Deacon's Challenge No. 4 Answer

A solution containing a substance of molecular weight 400 at a concentration of 3g/L transmitted 75% of incident light of a particular wavelength in a 1 cm cuvette. Calculate the % of incident light of the same wavelength that would be transmitted by a solution of the same substance at a concentration of 4 g/L and calculate the molar absorption coefficient for that substance at this wavelength. (MRCPath)

There are several ways to approach this problem. The simplest is to do the second part first and calculate the molar absorption coefficient.

$$\text{Absorbance} = \log_{10}\frac{I_o}{I} = \varepsilon \times l \times c \quad \ldots\ldots\ldots\ldots\ldots \text{(i)}$$

where
I_o = intensity of incident light = 100%
I = intensity of transmitted light = 75%
ε = molar absorption coefficient = ?
l = path length of cuvette = 1cm
c = molar concentration = $\frac{\text{conc (g/L)}}{\text{MW}} = \frac{3}{400} = 0.0075$ mol/L

Substitute these values into equation (i) and solve for ε:

$$\log_{10}\frac{100}{75} = \varepsilon \times 1 \times 0.0075$$

$$\log_{10} 1.333 = 0.0075\,\varepsilon$$

$$\varepsilon = \frac{\log_{10} 1.333}{0.0075} = \frac{0.1249}{0.0075} = 16.7 \text{ litres cm}^{-1} \text{ mol}^{-1}$$

For the first part of the question substitute the new concentration (4 g/L) expressed in molar terms, and the molar absorption coefficient into equation (i) and solve for I:

$$c = \frac{\text{conc (g/L)}}{\text{MW}} = \frac{4}{400} = 0.01 \text{ mol/L}$$

$$\log_{10}\frac{100}{I} = 16.7 \times 1 \times 0.01$$

$$\log_{10}\frac{100}{I} = 0.167$$

$$\frac{100}{I} = \text{antilog } 0.167$$

$$I = \frac{100}{\text{antilog } 0.167} = \frac{100}{1.469} = 68\%$$

Question No. 5

In a cancer clinic where the prevalence of ovarian malignancy is 40%, a tumour marker has a specificity of 88% and a sensitivity of 92%. Calculate the predictive value of a positive test result.

If this test was used as a screening tool in all patients attending a general gynaecological clinic with a cancer prevalence of 0.4%, what would be the predictive value of a positive test in this population?

(MRCPath, November 2000)