Chapter 4

Exercise Metabolism

Objectives

1. Discuss the relationship b/n exercise intensity/duration & the bioenergetic pathways that are most responsible for the production of ATP during various types of exercise.
2. Define the term *oxygen deficit*.
3. Define the term *lactate threshold*.
4. Discuss several possible mechanisms for the sudden rise in blood-lactate concentration during incremental exercise.

Objectives

5. List the factors that regulate fuel selection during different types of exercise.
6. Explain why fat metabolism is dependent on carbohydrate metabolism.
7. Define the term *oxygen debt*.
8. Give the physiological explanation for the observation that the O_2 debt is greater following intense exercise when compares to the O_2 debt following light exercise.

Energy Requirements at Rest

Rest-to-Exercise Transitions

The O_2 Deficit

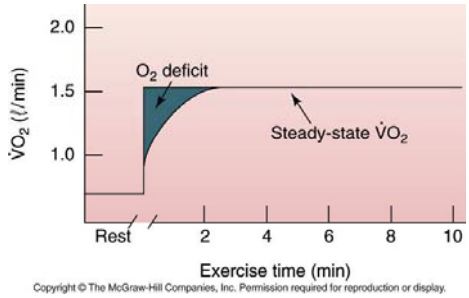


Figure 4.1

Differences in VO_2 b/n Trained & Untrained Subjects

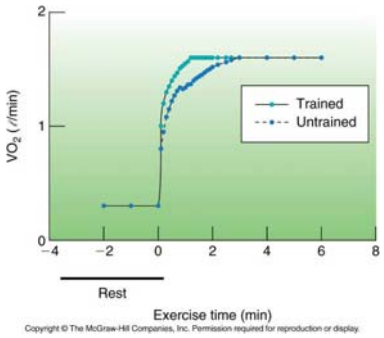


Figure 4.2

Recovery from Exercise Metabolic Responses

O_2 Deficit & Debt during Light/Moderate & Heavy Exercise

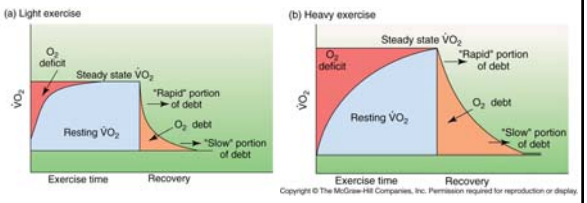


Figure 4.3

Bld Lactate Removal following Strenuous Exercise

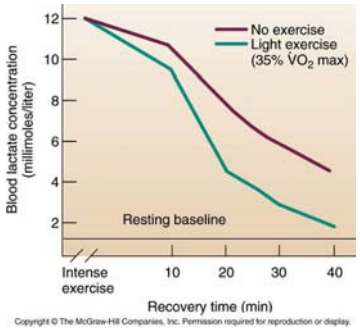


Figure 4.4

Factors Contributing to EPOC

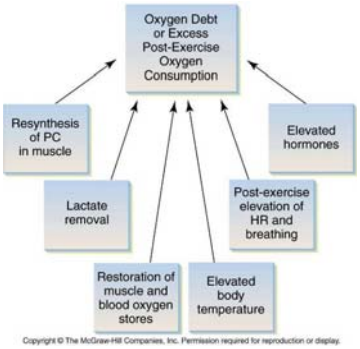


Figure 4.5

Metabolic Responses to Short-Term, Intense Exercise

Metabolic Responses to Prolonged Exercise

Upward Drift in VO_2 during Prolonged Exercise

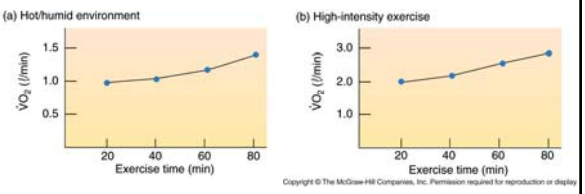


Figure 4.6

Metabolic Responses to Incremental Exercise

Δs in VO_2 during Incremental Exercise

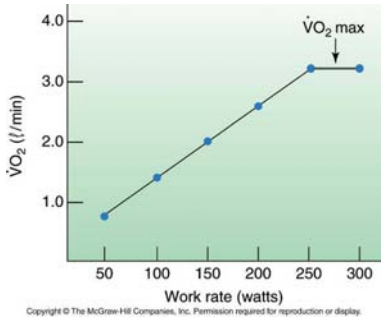


Figure 4.7

Lactate Threshold

- The point at which bld lactic acid rises systematically during incremental exercise
- Explanations for the lactate threshold
- Practical uses of the lactate threshold

Δs in Bld Lactate Concentration during Incremental Exercise

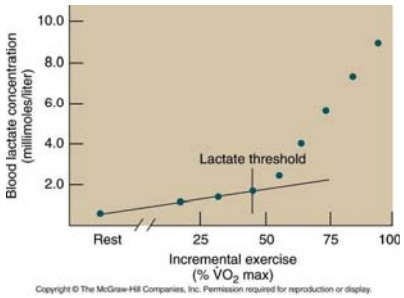
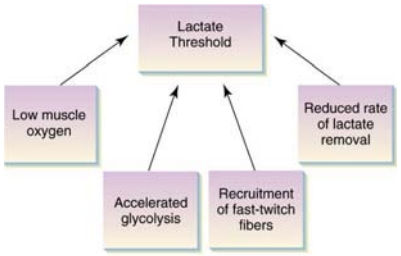


Figure 4.8

Mechanisms to Explain the Lactate Threshold



Potential causes of lactate threshold

Figure 4.10

Other Explanations for the Lactate Threshold

Effect of H^+ Shuttle & LDH on Lactate Threshold

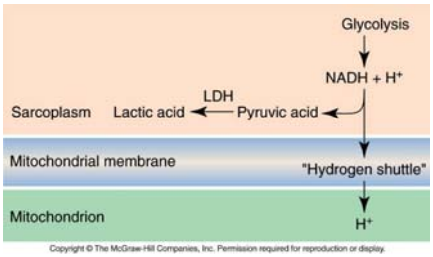


Figure 4.9

Estimation of Fuel Utilization During Exercise

Estimation of Fuel Utilization During Exercise

TABLE 4.1 Percentage of Fat and Carbohydrate Metabolized as Determined by a Nonprotein Respiratory Exchange Ratio (R)

R	% Fat	% Carbohydrate
0.70	100	0
0.75	83	17
0.80	67	33
0.85	50	50
0.90	33	67
0.95	17	83
1.00	0	100

Table 4.1

Exercise Intensity & Fuel Selection

- Low-intensity exercise (<30% VO_{2max})
- High-intensity exercise (>70% VO_{2max})
- "Crossover" concept

Illustration of the “Crossover” Concept

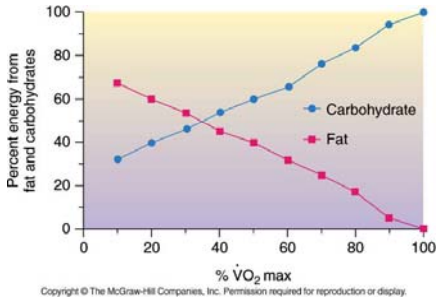


Figure 4.11

The Regulation of Muscle Glycogen Breakdown during Exercise

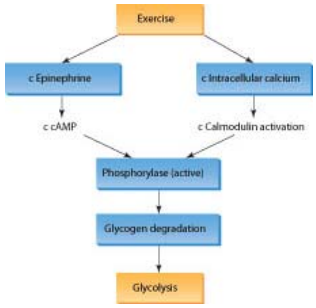


Figure 4.12

Exercise Duration & Fuel Selection

- Prolonged, low-intensity exercise

Shift from CHO to Fat Metabolism during Prolonged Exercise

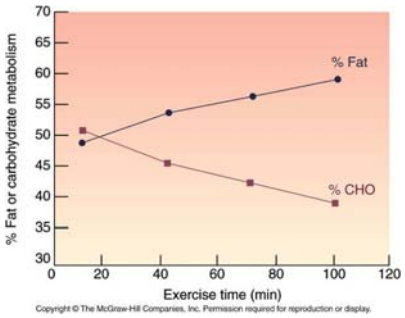


Figure 4.14

Interaction of Fat & CHO Metabolism during Exercise

- "Fats burn in the flame of carbohydrates"

Body Fuel Sources during Exercise

Influence of Exercise Intensity on Muscle Fuel Source

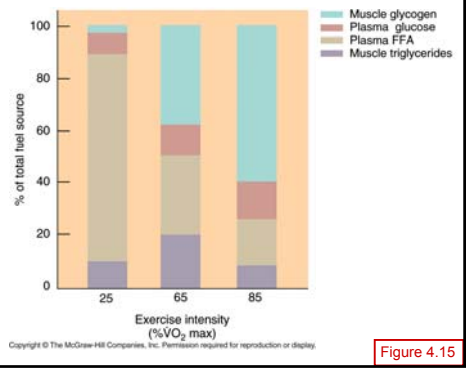


Figure 4.15

Effect of Exercise Duration on Muscle Fuel Source

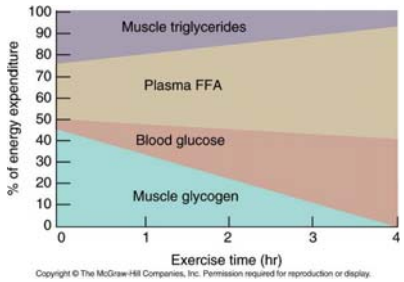


Figure 4.16

The Cori Cycle: Lactate As a Fuel Source

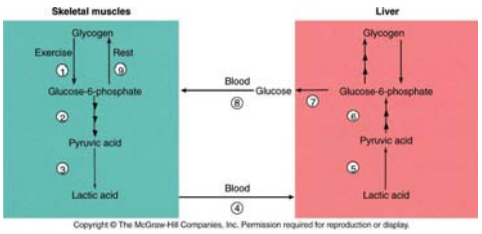


Figure 4.17

Quantifying Body Fuel Sources

TABLE 4.2 Principal Storage Sites of Carbohydrate and Fat in the Body of a Healthy, Nonobese (20% Body Fat), 70-kg Male Subject

Note that dietary intake of carbohydrate influences the amount of glycogen stored in both the liver and muscle. Mass units for storage are grams (g) and kilograms (kg). Energy units are kilocalories (kcal) and kilojoules (kJ). Data are from references 30, 31, and 62.

	Carbohydrate (CHO)		
Storage Site	**Mixed Diet**	**High-CHO Diet**	**Low-CHO Diet**
Liver glycogen	60 g (240 kcal or 1,005 kJ)	90 g (360 kcal or 1,507 kJ)	<30 g (120 kcal or 502 kJ)
Glucose in blood and extracellular fluid	10 g (40 kcal or 167 kJ)	10 g (40 kcal or 167 kJ)	10 g (40 kcal or 167 kJ)
Muscle glycogen	350 g (1,400 kcal or 5,860 kJ)	600 g (2,400 kcal or 10,046 kJ)	300 g (1,200 kcal or 5,023 kJ)
Fat			
Storage Site	**Mixed Diet**		
Adipocytes	14 kg (107,800 kcal or 451,251 kJ)		
Muscle	0.5 kg (3,850 kcal or 16,116 kJ)		

Table 4.2