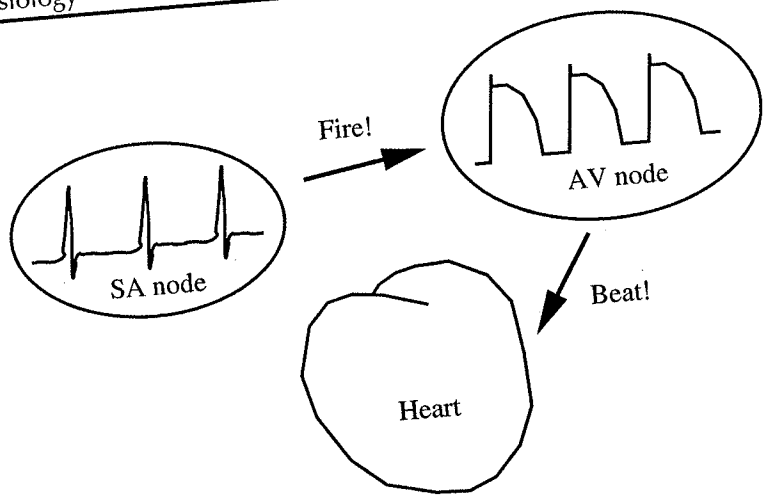

Figure 9.6. *A schematic of the heart beat control mechanism. Figure adapted from Adler* [1].

phenomenon. Second-degree block refers to the situation in which the heart skips every other beat (i.e., the AV node blocks every other signal from the SA node). The Wenckebach phenomenon refers to the situation in which the heart skips a beat every now and then, while it beats normally most of the time. Can your model produce other beating patterns?

Project 21: Ocular Dominance Columns

Visual information is transmitted via the optic nerve to the visual cortex. Scientists studying the visual cortex of cats and monkeys discovered columns (bands or stripes) of neurons that selectively respond to visual information from one eye or the other. The bands are interlaced, as shown in Figure 9.7.

Hubel et al. [94] suggested that the columns are formed through a competition process during the first several months after birth. Neurons in the visual cortex have a number of synapses receiving inputs from the eyes. A synapse is associated either with the right eye or the left eye. Initially, all neurons are binocular, that is, it has both right- and left-eye synapses, and the synapses are intermixed randomly. During development, synapses can switch allegiance from one eye to the other, as a result of competition. Swindale [153] demonstrated that ocular dominance patterns can be generated by assuming that interactions between right- and left-eye synapses follow two simple rules:

(1) Local interactions (within a region 200 μm in diameter) are stimulatory (for example, in a region where right-eye synapses dominate, there will be an increase in the number of right-eye synapses at the expense of left-eye synapses);

(2) Interactions over larger distances (200–600 μm) between opposite-eye synapses are inhibitory (for example, in an annular ring surrounding a region where right-eye

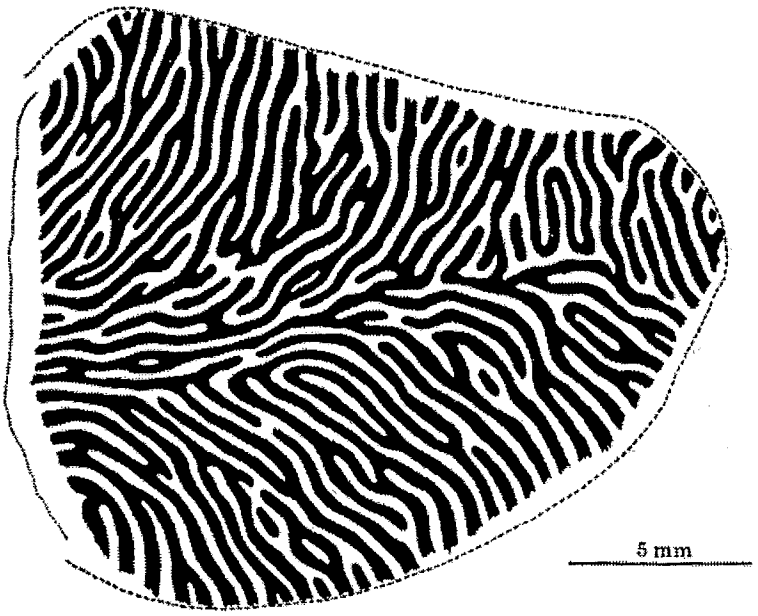

Figure 9.7. *Ocular dominance stripes in an area of the visual cortex of a macaque monkey. Black represents neurons receiving input from one eye; white represents neurons receiving input from the other eye. (Figure* 24 (a) *from Hubel and Wiesel* [93]*, reprinted with permission by the Royal Society of London.)*

synapses dominate, there will be an increase in the number of left-eye synapses at the expense of right-eye synapses).

Develop a cellular automaton simulation that implements the assumptions mentioned above. Initially, you may assume that the number of synapses remains fixed.

Investigate the effect of growth of the visual cortex during development of the ocular dominance stripes. How does this affect the pattern produced?

Investigate the effect of monocular deprivation (restricting the input from one eye for a period of time during development). Are there times at which monocular deprivation causes a change in the eventual pattern?

Project 22: The Sound of Many Hands Clapping

A popular topic in mathematical biology is the self-organization of many individual units, whether they be cells or people, to produce patterns in space and/or time.

An interesting example of self-organization is rhythmic applause produced by audiences in concert halls. An audience indicates its appreciation for a performance by the strength and nature of its applause. In [124], Neda et al. note that several transitions be-