Acid-Base Properties of Amino Acids

Amino acids can undergo an intramolecular acid–base reaction (proton transfer)

Transfer of the H from the –COOH group to the –NH₂ group forms a dipolar ion, an ion that has one (+) charge and one (-) charge. Neutral dipolar ions are known as zwitterions. (‘Zwitter’ meaning hybrid).

- Because they are zwitterions, amino acids have many of the physical properties we associate with salts:
  - can form crystals
  - have high melting points
  - are soluble in water
  - not soluble in hydrocarbon solvents

- In acidic solution (low pH), amino acid zwitterions accept protons on their basic –COO⁻ groups to leave only the positively charged –NH₃⁺ groups.

- In basic solution (high pH), amino acid zwitterions lose protons from their acidic –NH₃⁺ groups to leave only the negatively charged –COO⁻ groups.
The net charge of an amino acid molecule at any given moment depends on the particular amino acid and the pH of the medium.

The pH at which the net positive and negative charges are equal is the amino acid’s isoelectric point (pI). At this point, the overall charge of all the amino acids in a sample is zero.

**Chirality in Amino Acids**

- **Chiral**: Having right- or left-handedness with two different non-superimposable mirror image forms.
- One hand does not match the other when superimposed.
• **Achiral:** The opposite of chiral; having superimposable mirror images and thus no right- or left-handedness.
• It is easy to visualize the chair on top of its mirror image.

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**Molecular Handedness and Amino Acids**

• **Chiral carbon atom** (*chirality center*) A carbon atom bonded to four different groups.
• If a molecule has an atom bonded to four different groups, it can be chiral.
• The mirror-image forms of a chiral molecule like alanine are called enantiomers or optical isomers.

• Propane is an achiral molecule. The molecule and its mirror image are identical and it has no left- and right-handed isomers.

Enantiomers are one kind of stereoisomer, compounds that have the same formula and atomic connections but different spatial arrangements.

• Pairs of enantiomers have the same physical properties except they always differ in their effect on polarized light and how they react with other chiral molecules.

• Pairs of enantiomers often differ in their biological activity, odors, tastes, or activity as drugs.

• 19 out of 20 natural amino acids are chiral – they have four different groups on the α-carbon. Only glycine is achiral.

• Nature uses only one isomer out of a pair of enantiomers for each amino acid to build proteins. The naturally occurring amino acids are classified as left-handed or L-amino acids.
Tastes sweet!!

The amino acids are in L Form. If you switch them With the D isomer, then It will not taste sweet.

Shape Determining Interactions in Proteins (Tertiary 3D Structure)

**Covalent Bonds**: The disulfide bonds of Cys is the most common Covalent bond. Found in structure of Insulin.

**Hydrogen bonds**: Hydrogen bonding between backbone C=O And –N – H groups. H bonds also form between side chains and Between side chain – backbone.

**Salt Bridges**: Electrostatic attractions between two A.A residues That have ionic side-chains. A Lysine side chain with an aspartic acid side chain.

**Hydrophobic Interactions**: In aq. Solutions, proteins keep the polar groups for water solubility and the non-polar groups inward. The interaction within the non-polar groups interact and keeps water away. Weaker than the other interactions.

**Metal-Ion Coordination**: Metal ions, which are positive cations, can bridge between negatively charged side chains. Hence the importance of trace minerals in our bodies.
Movement of charged molecules in electrophoresis. Movement varies with charge (depending on acid/base side chains) size and shape, strength of the electric field, and the nature of the medium (pH) in which the protein is moving.

Hemoglobin in samples placed at the original position have moved left to right. The normal individual has only HbA. The individual with sickle-cell anemia has no HbA. The individual with sickle-cell trait has roughly equal amounts of HbA and HbS. HbA and HbS have negative charges of different magnitudes because HbS has two fewer Glu residues than HbA.
A Blood test to determine the levels of the immune proteins (globulins, or antibodies), and albumin.

Proteins have been separated by size and stained blue for viewing. Diseases can cause changes in the protein patterns seen.

Gel electrophoresis apparatus (DNA analysis)
An agarose gel is placed in this buffer-filled box and electrical current is applied via the power supply to the rear. The negative terminal is at the far end (black wire), so DNA migrates toward the camera.