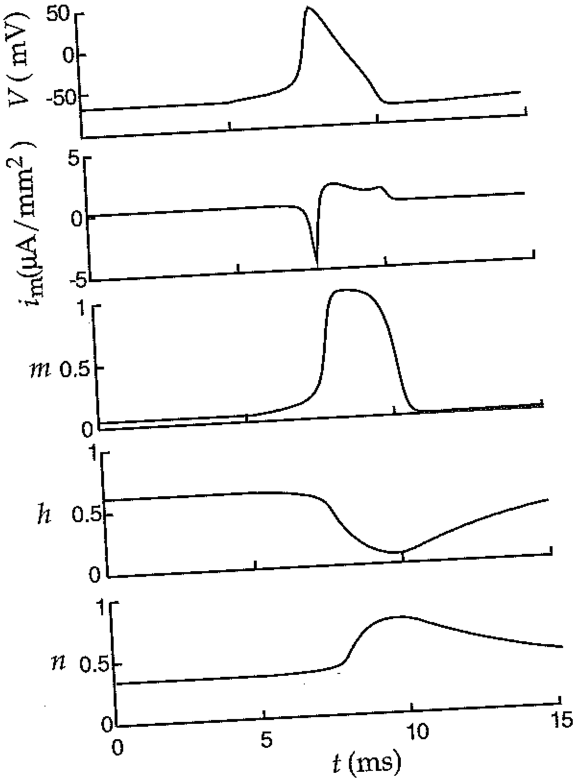

Figure 5.11 The dynamics of V, m, h, and n in the Hodgkin-Huxley model during the firing of an action potential. The upper-most trace is the membrane potential, the second trace is the membrane current produced by the sum of the Hodgkin-Huxley K^+ and Na^+ conductances, and subsequent traces show the temporal evolution of m, h, and n. Current injection was initiated at $t = 5$ ms.

membrane potential up to about -50 mV, the m variable that describes activation of the Na^+ conductance suddenly jumps from nearly 0 to a value near 1. Initially, the h variable, expressing the degree of inactivation of the Na^+ conductance, is around 0.6. Thus, for a brief period both m and h are significantly different from 0. This causes a large influx of Na^+ ions, producing the sharp downward spike of inward current shown in the second trace from the top. The inward current pulse causes the membrane potential to rise rapidly to around 50 mV (near the Na^+ equilibrium potential). The rapid increase in both V and m is due to a positive feedback effect. Depolarization of the membrane potential causes m to increase, and the resulting activation of the Na^+ conductance makes V increase. The rise in the membrane potential causes the Na^+ conductance to inactivate by driving h toward 0. This shuts off the Na^+ current. In addition, the rise in V activates the K^+ conductance by driving n toward 1. This increases the K^+ current, which drives the membrane potential back down to negative values. The final recovery involves the readjustment of m, h, and n to their initial values.