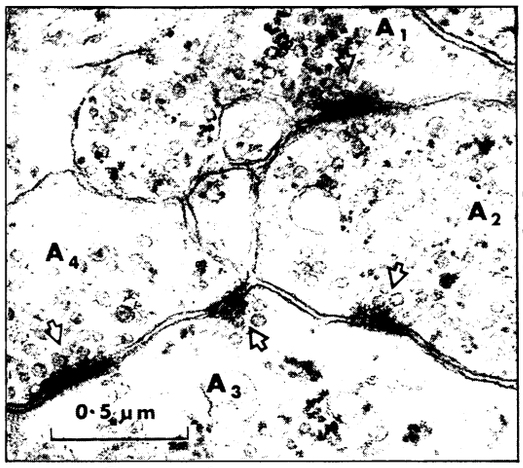

John E. Dowling, *Proc. Roy. Soc. B*

Cluster of synapses links retinal cells.

physiologists."

Neuroscientists are considering not only new paths of signal transmission but also a wider range of chemicals to carry the signals between cells. Evidence is mounting that in addition to recognized transmitters, such as acetylcholine, some amino acids serve in the brain as transmitters. Researchers are studying other chemicals for more general effects on nerve cell activity.

The multitude of possibilities for cell communication has serious implications for ideas on how information is processed in the brain. The model cannot limit dendrites to being simply conduits for signals. In some cases the dendrite and axon may each weigh their own inputs and produce outputs independently of the cell body computations. "The neuron was considered a standard computer unit, but now we feel that it is too variable," explains Henry J. Ralston III of the University of California at San Francisco. "The functional organization of local regions is in terms of synaptic circuits, not local neurons."

A query important to the new ideas is how far within the nerve cell local signals spread. Unless they are propagated as action potentials, these electrical signals will fade over a distance, dependent on the size and shape of the cell region, the geometry of its branches and the characteristics of its membrane. Researchers who make mathematical models of nerve cells to evaluate signal spread disagree on just how local is local—whether the cell body hears all or nothing of the activity in its branches. Wilfrid Rall of the National Institute of Arthritis, Metabolism and Digestive Diseases made a plea to the physiologists. He asked that when the experimenters sink electrodes into cells, they measure the parameters needed by the researchers who make theoretical models. To settle how much a cell body learns of the chatter in its distant branches, the theoreticians need measured electrical properties of cells whose detailed structure is also known.

Although the researchers generally agreed on the importance of being alert to the local, silent interactions, which would be missed by electrodes eavesdropping outside nerve cell boundaries, the details of those interactions are far from settled. Itzchak Parnass of Hebrew University in Jerusalem summarizes: "Each of us has an answer taken from one experimental system. Each rule right for one system is not right for another." Rodolfo R. Llinas of New York University Medical Center agrees. "It's time to be looking at different synapses, rather than generalizing." □

according to Edelman's model, but those groups activate other cell groups in a secondary repertoire, groups which Edelman calls R of R (recognizers of recognizers). An R of R group can respond, in addition, to the output of other R of R groups.

Consciousness, according to Edelman, is the result of cyclic repetition of sequences of events. "I see the brain as a seething mass of patterns going on and off all over the place," he says. In the first phase of cycling, signals are recognized by a cell group of the primary repertoire, and that group's output is recognized by several R of R groups, which fire repeatedly in their typical patterns. In a latter cycle, those processed signals can re-enter the arena and poll further R of R groups simultaneously with newly processed signals. "Such a system is designed so that an internally generated signal is re-entered *as if it were an external signal,*" Edelman says. This feature, he explains, provides a means of dealing with novelty and for reviewing internal states, in the context of new sensory inputs.

Edelman argues that his model could allow a brain to deal with new information, such as a new symphony, which neither it nor any other brain during evolution had previously confronted. He also believes that his model is sufficient for explaining consciousness and self-awareness. In addition, the room for individuality in how the cells respond implies a considerable degree of freedom and free will. "And it involves no little man who does the thinking," Edelman concludes, "and no infinite regress, such as 'who is guarding the guardian?' "

The listening neuroscientists, who had been provided before with an 80-page description of Edelman's model, questioned him during the next hour as if they were holding a giant oral thesis examination. First several respected elders made prepared comments to which Edelman replied, and eventually a few of the young conference participants asked questions. Edelman occasionally looked for support to senior neuroanatomist Vernon Mountcastle, who was chairing the meeting, for specifics on the arrangements of brain cells.

Speaking early because he had to catch a bus to catch a plane to return to Hungary, anatomist John Szentagothai gave general approval to the theory, saying that it fit the current knowledge of brain cells and their connections. He suggested, however, that re-entry of processed signals would allow too many possibilities. "Inhibition would have to be extremely sophisticated. How can it all be kept in check?" he asked. Szentagothai also questioned, on the basis of his experience in neuroscience since the 1930s, whether the area had matured to a stage where there were enough established facts for researchers to usefully begin such an extensive theoretical enterprise.

Other respondents were concerned about the actual composition of the basic group of cells, especially how an experimenter would recognize such a group. They also discussed at what point in evolution of the complex brain there would be enough cells and flexibility for a selective, degenerate mechanism, such as Edelman was suggesting. The greatest underlying concern, however, was whether Edelman's model was so general that it could not be tested by specific experiments. "This model will be difficult to disprove," Edelman admitted.

Comments by the younger scientists during informal discussion that continued over coffee on the conference buses and during cocktails revealed interest in Edelman's synthesis of ideas, but some skepticism over his model's usefulness. One young neurophysiologist advised, "Don't title your story 'Brain Solved' until we get some experimental evidence."

Thermonuclear burn in laser fusion

Imploded-pellet fusion is the name usually given to a whole class of experiments that are attempting to achieve controlled thermonuclear fusion by exciting mini explosions in tiny pellets of fuel. The explosions are expected to result from implosions of the fuel pellets caused by bombardment by laser light, beams of accelerated electrons or beams of accelerated ions. Such crushing of the fuel pellets, it is hoped, will induce in the center of the fuel mass the temperatures and densities characteristic of "thermonuclear burn," the state found in H-bombs and desired in any controlled fusion system.

Recent years have recorded the generation of nuclear fusions in pellet targets crushed by laser light and by electron beams. But fusions can be generated in the crushing of the pellet without necessarily achieving nuclear burn conditions in the material in the core of the pellet. Now, from the Lawrence Livermore Laboratory, one of the four major centers of laser-fusion research in the United States, comes a report claiming achievement of thermonuclear-burn conditions in the center of a laser-imploded pellet, one of the criteria necessary for practical use of the method. Until this report, by N. M. Ceglio and L. W.

Coleman in the July 4 PHYSICAL REVIEW LETTERS, "There [had] been, however, no explicit demonstration that the thermonuclear burn occurs within the compressed target core, nor had the spatial distribution of the fusion events within the burn region been measured."

The report concerns two experimental shots by the laboratory's Argus facility that the experimenters consider representative of a series. The earlier claims that fusions had taken place in imploded pellets were based on the recording of sizable numbers of neutrons with energies characteristic of neutrons given off in the particular fusion reactions under study (deuterium-tritium for the laser experiments and deuterium-deuterium for the electron-beam work). The thermonuclear-burn claim is based on measurements of another product of the D-T reaction, alpha particles.

The alpha particles were used to reconstruct an image of the thermonuclear-burn region in the centers of the imploded targets by a procedure called zone-plate-coded imaging. The technique combines elements of pin-hole photography and holography. The alpha particles from the targets are passed through a plate with circular zones (Fresnel zones) and produce a shadowgraph by making pinholes in a detecting sheet in the areas where the zone plate has let them through. A photographic image is made from the pin-holed shadowgraph and used like a holograph to reconstruct an image of the burn.

The two shots (designated A and B) irradiated targets with diameters of 86 and 88 microns. The laser power for shot A was 2.4 terawatts, for shot B 3.9 terawatts. After the pellets were crushed, the thermonuclear-burn regions turned out to have ovoid shapes. The major axis for shot A was 29 microns; the minor axis was 26 microns. The axes for shot B were 26 and 22 microns.

Conditions in those regions included ion temperatures of 5,600 electron-volts for shot A and 7,000 electron-volts for shot B. The ion densities were 6.3 x 10^{21} and 1.7 x 10^{22} ions per cubic centimeter respectively. (The numbers of deuterium and tritium ions in each case were equal.) Thermonuclear burn lasted 36 picoseconds for shot A and 27 picoseconds for shot B. "The size and shape of the D-T burn region of compressed, laser-driven fusion targets have been measured by the ZPCI alpha imaging technique and the concurrence of the results with the measured fusion yield ... has been demonstrated," Ceglio and Coleman conclude.

"These measurements provide an explicit demonstration that the thermonuclear burn produced by laser-driven implosions does indeed occur within a compressed core of the imploded target." Further work will attempt similar imaging of the superthermal X-rays and fast ions emitted in pellet-crushing shots to gain further data about conditions in the centers of the pellets. □

The biofeedback picture: Negative

Biofeedback, the darling of many behavioral researchers in the late 1960s and early '70s, is beginning to show some apparent flaws as it approaches adolescence. The technique—in which a person seeing a display of his own heartbeat, brainwave pattern, blood pressure or other "feedback" signal is able to control such bodily functions—was instantly hailed as immediate, electronic meditation. It would, researchers suggested, enable hyperactive persons to relax and hypertensives to lower blood pressure. More extravagant claims linked the process to weight loss, improved health and memory, gaining friends and quitting smoking. Scores of biofeedback machine manufacturers sprung up, touting their product in a manner similar to that of present-day citizens-band radio makers.

But the fad days of biofeedback have progressed into an era of more careful, comprehensive study and consequently, some less encouraging findings about the technique's effects. Last year, University of Pennsylvania researchers reported findings that cast considerable doubt on biofeedback's ability to produce the relaxing, introspective alpha rhythm state in human beings (SN: 3/6/76, p. 148).

Now, research psychologists at the University of Kansas report results that raise "serious questions concerning the effectiveness of ... 'biofeedback training' for altering heart rate." Citing "inconsistencies" in past work, Thomas W. White, David S. Holmes and David H. Bennett set out to find whether biofeedback enabled people to lower or raise their heart rate any better than if they used different methods, or none at all.

In the experiment, reported in the July JOURNAL OF EXPERIMENTAL PSYCHOLOGY, the researchers compared biofeedback's effectiveness against:

- Simply instructing subjects to change their heart rates. According to biofeedback proponents, being able to "see" your heart rate slow down or speed up is critical in control.
- Asking subjects to sit quietly, without instructions or feedback.
- Encouraging participants to conjure up cognitive thoughts of exciting or relaxing nature.

In studying 90 male and 90 female undergraduates, the researchers also examined whether biofeedback is more effective in slowing heart beat or speeding it up, and whether the sex of the subject makes any difference. In addition, biofeedback subjects were further compared to students who unknowingly received false feedback from a machine wired to a random voltage generator that caused the needle to register random changes unrelated to actual heart rate.

The results, the psychologists report, "revealed no value whatsoever in heart rate biofeedback." Attempts, through biofeedback, to decrease heart rate, "were completely ineffective. When appropriate control groups were considered, all decreases in heart rate could be attributed to a simple adaptation [non-feedback] effect," say White, Holmes and Bennett. Results in decreasing heart rate did not differ significantly between biofeedback subjects and those who were simply instructed to slow down their heart without feedback or asked to sit quietly. "This conclusion is in sharp contrast to many previous experiments," say the Kansas team members. "Unfortunately," they add, "those experiments lacked the [necessary] control groups."

Overall, biofeedback training offered no significant advantages in raising or lowering heart rate when compared to any other of the controls. In most cases, differences among sexes were not significant. "The present experiment included a number of controls that were not employed in the previous experiments," the researchers say, "and these controls place the performance of subjects who received biofeedback in a completely different perspective." □

New hope for a gonorrhea vaccine

A research group has obtained preliminary success with an experimental vaccine against gonorrhea. Members of the University of Pittsburgh team, who tested the vaccine on themselves with favorable results, now plan on pursuing an expanded test program on 50 to 100 persons.

The incidence of gonorrhea has grown to epidemic magnitude, increasing by 1 percent per month during the past decade. This past year, there were an estimated 10 million cases of infection in the United States alone. The severity of the problem has been further aggravated by the relatively recent appearance of a gonococcal strain resistant to penicillin, the traditional treatment.

Charles C. Brinton and four colleagues formulated their vaccine from parts of the offending gonococcus bacterium. The vaccine is derived from the pili (Latin for hair)—slender tentacles that mobilize the gonococcus and adhere to afflicted tissue. Pili in general have been spoken of in relation to possible vaccines against various diseases for several years (SN: 5/10/75, p. 301).

After being inoculated, the researchers' bodies responded by manufacturing the appropriate combative antibodies. In another phase of the experiment, two of the researchers were immunized and then all five deliberately infected with gonococcus. The immunized pair manifested a greater resistance to detectable gonococcal infection than the others. □