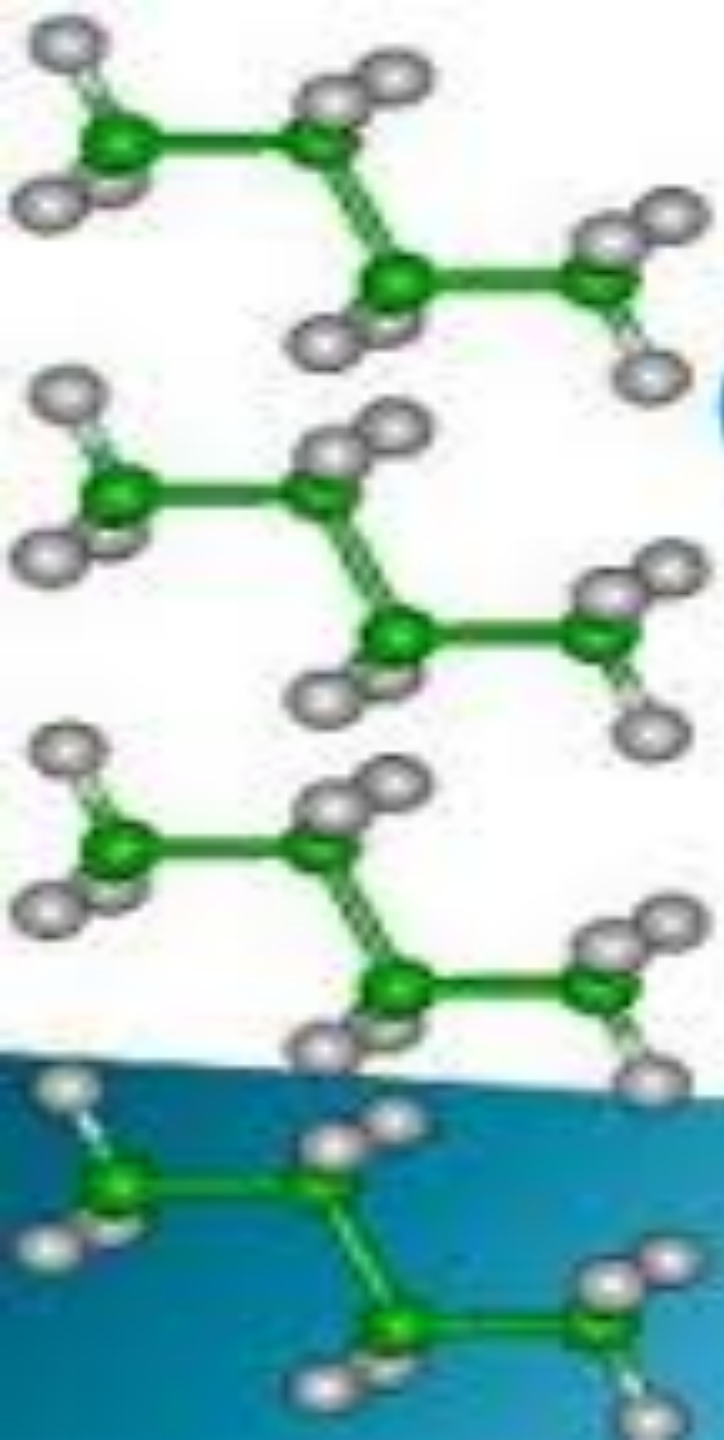
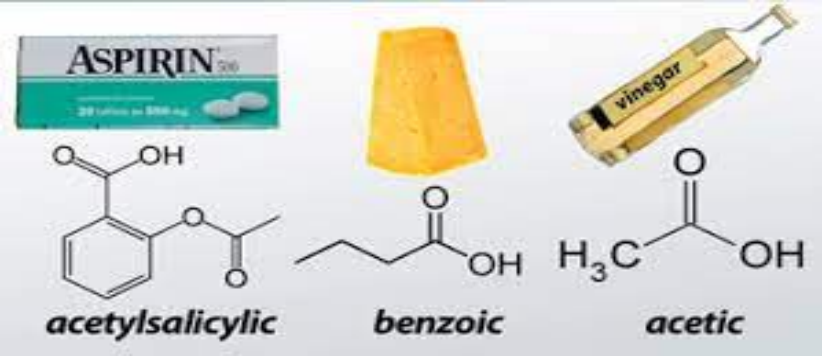
Carboxylic Acids, Colloids and Acid-Base Balance

Prof. Dr. May Jaleel



Carboxylic Acids



Carboxylic Acids

- Carboxylic acids or organic acids are the compounds containing in the molecule the carboxyl functional group attached to the hydroxyl group. They are largely distributed in nature and are intermediates in the degradation pathways of amino acids, fats, and carbohydrates.
- The carboxyl group consisting of a carbonyl (C=O) with a hydroxyl group (O–H) attached to the same carbon atom and is usually written as –COOH or CO_2H. The compounds presenting two or more carboxylic groups are called dicarboxylic, tricarboxylic acids, while their salts and esters are called carboxylates

- By the nature of the radical, they can be classified into saturated, unsaturated, or aromatic acids. In the International Union of Pure and Applied Chemistry (IUPAC) nomenclature, carboxylic acids have an “-oic acid” suffix added to hydrocarbons having the same number of carbon atoms. Still, some organic acids are called by their common name, for example, formic acid and acetic acid. The molecular weight of organic acids varies widely from relatively small compounds such as formic and acetic acids too much larger compounds (fatty acids) with higher numbers of carboxylic and phenolic functional groups. Monocarboxylic acids with 5–10 carbon atoms in the chain are colorless liquids with unpleasant smells. As the carbon chain length increases (>10 carbon atoms) the acids are wax like solids, and their smell diminishes with increasing molar mass and decreasing volatility. Due to the presence of both hydroxyl and the carbonyl groups in the molecule, the carboxylic acids can exhibit hydrogen bonding with themselves leading to increased stabilization of the compounds and show elevated boiling points. They are polar molecules soluble in polar solvents, but as the alkyl chain increases their solubility decreases due to the hydrophobic nature of the carbon chain.

- Carboxylic acids are compounds occurring naturally in different stages of life cycles (living organism-Krebs cycle; fermentation processes, and geological processes) or can be produced in the laboratories or at large scale (synthesis) from oxidation reactions of aldehydes, primary alcohols, and hydrocarbons, oxidative cleavage of olefins, base catalyzed dehydrogenation of alcohols or through the hydrolysis of nitriles, esters, or amides.

PROPERTIES OF

COLLOIDS

Colloids

- Colloids (also known as colloidal solutions or colloidal systems) are mixtures in which microscopically dispersed insoluble particles of one substance are suspended in another substance. The size of the suspended particles in a colloid can range from 1 to 1000 nanometres (10^{-9} metres). For a mixture to be classified as a colloid, its suspended particles must not settle (in the manner that the particles of suspensions settle at the bottom of the container if left undisturbed). Colloidal solutions are known to exhibit the Tyndall Effect, which is a phenomenon in which beams of light incident on colloids are scattered due to the interactions between the light and the colloidal particles.

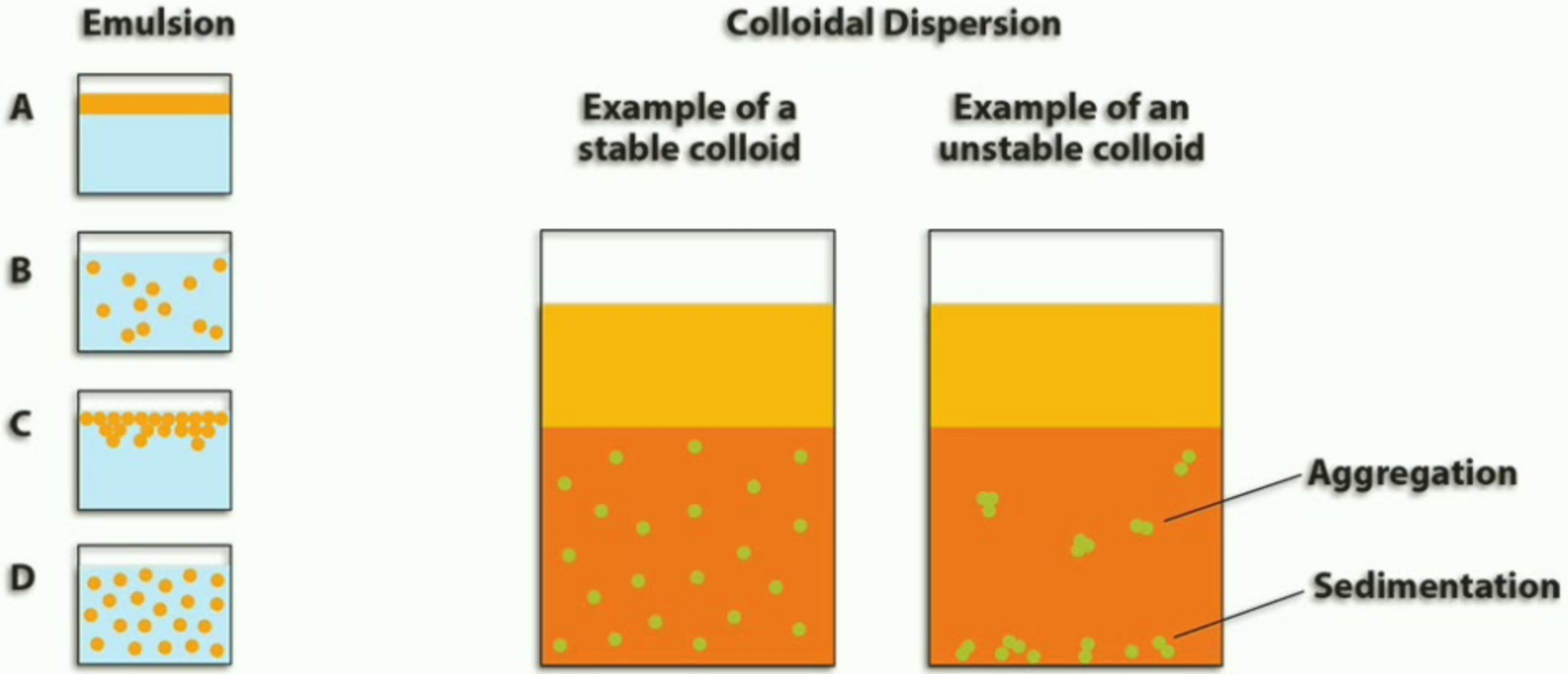
Examples of Colloids

- **1) Blood**
- A respiration pigment which has albumin protein in water. Pigment part contains albumin that acts as the dispersed phase and the dispersion medium is water. It is a hydrosol.
- **2) Cloud:**
- It contains air which is the dispersion medium and droplets of water as a dispersed phase. These are aerosol.
- **3) Gold sol:**
- It is a metallic sol in which gold particles are dispersed in the water.

- **<u>Application of Colloids</u>**

- **As food items**
- **Medicine**
- **In Purification of air**
-

COLLOIDAL DISPERSIONS



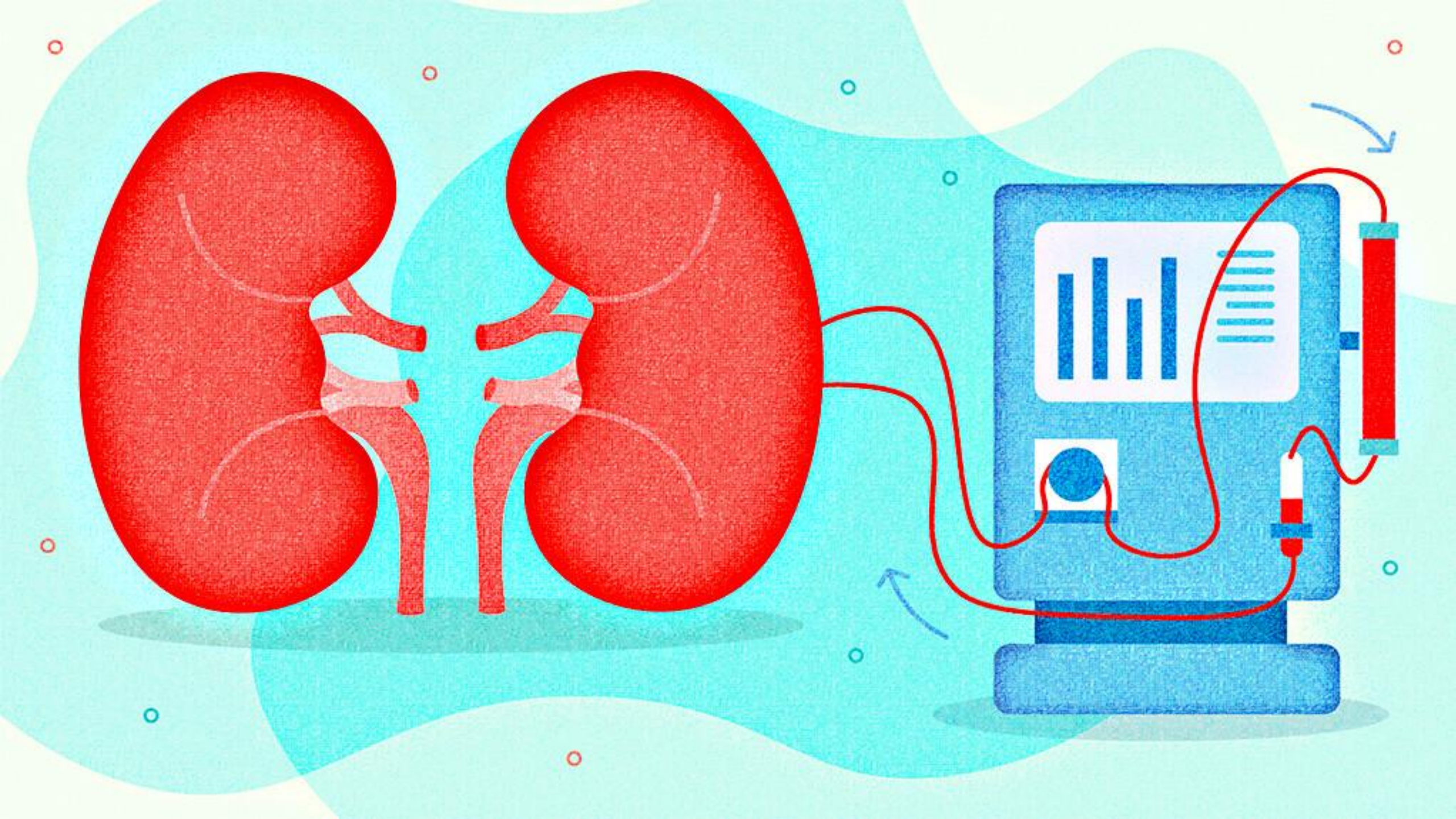
colloidal dispersion

- Colloidal dispersions are two-phase systems comprising the dispersed phase and the continuous or dispersion medium. The mixture is homogeneous over an appreciable time period. This period will depend on the application; precipitated metal hydroxides for potable water treatment are purposely short-lived in stability in order to flocculate and remove the natural organic matter. By contrast, domestic dispersions such as paint and abrasive cleaners will have a shelf-life of several months or years. The properties of the dispersion are determined to a large extent by the nature of the dispersed phase-dispersion medium interface. Colloid science and surface science are therefore closely linked.

Application of colloidal dispersion

•Dialysis

- **Dialysis is a procedure to remove waste products and excess fluid from the blood when the kidneys stop working properly. It often involves diverting blood to a machine to be cleaned.**
- Normally, the kidneys filter the blood, removing harmful waste products and excess fluid and turning these into urine to be passed out of the body.
- If kidneys was not working properly – for example, because patient have advanced **chronic kidney disease** (kidney failure) – the kidneys may not be able to clean the blood properly.
- Waste products and fluid can build up to dangerous levels in your body. Left untreated, this can cause a number of unpleasant symptoms and eventually be fatal.
- Dialysis filters out unwanted substances and fluids from the blood before this happens.



How long will patient need dialysis for

- It depends. In some cases, kidney failure may be a temporary problem and dialysis can be stopped when the kidneys recover.
- But often, someone with kidney failure will need a kidney transplant.
- It's not always possible to carry out a kidney transplant straight away, so dialysis may be needed until a suitable donor kidney becomes available.
- If a kidney transplant is not suitable for patient – for example, because he is not well enough to have a major operation – dialysis may be needed for the rest of his life.

$CO_2^{14} + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^-$

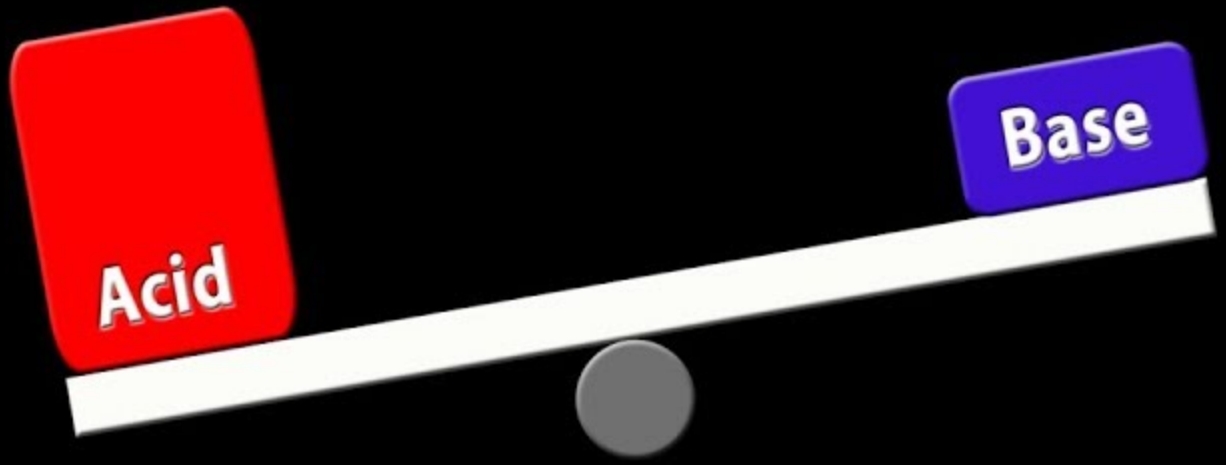
Basic

Neutral

Acidic

0

Acid-Base Balance



Alila
MEDICAL MEDIA

Acid Base And water

- *Factors affecting water intake and water output*

  1.Environment influences water intake and water output of an individual. In hot weather water output decreases (urine) and water intake increases. Water intake is less in cold climate and water output (urine) is more.

- 2.In disease like diabetes and renal diabetes, output of urine is more.

- *Disorders of water balance*

  1. Dehydration (water depletion). It is due to deficiency of water. It occurs in vomiting, diarrhea, diabetes incipidus and in lesions of hypothalamus.

- 2. Over hydration (Edema). It is due to excess water in body. It
- may leads to edema. It occurs in water intoxication, excessive
- administration of intravenous fluids, increased secretion of ADH, protein deficiency, cancer and drugs.

Electrolytes

- Charged solutes or electrolytes are present in body fluids like
- intracellular fluid (ICF), extracellular fluid (ECF), various secretions, blood plasma and in bone. The two types of solutes present in body are inorganic and organic. The inorganic solutes or electrolytes consist of cations and anions. The organic electrolytes are mainly anions. The inorganic cations are sodium (Na), potassium (K), calcium (Ca) and magnesium (Mg). The inorganic anions are chloride (Cl^{-}), bicarbonate (HCO_3^{-}), phosphate (PO_4^{-3}) and sulphate (SO_4^{-2}). The organic anions are contributed by proteins, organic acids and organic phosphates.

Dietary Sources of Electrolytes

Foods

Drinks

Electrolytes of blood plasma

- The important anions in blood plasma are
- bicarbonate, chloride, phosphate, sulfate, iodide and fluoride.
- Bicarbonate : Normal plasma bicarbonate level is 24-30 meq/L. It is responsible for the maintenance of blood pH. It is component of carbonic acid bicarbonate buffer system. Plasma bicarbonate level undergo changes in acid base and electrolyte disturbances.
- Chloride : It is the major anion in plasma. The normal range is 100-110 meq/L. It is
- required for maintenance of water distribution between plasma and cells. Chloride level decreases in vomiting and diarrhea.
- Phosphate : Normal phosphate level in plasma ranges from 2-4 mg/dl. It is
- involved in maintenance of plasma pH. It is component of phosphate buffer system. Cations in plasma are sodium, potassium, calcium, magnesium, iron and copper.
- Sodium : It is the major cation in plasma. Its normal range is 133-146 meq/L. Its level decreases in vomiting and diarrhea.
- Potassium : Its level ranges from 3.8-5.4 meq/L. Its level also decreases in Vomiting and diarrhea.
- Calcium : Normal plasma range is 9-11 mg/dl. Its level decreases in rickets.

Maintenance of electrolyte balance

- 1.For normal function of body electrolytes concentrations of body fluids must be controlled. Many mechanisms operate to control body electrolyte balance. One such mechanism is sodium pump. It maintains low intracellular level of Na^+ and high extracellular level. Hormone aldosterone maintains electrolyte balance by acting on kidney. It increases Na^+ absorption and K^+ excretion by kidney.
- 2.Diet, water and salt intake influences the concentration of electrolytes in body fluids.
- 3.Kidney maintains plasma bicarbonate concentration. Further, kidney maintain
- electrolyte balance by excreting salts or by retaining salts depending on diet and environmental condition.

Electrolyte disturbances

- Loss of body fluids due to vomiting, diarrhea, hemorrhage, burns and sunstroke results in electrolyte disturbances.

Acid base balance or Hydrogen(H+) Homeostasis

- The word acid base balance refers to maintenance of stable level of pH of body fluids. During metabolic processes both acids or bases are formed. Under normal conditions they are neutralized by specific systems involved in maintenance of pH level. Under pathological conditions excessive amounts of acids or bases may accumulate in body fluids and tissues leading to disturbances in acid base balance. In a normal healthy person the blood pH ranges from 7.35-7.45. Throughout ones life this blood pH remains constant.

Medical and biological Importance

- 1.Proper pH is required for the optimal action of enzymes and for the transport of molecules within the body and between cells and its surroundings.
- 2.Proper pH is required for the maintenance of structure of nucleic acids, proteins, coenzymes and various metabolites.
- 3.Acidosis and alkalosis are two important disorders of acid base balance.

Hydrogen (H+) Homeostasis

- Three different systems are involved in the maintenance of stable blood pH level. They are:
- I.Buffer systems of blood plasma, tissue fluids and cells like
- erythrocytes.
- II.Lungs.
- III. Kidneys.,By the combined action of these systems constant H^+ concentration is maintained in the body.

Buffer systems

- They are responsible for the maintenance of pH of plasma,ICF, ECF and tissues of the body. For the good understanding of role of buffer in the regulation of body pH, some physical chemistry of buffer is required.

Buffers of blood plasma

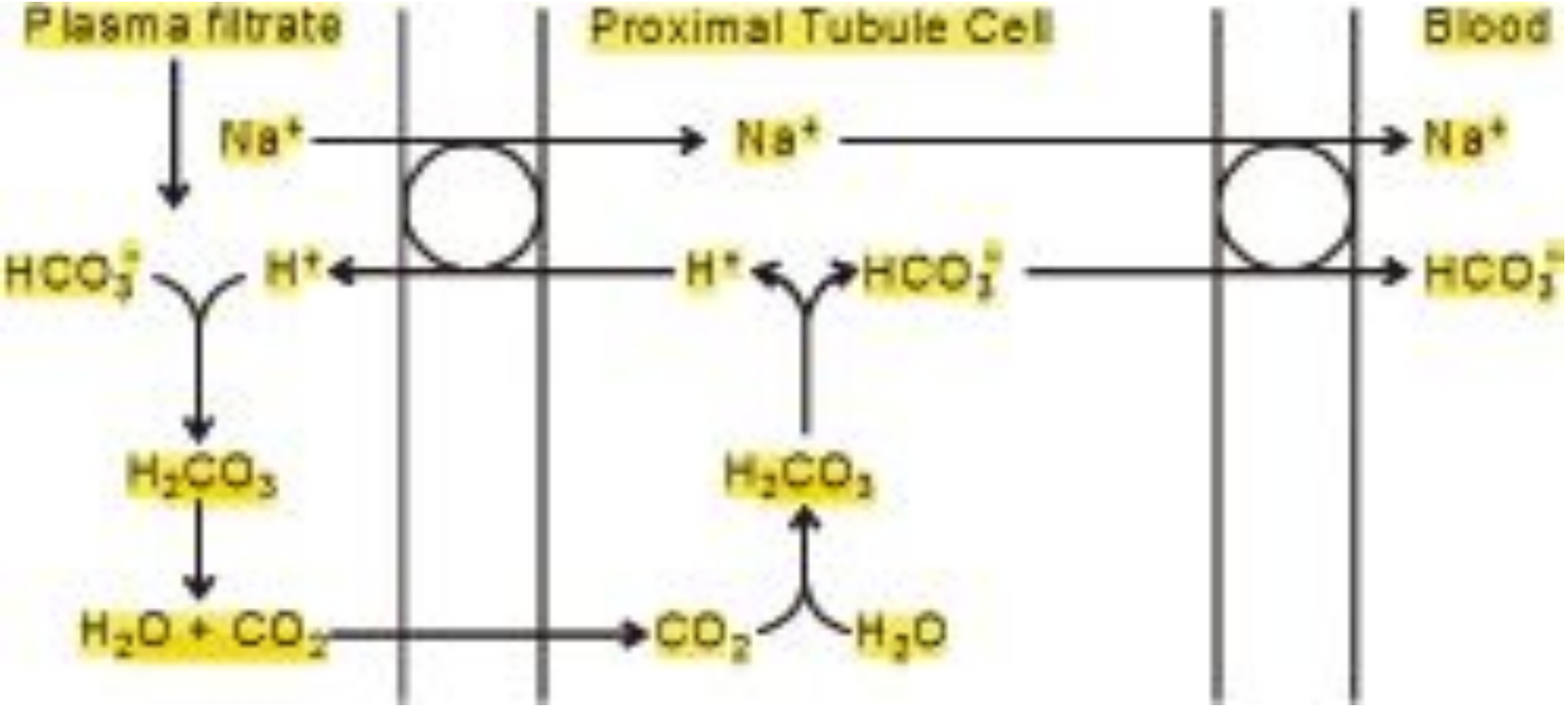
- Bicarbonate and Carbonic acid (HCO_3^-/H_2CO_3) buffer. It is present in greater concentration and plays major role in regulating pH of blood with in normal limits.
- The pH of blood remain 7.4 as long as this ratio is maintained. Increase or decrease in PH due to entry of acids or bases into blood is met by adjustment in this ratio. Any alteration in the ratio for prolonged time leads to disturbances in acid base balance.

Buffers of red blood cells

- Most important buffer in R.B.C. is haemoglobin (Hb–/HHb) buffer system. It is the major buffer system of blood as well as erythrocytes. The pK value of imidazole group (6.0) of histidine (part of haemoglobin) is close to body pH and hence Hb buffer system is effective at body pH. Further high Hb concentration (14 gm/dL) makes it major buffer of blood.

Kidney absorbs bicarbonate from filtrate in the form of .CO2

- In the lumen of the kidney the HCO_3^- combines with H^+ to form H_2CO_3 which is dehydrated to CO_2 and H_2O. The luminal membrane is impermeable to $H\ CO_3^-$ but permeable to CO_2. So, CO_2 diffuses into renal proximal tubule cells where it is rehydrated by carbonic anhydrase to carbonic acid. The bicarbonate ion formed from the dissociation of H_2CO_3 in the tubule cell diffuses into the blood plasma along with Na^+ by symport mechanism. Thus the kidney restores alkali reserve or bicarbonate level of plasma. Both the events are shown in Figure below



Reabsorption of sodium and bicarbonate in proximal tubule

Disturbances in Acid base balance

- They are grouped into acidosis and alkalosis.
- Acidosis. It is due to accumulation of acids and blood pH is below 7.4.
- Alkalosis. It is due to accumulation of alkali and blood pH is above7.4.
- Acidosis or alkalosis due to less or more of bicarbonate are called as metabolic acidosis or metabolic alkalosis
- respectively. Like wise acidosis or alkalosis due to more or less of carbonic acid are called as respiratory acidosis and respiratory alkalosis respectively. These disturbances can be acute or chronic and always body attempts to restore normal acid base balance or H CO_3- / H_2CO_3 ratio by changing the removal of CO_2 by lungs or by altering the reabsorption of HCO_3^- and H^+ removal in kidney. If the normal ratio of HCO_3^-, $H_2CO_3$is restored then the acidosis or alkalosis is compensated. If body fails in its attempt then the acidosis or alkalosis is uncompensated.

.Metabolic acidosis

- It is the most common acid base disturbance. In this condition the plasma bicarbonate level is low. Metabolic acidosis may result from
- a)Excess production of acids which occurs in diabetes mellitus, starvation, phenyl ketonuria and maple syrup urine disease. Intense muscular exercise may lead to accumulation of lactic acid then the condition is called lactic acidosis.
- b)Ingestion of mineral acids. Excessive administration of certain drugs.
- c)Loss of HCO_3^-. It occurs in vomiting, diarrhea, loss of pancreatic fluids or upper intestinal contents due to intestinal obstruction.
- d)Decreased H^+ secretion in kidney. It occurs in nephritis.
- e)Increased elimination of H CO_3^- by kidney. It occurs in renal failure.

Metabolic alkalosis

- It is rare. It is due to more bicarbonate in plasma. causes for
- metabolic alkalosis
- a)Excessive loss of HCl due to prolonged vomiting. It occurs in pyloric obstruction.
- b)Ingestion of salts of acids like sodium lactate or citrate and sodium bicarbonate.
- c)Excessive production and excretion of ammonia

- Respiratory acidosis. It is due to more plasma PCO_2 level. Causes for respiratory acidosis

a) Depression of respiration (Hypoventilation).

- Hypoventilation occurs due to excessive dosage of morphine, barbiturates and other respiratory depressants.
- (b) Obstruction to air passage. It occurs in pneumonia, emphysema, asthma and tracheal obstruction. Mainly renal mechanism compensate this condition by
- absorbing more HCO_3^- and eliminating more H^+ and ammonia in urine.
- Respiratory alkalosis. Plasma PCO_2 level is low in this acid base imbalance. Respiratory alkalosis may result from.
- Hyperventilation. Stimulation of respiratory center in the brain leads to hyperventilation.

It occurs in fever, head injury, anxiety, hysteria, salicylate poisoning, hot climate and high altitude.

- Kidney compensates this imbalance by elimination of more HCO_3^- and decreasing H^+ secretion
- Laboratory diagnosis of acid base disturbances. Determination of the type of acidosis or alkalosis can be made by measuring plasma pH, PCO_2 and HCO_3^-. Various blood parameters in acid base disturbances are given bleow :

Blood Parameters in acid-base disturbances

Condition	Plasma pH	Plasma H CO^-_3 Meq/L	Plasma PCo_2 mm Hg
Normal	7.4	25	40
Metabolic acidosis	7.25	18	40
Metabolic alkalosis	7.50	35	40
Respiratory acidosis	7.15	24.50	75
Respiratory alkalosis	7.50	25.50	20


Thank
YOU!
VectorStock®
VectorStock.com/9919075