Mother's Blood Shows Baby's Future

In his masterwork "Auguries of Innocence," poet William Blake hailed the power of imaginative vision that beholds "a World in a Grain of Sand." Now researchers, in a tour de force of their own, have found a way to decipher the chromosomal makeup of a 10-week-old fetus by peering into a drop of its mother's blood.

The study was a small one, involving just two pregnant women—one who feared that her baby might be born with sickle-cell anemia and another who worried that her baby might inherit a hemoglobin deficiency called thalassemia. Both fetuses were normal.

Despite the study's limitations, the implications for prenatal diagnosis of genetic disease are profound, asserts Yuet Wai Kan of the Howard Hughes Medical Institute at the University of California, San Francisco.

"The method could be applied to any genetic disease in which the mutation is known," he says. Kan and his colleagues report their findings in the November NATURE GENETICS.

David L. Rimoin of the University of California, Los Angeles, School of Medicine says that such a test, if it lives up to expectations, could usher in a new era of prenatal diagnosis.

"One can theorize, at least, that you could develop microchips with hundreds of mutations on them and screen for all of the mutations," he says.

Just 30 years ago, prenatal diagnosis did not exist. Now, amniocentesis and chorionic villus sampling can tell expectant parents whether their child will be born with sickle-cell anemia, thalassemia, or certain other genetic diseases. Parents can then decide whether to continue the pregnancy.

These diagnostic procedures carry slight risks because they require doctors to invade the uterus with a slender needle to obtain fetal cells. Amniocentesis provokes miscarriage in a fraction of 1 percent of cases. Chorionic villus sampling causes miscarriage about 1 percent of the time.

Using maternal blood would eliminate those risks, Rimoin says.

The Kan study was inspired, in part, by research showing that fetal cells circulate in a mother's blood. Indeed, scientists showed recently that lymphocytes descended from a fetus' white blood cells may flourish in the mother's blood for decades (SN: 2/10/96, p. 85).

Although the presence of fetal cells in a woman's bloodstream makes the new technique possible, the ability of the cells to replicate long after a baby's birth also means that doctors might recover cells stemming from an earlier pregnancy.

To eliminate this possibility, the researchers zeroed in on a red blood cell, called an erythroblast, that has a brief life span.

First, they sorted out maternal and fetal red cells from all others by mixing them with iron-bearing beads that had been coated with antibodies. These antibodies attached themselves to the red cells. The group then used a magnet to pull the beads laden with red cells from the maternal blood.

Next, the researchers washed the red cells off the beads and mixed them with antibodies to fetal hemoglobin. These antibodies, which had been tagged with an intense red dye, latched onto the fetal cells and stained them a brilliant scarlet.

Then came the painstaking task of picking out each dyed fetal cell from the thousands of other cells under a microscope. Once this task was complete, the researchers analyzed the fetal cells' DNA to determine whether the threatening mutations were present.

Kan says he and his coworkers will test the technique in more patients to assess its reliability. Then, he predicts, other researchers will computerize the process to hasten it along. Finally, perhaps, a new era of prenatal diagnosis will be born. — *S. Sternberg*

Jolting crystals into new nanostructures

Researchers have used the needle tips of scanning probe microscopes to manipulate atoms on a material's surface. They have positioned atoms to spell out nanoscopic messages and moved them about to create and characterize a variety of structures (SN: 10/9/93, p. 228; 9/14/96, p. 167).

Now, chemist Charles M. Lieber and his coworkers at Harvard University have discovered that a voltage applied to the tip of a scanning tunneling microscope can alter the nearby surface crystal structure. An electric pulse creates a nanocrystalline island with an atomic arrangement different from that of the rest of the material.

This technique represents a new approach to the fabrication of nanostructures, Lieber says. The scientists report their achievement in the Nov. 1 SCIENCE.

Lieber and his team start with a single crystal of tantalum diselenide oriented to display a surface consisting of an array of selenium atoms closely packed into a hexagonal arrangement. They use a special scanning tunneling microscope, operated in an ultrahigh vacuum and at a frigid 4.8 kelvins (the temperature of liquid helium), to modify this surface.

A pulse of electricity delivered through the microscope's tip induces surface selenium atoms to shift slightly away from the tip. These movements alter the bonding arrangement between the selenium atoms and the underlying tantalum atoms, creating a new local crystal structure.

As long as they keep the voltage of the pulse above a certain threshold value, the researchers can vary the voltage to create crystal islands that range in width from 7 nanometers to more than 100 nm.

Because Lieber can now, with "fair reproducibility," control the size of the nanocrystals created on a tantalum diselenide surface, he and his team can investigate the effect of confinement on the distribution of electrons in nanocrystals and on other physical characteristics important for determining potential applications.

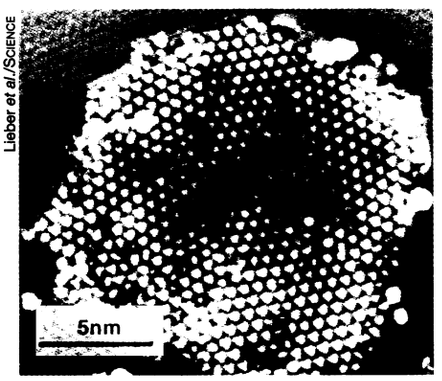

Image of an island of one crystal form of tantalum diselenide surrounded by another.

"We have enough control at this point to put two or three of these little nanoclusters very close together," Lieber says. "We can start to create arrays to study how these nanostructures might interact with one another at different separations." — *I. Peterson*