Deacon's Challenge No. 52 Answer

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?

$$pH = -\log_{10} [H^+]$$

Swapping these terms to opposite sides of the equation gives:

$$\log_{10} [H^+] = -pH$$

Taking antilogs gives an expression for determining hydrogen ion concentration (in mol/L) from pH:

$$\boxed{[H^+] = antilog_{10} (-pH)}$$

For urine substitute pH = 4.5:

$$[H^+] = antilog_{10} (-4.5) = 3.16 \times 10^{-5} \text{ mol/L} = 31600 \text{ nmol/L}$$

(Multiplication by 10^9 converts from mol/L to the more familiar nmol/L

i.e. $3.16 \times 10^{-5} \times 10^9 = 3.16 \times 10^{-5+9} = 3.16 \times 10^4 = 31600$)

For blood substitute pH = 7.40:

$$[H^+] = antilog_{10} (-7.40) = 3.98 \times 10^{-8} \text{ mol/L} = 40 \text{ nmol/L}$$

$$Gradient = \frac{[H^+] \text{ in urine}}{[H^+] \text{ in blood}} = \frac{31600}{40} = \mathbf{790:1}$$

Question 53

A woman had a beta hCG concentration measured at 265 IU/L and 11 days later, following some abdominal pain, it was 820 IU/L. Assuming hCG rises exponentially in early pregnancy, what has been the doubling time over this period? What is the significance of the result you obtain?

MRCPath, May 2005