Nerve, immune link found on membranes

Certain hyperactive immune system diseases disrupt nerve cells, but the immune-nervous system interaction lacks a molecular explanation. Researchers at the University of California at San Diego (UCSD) now have one candidate link — proteins that apparently appear on both immune system cells and nerve cells. The proteins, they say, could be at the root of such autoimmune diseases as multiple sclerosis and systemic lupus erythematosus.

To study the surfaces of nerve cells and white blood cells, Ken D. Pischel, Harry G. Bluestein and Virgil L. Woods Jr. of UCSD used antibodies against very late activation antigens (VLAs). These VLAs, recently discovered by Martin Hemler at the Dana Farber Cancer Institute in Boston, appear on white blood cells after the cells become active in fighting infection. The antibodies found and attached themselves to three proteins on nerve cells identical to the three subunits of VLA, the San Diego group reports in the August JOURNAL OF EXPERIMENTAL MEDICINE. Other cell types have been found to have one or two of the subunits, but neuronal cells are the only type shown to have all three, Bluestein says.

While research in other laboratories has shown other shared molecules on nerve and immune cells, the UCSD researchers believe the VLAs are more likely to be involved in the disease process. "This one is of particular interest to people interested in immunologically modulated diseases of the nervous system because it appears with the activation of the lymphocytes [white blood cells]," says Bluestein. His laboratory has preliminary evidence of antibodies to VLA in systemic lupus erythematosus, an inflammatory disorder that can affect a variety of organs.

While the exact connection between VLAs and lupus remains to be defined, Bluestein suggests one possible scenario: In the initial autoimmune disease, antibodies against VLAs on suppressor white blood cells destroy the immune system's "brakes." The same antibodies might also attack VLA-studded nerve cells, causing neurological problems. About 40 percent of people with lupus have neurological problems; half of this group suffers seizures or mental impairment with cognitive dysfunction.

In the spinal fluid of patients with multiple sclerosis, an autoimmune disease that specifically strikes nerve cells, Hemler's laboratory has found white blood cells with unusually high levels of VLA on their surface. Antibodies against the lymphocytes' VLA, Bluestein suggests, could also be attacking the nerve cells. *— J. Silberner*

Diamond electronics: Sparkling potential

A fiery sparkle isn't a diamond's only eye-catching quality. Its hardness and its ability to conduct heat and to act as an electrical insulator make diamond an attractive material for electronic circuits designed to survive high temperatures or withstand intense radiation. What has been missing is an economical, practical method for creating thin diamond films on silicon and other surfaces.

Last February, researchers at Pennsylvania State University in University Park confirmed that a vapor deposition process for growing diamond films, developed over the last few years by scientists in the Soviet Union and Japan (SN:1/26/85,p.57), actually works. "Our work," Russell Messier and his colleagues report, "has now provided the conclusive proof that continuous diamond films can be achieved in a practical deposition process." This finding has set off a spate of activity in the United States.

At a seminar last month, the Department of Defense's Strategic Defense Initiative Organization introduced its "diamond technology initiative" to investigate the synthesis, growth and processing of diamond films. Next month, Penn State is sponsoring a meeting that will bring together companies interested in pursuing diamond technology. The university intends to put together a consortium through which participating companies can sponsor applied research and benefit from ongoing diamond studies.

The basic process for generating diamond coatings involves passing a gaseous mixture of methane and hydrogen molecules at atmospheric pressure through a microwave bath. This breaks up the molecules into hydrogen and carbon atoms, which can then settle onto a silicon surface.

The presence of hydrogen appears to be necessary, says Messier, to ensure that carbon atoms end up in a tetrahedral diamond crystal arrangement rather than in a planar graphite structure. Hydrogen atoms apparently pick up "dangling" bonds on a freshly laid carbon surface so that its structure can't collapse into the graphite form. Moments later, carbon atoms replace the hydrogen atoms, and the crystalline diamond film continues to grow.

It takes about an hour to lay down a 1-micron-thick diamond layer. Each film consists of a random array of individual diamond crystals about 200 angstroms across. Efforts are now under way to speed up the deposition rate and to build films that each consist of a single diamond crystal.

"The net effect," says Messier, "is that it's very simple to make diamonds." The new process is potentially cheaper, cleaner and more versatile than high-temperature, high-pressure techniques now used to produce synthetic diamonds.

Because a diamond is so hard, diamond films could be used to coat cutting tools like drill bits. Its transparency and corrosion resistance allow its use for coating lenses and special materials that transmit infrared light. In the past, those materials have been too soft and weak for many applications. Another possibility is the use of diamond films to coat softer gemstones. Zirconia, for example, looks like diamond but is soft and easily scratched. A thin diamond coating would solve the problem. However, the process is still too expensive for many of these uses.

A diamond film's first application may be in microelectronics. Because this material conducts heat like a metal, tiny diamond slabs could be used as bases for electronic circuits that must survive high temperatures. Conventional silicon chips usually can't withstand temperatures greater than 300°C. In contrast, diamond-based devices could be used as sensors in engines or nuclear reactors. Furthermore, because overheating would be less of a problem, more circuit elements could be packed onto a single diamond-based chip.

Earlier this year, a Japanese company announced that it had succeeded in developing a diamond semiconductor. In this case, the film is doped with a small amount of phosphorus to turn it into an n-type semiconductor — one of the two types needed to create a transistor. This is one step toward creating diamond electronic devices.

In the United States, scientists at the Office of Naval Research in Washington, D.C., and at the Massachusetts Institute of Technology's Lincoln Laboratories have long worked on designs for diamond semiconductor circuits but until recently have lacked materials on which to test their designs. New research efforts to produce diamond films at Penn State, North Carolina State University in Raleigh and the Research Triangle Institute in Research Triangle Park, N.C., will now provide the raw materials for that work.

"There may be a very, very promising technology here," says John Angus of Case Western Reserve University in Cleveland. Angus spent about 20 years studying processes for producing diamond films. Says Angus, "It was a matter of stumbling onto something that works." *— I. Peterson*