Biochemistry

1st course 3rd stage

Amino acids

Physiological and chemical properties of amino acids

1. **Optical isomerism:**

   All amino acids but Gly have optical activities and rotate the plane of polarized light & exist as levo (L) or dextro (D) isomers.

- Optical activities depend on the pH & side chain.
- Few amino acids like Thr & Ile have an additional asymmetric carbon in their structure.

2. **Ultraviolet absorption:**

   Aromatic amino acids which are (Tyr, Trp, and Phe) can absorb UV light (in the region around 280nm) because they have aromatic rings.

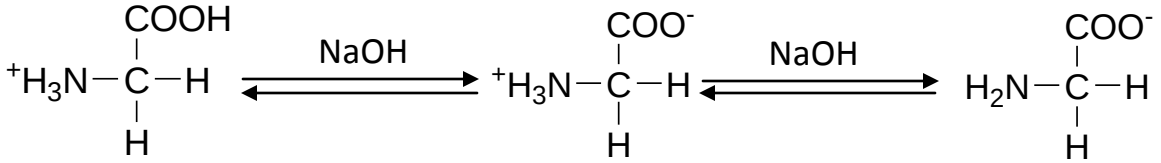
   This absorption is frequently used for the analytical detection of proteins.

3. **Amphoteric nature & isoelectric pH:**

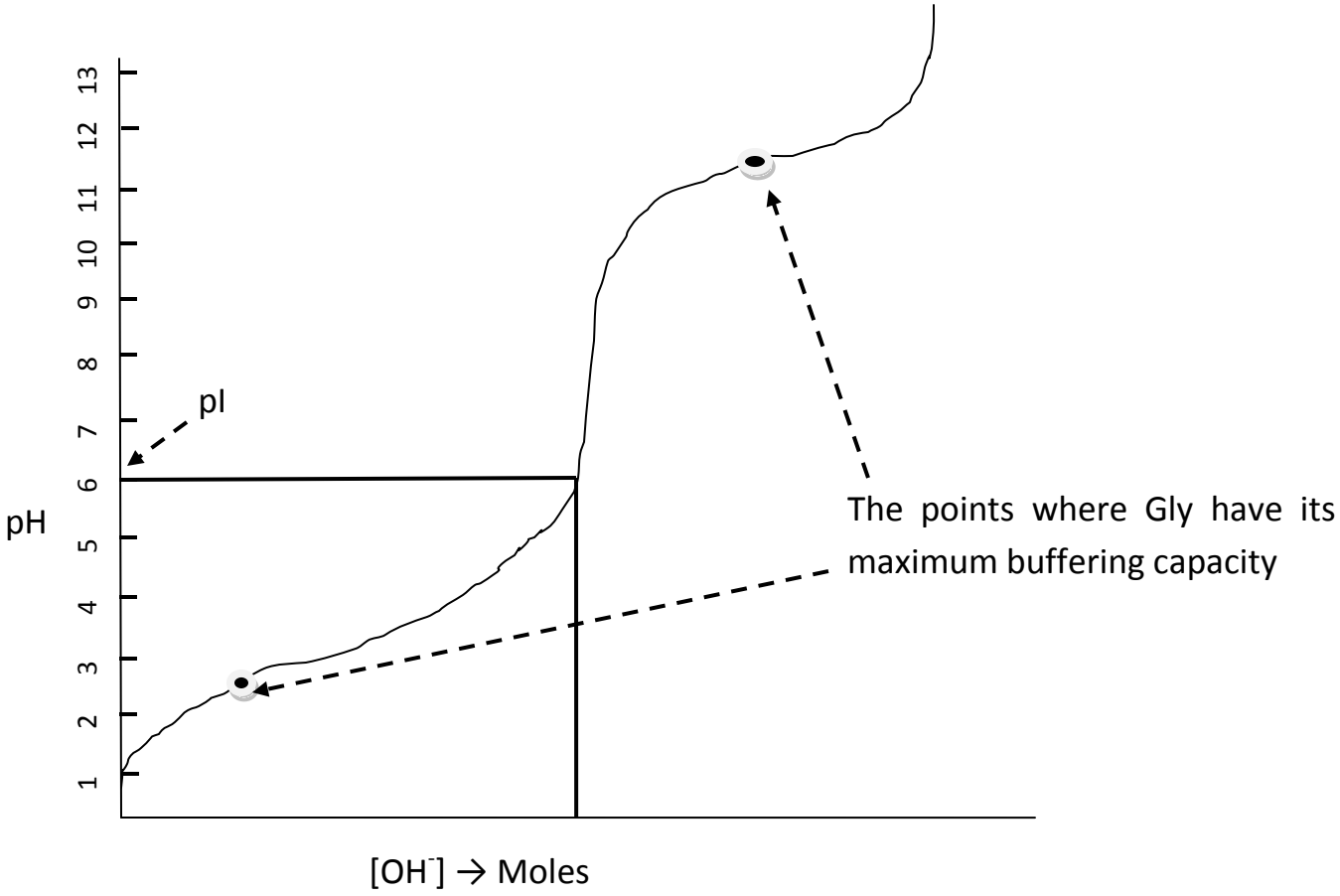
   The – NH_2 group, – COOH group and charged side chains of amino acids are ionized depending on the pH of solution,

these groups act as proton donors (acids) or as proton acceptors (bases); this property called ***ampholytes***.

- At specific pH amino acids can carries both charges in equal number; this pH is called ***isoelectric pH***.
- The pH at which the net charge on amino acids is zero is called ***isoelectric point.***
- Amino acids can be titrated potentiometerically and give titration curve. For example: -



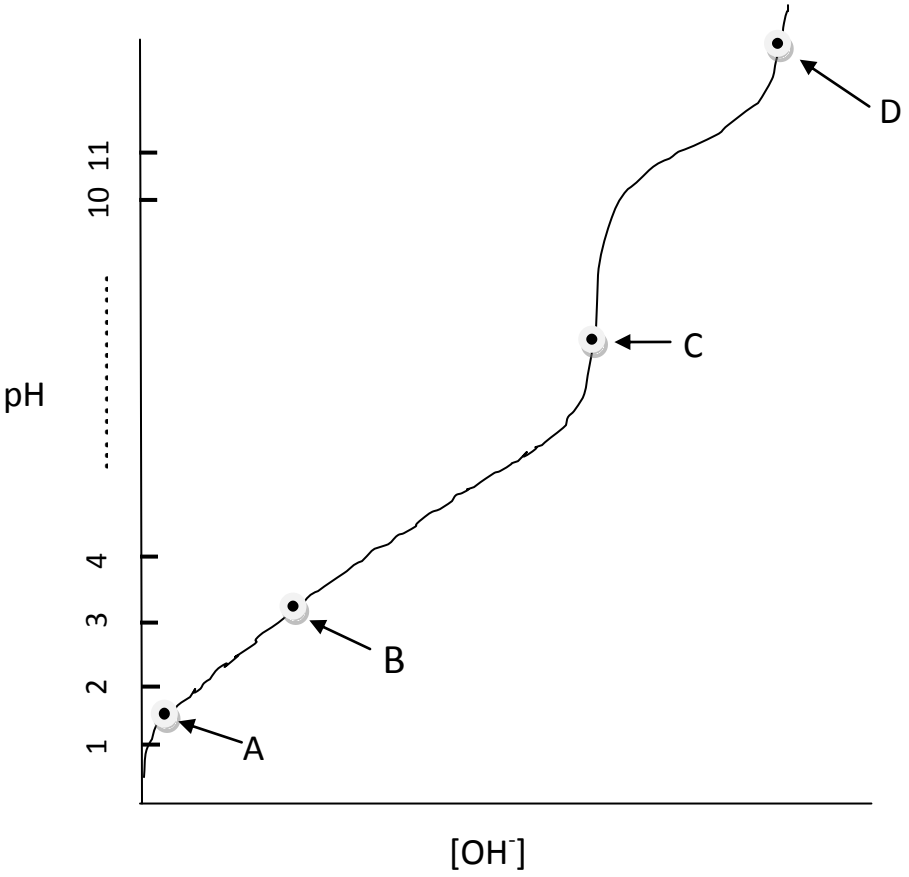
AA^{+1} AA^{o} AA^{-1}



$$\Rightarrow pI = \frac{pK_{a1} + pK_{a2}}{2} = \frac{2.3+9.6}{2} = 6$$

- Neutral amino acids are treated as diprotic acids Gly, Ala, Thr.
- Acidic amino acids (Asp, Glu) and basic amino acids (Lys, His, Arg) are treated as triprotic acids.

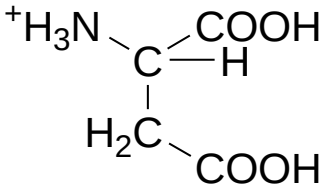
Titration curve of Asp: -



$$A \underset{PKa_1}{\rightleftharpoons} B \underset{PKa_2}{\rightleftharpoons} C \underset{PKa_3}{\rightleftharpoons} D$$

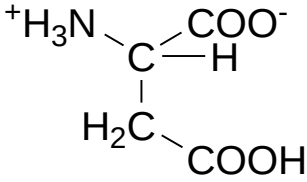
AA^{+} AA^{o} AA^{-} AA^{2-}

Structure of point A:



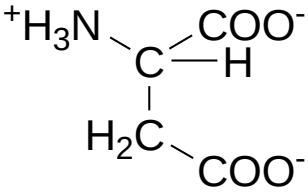
AA^{+}

Structure of point B:



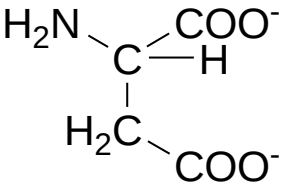
AA^{o}

Structure of point C:



AA^{-}

Structure of point D:



AA^{2-}

$$pI = \frac{pK_{a1} + pK_{a2}}{2} = \frac{2.1 + 3.8}{2} = 2.9$$

PKa $_{\alpha}$: -

COOH PKa_{α} ⟶ 2
NH_2 PKa_{α} ⟶ 9

PKa $_{R}$: -

-OH of Tyr ⟶ 10
-SH of Cys ⟶ 8
-Lys ⟶ 10.5
-His ⟶ 6
-Arg ⟶ 12.5
-Asp ⟶ 4
-Glu ⟶ 4

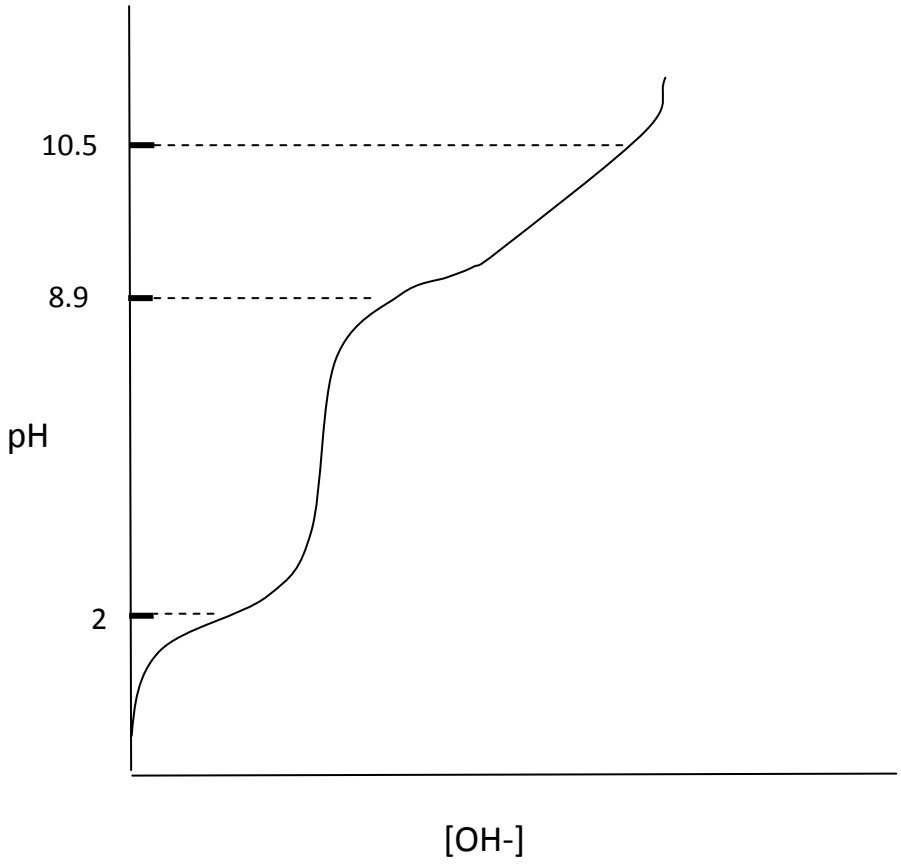
Note: the acidic strength of weak acids is expressed by their acid dissociation constant.

Note: Ka or pKa

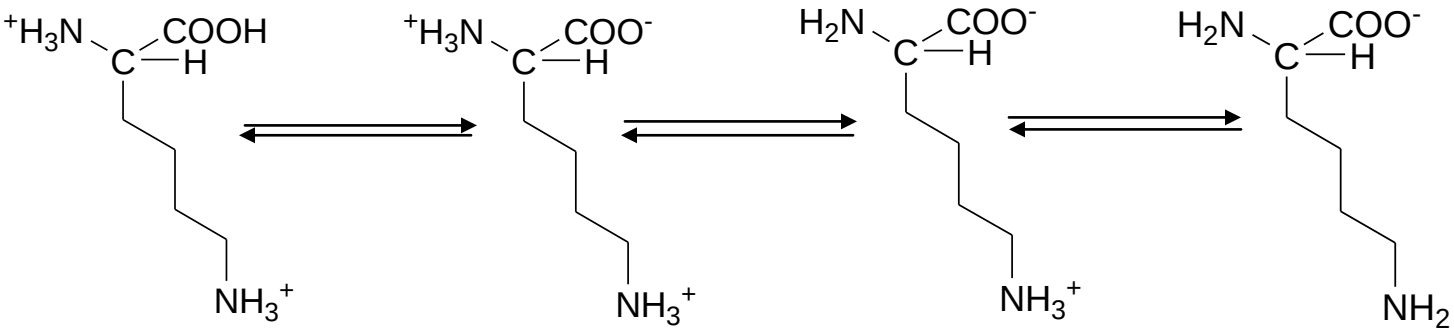
$$pKa = negative \log of\ Ka$$

$$pKa = -\log Ka$$

Titration curve of Lys: -



$$pI = \frac{pK_{a2} + pK_{a3}}{2} = 9.7$$



AA^{2+} AA^{+} AA^{o} AA^{-}

The calculation of pI from pK values on either side of the isoelectric amino acid structure: -

The calculation of pI is of value in the clinical laboratory to estimate the mobility of compounds in electrical fields and to select appropriate buffer for separation and also to separate amino acids on charge resin like ***DEAE cellulose*** or ***CM cellulose*** or ***Dowex resin***.

Q_1: two amino acids with pI values of 6 & 8, can we separate these two amino acids at a buffer with pH 7.0?

Q_2: Write the equilibrium equation for His; draw the structure of His in each ionization state. What is the pI of His?