nice to know, he says, that research into its mysteries has alerted us to the existence of biochemical pathways that we share with the sponges, "creatures from which humans have been separated by a billion years of evolution."

The Human Machine

"A Chip You Can Talk To" by Rachel Nowak, in *Johns Hopkins Magazine* (Dec. 1990), 212 Whitehead Hall, Johns Hopkins Univ., 34th and Charles Streets, Baltimore, Md. 21218.

If scientists at the Johns Hopkins Applied Physics Laboratory have their way, it won't be long before telephones dial numbers on spoken request, tape recorders transcribe conversations directly onto paper, and cars drive themselves. Nowak, a writer for *Bio World*, reports that researchers at the lab are making their first breakthroughs on computer chips that will enable machines to hear and see.

Today's digital and serial computers are ill-equipped to understand language or interpret light signals, Nowak explains. Signals entering a microphone, for example, are "analog." That is, they are recorded in fluctuating voltage levels. But computers can't read analog signals. They must first be converted into a "digital" string of ones and zeros—a clumsy, time-consuming process.

To get around this problem, the team has developed a "basilar membrane" computer chip, which interprets analog signals directly by imitating the human ear and brain. Each of the chip's 30 microscopic filters responds to a particular frequency range and then works with the others to interpret the signals. The researchers hope that all 30 filters soon will be contained on an even smaller chip requiring only a minuscule battery. It will process sound instantly, in "real time." Conceivably, the chip could be connected to the auditory nerve in a deaf person's ear. The ultimate goal, however, is to create a chip that can change sounds into language a computer can understand.

There are many obstacles, Nowak writes. While humans are able to separate meaningful sounds from noise (a humming refrigerator, for example, or droning traffic), computers can't. But researcher Marc Cohen has developed a prototype of a microchip that may be the first step toward a solution. The chip separates blended signals by detecting distinctive frequency patterns and separating them.

Work on chips that "see" is slower going. So far the team has fabricated a three-layer "silicon retina," which, while not as complex as the human eye, can "detect edges, as well as automatically adjust . . . to different light intensities." One such chip, which is one centimeter square, will soon replace a refrigerator-sized computer in a solar observatory in Sacramento.

Eventually, the goal is to link the "seeing" and "hearing" chips through an "associative memory" chip, Nowak notes, so that "the *sight* of an object, say a cup sitting on a table, triggers the *name* of the object."

How long will it be before we can expect a "perceptive computer, obedient to our slightest utterance?" At least 10 years, the researchers predict. The deepest mysteries confronting them do not involve fabricating new microchips but understanding the human organ the chips are supposed to mimic—the brain.

Ants in Bondage

"Slave-making Ants" by Howard Topoff, in *American Scientist* (Nov.–Dec. 1990), P.O. Box 13975, Research Triangle Park, N.C. 27709.

For centuries scientists have been fascinated by the complex social structure of ant colonies. Charles Darwin made detailed studies of ant societies and noted their remarkably efficient division of labor. In recent years, writes Topoff, a psycholo-