Food fuels and the three energy system

Comparing the three energy systems

- The most obvious comparison to be made between the three energy systems is their energy production.
- A unit of measure for quantifying chemical compounds, called moles, is used to compare the amount of energy available from each of the three energy systems.
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- 1 mol of ATP = 1000 mmol of ATP = 30 kJ of useful energy

Energy Systems

ATP-PC

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Anaerobic glycolysis

- Can potentially resynthesise 3 moles (3000 millimoles) of ATP from 1 mole of glycogen (180 grams)

Aerobic system

- Yields a total of 38 moles of ATP from the breakdown of one mole of glycogen (or 87 to 98 moles of ATP from the breakdown of all the stores of glycogen in the muscles)

Key characteristics of three energy systems

Characteristic	ATP–PC energy system	Lactic acid energy system	Aerobic energy system
Alternative name (also known as)	Alactic system, phosphocreatine (PC) or creatine phosphate (CP) system, phosphagen system	Anaerobic glycolysis, lactacid system	
Fuel source		Glycogen	*At rest:* FFAs *At submaximal and maximal intensities:* • CHO • Fats (when glycogen sparing and when glycogen stores are diminished) • Proteins (only under extreme conditions such as starvation, extended illness of depletion of CHOs and FFAs

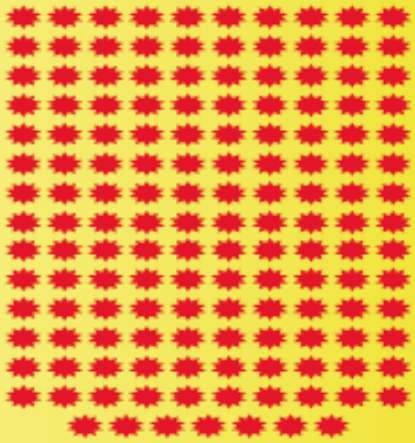
Intensity of activity	High intensity (>95% max HR)	• High intensity (>85% max HR) • Used for increases in intensity during long duration events when PC has not restored	
Duration system is dominant during activity	Short duration 1–5 seconds		Long duration >75 seconds
Peak power	2–4 seconds	5–15 seconds	1–1.5 minutes
Amount of ATP produced		Small amounts (2–3 ATP for each glucose molecule)	• Large amounts (endless) • Carbohydrates (38 ATP per glucose molecule) • Fats (441 ATP per triglyceride molecule)
Speed of production of ATP	• Explosive, instantaneous • Fast and simple chemical reactions	• Fast • Longer chemical reactions (12 of them) in the breakdown of glycogen compared to ATP–PC	• Medium • Complex chemical reactions • Availability of oxygen delays maximum power • Fats slower to resynthesise ATP than CHOs
By-products	• Inorganic phosphates (P_i) • ADP and AMP*		• CO_2 • H_2O • Heat
Total duration during activity	0–10 seconds	10–75 seconds	

Activity:

Which energy system produces the most energy, that is, has the greatest capacity to supply ATP?

Rate of ATP production and yield of ATP for the three energy systems 5.9

Energy system	Fuel used	Rate of ATP (energy) production	Total amount of ATP (energy)
ATP–PC system		Fastest 	0.7–1.0
Anaerobic glycolysis or lactic acid (LA) system	Glucose	Fast 	

Aerobic system	Aerobic glycolysis		Moderate 	36–38 
		Fatty acids	Slowest 	147 

Energy system interplay

- Virtually all physical activities derive some energy from each of the three energy systems
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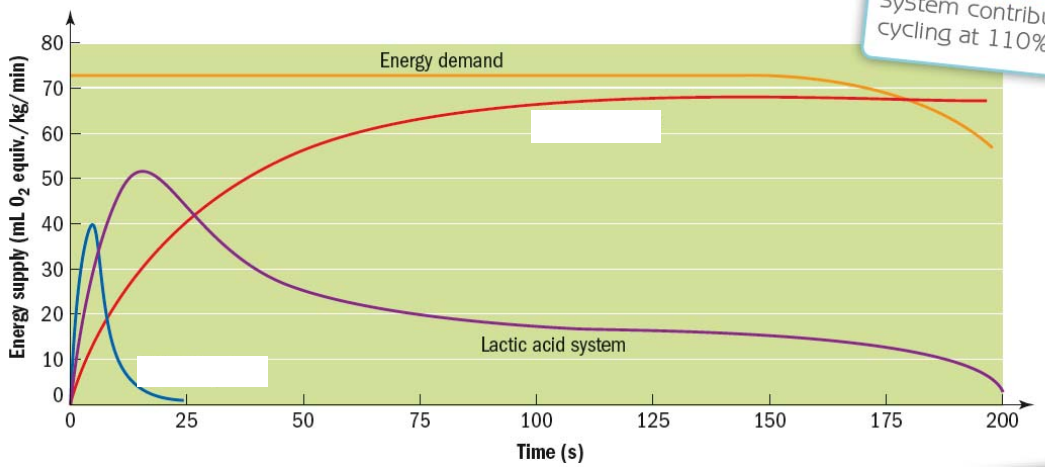

FIGURE 5.11 Energy system contribution during cycling at 110% VO_2 max

Figure 5.12

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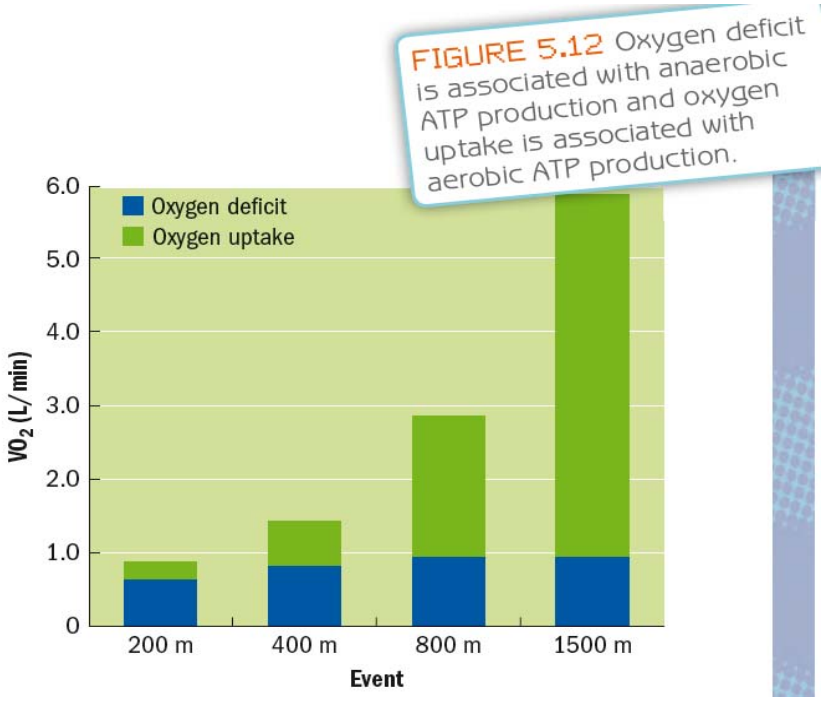

Training the ATP-PC system

- Short-interval, sprint training or plyometrics are favoured training methods to develop the capacity of the ATP–PC system.
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Training the anaerobic glycolysis system

- Training sessions occurring above the anaerobic threshold
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Training the aerobic system

- Training the aerobic system can be divided into high- or low-intensity bouts and can use continuous or long-interval training sessions.
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- Like most training, more is not necessarily better.

table 5.11

Training intensity, type of recovery and recommended work-to-rest ratio for the energy systems

Energy system	Training or exercise bout	Intensity	Work:rest ratio	Recommended recovery
ATP–PC	Up to 10 seconds	Maximal	1:3 → 1:5	Passive
Lactic acid		>85% max HR	1:2 → 1:3	Active
	Interval: about 2–3+ minutes		1:0.25 → 1:0.5	
	Continuous: about 30 minutes			Passive