Exercise walk-through

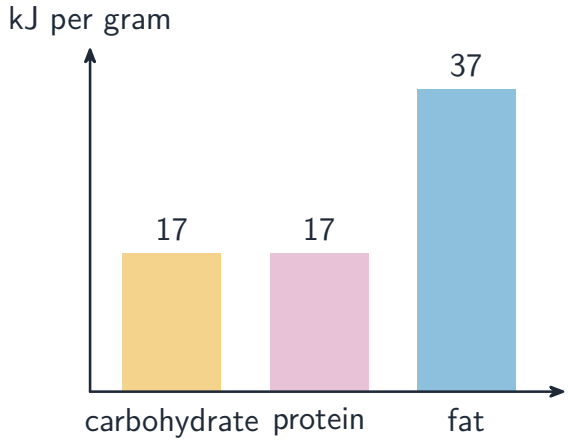
2.3 Energy systems

International Baccalaureate · IB Diploma · Sports, Exercise and Health Science · HL

Fuel supply is only one macronutrient role

Macronutrient	Role and limitation
Carbohydrate	Supports rapid ATP supply; glycogen in liver and muscle serves different local/systemic roles
Lipid	Energy store and membrane roles; high energy per gram does not mean fastest ATP supply
Protein	Amino acids for tissue, enzymes and repair; can also contribute to energy metabolism
Context	Growth, age, body composition, training and individual circumstances affect needs

Energy per gram



fat stores the most energy per gram;
carbohydrate supplies ATP faster;
protein builds and repairs first

> Fat stores more than twice as much per gram

Check the shared calculations and their interpretation

1. **Fluid and circulation.** Final model concentration 12, up 20%; sweat 0.70 kg, rate about 0.93 kg per hour; mass fall about 0.91%; both cardiac outputs 10.8 litres per minute.
2. **Fuel.** Portion 1,231 kJ; fat energy share about 24.0%, mass share about 12.7%. Defined availability 120 kJ per kilogram fat-free mass per day.
3. **Oxygen and evidence.** Relative values 60 and 40 millilitres per kilogram per minute; economy cost falls 10%; $6/24 = 25\%$. None alone establishes a clinical diagnosis or causal performance claim.

Exercise 2.1

2.1 Identify the energy system that supplies most of the ATP in (i) a 100 m sprint and (ii) a marathon. [2]



(i) 100 m (ii) marathon

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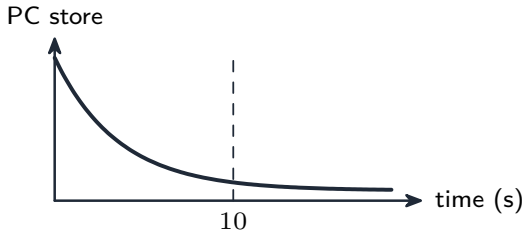


2.1

(i) ATP–PC system; (ii) aerobic system

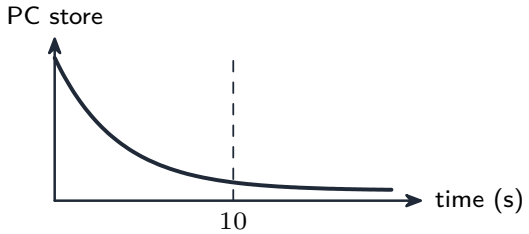
Exercise 2.2

2.2 Explain why the ATP–PC system can supply energy for only about 10 seconds of maximal work. [3]



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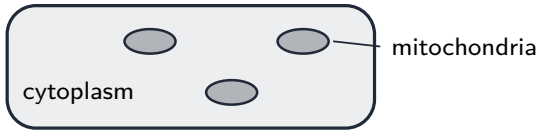


2.2

muscles store only a small amount of phosphocreatine; in maximal work it is used very quickly to resynthesize ATP, so it runs out in about 10 s; rebuilding PC needs energy from the aerobic system during recovery, which takes minutes

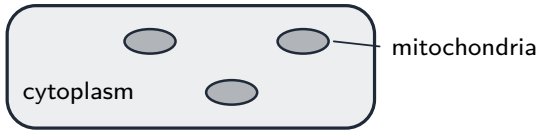
Exercise 2.3

2.3 Compare anaerobic glycolysis with the aerobic system. [3]



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2.3

anaerobic glycolysis does not need oxygen and happens in the cytoplasm; the aerobic system needs oxygen and happens mainly in mitochondria; anaerobic glycolysis supplies ATP faster but yields only 2 ATP per glucose; aerobic yields about 30 or more; anaerobic produces lactate (and acidity); aerobic produces CO_2 and water and can also use fat

Exercise 3.1 (a)

3.1 The graph shows the share of energy from aerobic and anaerobic systems in maximal exercise of different durations.

(a) Estimate the duration when the two shares are equal. [1]

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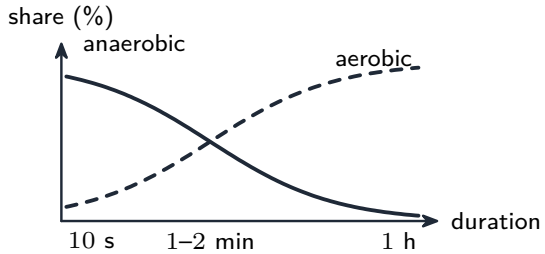
(a) Estimate the duration when the two shares are equal. [1]

(a) about 1–2 minutes (accept 60–120 s)

Exercise 3.1 (b)

3.1 The graph shows the share of energy from aerobic and anaerobic systems in maximal exercise of different durations.

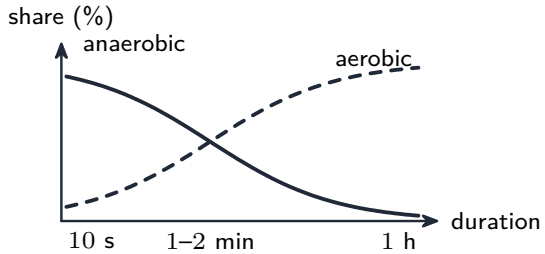
(b) Explain why all three energy systems contribute in an 800 m race (about 2 minutes). [3]



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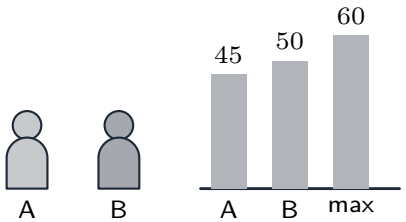


(b) the ATP–PC system supplies ATP in the first seconds, at the start and in the final sprint; anaerobic glycolysis supplies much ATP at high intensity in the middle of the race, producing lactate; the aerobic system rises as oxygen supply increases and gives about half the energy over two minutes

Exercise 3.2 (a)

3.2 Two runners both have a $\dot{V}O_2max$ of 60 ml kg^{-1} min^{-1}. At 16 km h^{-1}, runner A uses 45 ml kg^{-1} min^{-1} and runner B uses 50 ml kg^{-1} min^{-1}.

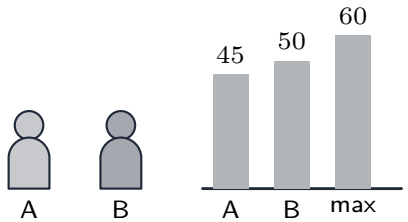
(a) Calculate the percentage of $\dot{V}O_2max$ each runner uses at this speed. [2]



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(a) Calculate the percentage of $\dot{V}O_2max$ each runner uses at this speed. [2]



(a) A: $45 \div 60 \times 100 = \mathbf{75}\%$; B: $50 \div 60 \times 100 \approx \mathbf{83}\%$

Exercise 3.2 (b)

3.2 Two runners both have a $\dot{V}O_2max$ of 60 ml kg^{-1} min^{-1}. At 16 km h^{-1}, runner A uses 45 ml kg^{-1} min^{-1} and runner B uses 50 ml kg^{-1} min^{-1}.

(b) Explain which runner is likely to run faster in a 10 km race. [2]

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(b) runner A, because A is more economical; A works at a lower percentage of maximum at the same speed, so A can sustain a higher speed before fatigue

Exercise 3.2 (c)

3.2 Two runners both have a $\dot{V}O_2max$ of 60 ml kg^{-1} min^{-1}. At 16 km h^{-1}, runner A uses 45 ml kg^{-1} min^{-1} and runner B uses 50 ml kg^{-1} min^{-1}.

(c) Suggest **two** factors that improve running economy. [2]

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(c) Suggest **two** factors that improve running economy. [2]

(c) any two: good technique (less vertical bounce); strength and plyometric training (stiffer tendons); lighter shoes or body mass; experience and training volume

Exercise 3.3 (a)

3.3 Blood lactate is measured as running speed increases, and oxygen uptake is measured after the run.

(a) Explain why blood lactate rises sharply above a certain speed. [2]

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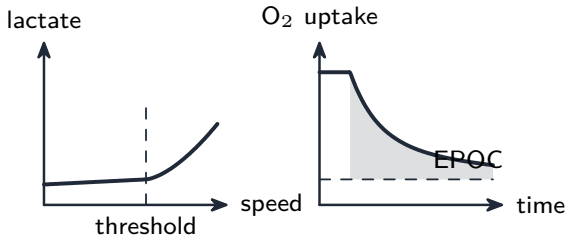
(a) Explain why blood lactate rises sharply above a certain speed. [2]

(a) above the lactate threshold, lactate is produced faster than it is removed; because more fast-twitch fibres are recruited and glycolysis is faster than the aerobic system can use pyruvate

Exercise 3.3 (b)

3.3 Blood lactate is measured as running speed increases, and oxygen uptake is measured after the run.

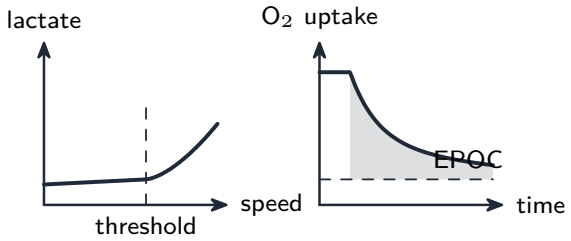
(b) Describe the fast and slow components of excess post-exercise oxygen consumption (EPOC). [4]



Exercise 3.3 (b)

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(b) Describe the fast and slow components of excess post-exercise oxygen consumption (EPOC). [4]



(b) fast component: lasts a few minutes; restores phosphocreatine and re-oxygenates myoglobin; slow component: can last much longer; used for removing lactate, and for raised body temperature, heart rate, breathing and hormone levels

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