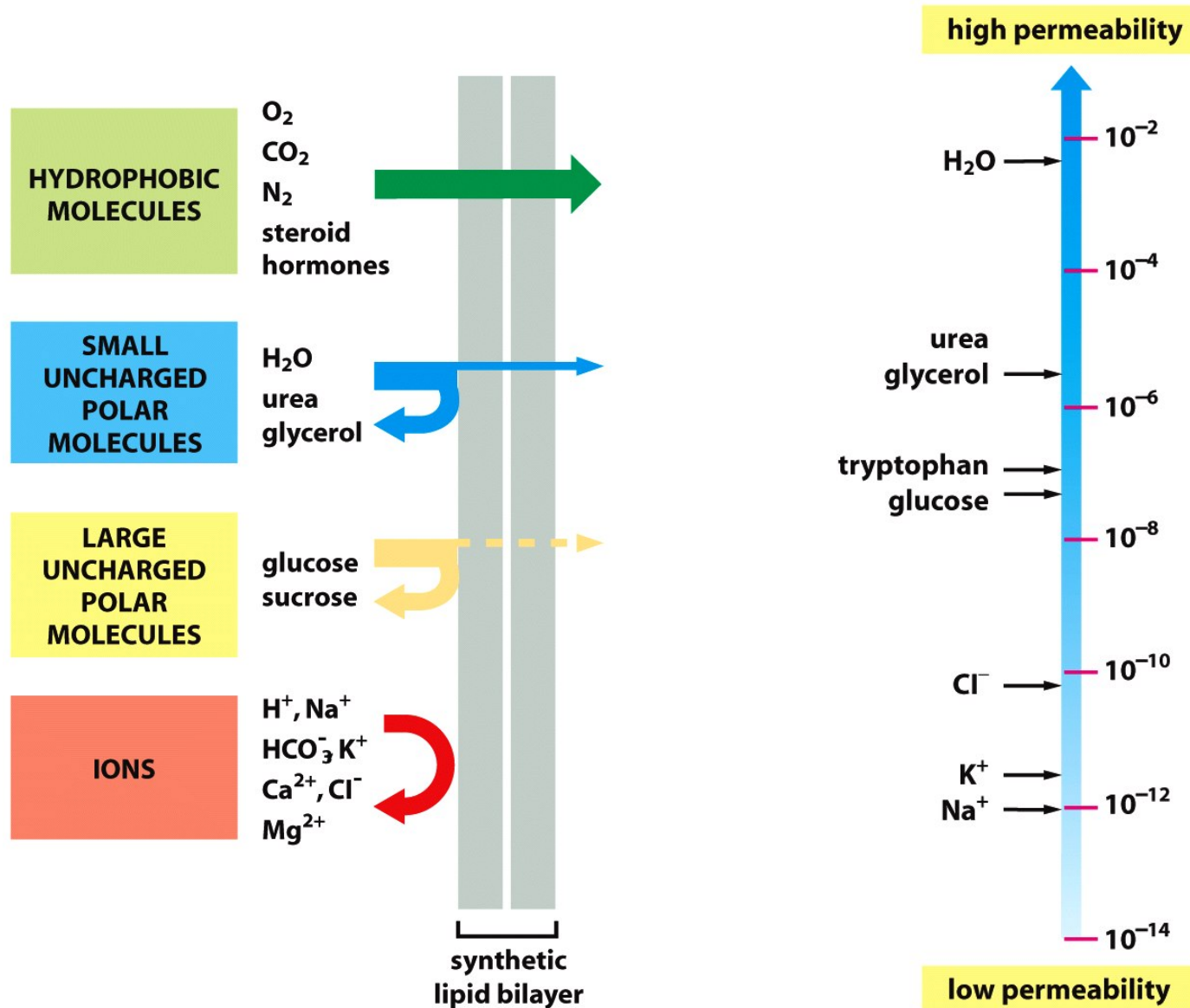
- **FILTRATION:** FLUID is PUSHED OUT OF CAPILLARY by
  1. **Blood hydrostatic pressure (BHP)** – pressure generated by pumping action of the heart
  2. Interstitial fluid osmotic pressure (IFOP)  $\approx 1$
- **REABSORPTION:** FLUID is PULLED INTO CAPILLARY by
  1. **Blood colloid osmotic pressure (BCOP)** - created by concentration of plasma proteins in suspension
  2. Interstitial fluid hydrostatic pressure (IFHP)  $\approx 0$



# Exchange of gases, nutrients, water, and wastes between the three fluid compartments of the body



# Transport Through Membranes



# What if there's too much tissue fluid in CT?

Sometimes, excess tissue fluid accumulates in connective tissue. This is called edema.

Some causes include:

## **Injury and inflammation**

This can cause increased permeability of capillaries, and leakage of fluid into connective tissue.

## **Too few plasma proteins in blood**

This decreases the osmotic pressure within vessels, and fluid leaks out of vessels into connective tissue.

## **Failure of kidney to excrete excess water**





- Excessive loss of body water leading to a decline in body water level is called
- Seen in; Diarrhea, Severe vomiting, Excessive sweating, Fluid loss in burns, Renal disease, Diabetes.
- Symptoms; Low cardiac output, Rapid pulse rate, Low blood pressure, Decreased skin turgor,
- Acidosis, Sunken eye balls, confusion, coma
- Intracellular dehydration may lead to death.

### Are You Dehydrated?

Pinch the skin on the back of your hand gently.

The skin should return to its normal flat state consistently and quickly.

If it doesn't...you are dehydrated.





# REGULATORY MECHANISMS

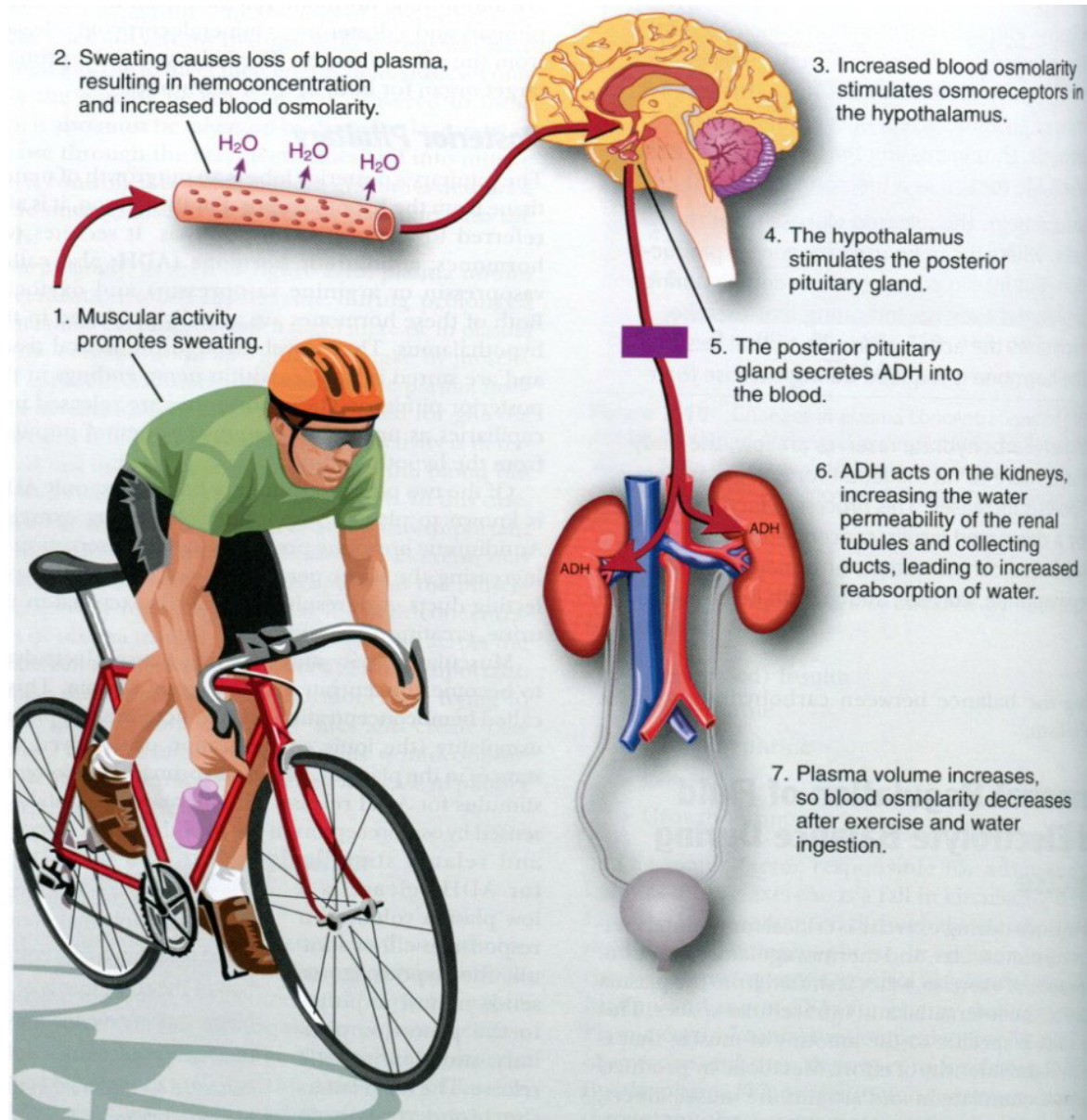
## Hypothalamus –Thirst mechanism

## KIDNEYS

- Kidney Function

## HORMONES

- Renin-Angiotensin-Aldosterone
- Anti-Diuretic Hormone



THE END



# THINK HYDRATION

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*Staying hydrated  
is important for  
our health and  
wellbeing*