Deacon's Challenge No. 51 Answer

Two pure solutions of the same substance gave transmissions of 25.1% and 63.1% in the same spectrophotometer under identical conditions.

What is the ratio of their absorbances?

MRCPath, May 1997

There are several approaches that can be used. It is useful to derive (then remember) an expression which directly relates percentage transmittance to absorbance:

Let I_0 = intensity of incident light

I = intensity of transmitted light

By definition:

$$\%\text{ Transmittance } (\%T) = \frac{I}{I_0} \times 100 \quad \text{and absorbance } (A) = \log_{10} \frac{I_0}{I}$$

Rearranging the expression for % transmittance gives:

$$\frac{I_0}{I} = \frac{100}{\%T}$$ which can then be substituted into the expression for absorbance

$$A = \log_{10} \frac{100}{\%T}$$

$$A = \log_{10} 100 + \log_{10} \frac{1}{\%T}$$

Since $\log_{10} 100 = 2$ and $\log_{10} \frac{1}{\%T} = -\log_{10} \%T$

$$\boxed{A = 2 - \log_{10} \%T}$$

Values for $\%T$ can then be substituted directly into this expression to calculate the corresponding absorbance:

$A_1 = 2 - \log_{10} 25.1 = 2 - 1.400 = 0.600$

$A_2 = 2 - \log_{10} 63.1 = 2 - 1.800 = 0.200$

Their ratios are then calculated:

$$\frac{A_1}{A_2} = \frac{0.600}{0.200} = 3.0$$

Question 52

If the pH of urine is 4.5 and of blood 7.40, what is the gradient of hydrogen ion concentrations across the tubular cell walls?