pH, pK, pH scale, acid, base, strong acid, weak acid.
Buffer: definition, body fluid buffers and basic mechanism of buffer action. HHE

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Acid, Base

Acid: are the substances which donate proton in aqueous solution, e.g. HCl, H_2SO_4, H_2CO_3

H (proton) + HCO_3(conjugate base) = H_2CO_3

Conjugate base: is the remaining anionic part of an acid after removal of proton.

Acid, Base

Strong acid: are the acids which are rapidly and completely ionized into hydrogen ion and its anionic conjugate base in solution. e.g. HCl

Weak acid: are the acids which are slowly and partially ionized into hydrogen ion and its anionic conjugate base in solution. e.g. H_2CO_3

Acid, Base

Base: are the substances which accept proton in aqueous solution.

Strong base: have greater tendency to accept proton.

Weak base: ----------

Acid, Base

Alkali: these are the metallic hydroxides which ionize to hydroxyl ions in solution.

Strong alkali: which rapidly & completely ionizes to hydroxyl ion. E.g. NaOH, KOH

Weak alkali: ----------

All alkalis are base, but all bases are not alkali.

Dissociation constant

pK: is the negative logarithm of dissociation constant.

For strong acid:

- Degree of dissociation is high, so pK is-----
- Affinity less, so conjugate base is …..

Conjugate base of strong acid is weak and conjugate base of weak acid is strong.

On the other hand, conjugate acid of a strong base is weak and that of a weak base is strong.

pH & pOH

pH: is the negative logarithm of hydrogen ion concentration which is expressed in mol/L.

Plasma pH is 7.35-7.45

pOH: is the negative of hydroxyl ion concentration when concentration is expressed in mol/L.

pH + pOH = 7+7 = 14

pH & pOH

Importance of pH:

- Maintenance of appropriate pH is necessary for homeostasis.
- Disturbances of acid base balance is diagnosed by measuring pH
- Proteins with its optimum pH maintains its 3-dimensional conformation for activity.
- Enzymes needed an optimum pH for its activity.

pH scale

It is a mathematical scale showing interrelationship among the different values of [H], [OH], pH, pOH of aqueous solution at 25◦C when the ionic product of water (K_w) is 10^{-14}

pH scale is within the range of 0 to 14 at 25◦C.

For unit change of pH,[H^+] changes 10 times inversely and [OH^-] changes 10 times directly.

Isoelectric pH

It is the pH at which biomolecules exist as zwitter ions possessing same amount of positive and negative charge on their surface with net charge zero.

Importace :

Used as the basis to develop different procedures for separation & quantification of biomolecules

Isoelectric pH

Properties of biomolecules at isoelectric pH:

1. Electrically neutral & remains as zwitter ions
2. No electrophoretic mobility
3. Least soluble in water
4. Rapidly precipitate out of solution

At pH below isoelectric pH biomolecules exists as cation & at pH above isoelectric pH biomolecules exists as anion.

Buffer

Buffer: is the **mixture of weak acid and its conjugate base** that tends to **prevent the marked changes of pH** of a solution when moderate amount of acid or bases is added to it.

Common buffer system

Buffer system	Buffer base	Buffer acid
Bicarbonate buffer	HCO_3^- or $NaHCO_3^-$	H_2CO_3
Phosphate buffer	HPO_4^- or $Na_2HPO_4^-$	H_2PO_4 or NaH_2PO_4
Protein buffer	Pr^-	HPr
Haemoglobin buffer	HbO_2^- or Hb^-	$HHBO_2$ or HHb
Ammonia buffer	NH_3	NH_4^+

Classification of buffer system according to site:

1. **Blood buffer:**

- Plasma buffer: bicarbonate buffer, phosphate buffer, protein buffer
- Corpuscular buffer: bicarbonate buffer, phosphate buffer, Hb buffer

2. **Intracellular buffer:** bicarbonate buffer, phosphate buffer (mostly), protein buffer (mostly)
3. **Interstitial fluid buffer:** bicarbonate buffer, phosphate buffer, protein buffer
4. **Urinary buffer:** bicarbonate buffer, phosphate buffer, ammonia buffer.

Mechanism of buffer action :

Buffer acts by converting strong acid by weak acid and strong base by weak base.

$HCl + NaHCO_3 \dashrightarrow NaCl + H_2CO_3$

$NaOH + H_2CO_3 \dashrightarrow NaHCO_3 + H_2O$

Buffer acts by donating proton into the solution by buffer acid when there is proton deficit.

$HB \dashrightarrow H^+ + B^-$

Buffer acts by removing proton from the solution by buffer base when there is proton excess.

$B^- + H^+ \dashrightarrow HB$

Buffer

An ideal or efficient buffer is one which can resist the pH change with equal capacity in either direction on addition of acid or alkali. A buffer can show this quality when acid content of that buffer is equal to its conjugate base content or pH = pK.

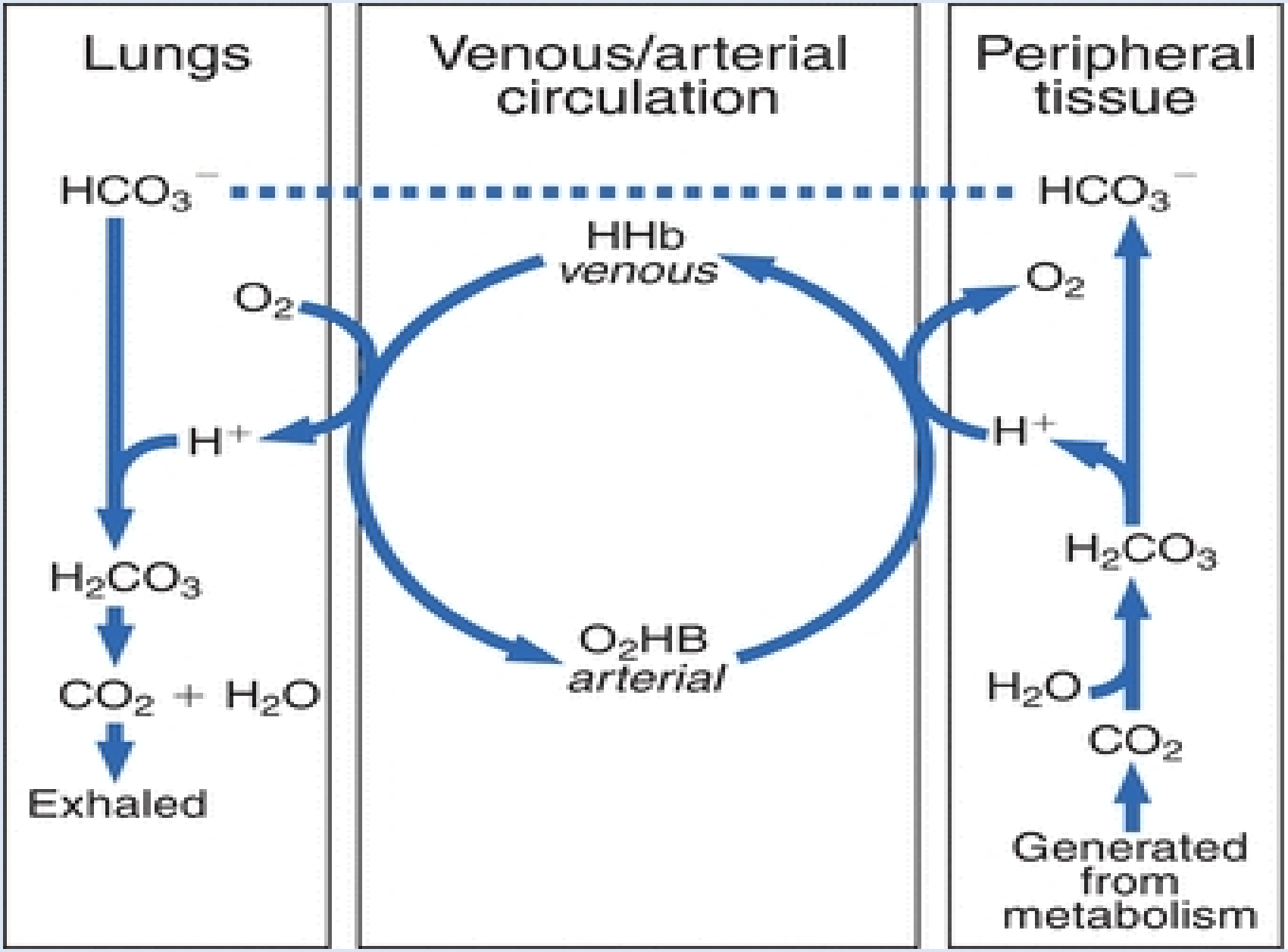
pK value of buffers:

bicarbonate buffer---------6.1
phosphate buffer----------6.8
protein buffer------------6.4-7.8
Hb buffer-----------------6.6-7.8
ammonia buffer---------9.0

Buffer

Bicarbonate buffer is regarded as most effective buffer:

- Wide field (both ECF & ICF) and high (60% of the total) buffering activity.
- Conjugate base is 20 times more than its acid content
- Works in cooperation with Hb buffer system that increases its efficacy.
- It is an open end system.


Lungs
Venous/arterial circulation
Peripheral tissue
HCO_3^-
HCO_3^-
HHb
venous
O_2
O_2
H^+
H^+
H_2CO_3
H_2CO_3
$CO_2 + H_2O$
O_2HB
arterial
H_2O
CO_2
Exhaled
Generated from metabolism

Law of mass action:

This law states that velocity of reversible chemical reaction at a definite temperature is directly proportional to the product of the concentration of that reactants.

Significance of law of mass action:

- To determine hydrogen ion concentration
- To determine pK value
- To predict rate of reaction

Henderson-Hasselbalch Equation:

The pH of a buffer solution can be calculated by using this equation----

$$pH = pK + \log \frac{[salt]}{[acid]}$$

Significance of HHE:

- To calculate pH of buffer solution
- Provide relationship between pH, dissociation constant and concentration of ingredients of buffer.


Thank
you!

Isotope

Isotopes are the atoms of same element having same atomic weight but different atomic mass due to different neutron number.

Types:

1. Stable isotope : usually naturally occurring isotopes which is stable and don't emit radiation.
2. Unstable/ radioactive isotope : are those which tends to become stable by emitting radiation.

Radioactivity: property or ability of radioactive isotope to emit radiation (α, β,ɤ rays) during radioactive decay.

Radioactive decay: spontaneous decomposition of radioactive isotope to stable isotope with simultaneous emission of radiation.

Radioactive half life: it is the time by which strength of a radiation is reduced to original length.

Importance:

- Measurement of red cell volume, plasma volume
- Determination of total body water & ECF
- Measurement of GFR & renal clearence
- Thyroid function test by radioactive ^{131}I uptake
- Radioimmunoassay of hormones
- Tracing of malignant tissue
- Organ scanning, e.g. bone, brain, thyroid scanning
- Helps in study for absorption of iron (^{59}Fe) & vit B_{12} (^{60}Co)
- For diagnosis of pernicious anemia (^{60}Co)
- For treatment of thyroid cancer (^{131}I)
- For treatment of Polycythemia vera & chronic lymphatic leukemia (^{32}P).
- Sterilization of medical instruments.

Radiosensitive tissue:

1. Bone marrow
2. Gonads
3. Lymph nodes
4. Skin
5. Intestine

Hazards of radioactive isotope

1. Immediate hazards---

   a. bone marrow depression & immune suppression

   b. damage to intestinal mucosa causing diarrhoea & malabsorption.

   c. baldness, rough & scaly skin

d. in pregnency: fetal growth retardation, congenital malformation, foetal death

2. Delayed hazards----

   a. carcinogenesis

   b. sterility

   c. cataract

3. Genetic effects: DNA damage, mutation

Isomer:

Isomers are the substances having same molecular formula but different structure or having same molecular formula and identical structure but different spatial configuration around one or more carbon.

Types:

1. Structural
2. Sterio
    a. geometrical
        i. trans
        ii. Cis
    b. optical

Epimer: differs with respect to the spatial configuration around only one asymmetric carbon, e.g. glucose & mannose (C2)

Anomer: in glucose if OH ion lies on right side it is α-anomer, if left β-anomer.

D – L isomer: different spatial configuration around penultimate carbon.

Pyranose- furanosering structure:

Aldose-ketos: