increasing the production of Crm1p in a cell, they could stimulate the nuclear export of Rev and certain kinds of RNA. Moreover, leptomycin B blocked this process and could break apart complexes formed by Crm1p and Rev.

Dargemont's group, experimenting with laboratory-grown cancer cells, also turned to leptomycin B for proof of Crm1p's job. They showed, for example, that the drug prevented the export of proteins bearing the nuclear export signal.

By providing evidence that Crm1p binds to certain proteins that form part of the nuclear pore, Rosbash and his colleagues added another chapter to the Crm1p story. Previous research had linked Rev to these pore proteins, but scientists had been unable to show that the molecules could join together directly. The new data suggest that the pore proteins and the Crm1p proteins bearing the nuclear export signal form a complex involved in export.

The work "indicates that Crm1p interacts with these nuclear pore components and delivers its cargo—Rev, for example—to the pore," concludes Rosbash.

While the identification of Crm1p as the protein used by Rev for exporting HIV's RNA represents a major advance in the nuclear export field, several key questions concerning Crm1p remain unsettled.

First, what material in a healthy cell's nucleus does Crm1p usually export? It clearly helps proteins bearing an export signal to leave the nucleus, but the scientists don't know whether those proteins are the ones that transport the cell's various forms of RNA.

In addition to the RNA that conveys protein-making instructions, the so-called messenger RNA, at least four other classes of RNA exist. Some of the recent experiments suggest that Crm1p exports the cell's messenger RNA, whereas some others indicate that it exports other classes of RNA.

"I think it's a little bit up in the air for the moment," says Rosbash.

"This is still an open question," agrees Weis, whose own data point to Crm1p as an exporter of messenger RNA.

It's possible that the cell's messenger RNA export occurs without Crm1p. Considering the size of the importin-beta protein family, scientists expect ultimately to identify several additional transport proteins. Each form of RNA may have its own export molecule.

One research group has already identified a specialized exporter. In the Sept. 19 CELL, Dirk Görlich of the University of Heidelberg and his colleagues describe a protein called CAS that recycles importin-alpha to the cytoplasm after the import molecule has released its cargo inside the nucleus. CAS is also a member of the importin-beta family of proteins, bolstering the notion that all such molecules are dedicated to either nuclear import or export.

As researchers eventually uncover the full roster of proteins driving import and export, they hope to grasp how cells manipulate nuclear transport to perform specific functions, such as regulating gene activity with proteins called transcription factors. "By changing the localization between cytoplasm and nucleus, you can make a transcription work or not work," notes Weis.

Studies of nuclear export may also help scientists design variations of leptomycin B that prevent Rev from exporting HIV's RNA but allow cells to continue normal nuclear export. "This could be another way of fighting HIV," speculates Forbes.

Finally, investigators note that the development of a nucleus to sequester DNA is the most important difference between eukaryotes, such as plants and animals, and prokaryotes, such as bacteria, whose DNA floats freely in the cell. Consequently, piecing together the molecules behind nuclear import and export could provide insight into how eukaryotes achieved that major evolutionary step. □

Chemistry

Biosensors respond with colored light

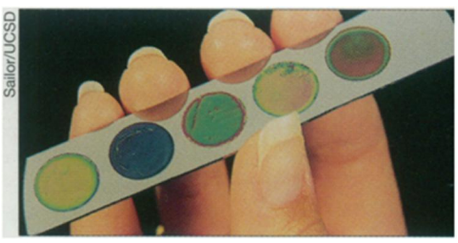
When the color of autumn leaves changes from green to red, orange, and gold, it's easy to tell that winter is afoot. Similarly, sensors that change color provide a clear way to discern the presence of chemical substances. Recently, two research groups have demonstrated new schemes for such devices.

One design consists of a specially prepared silicon wafer that signals the presence of organic molecules, DNA, and proteins through subtle changes in color. The device is "exquisitely sensitive," says Michael J. Sailor of the University of California, San Diego in La Jolla, detecting concentrations one-hundredth the size of those currently observable. Sailor, M. Reza Ghadiri of the Scripps Research Institute in La Jolla, and their colleagues describe the sensor in the Oct. 31 SCIENCE.

Etching produces a forest of tiny vertical channels in the thin silicon wafer, making the surface layer porous. This changes the optical properties of the normally silver-colored silicon, giving it an iridescent sheen. The specific colors produced depend on the thickness of the porous layer and the geometry of the channels.

The researchers then attach to the porous silicon a number of molecules that recognize and bind to the substance they want to detect. For example, to detect a particular sequence of DNA, the team attaches many complementary single strands of DNA to the wafer. As a solution containing the target sequence diffuses into the pores and the matching DNA strands bind to each other, the color of the silicon changes. By monitoring that color change with a spectrometer, the researchers can directly confirm the presence of the DNA.

Another sensor, developed by researchers at the University of Pittsburgh, takes advantage of the properties of colloidal crystals, or arrays of tiny polymer spheres (SN: 4/12/97, p. 224). Colloidal crystals diffract visible light and produce different colors, depending on the spacing of the spheres.



Silicon etched to five different depths displays a variety of colors.

John H. Holtz and Sanford A. Asher embed a colloidal crystal in a gel that can be made to swell when it encounters substances such as glucose or metal ions. As the gel increases in volume, it spreads the polymer spheres apart, thus changing the color of the diffracted light. The team reports its findings in the Oct. 23 NATURE. —*C.W.*

Single enzymes twist and twitch over time

Researchers at the Ames (Iowa) Laboratory have observed the behavior of individual enzyme molecules as they catalyze reactions. Weihong Tan and Edward S. Yeung trapped single molecules of the enzyme lactate dehydrogenase in two different types of vials: the pores of a membrane sold commercially as a filter and holes drilled into a quartz slide. Each vial held just one-thousandth of a trillionth of a liter of liquid.

By monitoring the fluorescent products of the enzyme reaction, the team saw that a single enzyme molecule can change its behavior over the course of a couple of hours. "One molecule can suddenly switch to a higher reaction rate, then go back to what it was before," Yeung says.

The switching probably results when the enzyme twists into different conformations as it interacts with the walls of the vial, he explains. Drugs designed to target these other forms might show greater efficacy. The report appears in the Oct. 15 ANALYTICAL CHEMISTRY. —*C.W.*