

## **Box Extension 7.1**

to accompany

*Animal Physiology*, Fifth Edition

Hill • Cavanaugh • Anderson

### ***Views on Animal Heat Production***

During the centuries when heat was considered a vital force, the “vital heat” produced by animals was thought to differ from the heat of a fire. This vital heat was believed to originate exclusively in the heart, lungs, or blood and to suffuse the rest of the body, bringing it to life. When William Harvey first described the circulation of the blood in the early seventeenth century, one of the principal roles attributed to the newfound circulation was transport of “vital heat” from tissues where it was produced to other tissues, which it animated.

The old view of animal heat began to change at about the time of the American Revolution, when Antoine Lavoisier, in France, showed that the ratio of heat production to CO<sub>2</sub> production was about the same for a guinea pig as for burning charcoal. From this and other evidence, Lavoisier and the Englishman Adair Crawford argued that animal respiration is a slow form of combustion, and that animal heat is the same as the heat produced by fire. Still, for several more decades, all animal heat was believed to originate in the lungs, and the lungs were thought to be the exclusive site of O<sub>2</sub> use. Not until 1837 did Heinrich Gustav Magnus show that the blood takes O<sub>2</sub> from the lungs to the rest of the body and returns CO<sub>2</sub>. Evidence for the all-important concept that tissues throughout the body make heat came a decade later when Hermann von Helmholtz demonstrated that muscular contraction liberates heat. In 1872, Eduard Pflüger presented evidence that all tissues consume O<sub>2</sub>.

The discovery that all tissues use O<sub>2</sub> and produce heat was one of several lines of thought and investigation that came together in the nineteenth century to give birth to our modern understanding of animal energetics. Other important developments were the flowering of the science of thermodynamics (sparked by the Industrial Revolution) and profound changes in the understanding of energy. In the 1840s, Julius Robert von Mayer in Germany and James Joule in England developed the seminal concept that heat, motion, electricity, and so on are all forms of one thing: energy. Mayer, a physician, was probably the first person to conceptualize the true nature of animal energy transformations, as described in this chapter in the main text.