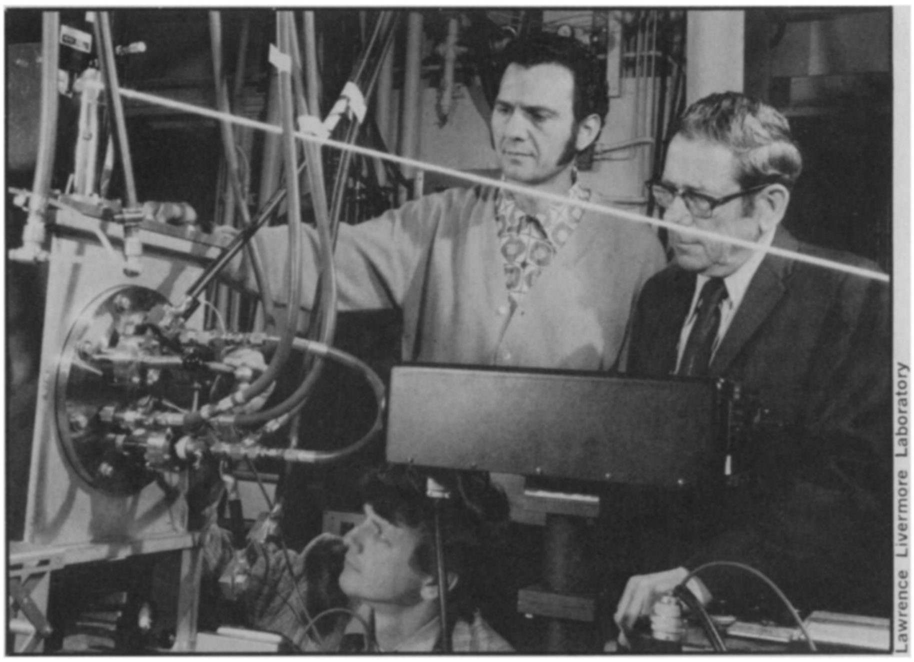
Uranium enrichment by laser achieved

An essential requirement for any kind of nuclear fission technology explosive or otherwise is the provision of enriched uranium fuel. Uranium comes in two isotopes, the common nonfissioning uranium 238 and the fissioning uranium 235. For reactor purposes a fuel must be provided that has at least three percent U-235 rather than the 0.7 percent found in a sample of natural uranium.

To make the enrichment requires separating the two isotopes. Chemical means do not generally work in such cases since different isotopes of the same element react the same way chemically. Physical means have to be used. The present technology, gaseous diffusion, in which hot gas diffuses up and down a stack so that the upper layers become richer in the lighter U-235, is cumbersome, expensive and slow. Therefore there is great interest in experiments that attempt to use laser light as a means of separating the uranium isotopes.



Laser enrichment of uranium: Scientists check chamber stimulated by laser beam.

At the 8th International Quantum Electronics Conference in San Francisco last week Benjamin R. Snavely of the Lawrence Livermore Laboratory gave for the first time some technical details of an experiment that has succeeded in separating "microscopic" quantities of the uranium isotope. In those microscopic amounts the proportion of U-235 went higher than 60 percent.

The basic method of laser separation is in fact applicable to many elements besides uranium, but the heavy interest is on uranium because the demand for it runs into tons a year and is rising, whereas the demand for other isotopes for medical or chemical purposes may be measured in grams or even fractions of a gram. Snavely estimates that successful commercial applications of laser separation of uranium could save upwards of $100 billion in capital investment.

Ironically, information is given more freely about experiments involving other elements than uranium because uranium is caught up in national defense, and information gets classified. In addition to Livermore uranium work is known to be going on by a collaboration of Exxon and the Avco Corp., in Israel and in West Germany. What may be going on in the Soviet Union is not public knowledge, but Soviet scientists have worked on laser separation of other elements and published accounts of their experiments.

Laser separation of isotopes depends basically on the way in which atoms and molecules absorb energy from incident light. Each species absorbs a particular pattern of specific resonant wavelengths that correspond to the different ways in which it can become energetically excited. It happens that because of the difference in atomic weight between two isotopes of the same element, the resonance pattern for one isotope will be shifted slightly from that of the other. If the shift is large enough it may be possible to tune a laser so that one isotope of the given element will absorb the light and become excited while the other is not affected.

In the uranium case, a stream of uranium vapor at 2,500 degrees K. is irradiated by light of 5,900 angstroms wavelength. This excites one of the isotopes. Then a second beam of light (3,000 angstroms from a mercury arc source) is passed through the vapor stream. This second light beam ionizes the already excited isotope but does not affect the other. The vapor stream now contains one isotope that is electrically neutral and one that is charged (ionized). The charged can be separated from the uncharged by a combination of electric and magnetic fields. Severe difficulties must be overcome before the method becomes commercial. If indeed it ever does, nevertheless success in the basic method is an important and essential first step.

Other experiments on other isotopes tend to use photochemistry rather than photoionization in making the separation. In these cases use is made of the fact that energetically excited atoms or molecules are chemically more reactive than unexcited ones and thus a chemical reaction can be used to separate the excited species. Work being done at the University of California at Berkeley and described by Stephen R. Leone preferentially excites bromine molecules containing bromine-81, then induces them to react with hydrogen iodide. This produces hydrogen bromide containing bromine-81. The hydrogen bromide can then be precipitated out by passing the gas over chilled baffles. Another photochemical method uses natural formaldehyde that is a mixture of the hydrogenated variety (H_2CO) and the deuterated variety (D_2CO). Laser light selectively excites the deuterated variety, and the molecule is then induced to break up into D_2 and CO, thus accomplishing the separation of deuterium from hydrogen. A photochemical method for recovering uranium isotopes might seem attractive from a rawmaterials point of view since one could start with the common substance uranium hexafluoride rather than having to refine out pure uranium first, but Snavely is very pessimistic about such a development because of difficulties with uranium chemistry and because the absorption frequencies of uranium hexafluoride overlap so much that laser tuning seems impossible. □

Portrait of a planet

Ever since the first early weather satellites, earthlings have been used to seeing photos of their cloud-streaked planet from space. But never before have there been views showing the fine detail of cloud structure seen in this week's cover photo. Transmitted by the new SMS-1 meteorological satellite in synchronous orbit 22,300 miles above the equator, the data were processed by a laser recorder and other special equipment at the White Sands Missile Range. The ground station there is currently the only station capable of assembling the data into photos with a resolution of a half mile.

The effect of the earth's rotation on atmospheric motion (the Coriolis effect) is illustrated by the counterclockwise rotation of the cloud systems around a low-pressure area in the northern hemisphere (far North Atlantic) and clockwise rotation in the southern hemisphere (South Atlantic). A stationary band of cumulus clouds typical of those frequently positioned over moist tropical regions extends across the central Atlantic.

Lake Titicaca, high in the Andes on the border of Peru and Bolivia, stands out clearly. The lake influences local climate in such a way that it is frequently left cloud-free. Similarly the dark band along the coasts of Chile and Peru may be the result of a cloud-clearing atmospheric effect due to the upwelling of deep, cold ocean water along the coast.

Note the almost three-dimensional sculptured appearance of the clouds at the extreme bottom of the picture.

Since this photo was taken on June 3, the SMS-1 satellite has been moved farther east into its position directly above the equatorial Atlantic to aid in the 14-week GARP Atlantic Tropical Experiment (SN: 6/1/74, p. 354), which began last weekend.

The unmaking and remaking of cells

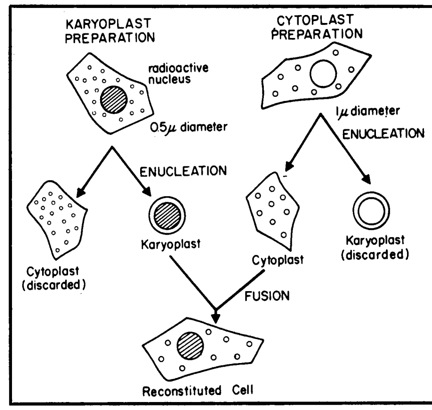
Why do cells develop into different tissues? Why do some of them become cancerous? Why do they grow old and die? It would be easier to answer such questions if cell scientists knew for sure which cellular functions are controlled by the nucleus and which by the cytoplasm. By joining the nucleus of one cell with the cytoplasm of another, for instance, it might be possible to determine which actions the nucleus and cytoplasm are responsible for. Would a cancerous nucleus make a normal cytoplasm cancerous? Could young nuclei rejuvenate old cytoplasts? Researchers have replanted nuclei from one cell to another, but usually in only one cell at a time.

Now a method has been developed for performing this operation on a wholesale basis. It makes feasible the analysis of many interactions between the nucleus and cytoplasm. George Veomett, D. M. Prescott, Jerry Shay and K. R. Porter of the Department of Molecular, Cellular and Developmental Biology at the University of Colorado in Boulder report the process in the May PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES.

The first step was to take some cells apart. Normal mouse cells were used in the experiment. They were treated with cytochalasin B, a fungus by-product that causes cell nuclei to migrate to one side of the cell where they remain attached to the main body of the cell by only a thin stalk. Centrifuging such cells causes them to separate completely into portions containing only nuclei and portions containing only cytoplasm. The resulting cytoplasts and nuclear structures, karyoplasts, quickly recover from this treatment and are able to function properly for several hours.

Then the cells had to be put back together in new ways. Sendai virus (related to the mumps virus) has been used to make whole cells fuse. In the Colorado experiment inactivated Sendai virus was used to reconstruct whole cells by fusing the previously separated cytoplasts and karyoplasts. Two groups of cells were used. One group, the cytoplast donors, was grown in a solution containing latex spheres of a specific size. Most cytoplasts absorbed five to ten spheres which they carried with them during separation. The spheres served to mark the source of the cytoplasm during the subsequent reconstruction. The other group of cells, the karyoplast donors, were similarly marked with spheres only half the size. In addition, the nuclei of these cells were radioactively tagged.

Both groups of cells were treated with cytochalasin B, centrifuged and



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separated into solutions of either cytoplasts or karyoplasts. The large-sphere cytoplasts and the radioactive nuclei were then mixed together, centrifuged and treated with the Sendai virus.

Fusion occurred. New cells were formed consisting of a radioactive nucleus and a cytoplasm with only large spheres. Control solutions were not treated with the Sendai and no fusion took place. Not only had cells been successfully reconstructed, they were living. Some had entered mitosis (cell division) after the fusion, indicating that the reconstructed cells are capable of proliferation.

In conclusion, say the scientists, this experiment "establishes the feasibility of constructing mixed cell types by combining karyoplasts and cytoplasts derived from parental cells of different types." □

Births declining among minorities

Historically blacks, American Indians, Mexican-Americans and the poor have borne substantially more children than urban whites. Two recent but separate studies to be published in the June 24 FAMILY PLANNING PERSPECTIVE, a quarterly of Planned Parenthood's Center for Family Planning Program Development, reveal that this trend has been waning for the past decade.

Using data from the U.S. Census, sociologist James A. Sweet of the University of Wisconsin analyzed the fertility declines of married women from various ethnic groups and compared them with those of urban whites. (Fertility in the United States has been declining for the overall American population since 1957.) Sweet found that fertility has dropped most rapidly for ethnic and low-income families. Whereas childbearing declined 27 percent for white urban women between 1960 and 1970, it declined 45 percent