Biochemical Calculations Molecular Weight from Composition

(Topic - Amino Acids, Peptides and Proteins)

Molecular Weight from Composition (pg - 111)

Molecular weight calculations from amino acid or prosthetic group analysis is based on the simple fact that there must be at least one mole of any residue present per mole of protein. There may be more than one mole of any given residue present. Thus, this method yields a ***minimum molecular weight***.

· Problem 2-11

Hemoglobin contains 0.335% iron by weight. Calculate the minimum molecular weight of hemoglobin.

Solution

At least one atom of Fe must be present per molecule of hemoglobin. A gram-atom of Fe weighs 55.85 g. Therefore, the *minimum* molecular weight of hemoglobin is the weight that contains 55.85 g of Fe. Another way to look at it is that 55.85 g represents 0.335% of the minimum molecular weight.

$$\frac{100 \text{ g protein}}{0.335 \text{ g Fe}} = \frac{MW_{min}}{55.85 \text{ g Fe}}$$

$$MW_{min} = \frac{(100)(55.85)}{(0.335)}$$

$$\boxed{MW_{min} = 16{,}672}$$

or

$$0.335\% \times MW_{min} = 55.85$$

$$3.35 \times 10^{-3}\, MW_{min} = 55.85$$

$$MW_{min} = \frac{55.85}{3.35 \times 10^{-3}}$$

$$\boxed{MW_{min} = 16{,}672}$$

In general:

$$\boxed{MW_{min} = \frac{MW_{constituent} \times 100}{\% \text{ of constituent}}} \qquad (13)$$

Physical measurements suggest a molecular weight of about 65,000. Thus, hemoglobin is a tetramer, containing one Fe per monomer.

· Problem 2-12

Amino acid analysis of 1.0 mg of a pure enzyme yielded 58.1 μg of leucine (MW = 131.2) and 36.2 μg of tryptophan (MW = 204.2). What is the minimum MW of the enzyme?

Solution

The minimum MW based on leucine content is calculated as follows:

$$\frac{10^{-3}\text{ g enzyme}}{58.1 \times 10^{-6}\text{ g leucine}} = \frac{\text{MW}}{131.2}$$

$$\text{MW}_{min} = 2258$$

The minimum MW based on tryptophan content is calculated as follows:

$$\frac{10^{-3}\text{ g enzyme}}{36.2 \times 10^{-6}\text{ g trp}} = \frac{\text{MW}}{204.2}$$

$$\text{MW}_{min} = 5641$$

Each calculation assumes that only one residue of each amino acid is present in a molecule of the enzyme. The molar ratio of leucine/tryptophan is:

$$\frac{58.1/131.2}{36.2/204.2} = \frac{0.443}{0.177} = \frac{2.5}{1}$$

There must be a whole number of residues of each amino acid present in a molecule of protein. Therefore, the actual ratio must be 5:2. The actual minimum MW then is the weight that contains 5 g-residues of leucine and 2 g-residues of tryptophan.

$$5 \times 2258 = \boxed{\textbf{11,290}}$$

or

$$2 \times 5641 = \boxed{\textbf{11,282}}$$

Of course, if a molecule of enzyme contained (for example) 25 leucine residues and 10 tryptophan residues, the true MW would be about 56,450.