ACTIVITY OF INTEGRATION
RESPIRATION
SENIOR FIVE

On the Kampala–Gulu highway, many long-distance taxi drivers spend 8–10 hours on the road without proper meals. By evening, they report dizziness, headaches, and body weakness. Doctors suspect this is linked to how prolonged fasting and continuous muscle activity affect respiration. Some drivers admitted that they only take tea in the morning and may skip meals until late evening, while others rely on soda and roasted maize at stopovers. Blood and muscle tissue samples were collected before and after the journey.

Group	Blood glucose (mmol/L)	Lactate (mmol/L)	Muscle glycogen (g/100g tissue)	Average ATP per mitochondrion	Resting heart rate (beats/min)	Fatigue score (1–10)
Before driving	5.0	1.2	2.5	30	70	2
After 8 hrs driving	3.4	3.6	0.6	18	90	8

TASK:

(a) Explain how prolonged driving without meals affects glucose levels, glycogen stores, ATP yield, and muscle activity.

(b) Analyse the role of lactate accumulation in muscle fatigue during the long journey.

(c) Suggest lifestyle or dietary practices that can improve energy levels and reduce fatigue in such drivers.

RESPONSE

(a)

- *Lower blood glucose (5.0 to 3.4 mmol/L): less circulating substrate for glycolysis, so cells have reduced immediate fuel. (Used: glucose drop of 1.6 mmol/L, 32%.)* ✓
- *Depleted muscle glycogen (2.5 to 0.6 g/100g): the large fall (76%) shows muscles have used stored carbohydrate for ATP production during sustained activity. With glycogen low, glycolytic flux is limited.* ✓
- *Reduced mitochondrial ATP production (30 to 18): a 40% drop in ATP per mitochondrion means less ATP available for muscle contraction and cellular maintenance; this directly reduces muscle force and endurance.* ✓
- *Increased heart rate (70 to 90 bpm): the cardiovascular system compensates for lower ATP/oxygen delivery by pumping faster to try to supply tissues.* ✓
- *Net effect on muscle activity: with both low blood glucose and depleted glycogen, and lower mitochondrial ATP, muscles tire quickly and cannot sustain normal work explaining reported weakness.* ✓

(b) ***Data:*** *Lactate rose from 1.2 → 3.6 mmol/L (200% increase) while fatigue score climbed from 2 to 8. when aerobic ATP production becomes limited (low substrate/oxygen utilization), glycolysis increases, ✓and pyruvate is converted to lactate. ✓ Accumulated lactate and associated H^+ lower intracellular pH, ✓inhibiting key glycolytic and contractile enzymes and reducing muscle force. ✓*
The marked lactate rise correlates with muscle fatigue and reduced performance; ✓ it is both a marker and contributor to the drivers' weakness. ✓

(c)

- *Small frequent carbohydrate-rich snacks (e.g., boiled matoke/posho pieces, boiled sweet potato, bread with peanut paste) every 2 to 3 hours, this help keep blood glucose nearer to pre-drive levels (target $greater\ than$ 4 mmol/L) and reduce the 32% drop seen. ✓*
- *Include a small protein source with snacks (e.g., boiled egg, groundnuts, milk sachet) to help muscle repair and replenish glycogen more effectively after activity (addressing the 76% glycogen fall). ✓*
- *Hydration with water (not sugary sodas): preserves blood volume and supports cardiac output instead of causing sugar spikes and crashes that worsen energy swings (helps limit the HR compensation seen: 70 → 90 bpm). ✓*
- *Planned short rest/stretch breaks (10 to 15 min every 2 to 3 hrs): reduces continuous muscle load, allows partial recovery and lowers lactate build-up (addresses the 200% lactate rise). ✓*
- *Avoid relying on high-sugar drinks as sole fuel: these cause transient glucose spikes then rapid falls, which can worsen overall energy and lactate production. ✓*
- *A small carbohydrate + protein meal after long trips to restore glycogen and ATP stores, to raise ATP per mitochondrion from the reduced level toward normal over recovery. ✓*