Chemistry

Elizabeth Pennisi reports from Atlanta at an American Chemical Society meeting

Probing cocaine's effect on the brain

Researchers suspect that chronic cocaine use alters the brain's chemical balance so that decreases in dopamine, a naturally occurring neurotransmitter, lead to cravings for more cocaine. However, experiments with animals given cocaine have not revealed much difference in the the total amount of dopamine measured in the brain.

An advance in analytical chemistry has now provided a clue to the mystery of addiction. By implanting tiny tubes into specific regions of the rat brain, analytical chemist Jay B. Justice at Emory University in Atlanta has detected a delayed effect of long-term cocaine administration. The probes, not much thicker than a human hair, stick into the fluid that surrounds nerve cells deep in the brain and provide a detailed accounting of what is going on there. "That's where we see [dopamine] depletion," Justice told SCIENCE NEWS.

Justice gave rats cocaine daily for 10 days. One day after they stopped receiving the drug, and then again 10 days later, he used the implanted tubes to assess their brain chemistry. Although dopamine concentration in fluid samples drawn from the rats was very low, Justice says he was able to detect a 50 percent decrease in dopamine levels 10 days after he stopped giving the rats cocaine. No such change appeared the day after cocaine administration ceased, he adds.

'Protective' gloves sometimes aren't

Often, only a thin layer of rubber stands between the skin and toxic substances. But workers who don safety gloves while handling organic chemicals might not get the protection they expect, say two chemists from the University of Akron in Ohio.

James K. Hardy and graduate student Christopher Fricker evaluated whether seven common organic solids penetrated five glove materials. For the tests, they mounted pieces of latex, urethane, nitrile, neoprene and polyvinyl chloride, one at a time, in a pressurized stainless steel cylinder. Then they put a pellet of organic solid on the test material and measured how quickly molecules from the pellet "broke through" to the other side and built up a concentration three times that already in the environment.

"No glove is totally impermeable," Fricker says. Some protected against a few solids, but none worked against every solid tested. Solids took minutes to hours to seep through. These times decreased as temperature increased, he notes.

The results showed that powdered camphor, used in polymer processing, generally went through the fastest. Overall, the nitrile material proved the most protective. Nonetheless, Fricker says, "I think they need to design a better glove material." Until then, he advises workers to change (and safely dispose of) their gloves often, every 5 minutes if possible.

Oyster shell protein fights corrosion

A piece of protein isolated from oyster shells may one day eliminate the scaly white buildup inside metal water pipes, tanks and pumps. This natural anti-scalant also seems to prevent corrosion, according to researchers from the Mineralization Center at the University of South Alabama in Mobile.

Biologist Eric Mueller reports that he and his colleagues have figured out how to synthesize this substance, called polyaspartate.

Industries that use water for cooling risk fouling their plumbing with deposits of calcium carbonate and other minerals. The chemicals used today to slow this precipitation and prevent corrosion can pollute the environment, Mueller says. But polyaspartate is "just amino acids," he says, "and when they break down they are usable in the environment."

He thinks the oyster-inspired chemical could become a standard water treatment.

Physics

Ivars Peterson reports from Washington, D.C., at an American Physical Society meeting

Did Brown see Brownian motion?

The name of Scottish botanist Robert Brown is inextricably linked with the term "Brownian motion," now used to characterize a wide range of physical processes that exhibit small, random fluctuations. But in 1827, when Brown first observed under a microscope the erratic jiggling of pollen grains and other tiny particles suspended in water, he had no convincing explanation of the motion's cause. The notion that these mysterious, random movements resulted from the combined effects of water molecules bombarding the suspended particles came many decades later.

About six years ago, chemist Daniel H. Deutsch of Pasadena, Calif., became curious enough about Brownian motion to try to see it for himself. He discovered that to observe true Brownian motion in water, he needed a powerful microscope well protected from vibrations. Moreover, the motion became readily apparent only when the suspended particles were about 1 micron in diameter — much smaller than a pollen grain — and had a density close to that of water. The care required to observe these movements raised a question in Deutsch's mind: Was the vigorous motion observed by Brown really caused by the action of bombarding water molecules?

Deutsch started digging into historical records of Brown's research to find an answer. "The more I looked, the more obvious it became that there was something wrong," Deutsch says. "There are at least half a dozen reasons why it would not have been possible for Robert Brown to have observed Brownian motion."

The microscopes Brown used were quite different from modern instruments, Deutsch says. They were much less rigid and had a narrower field of view. In addition, samples consisting of small water droplets remained uncovered during observation, allowing the water both to jiggle and to evaporate quickly. Instrument vibrations and currents induced by evaporation would cause particles suspended in a water droplet to move, he contends. These particles would quickly dart in and out of the field of view, making it difficult to track their movements.

"Brown was seeing, in effect, flotsam on the ocean, where you have waves knocking things about," Deutsch says. "It's very easy to be deceived. You need the proper equipment to observe Brownian motion."

Singling out molecules in solution

A newly developed technique for detecting individual dye molecules in solution may lead to a high-speed method for determining the base sequences that make up a single strand of DNA. The observation technique, developed by E. Brooks Shera and his co-workers at the Los Alamos (N.M.) National Laboratory, involves passing an extremely dilute solution containing dye molecules down a plastic tube and through a tightly focused laser beam. The pulsed laser light excites the dye molecules one at a time, causing them to emit light, or fluoresce. Thus, each passing molecule generates a readily detectable flash of light.

This work represents the first efficient detection of individual fluorescent molecules in solution, Shera says. Such a technique should have a variety of applications in biological and chemical science.

Applying the method to DNA sequencing requires tagging each type of base along a DNA strand with a chemical marker that fluoresces at a particular wavelength. By using enzymes to snip off one base at a time from the strand, then letting each cleaved, tagged base travel past a laser beam and detector, scientists could identify each base in the proper order. However, the Los Alamos researchers have yet to work out the details of how to tag DNA and other molecules of interest.