Notes

Chapter 1

1. *The American Heritage Dictionary* (1992) defines materialism as "the theory that physical matter is the only reality and that everything, including thought, feeling, mind, and will, can be explained in terms of matter and physical phenomena." "Physical phenomena" include forms of energy such as electricity and magnetism.

Chapter 5

1. This paragraph and the preceding one were written with the assistance of William T. Powers.

Chapter 6

1. Some of the better-known participants were social scientist Gregory Bateson, engineer Julian Bigelow, sociologist Paul Lazarsfeld, social psychologist Kurt Lewin, neurophysiologist Rafael Lorente de Nó, anthropologist Margaret Mead, neuropsychiatrist Warren McCulloch, mathematician Walter Pitts, physiologist Arturo Rosenblueth, information theorist Claude Shannon, electrical engineer Heinz von Foerster, mathematician John von Neumann, and, of course, cybernetician Norbert Wiener.

2. Apparently after rheostat, a device that resists the flow of electricity and whose resistance can be varied by mechanical means.

3. Figure 6.4 was provided by Bryan Thalhammer.

4. Another approach to modeling hierarchical networks of control systems is by Marken (1990), who created a three-level control hierarchy in the form of a computer spreadsheet that can be obtained from *www.uiuc.edu/ph/www/g-cziko/twd*.

5. Gather, a program for IBM-compatible personal computers, is also available from *www.uiuc.edu/www/ph/g-cziko/twd*.

6. Additional control system simulations of social behavior have been developed by Bourbon (1990).

Chapter 7

1. Although Lamarck did not see God as directly involved in the creation of currently existing forms of life, he nonetheless referred to God as "the supreme author of all things" (quoted in Burkhardt 1977, p. 185).

2. See Weiner (1994) for a fascinating account of the work of Peter and Rosemary Grant on the evolution of Darwin's finches on the Galápagos Islands.

3. Unfortunately, Weismann's research did nothing to dissuade Soviet biologist Trofim Denisovich Lysenko (1889–1976) from his doomed attempt to increase the productivity of Soviet agriculture based on Lamarckian principles. Stalin's receptivity to and imposition of Lysenko's Lamarckian beliefs crippled the development of Soviet biology and genetics until the 1960s (see Medvedev 1969, and Joravsky 1970, for accounts of the life and times of Lysenko).

4. It is the case that certain environmental factors (such as radiation and chemical substances known as *mutagens*) can increase mutation rates in organisms and thereby cause an increase in behavioral variation. However, these variations are like those that arise spontaneously in their being unrelated to the environmental factors that caused them and completely blind to the adaptive needs of the organism.

5. Since evolutionary theory recognizes all organisms as having descended from a common ancestor, all organisms are in this sense related to each other. I use the word "unrelated" in its more common definition of applying to two organisms with no close kin relationship and who are therefore unlikely to share a new or relatively uncommon gene.

6. This account of web building is taken primarily from Dawkins (1996, chapter 2) and Hoagland and Dodson (1995, pp. 140–141).

Chapter 8

1. Since Darwin's time, adaptive explanations have been provided for some human racial differences. For example, sunlight is an important factor in human health since skin exposed to sunlight permits the production of vitamin D, a vital nutrient. But because overexposure to the sun has damaging effects and may lead to skin cancer, the color of human skin is an adaptation to the intensity of sunlight. Tropical races have dark skin for protection against the sun's harmful effects, and temperate and Arctic races have light skin to allow more of the available solar radiation to enter the skin to be used for synthesis of vitamin D.

2. See Behe (1996) for a modern version of the same misguided argument.

3. See Buss (1999) for a valuable recent compilation of these findings. See also Johnston (1999) for a fascinating evolutionary account of human emotions.

Chapter 9

1. See Cziko (1995, pp. 186–187) and Dennett (1995, pp. 384–393) for two critiques of Chomsky's anti-Darwinian views.

2. Both figures 9.2 and 9.3 give a simple quantitative portrayal of the two complementary entities in question; however, their interaction is undoubtedly much more complex.

Chapter 11

1. For more information about these behavioral scientists and their work, see the Website of the Control Systems Group at *www.ed.uiuc.edu/csg*.

Chapter 12

1. For an example of a school consistent with such principles, see the video *A Learner-Centered School* about Williston Central School in Vermont (Burrello 1995).