## How Deep-Diving Marine Mammals Adapt to Oxygen-Poor Environments

**D**eep-diving marine animals, such as the sperm whale, have evolved several mechanisms for remaining submerged for up to 1 hour. Most have a large number of red blood cells per milliliter of blood, large quantities of the oxygen-binding pigment **myoglobin** in their muscles, and hemoglobin that releases oxygen much more easily than other mammalian hemoglobin.

The **diving reflex** is an evolutionary adaptation in those mammals that dive (e.g., whales) downward in the sea. In this reflex, blood is shunted away from most regions of the body during a dive and diverted mainly to the heart, brain, and skeletal muscles. Also, the skeletal muscles can incur an **oxygen debt;** they can continue to contract even after all oxygen is depleted. The ATP energy for contraction comes from glycolysis, which forms lactic acid that accumulates in the tissues. When the whale surfaces, it quickly exhales its moist, oxygen-poor air, which condenses to form the "spout." A large amount of carbon dioxide is blown off in the "spout," and oxygen quickly combines with hemoglobin passing through the lungs.

The second part of the diving reflex is the slowing of the heart rate (called bradycardia). This slowing is an adaptation to ensure less rapid depletion of oxygen until the whale can return to the air for more oxygen.