PHYSICAL SCIENCES

From our reporters at the joint meeting in Washington of the American Physical Society and the Biophysical Society

Radiation and cells

Tunnels of damage, extending for more than 100 microns through cells in the retina, are the most dramatic effect yet demonstrated for accelerated iron particles, Cornelius A. Tobias of the Lawrence Berkeley Laboratory reports. Such damage might affect astronauts, because iron nuclei are prominent in galactic cosmic rays. The core temperatures in those tracks are so high that they speed up free radical reactions. The mechanical action of these "miniature shock waves" might also disrupt molecular structures.

Researchers at the Berkeley Bevalac are studying accelerated heavy atoms primarily to find new cancer therapies. Tobias reports that argon ions are now the best candidates for specifically killing cancer cells. He attributes the effectiveness of certain heavy ions to their ability to produce several molecular breaks, side by side, as the particles cross a cell nucleus. Such multiple breaks in DNA are less likely than single breaks to be successfully repaired by a cell.

Harold H. Rossi and colleagues at Columbia University are also looking at the fine spatial distribution of radiation damage. They postulate that alterations combine in pairs to form damaging lesions. The sublesions, Rossi suggests, could be DNA breaks and the lesions incorrectly paired double strands. Rossi tested the theory by bombarding a cell with pairs of protons that have separations down to 15 nanometers. The spacing is achieved by forcing two joined particles (for example H_2^+) through a thin foil of varying thickness. The electron joining the atoms is stripped away and the emerging particles separate gradually. Rossi finds that two particles 1 micron or less apart are more effective in killing cells than are random particles.

Nanostripes

Microcircuitry gets more and more micro. For narrower and narrower conducting lines in printed circuits, newer and finer lithographic techniques are being developed. Standard photolithography can lay down lines as narrow as 2 microns. Ultraviolet, X-ray and electron-beam methods are under development to get narrower stripes. So far, according to R. B. Laibowitz, and four colleagues at IBM, the electron-beam method is the only one that has produced practical results.

Electron-beam lithography can lay down stripes as narrow as 8 picometers (8 millionths of a millimeter). Laibowitz and colleagues have studied nanostripes, as such thin wires are called, of niobium 25 picometers wide. They find that when made superconducting, such wires exhibit the same sort of current and voltage behavior as Josephon junctions. Among the questions they are investigating are: How thin can a metal be made and still exhibit bulk metallic behavior? When does it begin to act like a chain of atoms instead?

Flashing nerves

If only nerve cells would light up when they were active. Then scientists could map the patterns of cell firing that correspond to specific behaviors. Even in a simple organism such as a leech, the information-processing collection of nerve cells contains 350 members. If researchers were compelled to examine those cells' interactions by inserting electrodes two at a time, the project of 61,000 pairs of impalements would take a lifetime, says Larry B. Cohen of Yale University.

Cohen and colleagues can now sample 50 cells simultaneously using a visual, instead of an electrical, signal. They stain with dyes they have developed that convert changes in the nerve cell membrane potential into light signals. Cohen's newest apparatus, hooked up four weeks ago, is an array of 100 photodiodes that sense small changes in the dye signals. The researchers in their preliminary experiments observed a response to one electrical stimulation in nine cells. In the cells that receive information from a barnacle eye, at least five cells responded to a shadow. The researchers hope to improve their dyes to the point where activity can be followed with a fast movie camera. Cohen concludes, "It is still true to say that there is no animal so dumb that a human understands how its nervous system controls its behavior."

Brain cells: The right place and time

The connections between nerve cells in an adult animal are highly organized and specific. During development a nerve cell must choose with which cells it will establish synapses, the communication connections. Is a cell guided by a strict, predetermined instruction for a particular interaction? Or does it have more flexibility to hook up with cells in the right place at the right time?

E. R. Macagno of Columbia University finds that location and timing are important in synapse formation between eye and brain cells in the small crustacean, *Daphnia*. He uses genetically identical animals and a computer technique that reconstructs three-dimensional nerve cells and their connections from thousands of micrographs of thin slices. Macagno and coworkers traced the interactions between the cells during normal development and then changed the script. With a fine ultraviolet radiation beam, they destroyed or delayed development of a few eye neurons. They found that when eye neurons are deleted, the corresponding brain cells make synapses with the next group of neuron processes to reach the area. When no more eye neurons arrive, the leftover brain cells degenerate. If eye development is delayed, the late eye neuron processes arrive to find their usual brain cells already taken. They then synapse with whatever brain cells are available or, if none are free, they induce cells to form extra connections. Macagno concludes that, at least in this simple animal, development is an accommodating process in which a cell can follow a number of pathways. He says, "A neuron chooses its friends not because they are especially destined to be its friends, but because they are there at the right time and place."

Suddenly it's polarized

Certain molecules can apparently become electric dipoles when they are irradiated with light. That means that electric charges separate so that one end of the molecule becomes positively charged and the other end negatively charged. Hydrocarbons with a double carbon-carbon bond are particularly susceptible to this effect, so it could have numerous physical chemical and biochemical consequences. A direct experimental demonstration of this "sudden polarization effect" is yet to be made, but already it is being invoked to explain a number of physical and biological effects. Lionel Salem of the University of Paris, who with several colleagues worked out the theory of the effect, outlined some of these.

Among numerous photochemical effects attributed to sudden polarization are the photochemistry of vitamin D and the reception of light by the retina of the eye. Salem and a colleague have suggested that light impinging on rhodopsin in the retina creates a sudden polarization in the skeleton of the rhodopsin molecule (which is a protonated Schiff base of retinal). Positive charge would flow from one end of the molecule to the other, and thus make an electric signal. The primary process of vision would therefore be the transmutation of a light signal into an electrical one.

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