rocks, the scientists may be able to determine whether the soil is finely ground rock.

Before the Mossbauer spectrometer took its first measurements, Squyres surmised that the fine-grained particles in the soil are bound only weakly by electrostatic forces. If that were the case, the mechanical force exerted when the spectrometer presses down into the Martian surface would cause soil particles to "collapse and flatten like talcum powder," Squyres says. Yet pictures taken with the microscope after the spectrometer was removed showed little or no change in texture.

Squyres now proposes that sulfate and chloride salts act as a strong chemical glue that holds together the soil particles. The salts may have derived from ancient, gas-belching volcanoes or been transported by a salty ocean that once flowed on the planet, he adds.

Harry Y. McSween of the University of Tennessee at Knoxville says that olivine, such as that detected by the X-ray spectrometer, is rapidly transformed to other compounds in the presence of water. The Martian olivine may argue against the presence of vast amounts of liquid water billions of years ago at the site. Or it could mean that the soil formed after a body of water had evaporated.

Squyres says he's convinced that "lake sediments are in fact buried beneath our [rover's] wheels." It's just not clear how far below, he adds. —R. COWEN

Dawn of the Y

Papaya: Glimpse of early sex chromosome

The papaya plant carries the youngest Y chromosome ever found, reports a research team. That sex chromosome is so new evolutionarily that it doesn't have the stripped-down style of full-fledged Y chromosomes.

The papaya chromosome carrying the gene for maleness doesn't look different from the plant's other chromosomes, explains Ray Ming of the Hawaii Agriculture Research Center in Aiea. Fine-scale genetic mapping indicates two traits characteristic of Y chromosomes, Ming and his colleagues report in the Jan. 22 *Nature*. The papaya's male-determining region doesn't swap genes with the corresponding region of its partner chromosome, and the Y region shows signs of genetic degeneration.

INVENTING SEXES Papaya plants can be male, female, or some of both, thanks to incipient sex chromosomes that may show how sex chromosomes arise.

Deborah Charlesworth of the University of Edinburgh says, "It is not rash to call this a Y chromosome or at least an evolving Y." The findings support the evolutionary theories of how sex chromosomes arise, she adds.

"As far as the Y chromosome's evolution is involved, papaya obviously represents a very early step, probably the earliest studied now," says plant–sex chromosome specialist Boris Vyskot of the Czech Academy of Sciences in Brno.

"Knowledge of sex determination in plants is negligible," says Vyskot. Only about 5 percent of flowering plant species—including some familiar plants, such as hops, date palms, and spinach—form individuals with separate sexes. Papaya plants can turn out male, female, or hermaphroditic.

Not all plants with separate sexes have sex chromosomes that look different from their partner. Hemp does, for example, but willow trees don't seem to, says Charlesworth.

For plants, separate sex chromosomes probably arose only some 20 million to 25 million years ago, says Ming. In contrast, the human Y chromosome dates from 200 million to 320 million years ago.

The general location of papaya's male-determining gene was known before Ming's team began its work. The researchers used genetic markers to make a detailed map of the area around that gene, although they haven't yet sequenced the region's DNA.

"They've done a lot of beautiful genetics," Charlesworth says. "It's a triumph to be able to get this amount of detail."

In more than 2,000 papaya plants sampled, Ming and his colleagues found no evidence of gene swapping, or recombination, between the male-determining region and the comparable stretch on the partner chromosome.

Without recombination between chromosomes, Y chromosomes tend to degenerate. The papaya researchers report that this plant's sex-determining region is starting to lose genes for nonsexual traits and to accumulate anomalous DNA. The region has only 62 percent of the gene density of the rest of the papaya chromosomes. It also shows 28 percent more rogue genetic elements and nearly triple the amount of DNA with a reversed orientation.

Vyskot welcomes studies of the papaya, with its conveniently small genome, but he says that other plants also hold promise for research on sex chromosome evolution. For example, some researchers are examining liverworts, which at one life stage have only a single set of chromosomes. Nevertheless, Vyskot says, "we can expect rapid progress in understanding

the papaya genome, which is important both for basic research and plant breeding." —S. MILIUS

Pushing Cancer over the Edge

Compounds trigger tumor-cell suicide

Cancer cells are a picture of conflict. Seemingly aware of the danger they themselves pose, these abnormal cells often try to commit suicide by activating destructive enzymes called caspases. But as if simultaneously compelled by a self-preservation instinct, tumor cells usually thwart this impulse using proteins that foil the caspases.

Now, a team of researchers has found compounds that inhibit a specific caspase inhibitor, thereby triggering the death of various tumor cells growing in laboratory dishes or in mice.

"It looks like cancers are poised to die if you take this roadblock away," says John C. Reed, president of the Burnham Institute in La Jolla, Calif., an independent biomedical research center.

Reed and his colleagues, who describe their work in the January *Cancer Cell*, knew from previous studies that a protein called X chromosome–linked inhibitor of apoptosis (XIAP) binds to and blocks the action of several different caspases. Numerous studies have shown that many kinds of cancer cells overproduce this caspase inhibitor, apparently to stymie the cellular-suicide program called apoptosis. Other researchers have identified compounds that prevent XIAP from inhibiting some of the caspases.

These blocking compounds don't directly kill cancer cells. Instead, they make the cells more susceptible to traditional chemotherapy drugs.

Using an automated system, Reed and his colleagues screened more than a million compounds for substances that thwart XIAP's inhibition of a particular caspase called caspase 3. This enzyme acts late in a cell's suicide program, so the investigators hypothesized that inhibiting XIAP's interaction with caspase 3 would guarantee a cancer cell's suicide.

The mass screening identified eight compounds—all belonging to a class of synthetic molecules called polyphenylureas—that block XIAP's action against caspase 3. Unlike previously known XIAP inhibitors, these compounds directly kill a broad range of solid-tumor cells and leukemia cells, Reed and his colleagues report. In their laboratory tests, the potency of these compounds compared favorably with that of already approved cancer drugs.

In separate tests, the investigators implanted human prostate or colon cancer cells into mice, permitted the cells to grow into tumors, and then injected the newfound compounds into the rodents. In postmortem analyses, the investigators found evidence that the compounds had killed cancer cells and slowed tumor growth.

Just as important, Reed and his colleagues saw no obvious sign of damage to normal cells and tissue. "We had concern about whether [inhibiting XIAP] would be a safe approach," he acknowledges.

The scientists have already developed a second generation of XIAP inhibitors that last longer in the body and have other improved biochemical properties. Reed notes that more safety tests are required.

Still, Reed and other researchers are excited about the strategy of hindering XIAP so that cancer cells will commit suicide.

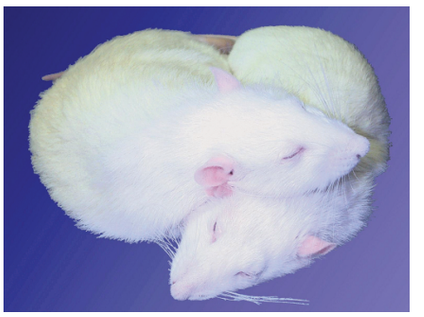
"It's one of the most exciting molecular targets in the cancer pathway," says Lily Yang of Emory University School of Medicine in Atlanta, who is also developing XIAP inhibitors. —J. TRAVIS

Sleeper Effects

Slumber may fortify memory, stir insight

There's nothing like a good night's sleep to get some serious thinking done. That, at least, is the theme of two new investigations, one conducted with rodents and the other with people.

Rats permitted to explore novel objects display distinctive activity throughout much of their brains. That activity reappears—even more strongly than originally—during a stage of slumber called slow-wave sleep, say neuroscientist Sidarta Ribeiro of Duke University Medical Center in Durham, N.C., and his colleagues.



SLEEP ON IT **Rats' memories for novel experiences may get a boost during slow-wave sleep.**

RIBEIRO

A reprise of waking neural activity during slow-wave sleep—the longest sleep stage in rats and people—promotes recall of novel experiences, the scientists propose. Then, neural changes crucial for memory storage occur during rapid eye movement (REM) sleep, in their view.

"These two phases of sleep play separate, complementary roles in memory," Ribeiro says. The new findings appear in the January *Public Library of Science Biology*, an online journal.

Ribeiro's team implanted electrodes in the brains of five rats to measure the activity of 59 to 159 neurons per animal. The electrodes were placed in the cerebral cortex, the hippocampus, the putamen, and the thalamus—regions that participate in sensory processing and memory formation.

After recording the animals' brain activity for 2 days, the researchers gave the rats access to four novel items: a golf ball mounted on a spring, a small brush, a stick with pins attached, and a tube that dispensed pieces of cereal.

Exploration of these objects elicited distinctive electrical activity throughout the rats' brains. This activity reappeared more strongly during slow-wave sleep over the next 2 days.

Slow-wave sleep orchestrates the recall and amplification of recent memories, Ribeiro proposes. Earlier research by Ribeiro and others indicated that REM sleep triggers certain genes to make proteins that groom brain cells for memory storage. Scientists have yet to determine whether rats that show activity reprises during slow-wave sleep actually display improved memory for the novel items.

A second study, in the Jan. 22 *Nature*, suggests that sleep's preservative effects on memory foster problem-solving insights.

Neurologist Jan Born of the University of Lübeck in Germany and his coworkers studied 66 volunteers who transformed a string of eight digits into a seven-digit sequence, using simple rules for converting each pair of digits in the initial string into a digit in a final string. The goal was to identify the last number in the new sequence as quickly as possible.

Participants improved either by calculating whole sequences faster or by realizing that the testers had chosen numbers such that the second number calculated was always the same as the final one in the new sequence.

None of the participants recognized that shortcut on initial trials. After a night's sleep, though, 13 of 22 volunteers solved the task much more quickly than they had before and described the shortcut to the researchers. That realization occurred in only 5 of 22 people who were retested after 8 hours of daytime wakefulness and in 5 of 22 who were retested after 8 hours of nighttime wakefulness.

"This is the first study to demonstrate rigorously that sleep can influence insight