Deacon's Challenge
No 122 - Answer

You need to make up a phosphate buffer with a pH of 7.4 and a total phosphate concentration of 50 mmol/L. Calculate the amounts of sodium dihydrogen phosphate and disodium monohydrogen phosphate that need to be weighed into 1 litre of water, given that the pKa is 6.82 (atomic weights: Na 23, P 31).

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The dissociation to be considered is:

$$H_2PO_4^- \longrightarrow HPO_4^{2-} + H^+$$

with the corresponding Henderson-Hasselbalch equation:

$$pH = pK_a + \log_{10} \frac{[HPO_4^{2-}]}{[H_2PO_4^-]}$$

Substitute pH = 7.4 and pK_a = 6.82:

$$7.4 = 6.82 + \log_{10} \frac{[HPO_4^{2-}]}{[H_2PO_4^-]}$$

Rearrange:

$$\log_{10} \frac{[HPO_4^{2-}]}{[H_2PO_4^-]} = 7.4 - 6.82 = 0.58$$

$$\frac{[HPO_4^{2-}]}{[H_2PO_4^-]} = \text{antilog}_{10}\, 0.58 = 3.80$$

The required total phosphate concentration is 50 mmol/L (i.e. 0.05 mol/L), therefore:

$$[\text{Total phosphate}] = [HPO_4^{2-}] + [H_2PO_4^-] = 0.05 \text{ mol/L}$$

Substitute $[HPO_4^{2-}]$ = 0.05 - $[H_2PO_4^-]$:

$$\frac{0.05 - [H_2PO_4^-]}{[H_2PO_4^-]} = 3.80$$

Solve for $[H_2PO_4^-]$:

$$0.05 - [H_2PO_4^-] = 3.80\,[H_2PO_4^-]$$
$$0.05 = 3.80\,[H_2PO_4^-] + [H_2PO_4^-] = 4.80\,[H_2PO_4^-]$$
$$[H_2PO_4^-] = \frac{0.05}{4.80} = 0.0104 \text{ mol/L}$$

$[HPO_4^{2-}]$ is obtained by difference:

$$[HPO_4^{2-}] = 0.05 - [H_2PO_4^-] = 0.05 - 0.0104 = 0.0396 \text{ mol/L}$$

The weight of each phosphate salt is calculated from these concentrations and their respective molecular weights:

$$\text{Weight (g/L)} = \text{Concentration (mol/L)} \times \text{MW}$$

First calculate their molecular weights:

$$NaH_2PO_4 = 23 + (2 \times 1) + 31 + (4 \times 16) = 120$$
$$Na_2HPO_4 = (2 \times 23) + 1 + 31 + (4 \times 16) = 142$$

Weight NaH_2PO_4 = 0.0104 × 120 = **1.25g**

Weight Na_2HPO_4 = 0.0396 × 142 = **5.62g**

(Answer given to 3 sig figs).

Question 123

A screening programme for Down's syndrome has a screen positive rate of 4% and a detection rate of 85%. Calculate the probability that a pregnancy judged to be at low risk will result in an affected child, given that the incidence of Down's syndrome at term is 1.84/1000 births in the absence of selective abortion. State any assumptions made.

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Mock FRCPath Practical
Friday 2nd September 2011, Birmingham

If you are coming up to your FRCPath practical, and would like to undertake a mock exam, then SWBH NHS Trust is again providing their popular training day. This course has been offered now for the last eight years and provides a clear and methodological approach. It is given in an intensive day at the bench in the Clinical Biochemistry Department at City Hospital, Birmingham. The course has helped many trainees approach the FRCPath practical with much greater confidence and an understanding on what they need to put on the page to achieve success.

The cost of the training day is £130, which will go towards the 2012 teambuilding ski trip to the Austrian Alps for members of the SWBH Pathology Department.

If you would like further details please contact Dr Jonathan Berg's Secretary, Email: rajvindergarcha@nhs.net as soon as possible as places are limited. ■