Deacon's Challenge No. 62 Answer

As Duty Biochemist you encounter a sample with an apparent plasma sodium concentration of 152 mmol/L. You discover that the blood was taken in error into an 'anticoagulation' Vacutainer tube containing 0.5 mL trisodium citrate solution (citrate concentration 0.105 mol/L). The total volume of anticoagulated blood in the tube is 4.5 mL. Assuming that the result is analytically correct, what is the true plasma sodium concentration?

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When any solution is diluted the total amount of a substance in the solution (derived from the solution) is the same both before and after dilution.

Since the total amount of a substance in a solution is the product of concentration and volume, we can write:

Final concentration x Final volume = Initial concentration x Initial volume

Which can be rearranged to calculate any component. It is essential, however, that the same concentration and volume units are used throughout.

In this problem the sodium present in blood is diluted with anticoagulant and the sodium present in anticoagulant is diluted with blood. Therefore, a proportion of the sodium in the anticoagulated blood is derived from each component of the mixture.

By rearranging the above equation it is possible to calculate the Na concentration in anticoagulated blood which was derived from the anticoagulant alone:

$$\text{Na from anticoagulant} = \frac{\text{Na concentration in anticoagulant x Anticoagulant volume}}{\text{Volume of anticoagulated blood}}$$

The anticoagulant contained 0.105 mol/L of trisodium citrate. Therefore this concentration must be multiplied by 3 (to allow for each molecule containing 3 sodiums) and by 1000 (to convert from mol/L to mmol/L), giving 0.105 x 3 x 1000 = 315 mmol/L. Therefore, 0.5mL of anticoagulant (containing 315 mmol/L of

Na) is diluted to 4.5 mL with blood, so that the Na concentration in the anticoagulated blood which is derived from anticoagulant is:

$$\frac{315 \times 0.5}{4.5} = 35 \text{ mmol/L}$$

The total Na concentration in anticoagulated blood is the sum of the Na concentrations derived from both blood and anticoagulant:

Total Na = Na from blood + Na from anticoagulant

So the concentration of Na derived from blood is simply the difference between the Na in anticoagulated blood (152 mmol/L) and the component derived from anticoagulant (35 mmol/L):

Na in anticoagulated blood derived from blood = 152 - 35 = 117 mmol/L

Since this is the concentration obtained when 4.0 mL of blood is diluted to 4.5 mL with anticoagulant, then the Na concentration in undiluted blood is:

$$\frac{117 \times 4.5}{4.0} = \textbf{132 mmol/L} \quad (3 \text{ sig figs})$$

Question 63

A plasma sample containing 70 g/L protein gives a result of 140 mmol/L for sodium when measured both by flame photometry and a direct-reading ion-selective electrode. By how much would you expect the two results to differ if the sample had had a protein content of only 50 g/L? Indicate any assumptions you made when arriving at your answer.

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