

2024 Bi H2 Q8

Section: Metabolism and Survival

Topic: Metabolic Rate

Question Summary

An athlete runs at different speeds. A combined graph shows heart rate and blood lactate concentration against running speed. You must describe the lactate trend, read a lactate value for a given heart rate, calculate percentage increase in heart rate, compute an average increase in power per bpm from a table, and infer blood lactate at a stated power output. Finally, you name the cell process producing lactate and explain why lactate falls during recovery.

Worked Solution

- (a)(i) From 2.0 to 4.8 m/s, blood lactate increases overall. It rises slowly at lower speeds then more steeply at higher speeds (for example, from about 1.0 mmol/L near 2.0 m/s to about 4.0-4.5 mmol/L by 4.8 m/s).
- (a)(ii) At heart rate 135 bpm, read horizontally to the heart rate curve, then down to speed and across to the lactate curve. Approximate value from the graph is about 1.6 mmol/L. (Award credit for any close reading consistent with the graph.)
- (a)(iii) Percentage increase in heart rate from 2.0 to 4.8 m/s. Example reading: heart rate increases from about 110 bpm to about 170 bpm. Percent increase = $((170 - 110) / 110) \times 100 =$

about 54 percent. (Accept values based on candidate readings.)

- (b)(i) From the table, average increase in power from 84 to 164 bpm: slope = $(184 - 120) \text{ watts} / (164 - 84) \text{ bpm} = 64 / 80 = 0.8$ watts per bpm.

- (b)(ii) 184 watts occurs at heart rate 164 bpm (from table). Use the graph to read lactate at the corresponding speed/heart rate. Approximate value is about 3.2 mmol/L. (Accept close readings.)

- (c) The cell process producing lactate is anaerobic respiration (lactate fermentation) via glycolysis.

- (d) Ten minutes after exercise, lactate falls to 1.1 mmol/L because oxygen uptake remains elevated (oxygen debt repayment). Lactate is converted back to pyruvate and oxidised for energy in muscle and heart, and/or transported to the liver for gluconeogenesis (Cori cycle). Increased circulation and ventilation clear lactate from the blood.

Final Answer

-> (a)(i) Lactate rises overall: slow rise at low speeds, steeper at high speeds

-> (a)(ii) About 1.6 mmol/L at 135 bpm (approx., from graph)

-> (a)(iii) About 54 percent increase (accept answers based on candidate readings)

-> (b)(i) 0.8 watts per bpm

-> (b)(ii) About 3.2 mmol/L at 184 W (from graph via 164 bpm)

-> (c) Anaerobic respiration (lactate fermentation)

-> (d) Lactate cleared by oxidation and Cori cycle during recovery

as oxygen debt is repaid

Revision Tips

- When graphs combine two y-axes, read one variable (heart rate) first, then transfer across to the other curve (lactate).
- Show percentage increase working: $((\text{new} - \text{original}) / \text{original}) \times 100$.
- Average rate of change from a table is change in quantity divided by change in the related variable.
- Recovery removes lactate: oxidation in muscle/heart and conversion to glucose in the liver.

