New test homes in on evasive Lyme disease

A powerful laboratory technique frequently used in basic research reliably identifies trace amounts of DNA from the spiral-shaped microorganism that causes Lyme disease, according to government scientists. The finding should help researchers develop a diagnostic test for this elusive disorder, and may help unlock the mechanism underlying the disease.

Lyme disease gets its name from the Connecticut town where researchers first investigated a cluster of adults and children who suffered periodic bouts of flu, arthritis and neurological problems. Physicians now recognize these as classic symptoms of Lyme disease, caused by *Borrelia burgdorferi* bacteria (SN: 3/25/89, p.184). Yet doctors still have trouble confirming the diagnosis. At present they must rely on blood tests to detect antibodies to *B. burgdorferi* – an unreliable method because some infected people display few, if any, such antibodies.

Patricia A. Rosa and Tom G. Schwan of Rocky Mountain Laboratories in Hamilton, Mont. (part of the National Institute of Allergy and Infectious Diseases) used a technique called polymerase chain reaction (PCR) to develop a test so sensitive that it can detect *B. burgdorferi* DNA in a sample containing as few as five spirochetes. That sensitivity is important because many Lyme patients have very few spirochetes in their blood or tissues.

The team first identified a target DNA sequence present in *B. burgdorferi* and then devised two DNA segments that home in on and bind with the target DNA. Adding the enzyme polymerase, which copies the original DNA target, prompts a chain reaction that generates millions of copies of the target, revealing the presence of spirochetes even in samples containing trace amounts of genetic material.

The scientists report in the December JOURNAL OF INFECTIOUS DISEASES that the PCR test picks out DNA from slightly different strains of *B. burgdorferi*. The test reacted with 17 of 18 strains tested – a significant finding because many people infected with a slightly unusual strain slip through current diagnostic tests, Rosa says. The PCR test proved highly specific, reacting only with material from *B. burgdorferi* and not with DNA taken from a close relative known as *B. hermsii*, which causes a disease called relapsing fever.

A number of researchers already are applying these results in a race to develop a commercial PCR test for Lyme disease. That effort will take at least six months, estimates W. John Martin of the University of Southern California Medical Center in Los Angeles.

Rosa and Schwan plan to use PCR to find out why some Lyme patients develop severe complications such as neurologic and heart problems. One theory suggests those problems result because the bacterium changes to a form the immune system cannot recognize. Another theory holds that the heart and nerve damage comes from an autoimmune process triggered after the immune system conquers the initial infection. PCR would show whether patients with late-stage Lyme disease still harbor any form of *B. burgdorferi*, Rosa says. – *K.A. Fackelmann*

Molecular custodians sweep away odorants

The nose earns its keep by translating chemical stimuli into neural signals that ultimately convey, say, the smell of smoke or lasagna. Biochemically minded neuroscientists get paid for uncovering the molecular details of such feats.

In a seminar this week at the National Institutes of Health in Bethesda, Md., Israeli researcher Doren Lancet described studies at his lab and elsewhere revealing previously unrecognized biochemical players in the complex molecular dance underlying the sense of smell. Lancet, of the Weizmann Institute of Science in Rehovot, reports discovering several enzymes in the olfactory system's patch of receptive tissue – called the olfactory epithelium – that closely resemble detoxification enzymes found in the liver and other body tissues. These olfactory-specific enzymes might be responsible for clearing molecular odor stimuli from the sensory tissue, Lancet says.

Most odorants are volatile, water-avoiding chemicals that readily penetrate oily cell membranes. As such, Lancet says, they should easily spread throughout the sensory epithelium, continuously stimulating the sensory cells. Yet electrode recordings from odorant-stimulated frog and rat olfactory tissue show that the cells stop responding within about a second after the odor source is removed.

Scientists have long imagined that this paradox might be solved by specific enzymes that transform odorants into nonodorants or remove them from the olfactory system. Lancet and his coworkers may have found some of those enzymes. "We identified several detoxification enzymes in the olfactory epithelium," he says. One is an olfactory-specific form of cytochrome P450, a group of enzymes found in many body tissues that help detoxify chemicals that would otherwise remain inside cells to do biochemical mischief. The other is an olfactory-specific form of a different class of detoxification enzymes, known as the uridine diphosphate glucuronyl transferases, or UDPGTs. These typically pick up where a cytochrome P450 leaves off, transforming a water-avoiding molecule into a water-loving form readily cleared from tissue.

Lancet says he suspects that these enzymes, and similar ones still to be discovered in olfactory tissue, change excess odorant molecules into odorless, water-soluble forms that clear from the sensory epithelium. The researchers find the odor-eating enzymes in the glial cells that surround and support the sensory cells and in mucus-secreting cell assemblies called Bowman's glands, also located in the epithelium.

The resemblance of the olfactory forms of cytochrome P450 and UDPGT to known detoxification enzymes is not casual, Lancet suggests. In addition to helping clear out odorants, they may play a role in disarming potentially harmful chemicals, just as their enzymatic kin do in other tissues. Sensory epithelium is a penny-thin barrier between the nasal cavity and the brain, Lancet points out. "Wouldn't it be important," he asks, "for olfactory epithelium to carry a detoxification device such as these two enzymes in large amounts?" – *I. Amato*

'Preshock' pattern may foretell quakes

Investigations of the Oct. 17 Loma Prieta earthquake in northern California hint at a pattern that may help scientists predict some major quakes one to several years before they strike, seismologist Karen C. McNally reported this week at a meeting of the American Geophysical Union in San Francisco. At the same session, other researchers discussed why most structures fared so well in the quake while others collapsed.

McNally, from the University of California, Santa Cruz, observed a trend in the moderate-sized shocks occurring in the year and a half before the Bay area's magnitude 7.1 quake, and noted that the same pattern preceded a magnitude 5.8 temblor in 1986 near Livermore, Calif. In both instances, after a long period of quiet, a series of progressively deeper and larger "preshocks" led up to the main shock.

"I find this an encouraging lead in our effort to track down earthquakes," McNally says. She adds, however, that much more work is needed to determine whether this progression represents a chance occurrence or a reliable sign of an impending quake.

Loma Prieta, the strongest earthquake in the Bay area since 1906, was centered beneath the Santa Cruz mountains, striking the San Andreas fault at the southernmost section of the 1906 rupture (SN: 10/28/89, p.277). For decades the section had remained inactive. But in June 1988, a magnitude 5.1 shock broke it at a depth just shy of 14 kilometers. The next moderate temblor hit the area in August 1989, at a depth of almost 17 km. The October quake ruptured the fault at 18 km.

McNally discerned a similar pattern in three smaller shocks occurring in the months before the Livermore-area quake along the Calaveras fault. She calls the earlier quakes "preshocks" to distinguish them from the foreshocks that can appear hours or weeks before a main shock. She also notes that some quakes in Mexico and Costa Rica apparently have followed the deepening preshock pattern.

Geoscientists say the Loma Prieta quake verified the reliability of their techniques for making rough forecasts several decades before a main shock. McNally's observations now suggest a method for intermediate-term predictions: watching for quiescence followed by progressively deeper and larger preshocks. Data from Loma Prieta, however, have not offered hope for making predictions just weeks before a large quake.

William H. Prescott of the U.S. Geological Survey in Menlo Park, Calif., reports that several instruments near the fault detected no precursory signs of the main shock. One such instrument was a dilatometer, which measures strain in the ground and can detect changes one-thousandth the strength of those occurring during the main shock. Located 35 km from Loma Prieta's center, the device may have been too distant to pick up early signals, he suggests. Prescott notes that researchers are now conducting experiments in Parkfield, Calif., to learn what kinds of short-term signals might precede major quakes. Parkfield sits on a San Andreas segment that ruptures at regular intervals, leading scientists to predict a magnitude 6 temblor there within the next three years.

In terms of structural damage, engineers and geologists maintain Loma Prieta held few surprises. As in the 1906 quake, areas on landfills and soft soil shook the hardest. Overall, most buildings fared well, in part because of improved building codes and the relatively isolated location of the quake's epicenter. But peculiar aspects of the shaking also help explain the limited damage, researchers say. The fault broke quickly, producing a shaking that lasted only 6 seconds near the epicenter, says Hiroo Kanamori of the California Institute of Technology in Pasadena. In contrast, last year's magnitude 6.9 earthquake in Armenia shook for 30 to 40 seconds, he says. Usually, the longer the shaking, the more damage wrought. So, although many buildings withstood Loma Prieta, engineers caution that this is no proof they could survive another 7.1 temblor centered just as far away. *— R. Monastersky*

Starry lens puts a twinkle in quasar's eye

The 1985 discovery of four separate spots of light, or images, representing the same distant quasar provided a dramatic illustration of how the gravitational effect of an intervening galaxy can bend the path of light. Now, for the first time, astronomers have observed what they believe is the focusing of light by a single star in that galaxy. The observation, they say, should allow them to estimate the star's mass and the quasar's size.

"This represents the first detection of a microlensing event," M.J. Irwin of the Institute of Astronomy in Cambridge, England, and his colleagues write in the December ASTRONOMICAL JOURNAL.

The quasar, designated QSO 2237+0305, lies almost directly behind the center of a bright nearby galaxy (SN: 1/5/85, p.9). The galaxy's gravity splits and focuses the quasar's light into four images that collectively look like a four-leaf clover.

If the light forming one of these images happened to pass close to a star in that galaxy, the star's gravity would also focus the light. But the magnitude of that effect would change as the star moved within the galaxy, causing the image's brightness to vary over a period of a few months.

In August 1988, Irwin and his colleagues found one of the quasar's images 70 percent brighter than it had been in the previous year. A month later, the image had faded a little. The change was too rapid to result from the motion of the galaxy as a whole and too slow to have been caused by shifts in the quasar's own brightness, they say.

The astronomers calculate that the object responsible for altering the image's brightness has a mass between one-thousandth and one-tenth that of the sun. This suggests the lensing object may even be a brown dwarf — a difficult-to-detect lump of gas larger than a planet but having too little mass to sustain the fusion reactions that occur at the cores of stars.

Additional observations of brightness variations over time should provide detailed information about the quasar's size and structure. "Continued monitoring of the 2237+0305 system to accumulate data on a number of individual events offers the possibility of constraining both the size of the quasar-continuum-emitting region and the mass distribution function for stars and any other population of compact objects within the intervening galaxy," the astronomers say. In other words, it's a system worth watching.

— I. Peterson

Does the moon spark like a Life Saver?

For centuries, amateur and professional astronomers alike have reported observing sudden brightenings or flashes on the surface of the Earth's moon. These events are sometimes described merely as "lunar transient phenomena," for lack of a universally accepted way to explain them. Scientists seeking an energy source for the strange flashes — which observers have seldom if ever found while deliberately looking for them — have speculated on causes, including light emissions stimulated by solar ultraviolet photons, accelerated particles from the tail of Earth's magnetic field, and processes somehow associated with solar flares.

Now, Richard R. Zito of Lockheed Missiles and Space Co. in Sunnyvale, Calif., proposes yet another possible origin — the rocks of the moon itself. Inert gases such as helium would be the likeliest to produce such glows, he writes in the December ICARUS, adding that "surface rocks returned from the moon by Apollo 11 show inert gas concentrations 20 to 10,000 times larger than those of the terrestrial values."

The gases can be released through cracks created by heat stresses, such as those that occur when parts of the lunar surface pass from darkness into sunlight, Zito points out. Many of these surface flashes, he says, have appeared in or near craters associated with fault systems. As for the energy to light up the little puffs of gas, he says, "it has recently been observed that flashes of light are emitted during the laboratory fracturing of rocks."

According to Zito, the flashes appear to take place when energetic electrons are emitted from freshly fractured surfaces. He also notes that "a similar effect is known to occur when Wint-O-Green Life Savers are cracked" (SN: 7/30/88, p.78).

Furthermore, the fracturing of a rock sometimes produces not only the optical pulse but also "a curious radio emission" with frequencies ranging from about 900 to 5,000 hertz, Zito says. This is "believed to be due to the rotational, vibrational and linear motions of charged fresh surfaces created during cracking" — in other words, a rearranging of the rock's crystal structure. The wavelengths of emissions at these frequencies ought to be detectable by an antenna aboard a moon-orbiting satellite, he says. If Zito's hunch is correct, the radiation pattern should resemble that observed in the laboratory studies. *— J. Eberhart*