

CHECKPOINT

6. Explain how a skeletal muscle contracts and relaxes.
7. What is the importance of the neuromuscular junction?

4 Metabolism of Skeletal Muscle Tissue

OBJECTIVES

- Describe the sources of ATP and oxygen for muscle contraction.
- Define muscle fatigue and list its possible causes.

Energy for Contraction

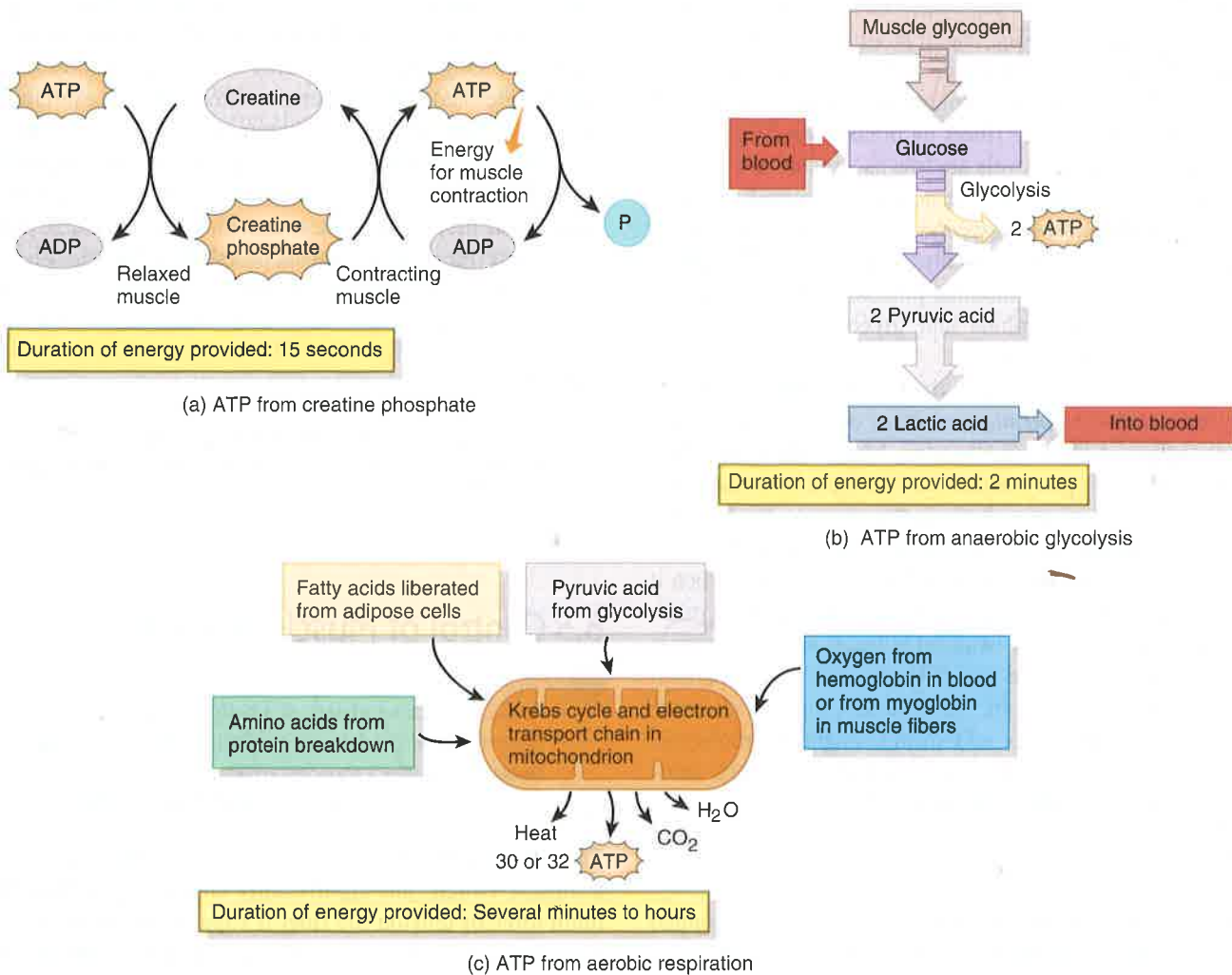
Like most cells of the body, skeletal muscle fibers often switch between virtual inactivity, when they are relaxed and using only a

modest amount of ATP, and great activity, when they are contracting and using ATP at a rapid pace. However, the ATP present inside muscle fibers is enough to power contraction for only a few seconds. If strenuous exercise is to continue, additional ATP must be synthesized. Muscle fibers have three sources for ATP production: (1) creatine phosphate, (2) anaerobic glycolysis, and (3) aerobic respiration.

While at rest, muscle fibers produce more ATP than they need. Some of the excess ATP is used to make **creatine phosphate**, an energy-rich molecule that is unique to muscle fibers (Figure 8.8a). One of ATP's high-energy phosphate groups is transferred to creatine, forming creatine phosphate and ADP (adenosine diphosphate). **Creatine** is a small, amino acid-like molecule that is synthesized in the liver, kidneys, and pancreas and derived from certain foods (milk, red meat, fish), then transported to muscle fibers. While muscle is contracting, the high-energy phosphate

Figure 8.8 Production of ATP for muscle contraction. (a) Creatine phosphate, formed from ATP while the muscle is relaxed, transfers a high-energy phosphate group to ADP, forming ATP, during muscle contraction. (b) Breakdown of muscle glycogen into glucose and production of pyruvic acid from glucose via glycolysis produce both ATP and lactic acid. Because no oxygen is needed, this is an anaerobic pathway. (c) Within mitochondria, pyruvic acid, fatty acids, and amino acids are used to produce ATP via aerobic respiration, an oxygen-requiring set of reactions.

During a long-term event such as a marathon race, most ATP is produced aerobically.



Where inside a skeletal muscle fiber are the events shown here occurring?