ARTIFICIAL CELLS

Biochemical microcapsules

In recent years scientists have identified and described with increasing precision a number of enzyme-deficiency diseases generally classed as inborn errors of metabolism. These genetic disorders occur because genes either fail to code for the production of a certain enzyme, or code for one that is incomplete and nonfunctional.

Though some of these diseases can be treated, few can be actually cured. Theoretically, scientists would like to be able to inject these patients with the missing enzymes, but the immune system would reject the foreign material.

One way around this difficulty could be to encapsulate biological materials inside a semipermeable but biologically inactive membrane. This technique gives the body biochemical access to missing substances or processes while fending off antibodies.

Injected, according to Dr. Thomas M. S. Chang of McGill University in Montreal, these artificial cells offer a promising approach to enzyme-deficiency diseases. And masses of such cells, he reported at a meeting of the American Society of Artificial Internal Organs in Washington, D.C., last week, can also represent an effective artificial kidney.

Dr. Chang builds microcapsules of semipermeable cellulose or nylon membranes with moderately sized pores—large enough for metabolites such as creatine, small enzymes and blood toxins to pass through, and small enough to keep large proteins such as antibodies and blood cells out. The microcapsules, which are approximately the same size as cells, can be filled with enzymes or absorbent materials such as activated charcoal and function as artificial cells.

In experiments with a strain of mice genetically deficient in the enzyme catalase, Dr. Chang demonstrated that incorporating catalase inside artificial cells and injecting them into the animals corrected the deficiency. Because antibodies could not cross the cells' membranes and come into contact with the encapsulated catalase, there was no immune reaction when cells were injected into the peritoneal cavity. Yet the enzyme was able to come into contact with molecules that normally get into the interior of a cell and restore enzyme function in the deficient mice.

Similar experiments showed that asparaginase, an antitumor enzyme, and hemoglobin, the oxygen-carrying component of blood, could also function in artificial cells.

Building on a similar principle, Dr. Chang has applied the artificial cell concept to treatment of uremia, which accompanies kidney failure; an artificial kidney of packed artificial cells has been tested in one patient.

The Montreal researcher packs artificial cells containing activated charcoal into a small, disposable chamber. As blood passes through it, molecules of creatine and uric acid penetrate the cell membranes and are absorbed by the charcoal.

Functioning on the same principle as current kidney dialysis machines, Dr. Chang's kidney is used outside the body, and the patient's blood is circulated through it. Before trying it on a patient—a man who was unable to get into a standard dialysis program because of an equipment shortage—Dr. Chang used his compact kidney, not much larger than a human hand, on 54 dogs, with no apparent problems.

Dr. Chang stresses that his device as it stands is only a partial system, not a fully functional artificial kidney. Ideal artificial cells, he says, will require new membrane materials.

In the last few months he has been coating his cellulose membranes with albumin to achieve a surface more compatible to blood. Newer polymer membranes such as those being designed at the University of Utah in Salt Lake City (SN: 4/11, p. 375) may be valuable for artificial cells.

Refinement of the cell kidney will entail finding ways of removing from blood not just creatine and uric acid but all of the other substances that must be cleared—most importantly, urea. At Case Western Reserve University in Cleveland, Dr. Robert Sparks and his colleagues have encapsulated the enzyme urease in microcapsules and find that when urea molecules penetrate the membranes, the urease breaks them down into ammonia, which hypothetically can be absorbed out of the blood, and carbon dioxide, which reenters the blood and is cleared by the lungs (SN: 11/30/68, p. 540).

Dr. Sparks' group is testing microcapsule systems which operate internally—the capsules are swallowed—but Dr. Chang speculates that an extracorporeal kidney that combined cells containing urease and cells containing activated charcoal might work well.

TAPS

A breathing spell

Conservationists have bitterly opposed construction of the $1.5 billion Trans-Alaska Pipeline System (SN: 2/14, p. 177) before intensive ecological studies are done. They claim Interior Department permit requirements and stipulations for the pipeline and parallel road do not begin to meet the requirements for a really full-scale study.

They have won one round so far. The Environmental Defense Fund, Friends of the Earth and the Wilderness Society prevailed upon Federal Judge George L. Hart Jr. of Washington, D. C., to rule this week that Interior Secretary Walter Hickel could not grant right-of-way permits until the issue gets a full airing in court.

Interior is expected to appeal, but the appeal procedure itself will give the conservationists an opportunity to present at least some of the environmental issues involved. And if the full-scale trial is held, they are confident that a delay of possibly three years can be secured.

"The oil companies are walking in molasses now," says Stewart M. Brandborg, executive director of the Wilderness Society. "With each step, they will find themselves more deeply mired in scientific evidence that shows that great numbers of unknowns exist about the ecological effects of the pipeline."

Judge Hart based his decision on a technicality in the Mineral Leasing Act of 1920 regarding width limits of rights-of-way, and on the National Environmental Policy Act of 1970, which requires agencies to submit detailed statements on such proposals to the new Council on Environmental Quality.

The 800-mile pipeline would carry hot oil from the North Slope oil fields to the port of Valdez. A major concern of the environmentalists is the fact the pipeline will pass through a known earthquake area; earthquakes, says Brandborg, could break the pipeline and release huge quantities of oil into rivers or other ecosystems. But a representative of Atlantic-Richfield Co., one of three major participants in the pipeline plan, says TAPS plans to include an elaborate earthquake monitoring system that would close valves the minute there was a seismic disturbance.

Another concern is the effect of the buried portions of the pipeline on permafrost with high moisture content. The oil companies say only 40 miles of pipe would have to be above ground to prevent serious thawing and erosion; conservationists say far greater portions of the pipeline would have to be on stilts, well above the sensitive permafrost. Brandborg says that Interior Department officials, when questioned at legislative hearings, admitted to doubts about the 40-mile estimate.

Alaskan Indians also have protested the pipeline; they claim it would damage their way of life. □