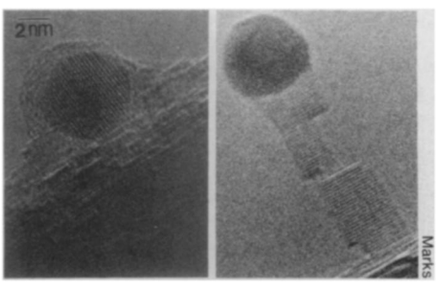
The liquid state of solid gold particles

Tiny particles of gold, made up of only a few thousand atoms, sometimes behave more like liquids than solids. New experimental evidence suggests that although such particles have a particular, orderly atomic structure at any given moment, they can easily shift from one atomic arrangement to another. Under these conditions, the particle appears to be in a "quasimolten" state, even though the material is at a temperature far below its normal melting point.

"It's both a solid and a liquid," says materials scientist Laurence D. Marks of Northwestern University in Evanston, Ill. "If you look at it for minutes to hours, it's a liquid. But if you look at it on the [much shorter] time scale, say, of a chemical reaction at the surface, it's a solid." Marks and P.M. Ajayan report their findings in the July 17 PHYSICAL REVIEW LETTERS.

The researchers used an intense electron beam to dislodge "ultrafine" gold particles attached to a magnesium oxide surface. Once free, the particles started rapidly and randomly changing their atomic structure. The experiments showed that whereas a large amount of energy was needed to initiate this behavior, only a small amount was required to sustain it.



A small gold particle, covered by a thin carbon coating, sits on a magnesium oxide substrate (left). The evenly spaced lines represent rows of gold atoms. Turning on the electron beam eliminates the carbon contamination and initiates the formation of a pillar beneath the gold particle. Eventually, the particle atop its pillar becomes so loosely attached to the substrate that its structure starts to fluctuate freely, even when the electron beam is faint. The particle's atomic arrangement shifts so many times in the 3 seconds it takes to produce an image that clearly defined rows of atoms are no longer visible (right). This behavior can last up to 40 minutes.

"We actually turned the beam off for 5 or 10 minutes, and when we turned the beam back on, it was still in the state," Marks says. That observation demonstrates that the particle's fluctuating behavior is a property of the particle itself rather than an electron-beam effect.

Marks and Ajayan also observed that tiny gold particles can sometimes induce the formation of a pillar of material beneath them. "Where the gold touches the magnesium oxide, it strains the material," Marks says. "As a consequence of that strain, some matter gets pulled out toward the particle."

Chemists often use fine particles as catalysts to speed up reactions. Usually, catalysis works by a lock-and-key mechanism in which the particle, having a certain surface structure, is the lock and the incoming molecule the key. "You really have to change how you think about a small particle," Marks says. "Your lock is actually changing in structure. It's varying its code all the time." —*I. Peterson*

Land plants' algal roots

Scientists know little about how plants evolved from their green algal ancestors. The problem is plain: Primitive plants, lacking hard parts, made poor fossils. But botanists probing living organisms have inserted a new piece into the plant-ancestry puzzle.

In the alga considered the best model organism for a land-plant ancestor, researchers at the University of Wisconsin-Madison have discovered a compound similar to lignin — an important structural element of wood and of cell walls in all vascular plants.

The finding provides a "chemical missing link" between land plants and the group of green algae that scientists believe gave rise to them about 400 million years ago, says Cornell University plant scientist Karl J. Niklas. Moreover, it suggests that lignin originated in algae and not, as previously thought, in early land plants, says study leader Charles F. Delwiche, who reports his group's results in the July 28 SCIENCE.

The new evidence also suggests that lignin's first function was not structural, since algae need not stand up in the water. Rather, the woody material probably acted initially as an antimicrobial agent, only later taking on a mechanical role, Delwiche says.

In addition, the Madison research team found a striking similarity between the distribution of the lignin-like chemical in the alga *Coleochaete* and in a species of hornwort, an early group of land plants related to mosses. This similarity indicates a closer-than-expected relationship between green algae and hornworts, Niklas says.

Delwiche's team began to suspect that something like lignin lurked in *Coleochaete* when they boiled the millimeter-wide organisms in strong acid and discovered, to their surprise, that much of the tissue remained intact. Using chemical and microscopic tests, they went on to confirm the identity of the durable debris. □

Cancer roadblock on cholesterol pathway

The road to cholesterol synthesis is paved with more than a dozen chemical precursors. Biochemists now report that blocking the production of one of these precursors yields an unexpected payoff: A protein involved in pancreatic and colon cancers can no longer prompt cellular changes associated with cancerous growth.

The finding, they say, establishes the first major link between cholesterol synthesis and cancer. It also suggests a new arsenal of anticancer drugs — possibly including a compound now marketed as a cholesterol-lowering agent — that target specific cholesterol precursors. On a more basic level, the discovery may help clarify the chemical changes and genetic mutations that trigger some genes, called oncogenes, to cause cancerous alterations in cells.

Researchers at the University of California, Berkeley, and the Lawrence Berkeley Laboratory inhibited the formation of mevalonate, a precursor to cholesterol and other compounds. Without mevalonate, the protein encoded by the *ras* oncogene cannot attach to cell membranes — a critical step in promoting pancreatic and colon cancers. Though the protein retains its ability to promote cancer, without membrane attachment it never gets the chance.

In unfertilized frog eggs, the group observed that human oncogenic ras — a rare, mutant relative of the normal ras protein found in cells — caused breakdown of the envelope surrounding the cell nucleus, indicating the protein induced cell division. But preinjecting the eggs with compactin or lovastatin — drugs that block the formation of mevalonate — prevented oncogenic ras from maturing and initiating envelope breakdown. Adding mevalonate to these eggs restored the ras protein's ability to cause envelope breakdown, the researchers report in the July 28 SCIENCE.

Because physicians already prescribe lovastatin to lower cholesterol in some patients (SN: 9/12/87, p.166), researchers are eager to know if the drug also lowers the incidence of cancers associated with the *ras* oncogene. But the California scientists and others emphasize that the anticancer potential of any such drug would hinge not on its cholesterol-lowering properties *per se* but on its ability to block precursors that assist oncogenic ras. In fact, note study coauthors Jasper Rine and William R. Schafer, better anticancer drugs might come from compounds that act on another cholesterol precursor, farnesyl pyrophosphate, which derives from mevalonate and serves to "glue" ras to cell membranes.

"Proteins such as ras are water-loving