

5.4.3
The structure of glucose has been derived from a consideration of facts and conclusions such as the following:

1. Elemental analysis and molecular weight determination show that the molecular formula of glucose is $C_6H_{12}O_6$.
2. Complete reduction of glucose with concentrated hydriodic acid in the presence of red phosphorous produces n-hexane (C_6H_{14}) as the major product. This indicates that the six carbon atoms in the glucose molecule form a consecutive, unbranched chain.
3. Glucose readily dissolves in water to give a neutral solution. This indicates that the glucose molecule does not contain a carboxyl ($\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{O}- \end{array}$) group.
4. Glucose reacts with hydroxylamine to form a monoxime, or adds only one mole of hydrogen cyanide to give a cyanohydrin. These reactions indicate the presence of either an aldehyde ($\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{H} \end{array}$) or a ketone ($\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}- \end{array}$) group.
5. Mild oxidation of glucose with bromine water gives gluconic acid, a monocarboxylic acid with molecular formula $C_6H_{12}O_7$. This indicates the presence of an aldehyde group since only the aldehyde group can be oxidized to an acid by gaining one oxygen atom without losing any hydrogen atom.
6. Further oxidation of gluconic acid with nitric acid gives glucaric acid, a dicarboxylic acid with molecular formula $C_6H_{10}O_8$. This indicates the presence of a primary alcohol group, since oxidation occurs with the loss of two hydrogens and gain of one oxygen atom.
7. Glucose reduces an ammoniacal solution of silver oxide (Tollen's reagent) to metallic silver, or a basic solution of cupric ion (Fehling's solution) to red cuprous oxide. These reactions further confirm the presence of aldehyde group.
8. Glucose reacts with acetic anhydride in the presence of pyridine to form an pentaacetate. This reaction indicates the presence of five hydroxyl groups in a glucose molecule.

With the help of above reactions, it can be concluded that glucose is a pentahydroxy hexanal, which can be represented as,



2,3,4,5,6- Pentahydroxy hexanal
(Glucose)