READING: Marchand, Ch. 4, pages 106–11

I. PHYSICAL and PHYSIOLOGICAL THERMOREGULATON

A. LOWER CRITICAL TEMPERATURE

1. What is the *lower critical temperature (LCT)* of an animal? Define LCT in terms of the relationship between *physical* and *physiological* thermoregulation. See Marchand, page 113, Fig. 36.

2. What is the adaptive advantage of lowering LCT during winter acclimatization?

3. What are three ways in which an animal can *lower* its LCT as part of *acclimatization* to winter?

a.

b.

c.

II. PHYSIOLOGICAL THERMOREGULATION

A. DEFINITION:

1. What is physiological thermoregulation?

2. Distinguish physiological from physical thermoregulation:

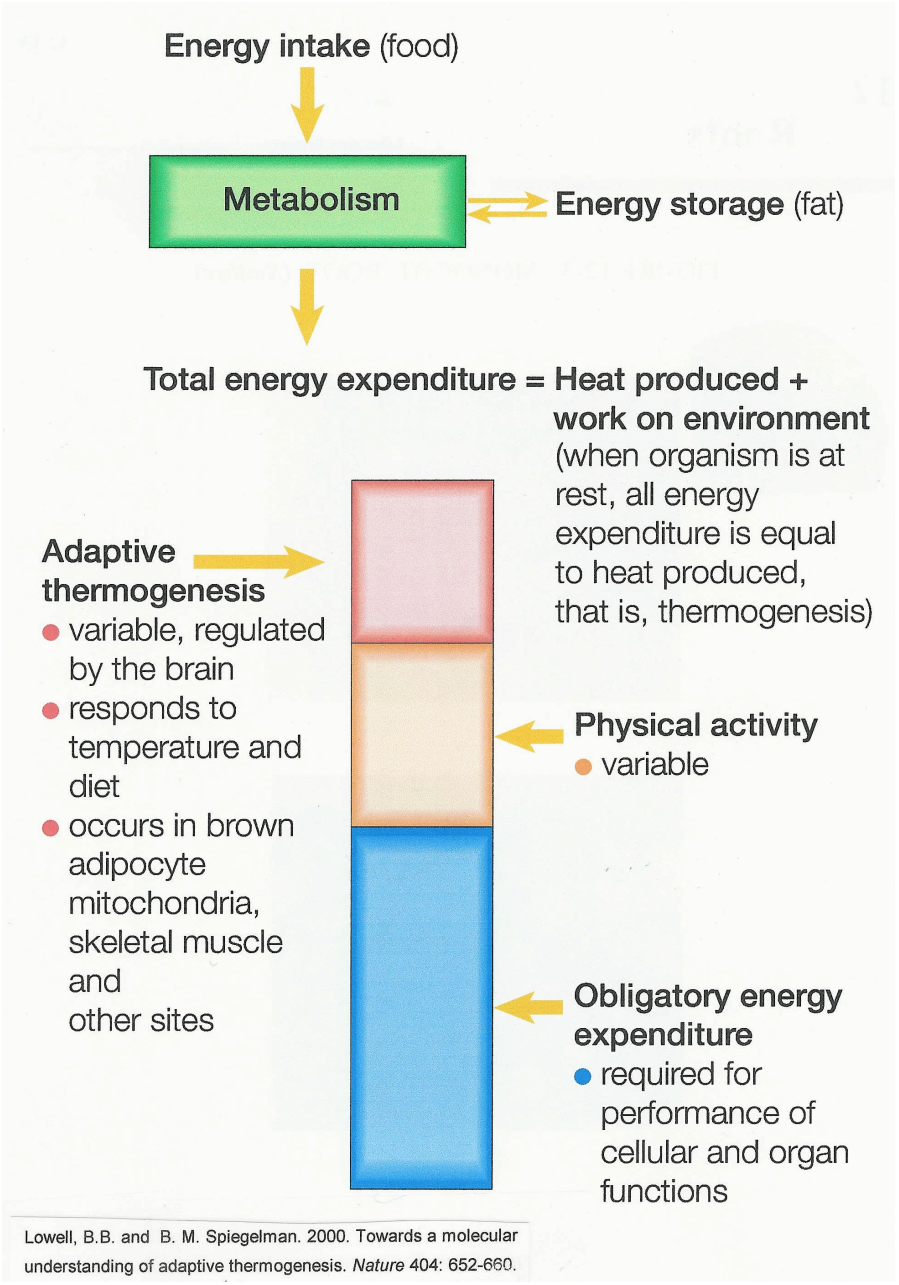
B. EXPERIMENTAL:

1. Describe an experiment to determine when physiological thermoregulation has "kicked in" in a small mammal.

2. What is *brown fat*? How is it different from white fatty tissue? Why is its function likened to a "heating pad?"

C. PHYSIOLOGY OF ACCLIMATIZATION: Environmental Cues, Cellular Mechanisms

Discuss acclimatization in small mammals as it relates to environmental cues in the fall, and resultant neurological and hormonal mechanisms. See color graphics on the following pages. Pending time available, this discussion may be continued and expanded during our “North Woods Trip.”



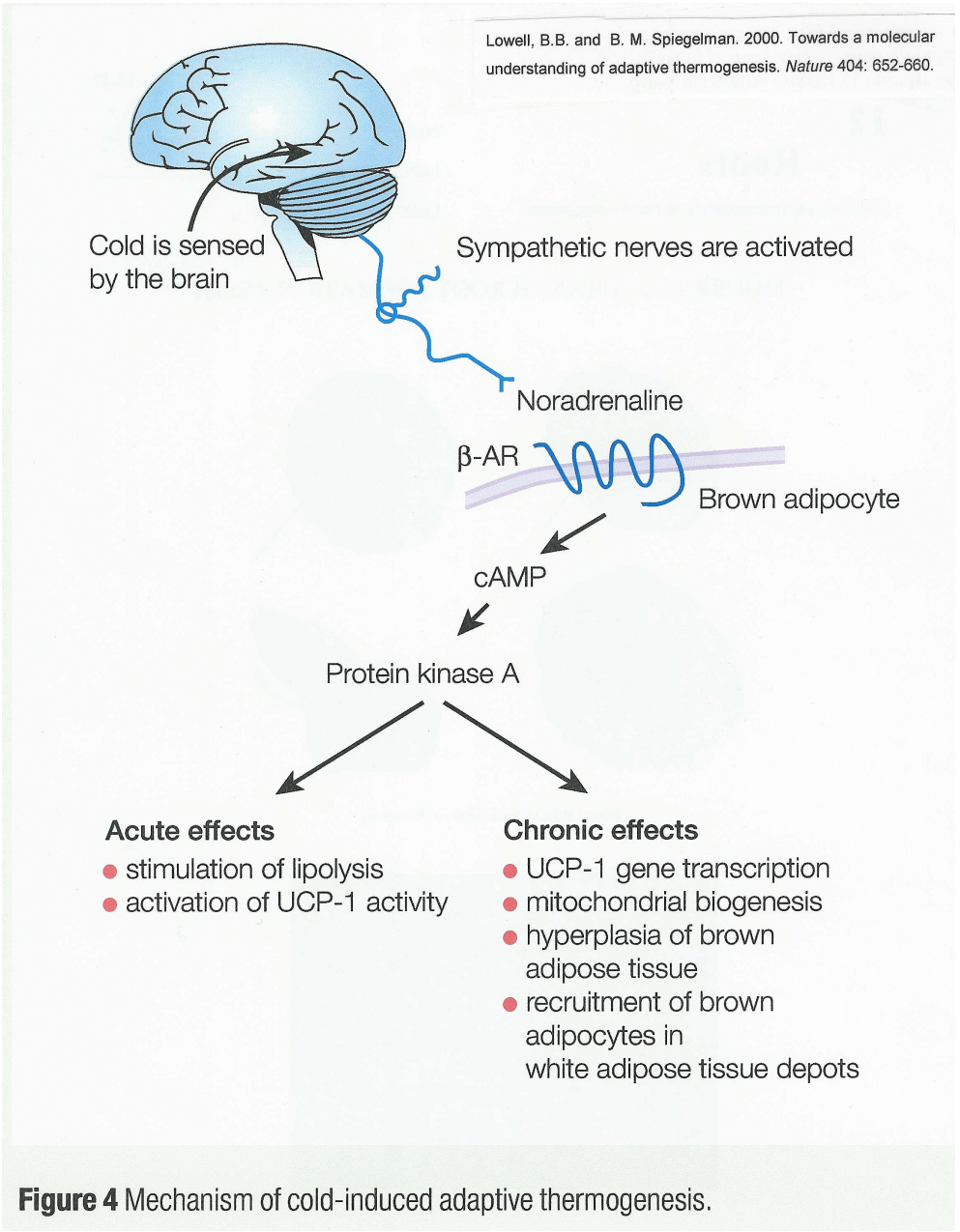


Figure 4 Mechanism of cold-induced adaptive thermogenesis.

8.4

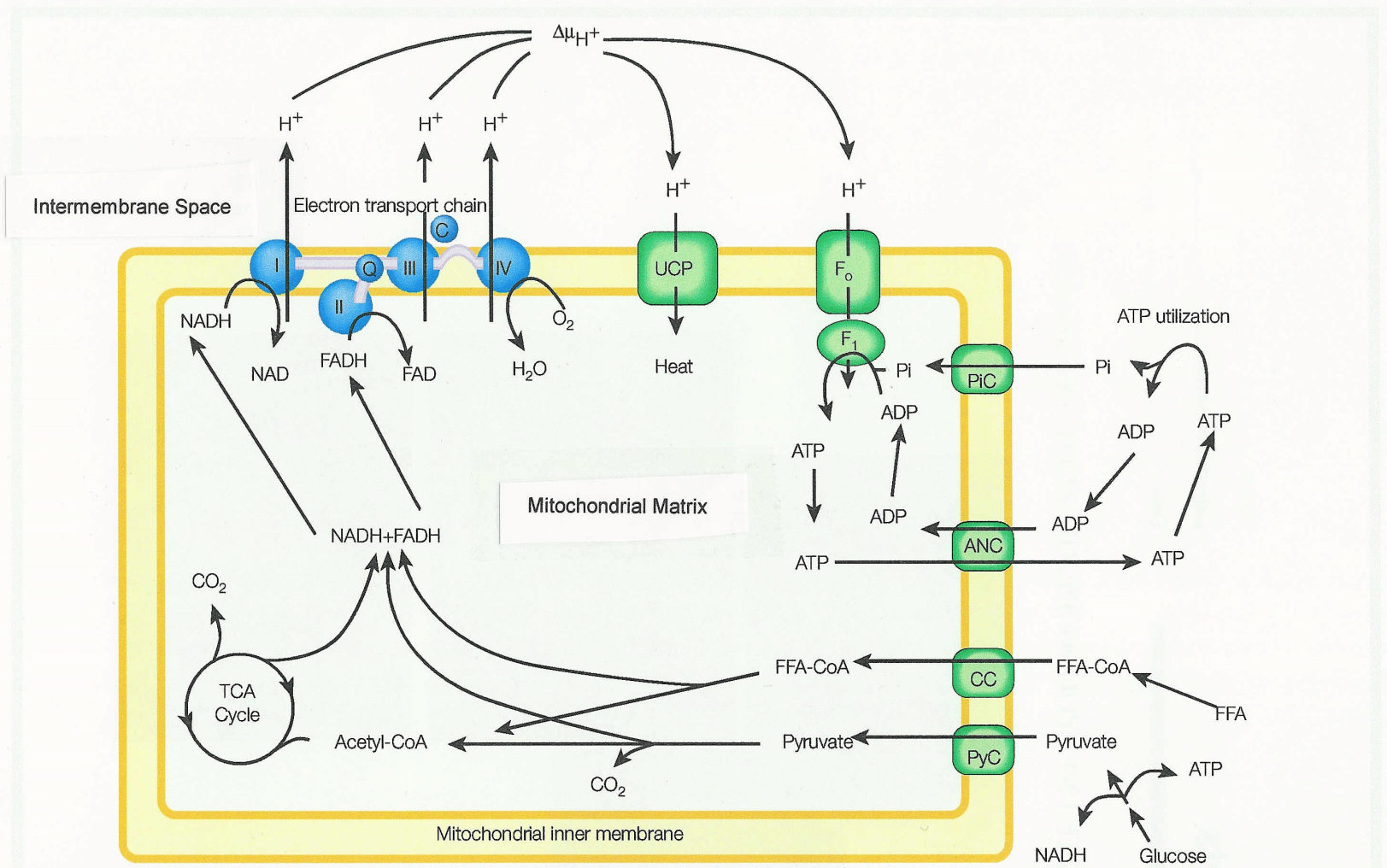


Figure 2 Mitochondrial energy metabolism. Free fatty acids (FFAs) and glucose are oxidized to generate NADH and $FADH_2$ which donate electrons to the electron transport chain. Ubiquinone (Q) shuttles electrons from both complexes I and II to complex III, whereas cytochrome *c* (C) shuttles electrons from complex III to complex IV. Molecular oxygen (O_2) is the terminal electron acceptor. Protons are pumped out by complexes I, III and IV of the electron transport chain, which creates a proton electrochemical potential gradient ($\Delta\mu_{H^+}$). Protons may re-enter the mitochondrial matrix through the F_0/F_1-ATPase, with energy being used to generate ATP from ADP and Pi. Protons may also re-enter through an uncoupling protein (UCP), with energy being released in the form of heat. Proton re-entry by means of ATP synthase depends upon the availability of ADP, which is generated in the cytosol from reactions using ATP. Abbreviations: ANC, adenine nucleotide carrier; CC, carnitine carrier; complex I, NADH–ubiquinone oxidoreductase; complex II, succinate–ubiquinone oxidoreductase; complex III, ubiquinone–cytochrome-*c* oxidoreductase; complex IV, cytochrome-*c* oxidase; PiC, phosphate carrier; PyC, pyruvate carrier.

Lowell, B.B. and B. M. Spiegelman. 2000. Towards a molecular understanding of adaptive thermogenesis. *Nature* 404: 652-660.