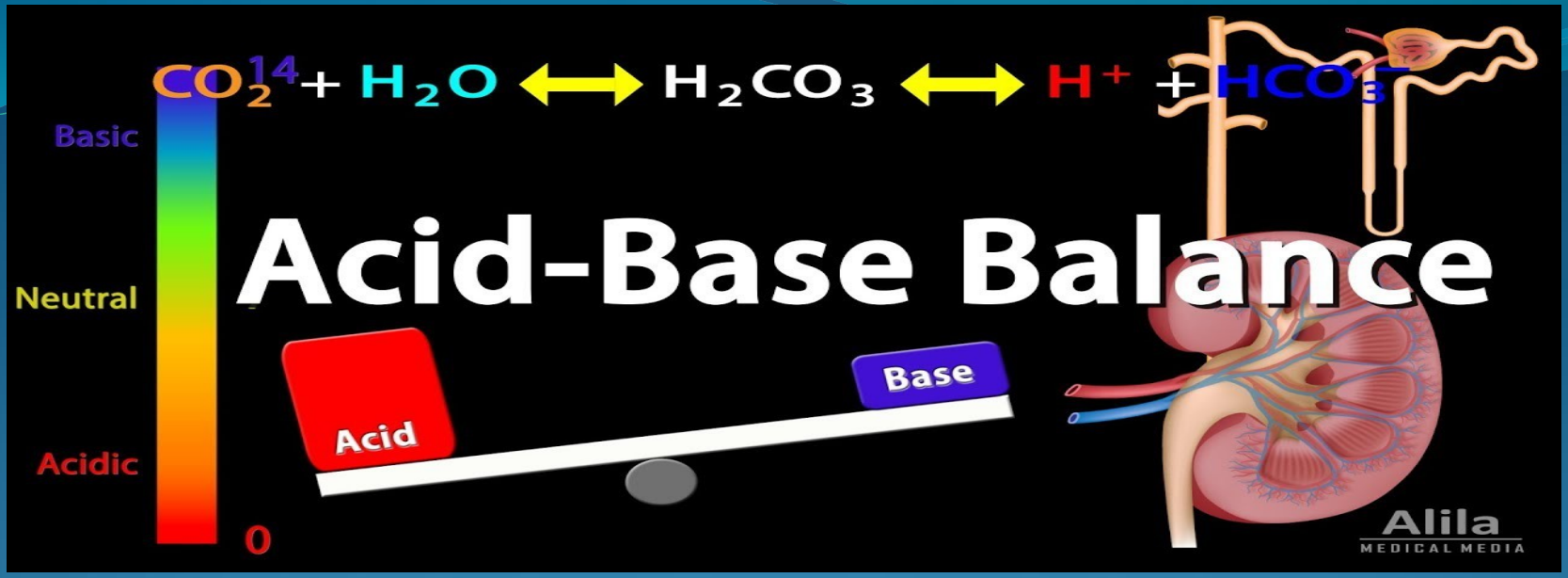


GHC 2013

FLUID, ELECTROLYTE & ACID-BASE BALANCE (I)

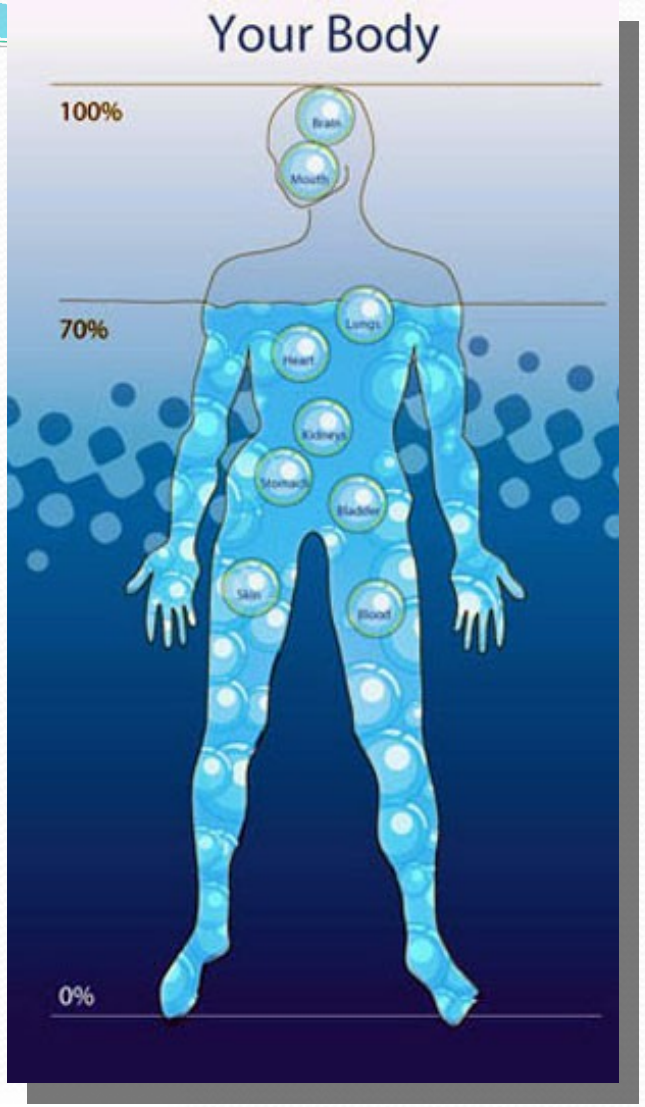
VISION COLLEGE

Learning Outcome

- Upon completion of this lesson, you should be able to:
  - Explain water and electrolyte balance and discuss the importance of this balance.
  - Describe how the body fluids are distributed within compartments, how fluid composition differs between compartments, and how fluids move from one compartment to another.
  - List the routes by which water enters and leaves the body and explain how water input and output are regulated.
  - Explain how electrolytes enter and leave the body and how the input and output of electrolytes are regulated.

Water

- Essential to the life of every living being.
- About 2/3 of body is water and all the organs, tissues and fluids of the body contain water as an essential constituent.
- Male compose of 60% (has more muscle tissues) and female 50% (more on adipose tissues).
- The main source of water for the body is food and drink, although some is produced when nutrients are oxidized to produce energy.



Eg. When the glucose is oxidized, it breaks down to produce carbon dioxide and water.

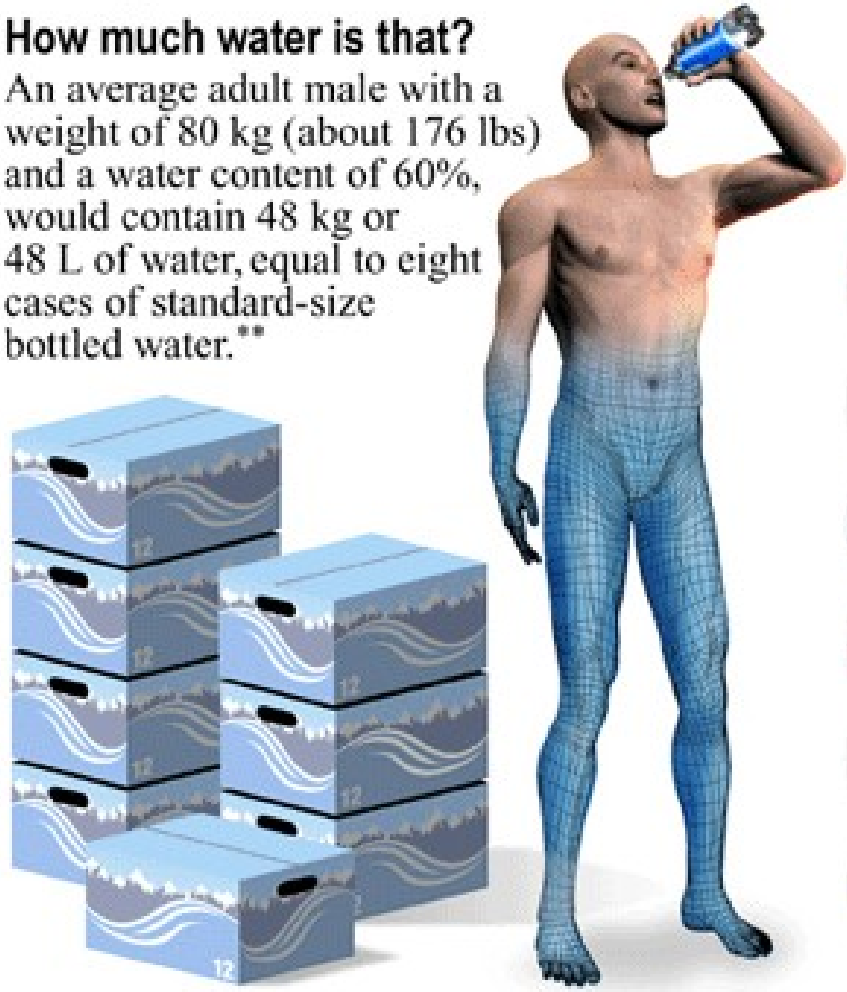
VISION COLLEGE

Your very own body of water

The average human body is composed of about 55% water. The average adult male is about 60% water, the average adult female about 50% water.*

How much water is that?

An average adult male with a weight of 80 kg (about 176 lbs) and a water content of 60%, would contain 48 kg or 48 L of water, equal to eight cases of standard-size bottled water.**



Where is all of that water?

All parts of the body contain some water. Here are some of the more "watery" parts.

- Lungs: **90%** water
- Blood: **82%**
- Skin: **80%**
- Muscle: **75%**
- Brain: **70%**
- Bones: **22%**

** Muscle contains more water than fat does. Males generally have higher muscle content than females.*

*** 1 litre of water weighs 1 kilogram. A standard size container of bottled water is 500 mL.*

Daily Water Chart

www.fullspike.com

Water Composition

Daily Requirement

Weight	Water	
20 lbs	8 oz.	1 cup
40 lbs	16 oz.	
60 lbs	24 oz.	
80 lbs	32 oz	4 cups (1/4 gallon or 1 quart)
100 lbs	40 oz	
120 lbs	48 oz.	
140 lbs	54 oz.	
160 lbs	64 oz.	8 cups (1/2 gallon)
180 lbs	72 oz.	
200 lbs	80 oz.	
220 lbs	88 oz.	
240 bs	96 oz.	12 cups (3/4 gallon)
260 lbs	104 oz.	
280 lbs	112 oz.	
300 lbs	120 oz.	
320 lbs	128 oz.	16 cups (1 gallon or 4 quarts)

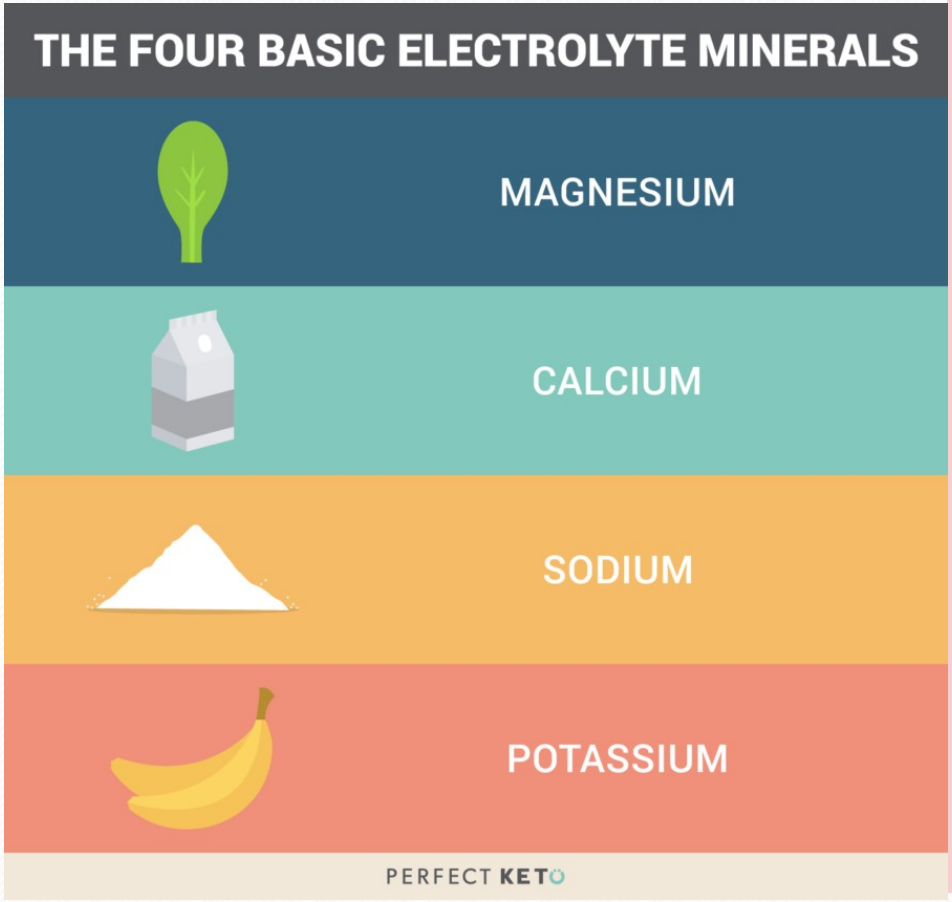
Electrolytes

- Electrolytes are minerals in the body that have an electric charge.
- They are in blood, urine, tissues, and other body fluids.
- Electrolytes are important to;
  - Balance the amount of water in the body
  - Balance body's acid/base (pH) level
  - Move nutrients into cells
  - Move wastes out of cells
  - Make sure that nerves, muscles, heart, and brain work the way they should

Level of electrolytes

- Sodium, calcium, potassium, chloride, phosphate, and magnesium are all electrolytes – ingested from food, drinks and supplement products.
- The levels of electrolytes in the body can become too low or too high - this happen when there is changes of body water/fluids level.
- Some medicines, vomiting, diarrhea, sweating, and liver or kidney problems can all upset the water balance.

Importance of electrolytes

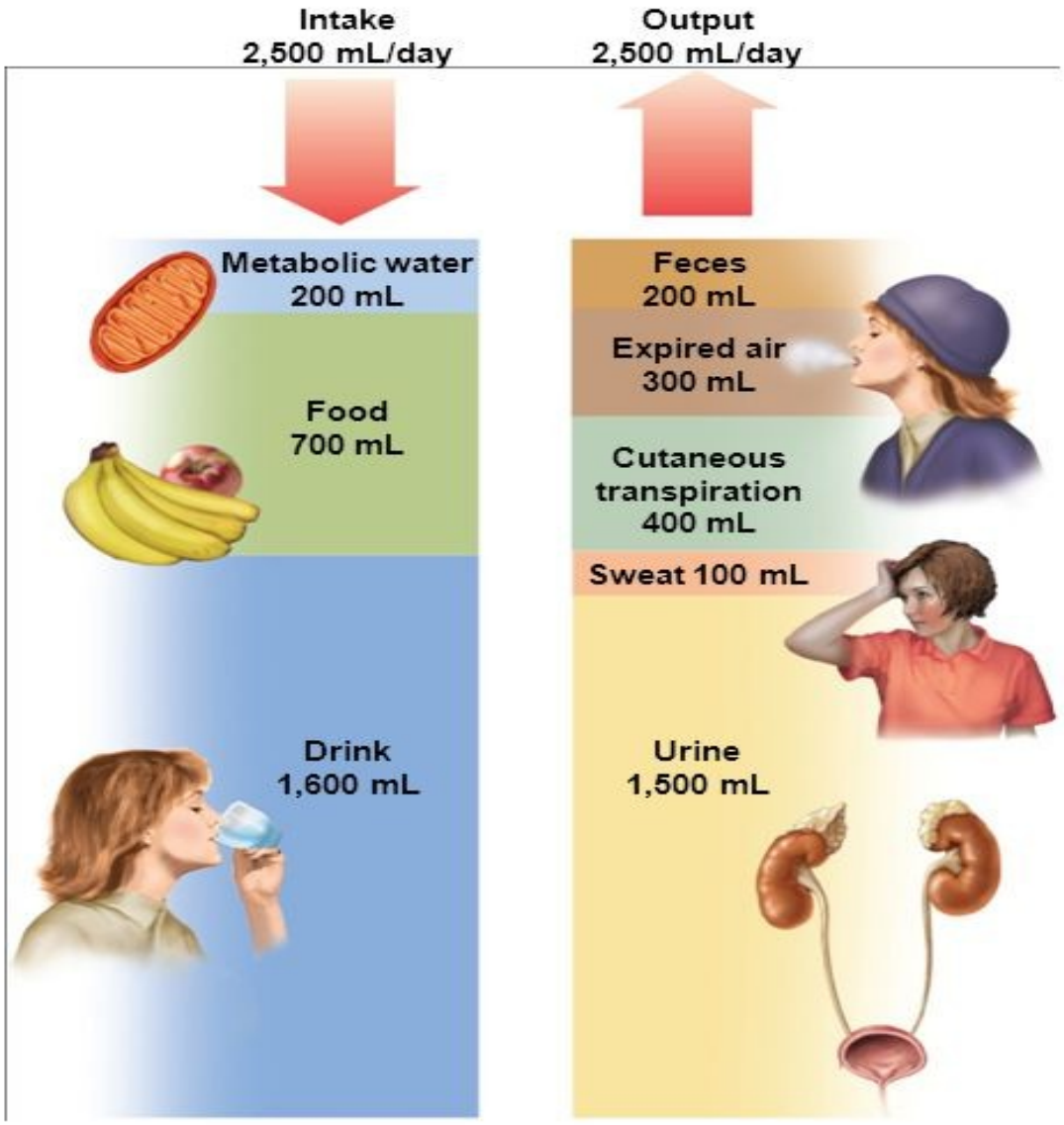


CALCIUM	Necessary for muscle contraction, nerve function, blood clotting, cell-division, healthy bones and teeth
POTASSIUM	Regulates heart contraction, helps maintain fluid balance
MAGNESIUM	Necessary for muscle contraction, nerve function, heart rhythm, bone strength, generating energy and building protein
SODIUM	Maintains fluid balance and necessary for muscle contraction and nerve function
CHLORIDE	Maintains fluid balance in the body

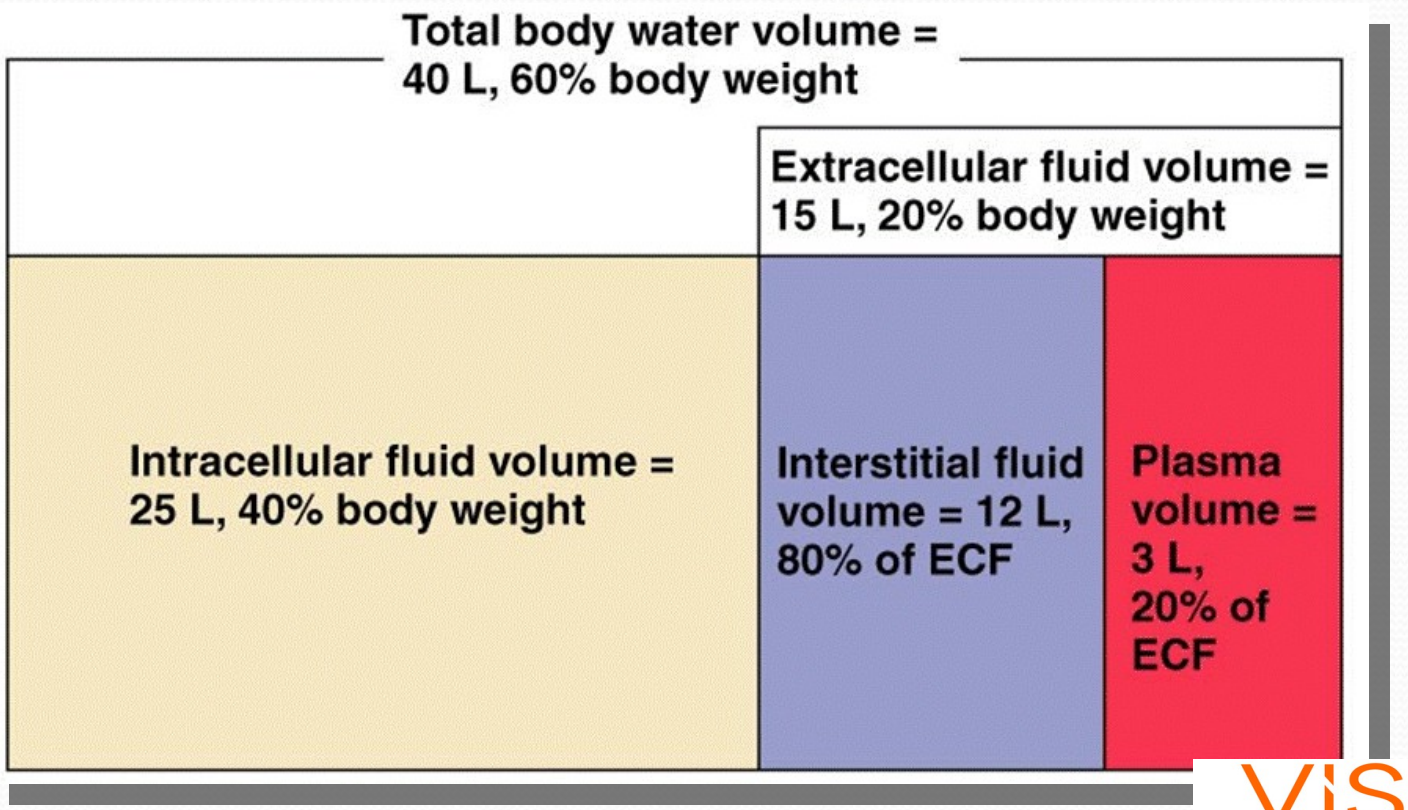
Importance of Fluid & Electrolyte Balance

- 'Balance' suggests a state of equilibrium.
- For water and electrolytes, quantities entering and leaving the body must be equal – using fluid balancing mechanism.
- Water balance and electrolyte balance are interdependent because electrolytes are dissolved in water of body fluids – both the structures will be involved (adding or removing)

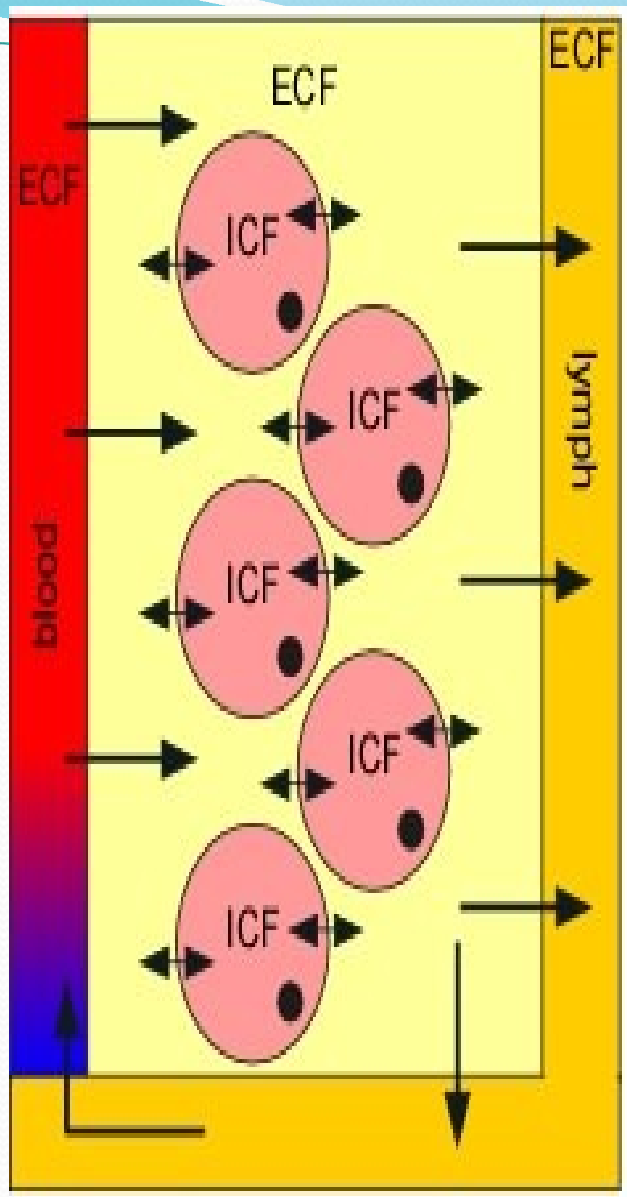
Fluid Balance



- Water in the body (about 40 liters), together with its dissolved electrolytes, is distributed into two major compartments:
  - Intracellular fluid compartment (ICF)
  - Extracellular fluid compartment (ECF)



- Intracellular fluid compartment (ICF) includes all the water and electrolytes that cell membranes enclose.
- Extracellular fluid compartment (ECF) includes all the fluid outside the cells- within the tissue spaces (interstitial fluid), the blood vessels (plasma), and the lymphatic vessels (lymph).



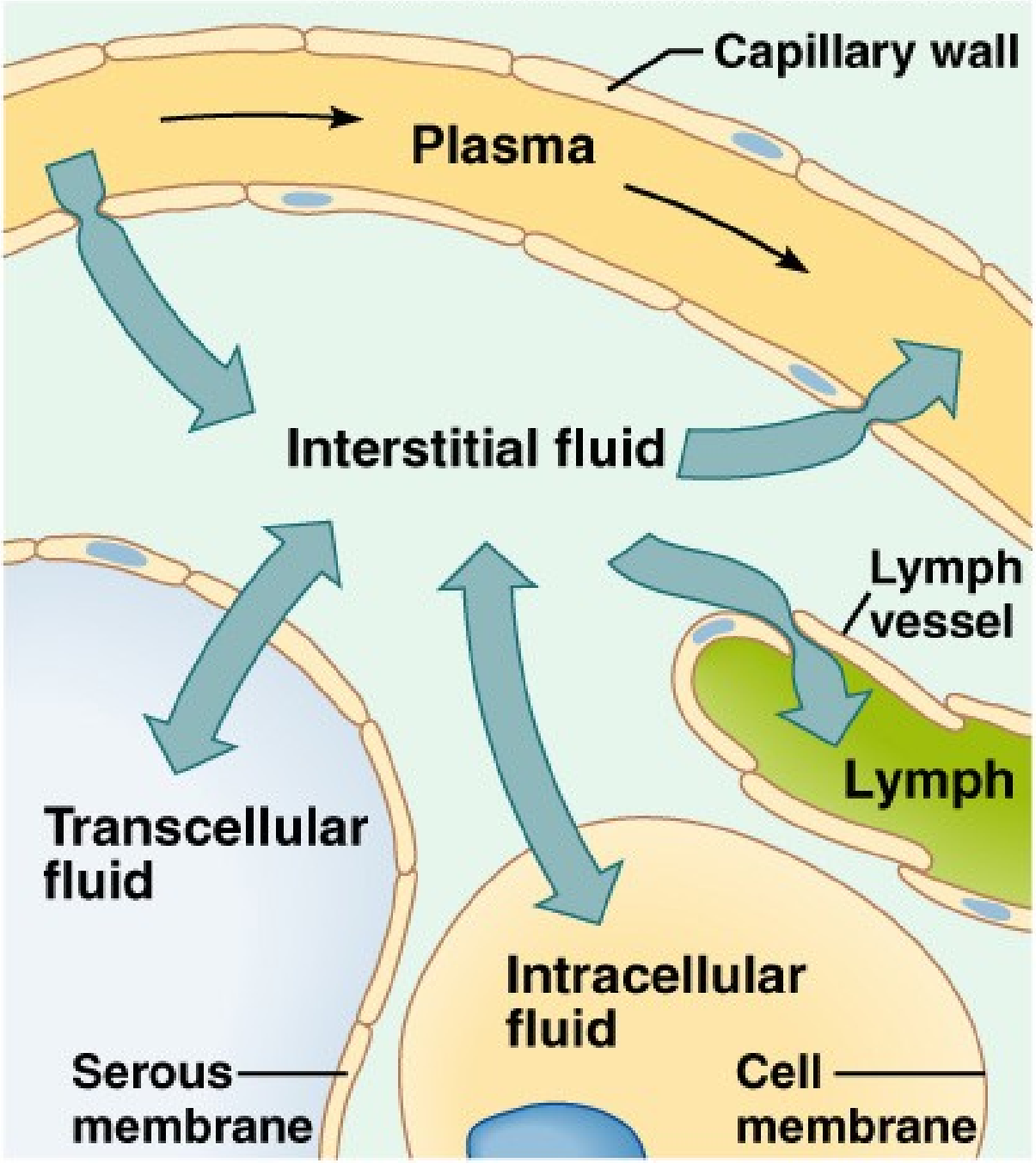
Compositions of Fluid in Compartments

- ECF generally have similar compositions:
  - High concentrations of sodium, chloride, calcium, and bicarbonate ions and lesser concentrations of potassium, magnesium, phosphate, and sulfate ions.
  - The blood plasma fraction of ECF contains considerably more protein than do either interstitial fluid or lymph.

- ICF has high concentrations of potassium, phosphate, magnesium ions, sulfate ions and lesser concentrations of sodium, chloride, and bicarbonate ions than does ECF; also has greater concentration of protein than plasma.

Movement of Fluid Between Compartments

- Hydrostatic and osmotic pressure regulate fluid movements.
- Fluid *leaves plasma* because of *hydrostatic pressure* and *returns to plasma* because of *osmotic pressure*.
- Hydrostatic pressure drives fluid into lymph vessels.
- Osmotic pressure regulates fluid movement in and out of cells.
- Sodium ion concentrations are especially important in fluid movement regulation.



Fluid leaves plasma at arteriolar end of capillaries due to net outward force of hydrostatic pressure

Fluid returns to plasma at venular ends of capillaries because of net inward force of osmotic pressure

Hydrostatic pressure within interstitial spaces forces fluid into lymph capillaries

Interstitial fluid is in equilibrium with transcellular and intracellular fluids

Water Balance

- Water balance exists when water intake equals to water output.
- Homeostasis requires control of both water intake and water output.
- Water intake:
  - The volume of water take-in varies from person to person (from drinking and eating- oxidation of metabolism)

Regulation of Water Intake

- The body loses as little as 1% of its water.
- An increase in osmotic pressure of ECF due to water loss stimulates osmoreceptors and thirst center in the hypothalamus.
- Activity in the hypothalamus causes the person to feel thirsty and increase in water intake.
- Drinking resulting in distension of the stomach by water.
- Water is absorbed through the walls of the stomach and small intestine.
- The osmotic pressure of ECF returns to normal.

Water Output

- Water is lost in a variety of ways.
  - excreted in the urine, feces, and sweat.
  - Insensible loss occurs through evaporation from the skin and lungs.

Regulation of Water Output

- Depends on two conditions:
  - Dehydration (Excess water loss)
  - Excess water intake

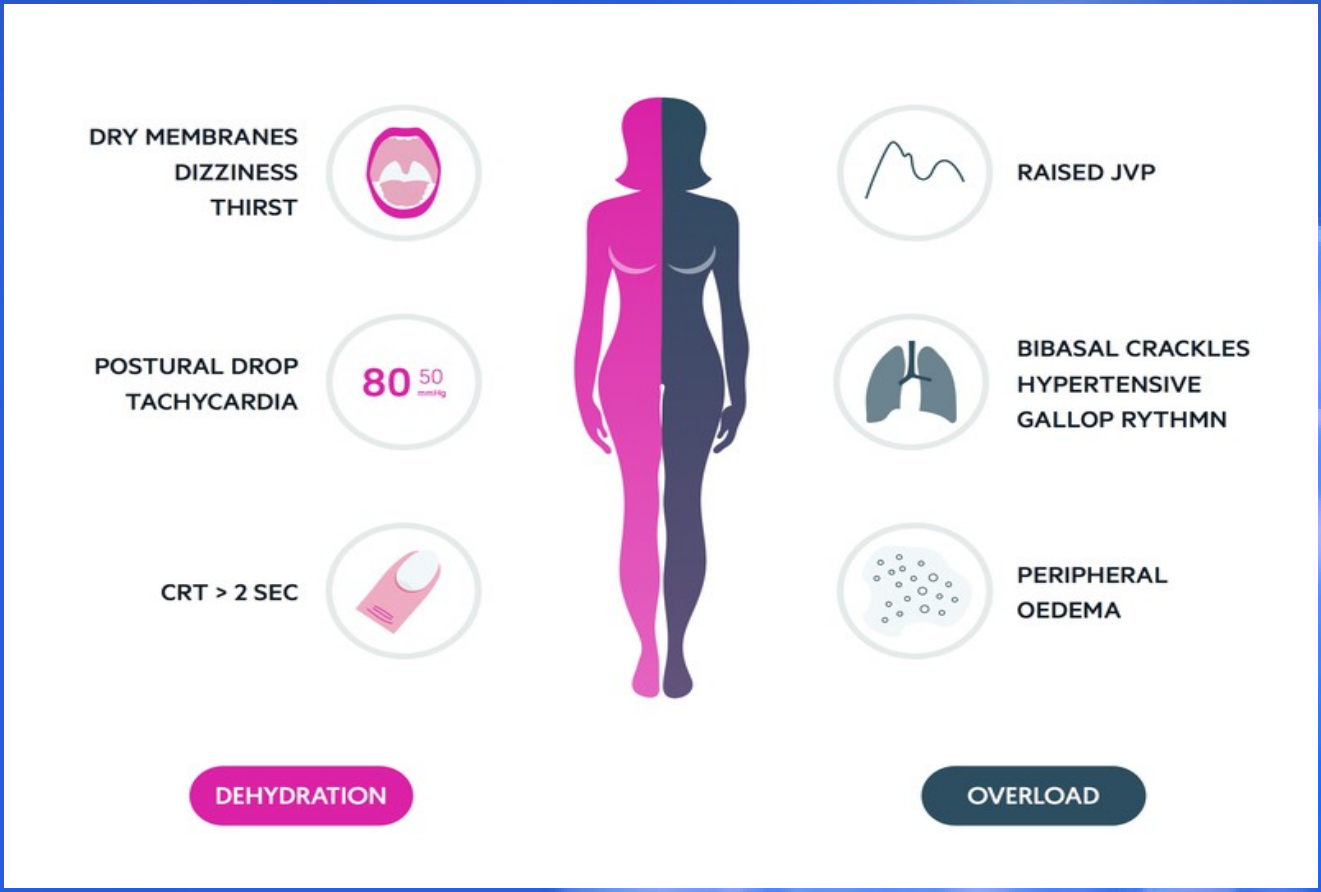
Dehydration

1. ECF becomes osmotically more concentrated (osmotic pressure is increased).
2. Osmoreceptors in the hypothalamus are stimulated by the increase in the osmotic pressure of body fluids.
3. The hypothalamus signals the posterior pituitary gland to release ADH into the blood.
4. Blood carries ADH to the kidneys.
5. ADH causes the distal convoluted tubules and collecting ducts to increase water reabsorption.
6. Urine output decreases, and further water loss is minimised.

Excess Water Intake

1. ECF becomes osmotically less concentrated (osmotic pressure is decreased).
2. This change stimulates osmoreceptors in the hypothalamus.
3. The posterior pituitary gland decreases ADH release.
4. Renal tubules decrease water reabsorption.
5. Urine output increases, and excess water is excreted.

ALTERED FLUID BALANCE



Altered fluid balance

- Divided to 2 groups:
  - Fluid overload
  - Fluid deficit

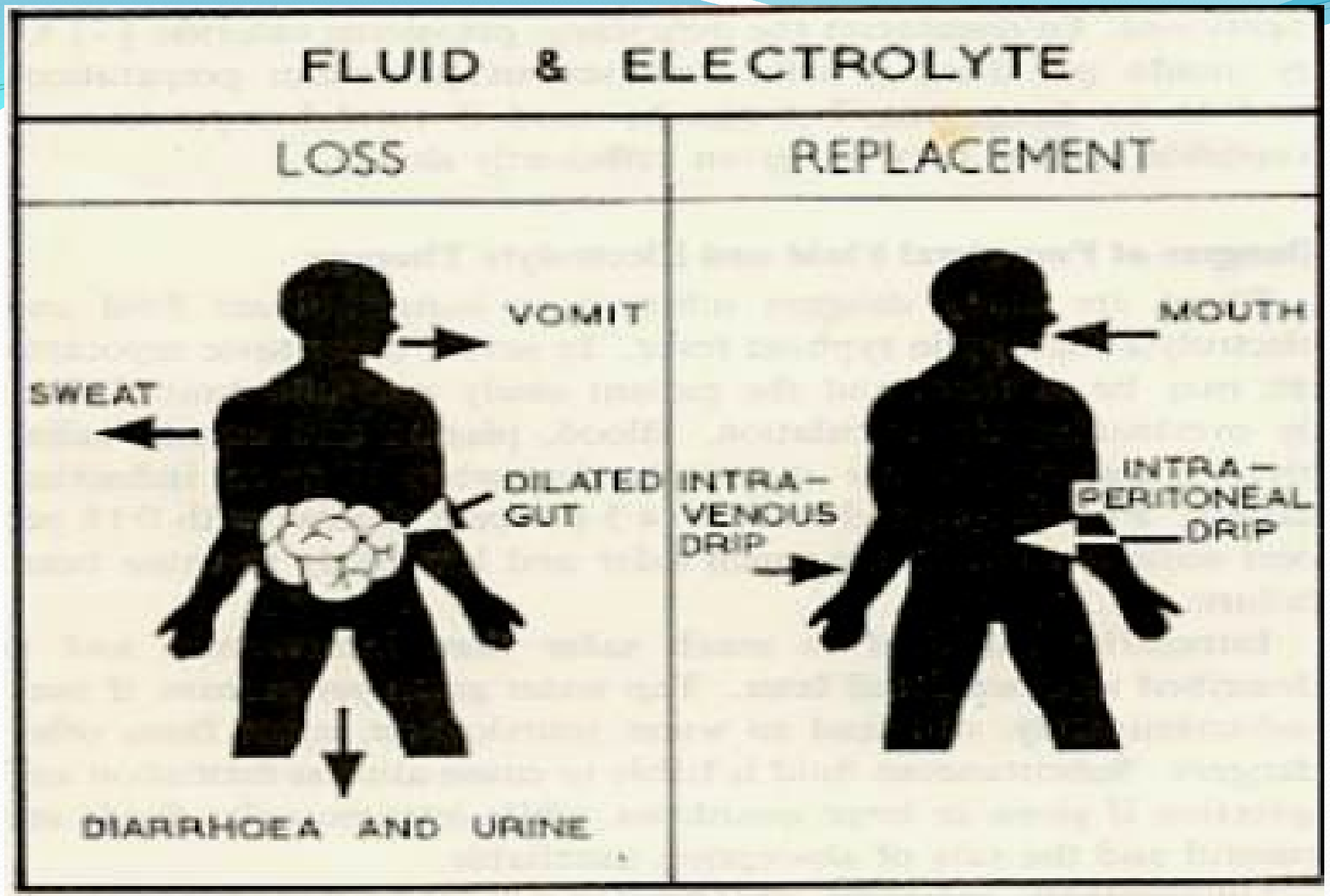


Fig. 28

Fluid overload (Hypervolemia)

- Definition: Accumulation of extra fluid in the blood.
- Fluid intake is more than output.
- Causes (etiology):
  - Excessive fluid intake (e.g: IV fluid)
  - Retention of body fluid (e.g: renal failures, congestive cardiac failure).
  - Excessive intake of sodium, high solutes – (protein and glucose).
  - Failure in body fluid regulatory mechanism.

Signs and symptoms

- Symptoms of hypervolemia can cause discomfort, stress on your body and even organ trouble.
- Signs of fluid overload may include;
  - Rapid weight gain
  - Noticeable swelling (edema) in your arms, legs and face
  - Swelling in your abdomen
  - Cramping, headache, and stomach bloating
  - Shortness of breath
  - High blood pressure
  - Heart problems, including congestive heart failure

- Clinical manifestation:
  - General: Anasarca – collection of fluid in the interstitial space throughout body space (extreme generalized edema, swelling of the skin).
  - Cardiovascular: - Tachycardia
    - Hypertension
    - Increased of venous pressure

- Respiratory: - Dyspnea
  - Orthopnea
  - Cough
  - Pleural effusion
- Integumentary: - Pitting edema
  - Pallor , cold and clammy skin
- Neurological: - Confused
  - Dizzy
  - Disoriented
- Neuromuscular: - Weakness of muscles
  - Decreased vision
- Gastrointestinal: - Ascites

Anasarca

Massive generalized edema

Complication of fluid overload

- Pulmonary edema, general edema, ascites
- Water intoxication

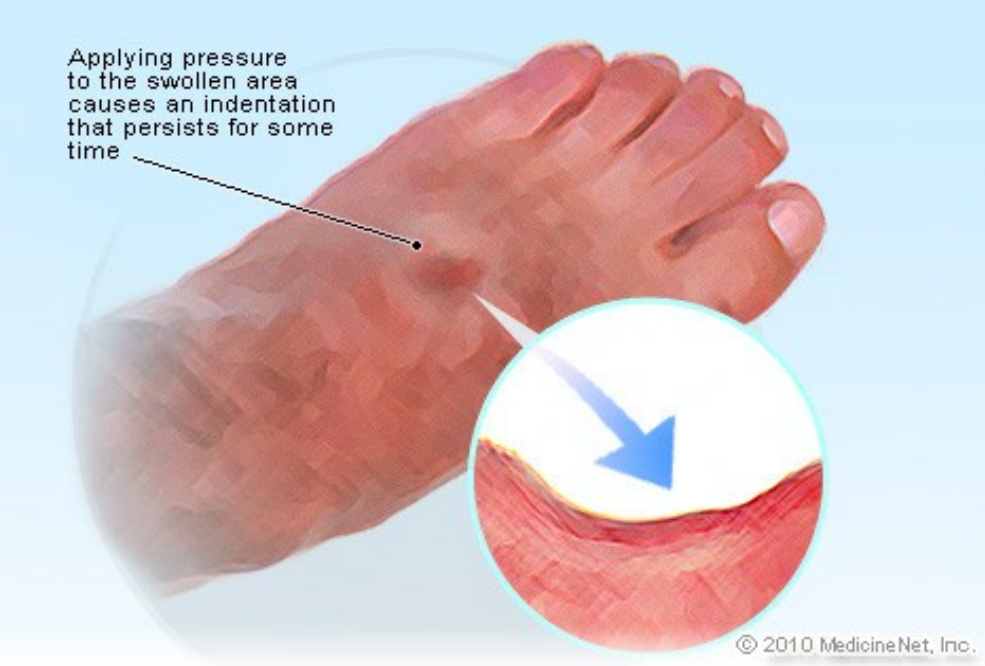
EDEMA

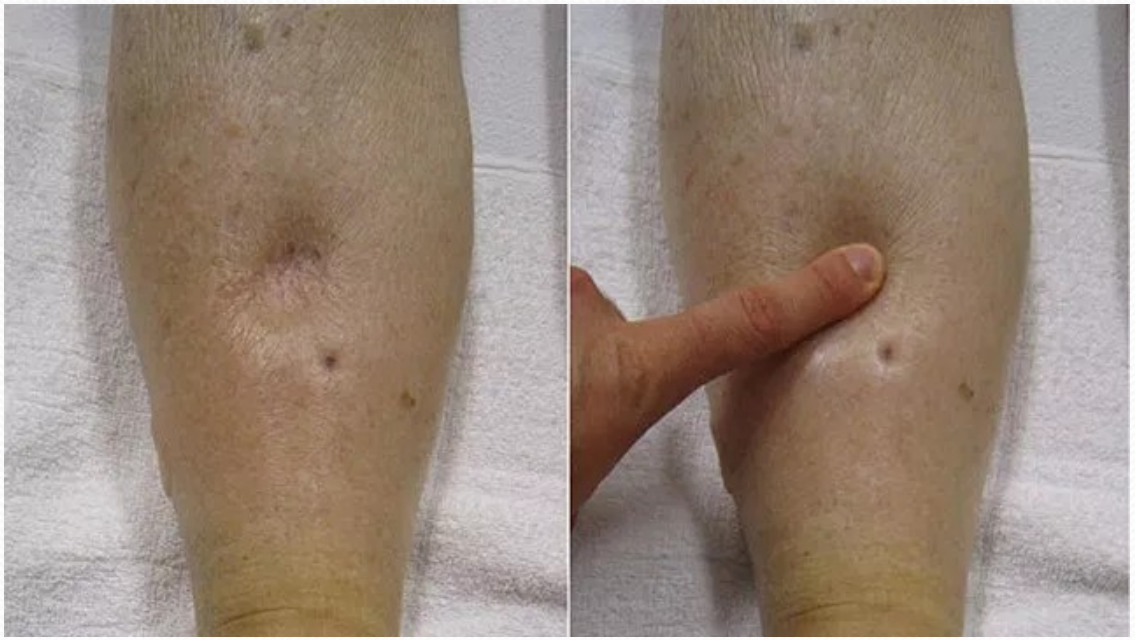
- Excessive collection of fluid in interstitial space.
- Occurs specific (pitting edema) or general (ascites, pulmonary edema)
- Causes:
  - Increase in hydrostatic pressure in the capillaries (more fluid drained out of the capillaries)- venous obstruction, lymphatic obstruction, CCF
  - Decreased in osmotic pressure (failure in abstracting back fluid back to capillaries)- nephrosis, increased albumin loss in burn, nutritional protein deficiency.

Classification of edema

- Pitting edema
- Dependent edema – with gravity
- Others –
  - Ascites (fluid accumulation in the peritonuem cavity)
  - Pulmonary edema (accumulation of fluid in interstitial and alveolar space of lungs)

Pitting edema



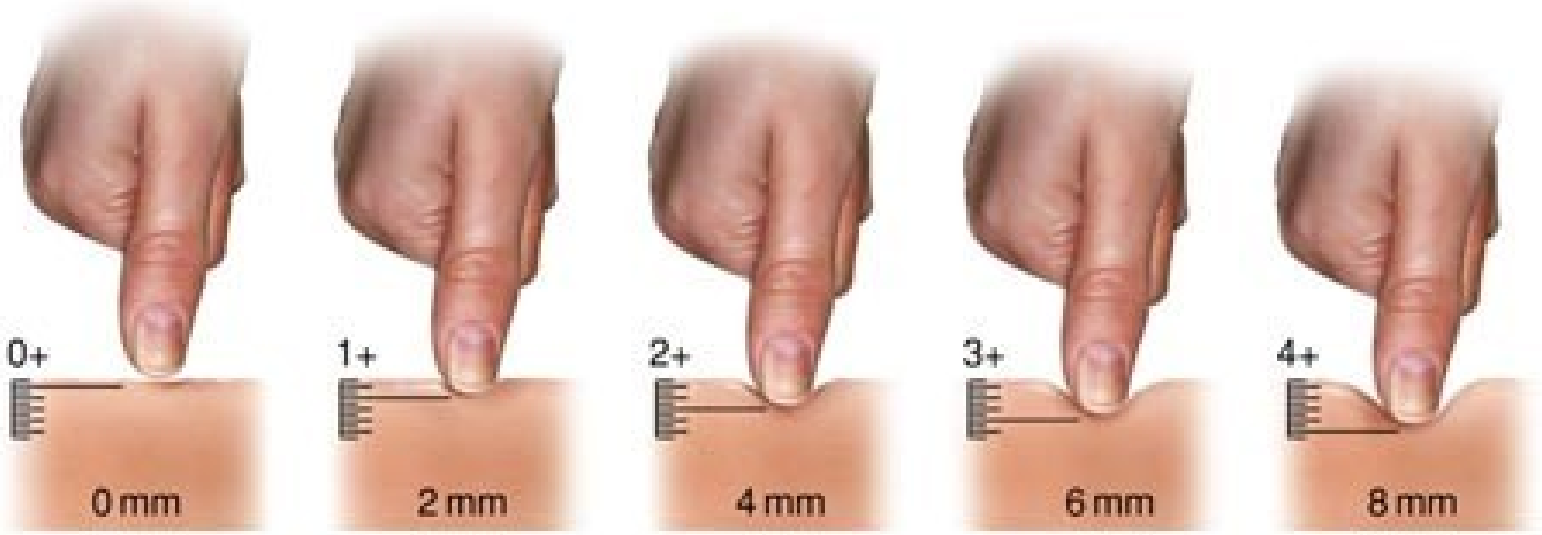


Ascites is the accumulation of fluid in the peritoneal cavity.

Clinical manifestation of edema

- Increased in body weight
- Swelling of the tissues
- Weakness of limbs
- Anorexia
- Tired
- Decreased in urine output
- Stretching of skin
- Disorientated

Grade of edema



0+ No pitting edema
1+ Mild pitting edema. 2 mm depression that disappears rapidly.
2+ Moderate pitting edema. 4 mm depression that disappears in 10–15 seconds.
3+ Moderately severe pitting edema. 6 mm depression that may last more than 1 minute.
4+ Severe pitting edema. 8 mm depression that can last more than 2 minutes.

Fluid deficit (Hypovolemia)

- Excessive fluid loss from the body @ intracellular and extracellular space.
- Causes (Etiology):
  - Polyuria (voiding more)
  - Wound (burn)
  - Failure of fluid balancing regulatory mechanism
  - High metabolic and fever – requirement of fluid increased
  - Medications – diuretics, laxatives
  - Less drinking
  - Vomiting

Clinical manifestation

- Decreased weight
- Fatigue
- Anxiety, restlessness
- Disorientated
- Disturbance in sensory
- Coma
- Orthostatic hypotension

Cont'..

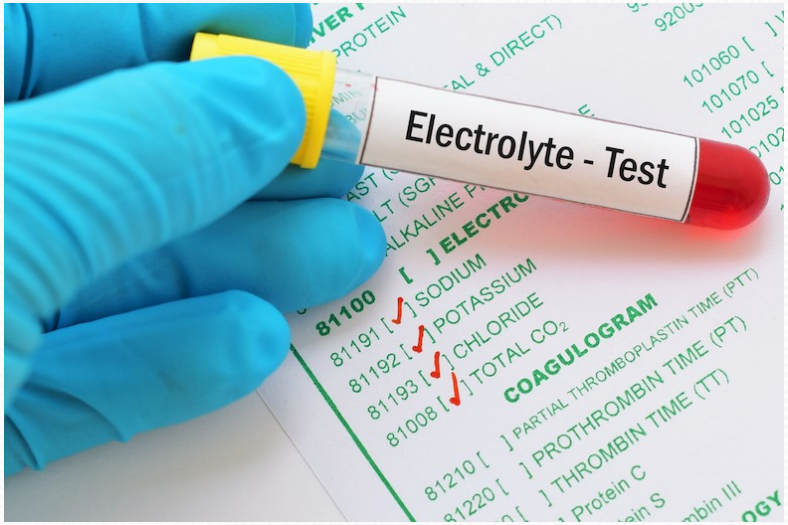
- Potential for hypovolemic shock
- Oliguria
- Concentrated urine
- Less skin turgor
- Dry skin
- Dry mucosal membrane
- Thirsty
- Changes in body temperature

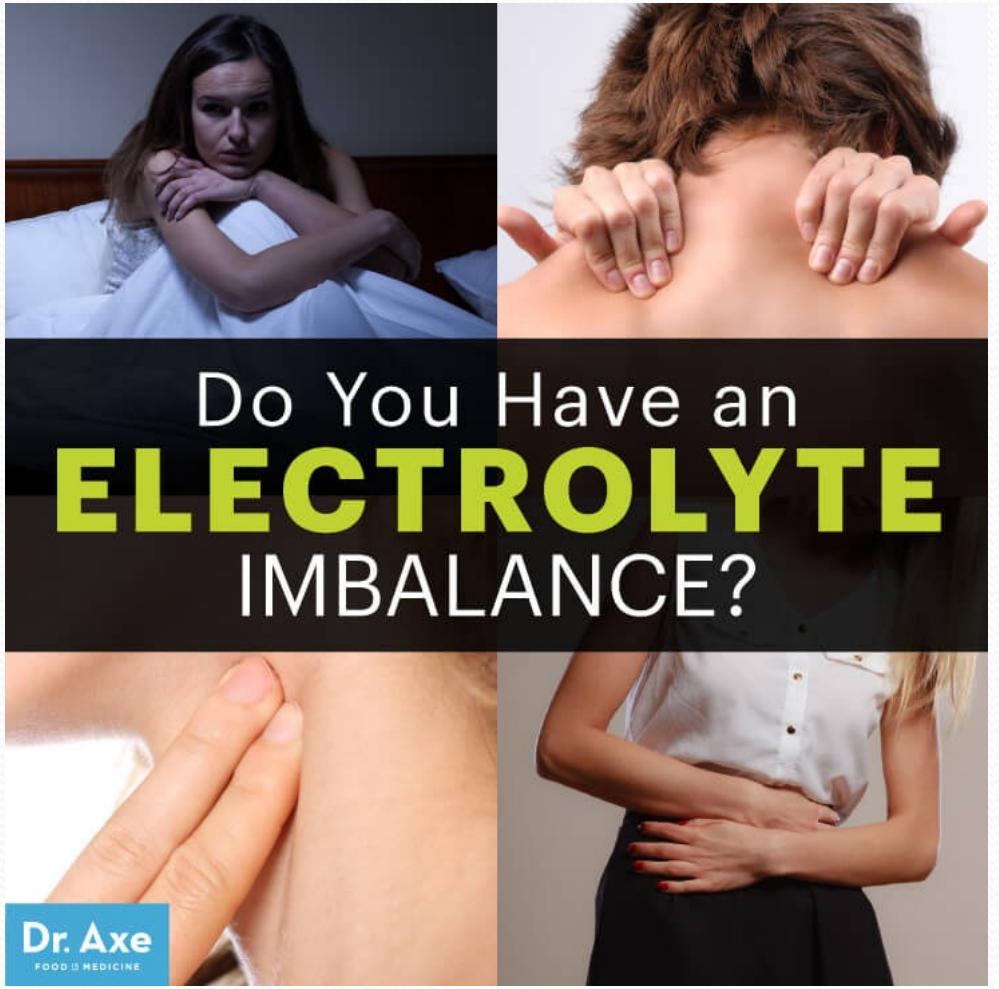
VISION
COLLEGE

Complication of dehydration

- Hypovolemic shock
  - Decreased in blood volume causes hypotension
  - Reduce in O_2 to tissues
- Cerebral edema
  - Isotonic dehydration
  - Hypotonic dehydration
- Seizures
- Renal failure

ELECTROLYTE IMBALANCE



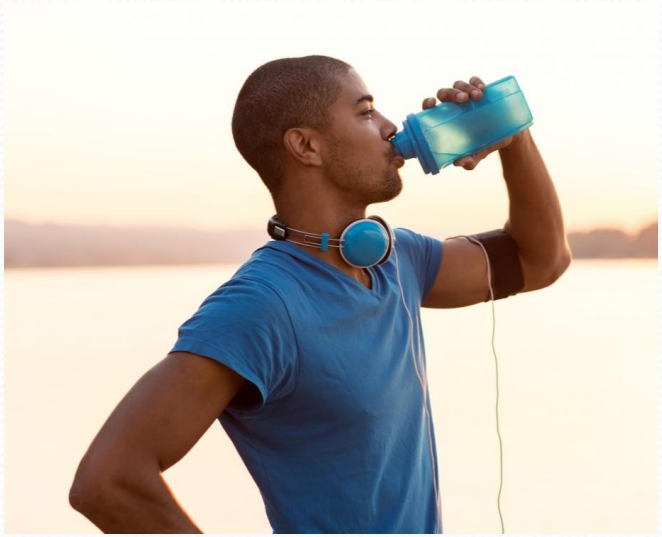


Regulation of electrolyte intake

- Electrolytes are usually obtained in sufficient quantities in response to hunger and thirst mechanisms.
- In a severe electrolyte deficiency, a person may experience a **salt craving**.

Electrolyte Output

- Electrolytes are lost through perspiration, faeces and urine.
- Quantities lost – vary with temperature and physical exercise.
- The greatest electrolyte loss occurs as a result of **abnormal kidney functions**.

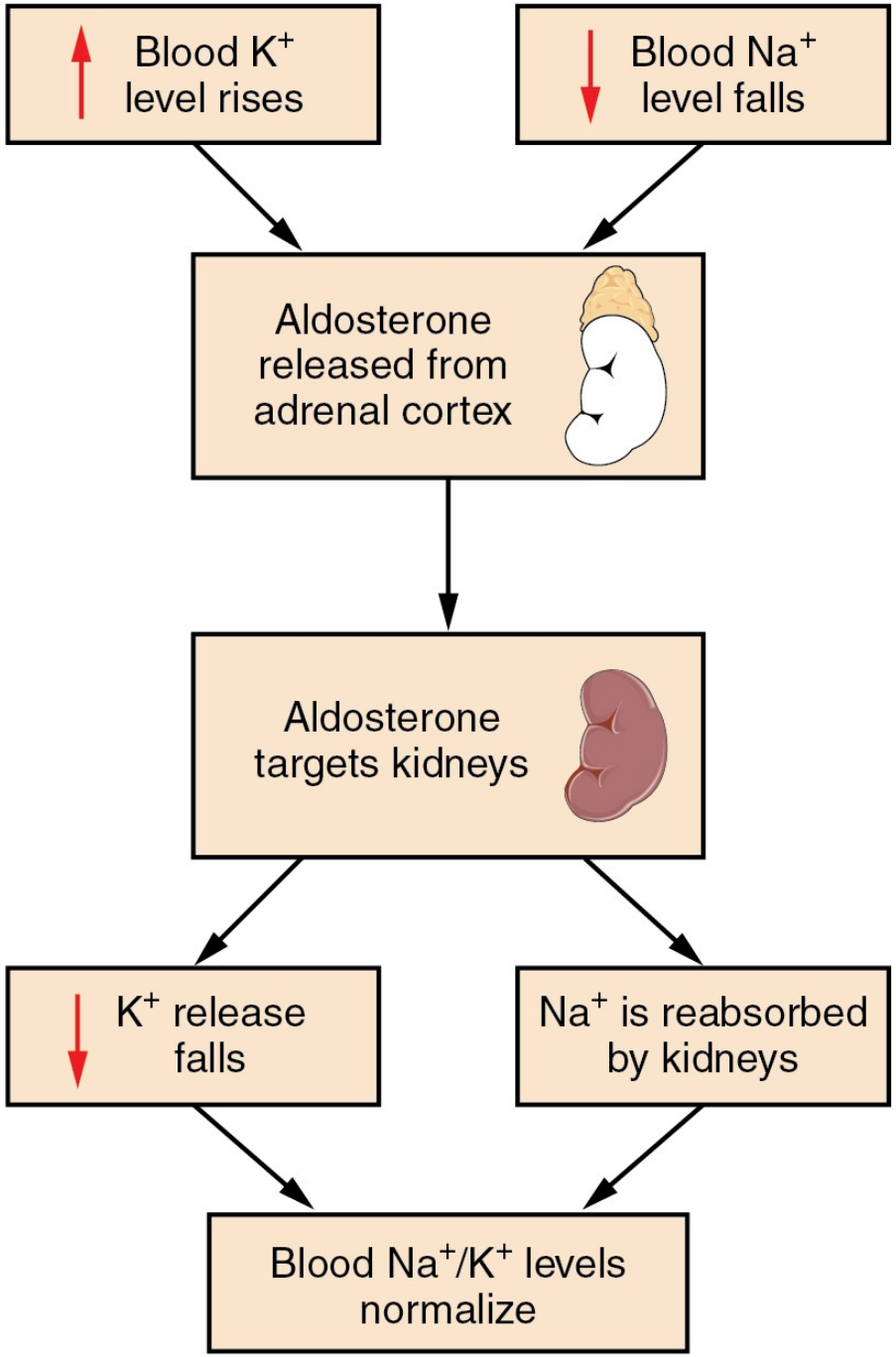


Regulation of electrolyte output

- The regulation of sodium and potassium ions involves the secretion of **aldosterone** from the adrenal glands.

- **Calcitonin** from the thyroid gland and **parathyroid hormone** from the parathyroid glands regulate calcium ion concentration.

- The mechanisms that control positively charged ions secondarily regulate negatively charged ions.
  - Chloride ions are passively reabsorbed in renal tubules as sodium ions are actively reabsorbed.



Regulation of sodium and potassium ions

Normal values of main electrolytes

Electrolytes	Normal values
Sodium (Na +)	135-145 mmol/L
Potassium (K+)	3.5-5.5 mmol/L
Calcium (Ca 2+)	2.2-2.6 mmol/L
Chloride (Cl-)	100-106 mmol/L
Bicarbonate (HCO3-)	24-28 mmol/L
Phosphate (HPO4 2-)	0.8-1.5 mmol/L
Magnesium Mg2+	0.8-1.3 mmol/L

Electrolyte disorder

- An electrolyte disorder occurs when the levels of electrolytes in the body are either too high or too low.
- Electrolytes need to be maintained in an even balance for the body to function properly. Otherwise, vital body systems can be affected.
- Severe electrolyte imbalances can cause serious problems such as;
  - **Coma**
  - **Seizures**
  - **Cardiac arrest**

Causes of electrolyte disorder

- Most often caused by a loss of bodily fluids through **prolonged vomiting**, **diarrhea**, or **sweating**.
- May also develop due to **fluid loss related to burns**.
- **Certain medications** can cause electrolyte disorders as well.
- In some cases, affected due to underlying diseases, such as **acute or chronic kidney disease**.
- The **exact cause may vary** depending on the specific type of electrolyte disorder.

Types of electrolyte disorder

- Conditions caused by electrolyte level imbalances include:
  - Calcium: **hypercalcemia** and **hypocalcemia**
  - Chloride: **hyperchloremia** and **hypochloremia**
  - Magnesium: **hypermagnesemia** and **hypomagnesemia**
  - Phosphate: **hyperphosphatemia** or **hypophosphatemia**
  - Potassium: **hyperkalemia** and **hypokalemia**
  - Sodium: **hypernatremia** and **hyponatremia**

Symptoms of electrolyte disorder

- **Mild** forms of electrolyte disorders may **not cause any symptoms**.
- Such disorders can go undetected – until discovered during a routine **blood test**.
- Symptoms usually **start to appear** once a particular disorder becomes **more severe**.
- Not all electrolyte imbalances cause the same symptoms, but many **share similar** symptoms.

Common symptoms of an electrolyte disorder

- irregular heartbeat
- fast heart rate
- fatigue
- lethargy
- convulsions or seizures
- nausea
- vomiting
- diarrhea or constipation
- abdominal cramping
- muscle cramping
- muscle weakness
- irritability
- confusion
- headaches
- numbness and tingling

Great Food Sources for Electrolytes

Calcium

Kale
Collard Greens
Sardines
Spinach

Sodium

Table Salt
Tomato Juice
Salted Nuts
Soup

Potasium

Bananas
Potatoes (with skin)
Mushrooms
Leafy Greens

Chloride

Celery
Olives
Lettuce
Seaweed

Magnesium

Spinach
Quinoa
Almonds, Cashews, & Peanuts
Dark Chocolate

10 FOODS TO NATURALLY REPLENISH Electrolytes

www.paleoplan.com

Thank you