

5.5 Renal physiology and acid–base

Name: _____ Class: _____ Date: _____

Total: 23 marks

KEY WORDS clearance

Objective

Compute clearance, filtered loads and acid–base panels.

1 Key knowledge and worked examples

■ The tools

GFR 125 mL/min; $C = UV/P$; $\text{pH} = 6.1 + \log_{10} \frac{[\text{HCO}_3^-]}{0.03P_{\text{CO}_2}}$; Winter: expected $P_{\text{CO}_2} = 1.5 \times [\text{HCO}_3^-] + 8$.

■ Worked example: the panel

HCO_3^- 12, P_{CO_2} 24: pH 7.32 ✓; expected $P_{\text{CO}_2} = 26 \pm 2$ – measured 24 is just inside: compensated metabolic acidosis.

2 Practice

2.1 Compute clearance for $U = 8$ mg/mL, $V = 1.5$ mL/min, $P = 0.1$ mg/mL. [3]

2.2 What fraction of filtered Na^+ does the proximal tubule reabsorb? [3]

2.3 Compute the pH for HCO_3^- 24, P_{CO_2} 40. [3]

3 Exam-style questions

3.1 A panel shows pH 7.20, HCO_3^- 9, P_{CO_2} 22.

Compute the expected P_{CO_2} by Winter's formula. Decide whether compensation is appropriate. Identify the acid-base disorder(s). [7]

3.2 A diabetic presents with glycosuria (fictional).

Compute the filtered glucose load at plasma 15 mmol/L. State the transport consequence above T_m . Explain the osmotic diuresis that follows. [7]

Solutions

2.1

- $C = 8 \times 1.5/0.1 = 120 \text{ mL/min}$ ✓ ($\approx \text{GFR}$).

2.2

- About 65 %.

2.3

- $6.1 + \log(24/1.2) = 6.1 + 1.30 = 7.40$ ✓.

3.1

- Expected: $1.5 \times 9 + 8 = 21.5 \pm 2$ ✓.
- Measured 22 is inside – compensation appropriate.
- Metabolic acidosis with appropriate respiratory compensation (single disorder).

3.2

- Load = $15 \times 125 = 1875 \text{ } \mu\text{mol/min}$ ✓ (vs $T_m \sim 2000$ at saturation: borderline).
- Above T_m , transport saturates: excess glucose remains in the tubule.
- The unreabsorbed glucose holds water osmotically $\rightarrow$ polyuria; water loss drives thirst and (eventually) volume depletion.