Space Sciences

Space-spores, balls and blood cells

Last November, the space shuttle Columbia blasted off with the European Space Agency's 17-ton, billion-dollar Spacelab research module packed into its bay (SN: 12/10/83, p. 373). Spacelab carried over 70 scientific experiments in physics, astronomy, earth observations and material and life sciences, and the shuttle's crew swapped 12-hour shifts round the clock to milk the lab for all it was worth. Fourteen papers in the July 13 SCIENCE describe findings from the life sciences experiments carried out during Columbia's 10-day orbit. Among the reports:

- Bacterial spores have been revived after 7,000 years of dormancy in a lakebed, but how do they fare in the more hostile space environment? To find out, West German scientists sent millions of *Bacillus subtilis* spores aloft and looked at solar radiation and vacuum effects on spore survival, mutation rate and DNA repair. They found that spore viability dropped by half and the mutation rate jumped tenfold in spores subjected to the vacuum of space compared with those kept at one atmosphere pressure on the same platform during the 10-day flight. And spores exposed to various wavelengths of solar ultraviolet (UV) radiation for periods ranging between 19 minutes and over five hours fared better at atmospheric pressure than in a vacuum, although survival was low regardless following five hours of UV exposure.
- Most people judging the weight of an object will heft it. One reason the weight of, say, a tossed head of lettuce is easier to guess than one held motionless is that our brains use "inertial cues"—clues about an object's mass figured from the amount of force it takes to accelerate it. The near-zero gravity in earth orbit gave Spacelab scientists a chance to study the importance of such clues. Because in the absence of gravity things are weightless but have mass, the only way to guess the "weight" of an object in space is to give it a push — accelerate it — and judge from how hard it is to push how much it must "weigh."

Spacelab astronauts were asked to judge the relative masses of 50- to 64-gram lead and epoxy balls by jiggling them one at a time. The astronaut would pick up one ball of a pair, heft it, then pick up and heft its companion and mark down which he thought was heavier. This process was repeated for a total of 72 pairs of balls. On the average, they guessed right two-thirds of the time. On earth, their average score on the same test was three quarters correct. That and other findings lead H. Ross of the University of Stirling in Scotland and colleagues to tentatively conclude that "gravity does indeed play an essential role in weight discrimination and humans are not as sensitive to inertial mass as they are to weight."

- Two Spacelab studies looked at the effects of weightlessness on the body's disease-fighting white blood cells called lymphocytes. In one, lymphocytes grown in culture were stimulated with concanavalin A (Con A) a chemical that induces resting cells to divide. Compared with lymphocytes in control experiments on the ground, the "activation" of cells in orbit by Con A was suppressed more than 97 percent. This result, and findings from related earth-based studies, "supports the hypothesis ... that microgravity depresses whereas high gravity enhances cell proliferation rates," writes A. Cogoli of the Laboratorium für Biochemie in Zurich. Cogoli notes that similar effects have been seen in lymphocytes taken from crew members after space flight, but that conclusions drawn from these in vitro experiments can't be extrapolated to living systems.

A related experiment makes the point. A study of antibody production by lymphocytes in four crew members before, during and after the flight showed that microgravity effects were "insignificant." Weightlessness doesn't block antibody change in the short run, however "microgravity may impair the lymphocyte activation process, altering the response to new antigenic stimuli," notes Edward W. Voss, Jr., of the University of Illinois in Urbana, the author of the study.

Biology

The genes behind the light

The ocean is aglow with luminescent bacteria, some floating freely and others ensconced within larger organisms. The biochemistry underlying this remarkable undersea brilliance is incompletely understood (SN: 10/18/78, p. 106). By applying the techniques of recombinant DNA to the problem, scientists have discovered that seven genes are required for light production by the bacterium *Vibrio fisheri,* which colonizes special organs of the fish *Monocentris japanicus.* JoAnne Engebrecht of the Agouron Institute and Michael Silverman of Scripps Institution of Oceanography, both in La Jolla, Calif., have analyzed these genes, called *lux,* which are contained in a segment of DNA that can cause the nonluminescent laboratory bacterium *Escherichia coli* to glow. They find that two of these genes encode the two subunits of the enzyme luciferase, which in a reaction involving a long-chain aldehyde produces a photon of light. Three of the genes encode enzymes required to provide the aldehyde for this reaction. The two other genes have regulatory functions.

Luminescence of *V. fisheri* occurs primarily when the bacteria are densely packed, as they are in the fish light organ. The bacteria secrete a molecule called an autoinducer that accumulates in the environment and at a critical concentration induces a 10,000-fold increase in each bacterium's light emission. This molecule has been identified as *N-(beta*-ketocaproyl) homoserine lactone. Engebrecht and Silverman now report that of the two genes with regulatory function, one encodes a substance required for the synthesis of the autoinducer and the other encodes a product necessary for a bacterium to respond to the autoinducer. The scientists have used the genes to produce the individual components of the light-producing system. They now plan to detect the location of these components in the *V. fisheri* cells. They conclude in the July PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES (No. 13), "Knowing the identity of *lux* gene products should assist in the purification and biochemical analysis of poorly understood components of the bioluminescence system such as those for aldehyde cycling and for the synthesis, excretion, and sensing of autoinducer."

Gene-spliced corn field test postponed

A genetic engineering experiment that might have produced rows of purple corn has been delayed, Stanford University biologists recently announced. Ronald Davis and Virginia Walbot had planned this summer to attempt to alter the genetics of white-kernel corn by introducing the genes that provide the purple color to Indian corn. The genes have been reproduced in the laboratory in bacteria and also in yeast. The purpose of the work was to show that the gene transfer process that has been successful in laboratories and in greenhouses can also work in the open field.

Permission to perform this experiment was granted in 1981 by the National Institutes of Health. Walbot and Davis say that since that time they have been developing the facilities, techniques and materials to conduct the test. A recent court decision enjoined the NIH from approving government-funded experiments involving the release of organisms altered by recombinant DNA techniques. It also prohibited an experiment in which other researchers planned to release genetically altered bacteria in a field test for protecting crops against frost (SN: 5/26/84, p. 325). But the court did not specifically bar the Stanford experiment.

Walbot and Davis say, "Although a corn plant containing recombinant DNA ... would have no more adverse effect on the environment than our present strains of corn, we will curtail our experimentation during the present growing season in hope that some further and timely resolution can be achieved on the environmental review question." They add that during this period they plan to conduct greenhouse plantings using nongovernmental funds.