Deacon's Challenge No. 84 Answer

You receive a cerebrospinal fluid (CSF) sample that is blood stained, with a CSF red cell count of 12,100 cells per cubic millimetre. Following immediate centrifugation a clear colourless supernatant is obtained, on which the CSF protein concentration is 1.67 g/L. On a blood sample taken on the same day, the serum total protein concentration was 71 g/L and the blood red cell count (RBC) was 4.2 x 10^{12} cells/L. How much of the CSF measured protein was due to contamination from blood during the lumbar puncture?

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When blood leaks into CSF, the ratio of red cells to protein added to the CSF remains constant. This is regardless of whether the blood in the CSF arises by trauma during collection or from a subarachnoid haemorrhage. i.e.

$$\frac{\text{Red cell count in CSF}}{\text{Red cell count in blood}} = \frac{\text{Protein concentration in CSF arising from blood}}{\text{Protein concentration in blood}}$$

It is important that the units used should be the same for blood and CSF. The units for the red cell counts are different (cell per cubic millimeter of CSF, cells per litre of blood). To convert the red cell count units in CSF to those used for blood first determine the number of cubic millimetres present in one litre:

$1L = 1000\ cm^3 = (10\ cm)^3 = (100\ mm)^3 = 1{,}000{,}000\ mm^3 = 1.0 \times 10^6\ mm^3$

Therefore: CSF red cell count $= 12{,}100\ cells/mm^3 = 1.21 \times 10^4\ cells/mm^3$

$= 1.21 \times 10^4 \times 1.0 \times 10^6 = 1.21 \times 10^{10}\ cells/L$

(Note that when multiplying numbers which are in exponential form, the exponents are added, not multiplied)

Substituting these values into the equation relating CSF and blood ratios:

$$\frac{1.21 \times 10^{10}}{4.2 \times 10^{12}} = \frac{\text{CSF protein derived from blood}}{71}$$

$$\text{CSF protein derived from blood} = \frac{71 \times 1.21 \times 10^{10}}{4.2 \times 10^{12}}$$

$$= \frac{71 \times 1.21}{4.2 \times 10^2}$$

$$= \frac{85.91}{420}$$

$$= \mathbf{0.20\ g/L}\ (2\ \text{sig figs})$$

Expressed as a percentage of the CSF protein

$$= \frac{0.20 \times 100}{1.67} = 12\%$$

Question 85

A 35-year old woman was found to have a fasting plasma glucose concentration of 6.2 mmol/L. One week later, the baseline sample of an Oral Glucose Tolerance Test gave a glucose of 5.5 mmol/L. The Hoorn study in a largely elderly Caucasian population has shown that the biological coefficient of variation (CV) for fasting plasma glucose is 6.3% and your assay runs a standard deviation (SD) of 0.04 on its low control at 2.4 mmol/L. Is it likely that the patient was not fully fasting for the first sample? Justify your answer and state any assumptions you make.

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