Some data were lost, and several samples formed bubbles. The researchers are still analyzing the unexpected imperfections.

Based on earlier results, Andrews chose an aluminum nitride container for the 1996 experiments in order to minimize the wetting behavior. Some scientists, however, have gotten rid of containers altogether. An apparatus called the Electromagnetic Containerless Processing Facility (referred to by its German acronym TEMPUS) flew on two shuttle missions in 1994 and the summer of 1997.

Built for the German space agency, TEMPUS uses an electromagnetic field to levitate droplets of molten metal about 7 millimeters in diameter. Scientists can then heat and cool the samples and measure their physical properties.

"The sample is completely spherical. This is something that we can only achieve in microgravity," says project scientist Ivan Egry of the German Aerospace Center in Cologne. Spherical samples can provide more accurate measurements.

The containerless technique enables scientists to study crystallization over a greater temperature range than is possible on Earth. To study the crystallization, the scientists melt the sample, then cool it carefully below its freezing point. Ordinarily, "any scratch on the container causes it to immediately solidify," says Jan R. Rogers, the U.S. project scientist for TEMPUS who is based at the Marshall Space Flight Center. The scratches serve as nucleation sites, or starting points for the crystal formation.


Marshall Space Flight Center

A palladium-copper-silicon sphere glows when heated in an apparatus that holds metal samples electromagnetically.

Without those imperfections, though, the molten metal globules can cool past the freezing point and remain liquid. Then, Rogers says, TEMPUS stabs the sample with a needle, triggering crystallization when the scientists are prepared to measure it.

On Earth, containerless processing devices need powerful magnetic fields. "Metals have a high density, so it takes a lot of force to lift them up against gravity," Rogers says. Those high fields also tend to heat the samples, which then have to be cooled with a stream of gas, introducing impurities.

The first flight of TEMPUS was "not that successful," Rogers says, but the 1997 flight yielded much useful information. TEMPUS processed 18 samples, ranging from individual metals to alloys combining two to five elements. The remotely controlled apparatus measured the viscosity, surface tension, and other physical characteristics of the liquids at temperatures lower than could be achieved on Earth.

The basic information gleaned from these studies could help scientists develop better models to predict the properties of metals and metal alloys, says Coriell. Those, in turn, could lead toward ways to improve metal processing—increasing its efficiency, reducing its cost, or perhaps creating new alloys with interesting properties.

Could metal alloys be processed commercially in space, considering that microgravity allows them to mix in unusual ways? Sure, Andrews says, but "could anyone afford to purchase them? Probably not." It seems that even materials that are born in space will have to be manufactured on Earth. □

Biochemistry

New penicillin booby-traps bacteria

For years after its introduction as a drug in the 1940s, penicillin served as the first-line defense against bacterial infections. Bacteria evolved, however, into new strains with the ability to survive the drug. Now, many infections are resistant to penicillin and other antibiotics, fueling fears that doctors may soon run out of tools to keep these diseases in check.

A new study suggests that, with modification, penicillin might still have some punch left. Researchers at the University of Limerick in Ireland have attached a molecular booby trap to penicillin that can potentially defeat resistant bacteria. Timothy P. Smyth and his colleagues reported their strategy on Oct. 9 in the online version of the JOURNAL OF ORGANIC CHEMISTRY.

Bacterial strains resistant to penicillin have enzymes called beta-lactamases, which clip a crucial ring of the penicillin molecule, rendering it ineffective. "Over 190 of these enzymes have been identified so far, and the count is rising," Smyth says.

He and his colleagues chemically modified penicillin so that it releases a molecular fragment when a beta-lactamase cuts the ring. The fragment can be designed to kill bacteria. The most effective penicillin molecule they have synthesized to date kills *Escherichia coli* in the test tube, but only at high doses. Any bacteria that do not produce a beta-lactamase would be destroyed by the regular action of the antibiotic.

A strategy currently used to overcome resistant bacteria combines penicillin with compounds that block beta-lactamases, thus protecting the antibiotic. Bacteria, however, quickly develop beta-lactamases that don't bind those substances. To avoid that problem, the Limerick team uses the enzyme itself as a trigger to release and activate the lethal fragment, Smyth says.

Although the scheme looks promising, he adds, "there is some way to go yet to deliver a therapeutically useful drug." —*C.W.*

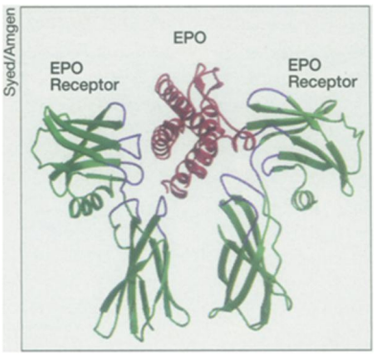
A new angle on a blood-cell hormone

People who need a boost in red-blood-cell production—anemic patients or those undergoing chemotherapy, for example—often take doses of the natural hormone erythropoietin (EPO). Now, a team of scientists in California has learned more about how EPO stimulates the creation of those cells.

Acting in the bone marrow, EPO binds simultaneously to two closely spaced molecules on the surface of a blood-precursor cell, thus triggering a cascade of biochemical reactions that transform the precursor cell into a red blood cell.

By looking at the three-dimensional structure of EPO with its bound receptor molecules, the researchers saw that the angle the receptors form is crucial. The receptors normally form a 120° angle, says Rashid S. Syed of Amgen in Thousand Oaks, Calif. This alignment best triggers the cell's biochemical cascade, he and his colleagues report in the Oct. 1 NATURE.

The three-dimensional structure seems to explain why smaller, synthetic proteins designed to bind to EPO receptors don't produce many red blood cells. These mimics move the receptors into a less efficient, 180° angle and twist them slightly. Molecules that can correct both the angle and the twist might be better substitutes for EPO, Syed says. —*C.W.*



Syed/Amgen

The three-dimensional structure of erythropoietin (center) bound to its two receptors (left and right).