might not be worth it, especially considering the enormous environmental risks, the ASLO participants say. Iron enrichment could dramatically alter the composition of phytoplankton species, with effects propagating up the food chain. And it might render the deep ocean oxygen deficient and lead to an increase in nitrous oxide and methane, two greenhouse gases more powerful than carbon dioxide. In sum, the participants urge governments to abandon any notion of a quick fix and concentrate instead on curbing emissions.

But once the policy fix is divorced from the underlying science—Martin's iron hypothesis—the oceanographers become visibly excited. Notes Chisholm: "The hypothesis is gathering momentum while the geochemical engineering option is losing momentum." While the hypothesis still has vehement detractors, new evidence from several groups seems to support it, says Chisholm. Richard Barber of Duke University Marine Laboratory, for instance, has just analyzed phytoplankton growth rates and nutrient and iron concentrations at stations across the Pacific. "My equatorial data suggest Martin is absolutely correct," he asserts.

The only way to find out for sure is to test the hypothesis—and in this case, at least, it should be feasible. For years, limnologists have been able to manipulate lake ecosystems, adding nutrients and studying the effects on the food web. But such experiments have been impossible in the ocean, says Chisholm, given its vast expanse and the huge quantity of nutrients required. But if Martin is right—if tiny amounts of iron are a limiting factor in phytoplankton growth—then oceanographers have a shot at a successful experiment.

Indeed, Martin and Chisholm are already planning an experiment—one that might cost half a million dollars rather than $50 million or $150 million. They are thinking of fertilizing a 100- to 400-square-kilometer patch in the equatorial Pacific. Chisholm, Martin, and others will meet in Monterey in October to firm up plans for the experiment, which, if funded, will be done as part of the international Joint Global Ocean Flux Study.

Does that mean the Geritol solution to greenhouse warming, as it has been dubbed, is dead? Not necessarily. Though Martin is more circumspect now and talks only of testing the basic hypothesis, he still waxes rhapsodic about iron. "Iron is a common element. Plants love it—dump some on your lawn and see what happens." And, he adds, "if we find it could remove carbon dioxide without damaging the food chain, and if the greenhouse scare becomes true," then people just might change their minds about seeding the oceans. ■ LESLIE ROBERTS

Space May Be Bad for Your Health

The 2000 jellyfish lofted into space aboard the space shuttle in June swam around placidly, much as they do on Earth, but not so the seven humans and 29 rats on board. In fact, the mammals produced some surprising data, according to scientists who at a briefing last week described preliminary findings from the first major life sciences project flown by the National Aeronautics and Space Administration since 1974. Concluded Laurence Young, director of the man-vehicle lab at the Massachusetts Institute of Technology, unless better "countermeasures" are developed, astronauts on long trips—such as a flight to Mars—will need "artificial gravity." And that would be enormously expensive, requiring that living quarters be spun continuously.

It was Arnauld Nicogossian, NASA's life sciences chief, who explained the biggest surprise from the mission. Physiological changes induced by weightlessness, he said, seem to occur very quickly. The shuttle crew members, elaborately wired and catheterized, showed the classic effects of space travel almost from the moment of liftoff. These included a shift of blood volume from the legs to the upper torso, an increase in heart rate, a reduction of liquid and food consumption, weight loss, a decrease in total plasma volume, and motion sickness. The rapidity with which these occurred is not currently reflected in computer models, Nicogossian said, and so the models must be "refined."

Researchers also were surprised to learn that something they had taken for granted about the lungs proved to be wrong. On Earth, the blood is concentrated more heavily in the lower part of the lungs while air collects in the top, and researchers assumed that this imbalance would disappear in the absence of gravity. It did not—a discovery that will compel a review of lung function theory.

Another striking discovery, said Young, is that the mammalian brain may be able to adapt on long flights to the confusing signals it receives when the body is set adrift in zero gravity, much as sailors adapt to the roll of the ocean by developing "sea legs." This news could be encouraging, for Young points out that two-thirds of the people who go into space now suffer from motion sickness. For example, all but one of the astronauts on this trip had motion sickness. Young cites the "sensory conflict" theory to explain the phenomenon: Messages from the visual and tactile sensors tell the brain the body is stable, while messages from the inner ear, freed from gravity's reference frame, signal that the body is tilting. The brain's inability to resolve this conflict may induce sickness.

A study of rats, directed by Muriel Ross and her colleagues at NASA's Ames research center, suggests that the brain may be able to resolve the conflict, given enough time. A microscopic examination of the astro-rat tissues has revealed first, that the small calcium crystals called otoliths that move around in the inner ear were not affected by the loss of gravity. (Some feared they would de-mineralize like other bones.) However, the preliminary data do hint at changes in the otolith receptor organ, the vestibular macula. Ross says that the first indications are that the number of receptor synapses seems to increase when the animal is in zero gravity. This may be an attempt to overcome sensory conflict by boosting the signal. Says Ross: The mammalian inner ear seems to be "beautifully adaptive" to space flight.

While this physiological response may be good for space travelers, other responses may not. For example, the shift in blood from the lower limbs to the chest seems to suppress lymphocyte and red cell production, which in turn could impair the immune system. The long bones grow less rapidly while—according to preliminary data—the head mass may increase. The leg muscles that serve as the main counterforce to gravity atrophy quickly in space, even more rapidly that they recover once back on the ground. Finally, the kidney changes in space, increasing its filtration rate while the plasma flow decreases. This raises a special concern about kidney stones, said Carolyn Leach-Huntoon of NASA's Johnson Space Center.

It will be about a year before these scientists are prepared to release their research in final form, but already they are crowing, as MIT's Young says, that the project is churning out valuable data "like gangbusters." Considering the price tag for the shuttle mission—upwards of $400 million—that's just as well. Then again, NASA's critics may conclude that the agency's budget remains just as immune to gravity as the jellyfish it lofted. ■ ELIOT MARSHALL