Deacon's Challenge No. 76 Answer

The following results are generated on an adult male from a blood sample and a urine collection stated to be of 24 hours duration:

	Serum	Urine
Sodium	144 mmol/L	72 mmol/L
Creatinine	92 µmol/L	2.1 mmol/L
Calcium	2.95 mmol/L	3.1 mmol/L
Phosphate	0.74 mmol/L	12.1 mmol/L
Volume		520 mL

On the basis of these data calculate:

a) Calcium excretion per 24 hours
b) Calcium filtration per minute
c) Fractional excretion of calcium

Comment on the validity of these results.

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a) Calcium excretion (mmol/24h) = Urine calcium (mmol/L) x Urine production rate (L/24h)

Urine production rate (L/24h) = $\frac{\text{24h vol (mL)}}{1000} = \frac{520}{1000} = 0.52$ L

Calcium excretion (mmol/24h) = 3.1 x 0.52 = **1.6 mmol/24h** (2 sig figs)

b) Calcium filtration rate (mmol/min) = Plasma calcium (mmol/L) x GFR (L/min)

GFR (L/min) = $\frac{\text{Urine creatinine (µmol/L) x Urine flow rate (L/min)}}{\text{Plasma creatinine (µmol/L)}}$

Urine creatinine (µmol/L) = Urine creatinine (mmol/L) x 1000

Urine flow rate (L/min) = $\frac{\text{Urine volume (mL/24h)}}{1{,}000 \times 24 \times 60}$

Therefore GFR = $\frac{2.1 \times 1{,}000 \times 520}{92 \times 1{,}000 \times 24 \times 60}$ = 0.0082 L/min (2 sig figs)

Substitute for plasma calcium and GFR to obtain the calcium filtration rate:

Calcium filtration rate (mmol/min) = 2.95 x 0.0082

= **0.024 mmol/min** (2 sig figs)

c) The fractional excretion of calcium is the fraction of filtered calcium which is excreted in the urine:

Fractional excretion (FE) = $\frac{\text{Rate of urinary excretion (mmol/min)}}{\text{Rate of filtration (mmol/min)}}$

Note that the units have to be the same.

Rate of urinary excretion (mmol/min) = $\frac{\text{Rate of urinary excretion (mmol/24h)}}{24 \times 60}$

Therefore FE = $\frac{1.6}{24 \times 60 \times 0.024}$ = **0.046 or 4.6%** (2 sig figs)

Comment:
The calculated GFR is ridiculously low and out of all proportion to the plasma creatinine concentration. The calculated creatinine excretion is very low (approx 1 mmol/24 h) – a figure in the order of 10 mmol/L would be expected for an adult. The most likely cause is an incomplete urine collection (or inaccurate recording of the volume). Therefore calculations based on the urine volume (calcium excretion and filtration rate) are invalid. However, the fractional excretion is probably reliable since the urine volume is used in both the numerator and denominator so any errors cancel. ■

Question 77

In order to evaluate the recovery of a renal tubular protein in an immunoassay, 500 µL of a normal urine containing the protein at 310 pg/mL was spiked with 50 µL of protein standard, 2,000 pg/mL. The measured protein concentration in the mixture was 430 pg/mL. Calculate the recovery.

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