Course of AIDS Foretold by T Cells

Any football fan knows that a team must be able to stop passes as well as runs—victory hinges on an array of defenses. Hence, one way to pick the winner in any match is to predict how each defense will perform.

Football is just a game—AIDS, of course, is anything but.

Yet a new study indicates that the same principle may apply. The diversity of an infected person's defenses may be the best way to tell soon after infection how long he or she will survive.

The study evolved from work by Anthony S. Fauci, Giuseppe Pantaleo, and other scientists in Switzerland, Canada, Italy, and the United States. For years, these researchers have studied HIV-challenged immune systems. At the 11th International Conference on AIDS in Vancouver last July, Fauci noted that the immune system is far from helpless against HIV.

"Initially, there is a profound suppression of virus, but some virus escapes," said Fauci, director of the National Institute of Allergy and Infectious Diseases in Bethesda, Md.

This ability to elude the immune system's onslaught and then rebound makes HIV unique. No other known virus, except herpes and possibly hepatitis B, evades destruction without overwhelming and killing the infected individual. Herpesviruses flee into latency, chronic infection with hepatitis B is unusual, but HIV not only survives, it thrives.

Still, some people with HIV infection live for a long time. By examining the interplay of HIV and immunity, the researchers may have uncovered why.

The secret is the killer T cell, a roving defender against invading microbes. Killer T cells normally exist in profusion, with more than 1,200 per microliter of blood. There are also many kinds—24 families have been identified. Each family of T cells is distinguished by differences in the second of two receptor proteins, known as alpha and beta chains, which protrude in a V from a T cell's membrane.

When a wandering virus locks into the notch made by the two arms of the V, the T cell destroys the virus. The cell then makes copies of itself that attack identical viruses. Each person has a unique arsenal of killer T cells, which Fauci says explains why some people are more susceptible than others to certain viruses.

Fauci's international team studied the T cell response in 21 people infected with HIV. All of these individuals had similar numbers of HIV cells in their blood at the start of the study. The researchers found three distinctly different patterns of responses.

In the first, HIV provoked a major expansion of a single family of T cells. In the second, two families began to multiply. The third was marked by scattershot production of small quantities of T cells from a diverse array of families.

People whose immune systems responded by producing a flood of a single T cell family "did uniformly badly," Fauci says. In just a year, the T cell counts of people in this group dropped to an average of 101 per microliter of blood, too few to ward off other infections.

People who had a more diverse population of T cells fared better. After a year, the T cell counts of people with the two-family response fell to 456 per microliter of blood, an amount sufficient to stave off other microbes. Those with the most diverse response had the slowest T cell decline and an average T cell count of 651 per microliter.

The findings appear in the Jan. 7 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES. Ultimately, Fauci says, the research may help scientists tailor a vaccine to provoke the most effective counteroffensive against HIV. It may also guide doctors in their choice of treatments. Detecting the quantity of HIV in a person's blood, now the only way to predict the course of illness, doesn't become useful until months after infection, when the virus rebounds.

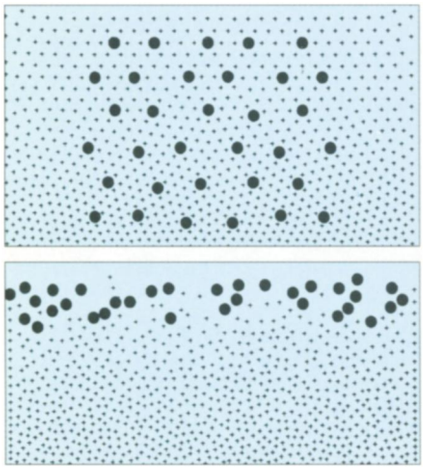
John Mellors of the University of Pittsburgh School of Medicine, a pioneer of this so-called viral load test, cautions against drawing firm conclusions from the new study. "Although this is an interesting and important observation," he says, "it must be extended to a larger population." —*S. Sternberg*

Pumping the fizz into liquid simulations

A freshly poured soft drink foams and crackles as bubbles of carbon dioxide rise to the surface and burst. Each pop churns a little liquid into the air, tickling the nose of anyone who tries to sip the beverage too soon after pouring.

Applying an innovative approach to the computer simulation of gas bubbles rising inside a liquid, two mathematicians have now obtained results that show how the movements of bubbles disturb the liquid. Analyzing such flows in detail may make possible the development of a new theory of turbulence based on molecular interactions, says Donald Greenspan of the University of Texas at Arlington.

Korlie



In this computer simulation, small bubbles of carbon dioxide (black circles) distributed in water (top) rise to the surface (bottom).

Mark S. Korlie of Montclair State University in Upper Montclair, N.J., described the findings last week at the Joint Mathematics Meetings in San Diego.

Instead of modeling the bubbles and liquid as flowing fluids, which are continuous, Korlie and Greenspan focused on the behavior of the individual molecules responding to gravity and the electric forces between them. The molecules move about erratically, colliding and rebounding like billiard balls.

To simplify the simulation, the researchers clumped the huge number of molecules present in a typical container into a relatively small number of larger units called quasimolecules, or particles (SN: 7/9/88, p. 21). Applying Newton's laws of motion, they computed how a collection of these randomly moving particles would behave.

When the simulation included a mixture of carbon dioxide and water particles, the carbon dioxide particles acted like tiny bubbles, rising to the liquid's surface. By initially placing all the carbon dioxide particles next to each other to represent a single large bubble, the mathematicians could also observe oscillations of the rising bubble and the flow of water in its wake. They noted additional turbulent motion at the liquid's surface as the bubble broke apart and carbon dioxide escaped.

Korlie and Greenspan did their simulations in two dimensions. However, "we can extend the method directly to the three-dimensional case," Korlie says.

—*I. Peterson*