strongly recommended that NASA concentrate a much larger portion of its efforts and resources on this project, and the launch schedule should be compressed if possible."

The first launch has been scheduled for late 1971 or early 1972. "Inasmuch as the origins of the program date back to 1964," said the subcommittee report, "approximately eight years will have passed before the first launch, despite repeated urgings from Interior and Agriculture, and the Subcommittee on Space Science and Applications, for the earliest possible launch."

Congress is still urging. For fiscal 1970, NASA is requesting only $25 million to begin work on a satellite that is enthusiastically backed by numerous Government agencies and private organizations. Subcommittee Chairman Joseph Karth (D-Minn.) insists that the amount is not enough, yet NASA Space Sciences and Applications Administrator Dr. John E. Naugle says that approval of even the $25 million resulted only after a bitter internal battle.

Nevertheless, NASA Administrator Dr. Thomas O. Paine, in his first appearance before the full House space committee, placed the search for earthly benefits above even manned flight among space priorities. "We should do all we can," he said, "to understand and put to early use the promise of space for people here on earth. . . . We should continue to foster prompt introduction into the economy of space applications and technology."

Other unmanned earth satellite plans for the 1970's include a variety of small research probes, as well as expansion of the at-last successful Orbiting Astronomical Observatory program. A complicated plan for visiting all the planets in the solar system within the decade is also on the unmanned schedule.

Astronauts are likely to have more to do than just carry out lunar surface studies, however. Though the Apollo Applications Program of earth-orbiting workshops has gotten progressively smaller through the last several rounds of policy and budget planning, the space agency is considering the development of large space stations, possibly carrying more than 100 men, for the late 1970's. In addition, if the powerful NERVA nuclear upper-stage booster has been developed by that time, other manned missions are more than likely to appear.

Other items that may well be standard items in the NASA repertoire by the end of the decade include a reusable space shuttle to ferry crews and equipment to and from orbit, and what NASA calls a Big Dumb Booster—essentially a low-precision, low-cost rocket consisting of a simple fuel tank with a basic-plumbing engine fitted to it.

CLONAL REPRODUCTION

Closing in on mammals

Genetic manipulation of human heredity is still a quarter century off, according to molecular biologists.

But genetic copying of mammals could be a lot closer. Depending on how quickly some now-defined technical problems are overcome, biologists could within a few years produce identical copies of mammals from a single original. Such success could revolutionize for example, cattle breeding, producing large numbers of identical prize animals from one blue-ribbon winner.

The bullish sentiments of biologists on the chances of quick success in genetic copying are based on experiments with frogs which have achieved identical copies (SN: 1/11, p. 31), and preliminary success with mice.

The first steps in performing the task in mice were reported this month at a national meeting of the Biophysical Society in Los Angeles. Mammal duplication has several difficulties that are not present in the tadpole process.

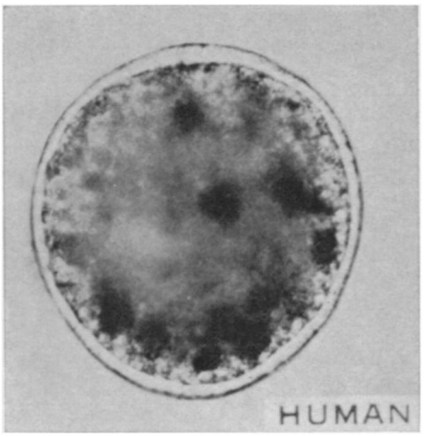
The earlier work, by Dr. J. B. Gurdon of Oxford University, has shown that the nuclei of unfertilized frogs' eggs can be replaced by nuclei from tadpole intestinal or kidney cells. A few of these eggs develop into tadpoles and ultimately into adult frogs. These frogs are exact genetic duplicates of tadpoles whose nuclei were used and have little or nothing in common, genetically speaking, with the frog that laid the eggs. The identity is proved by skin grafts from the original, which are not rejected by the copy.

In frog duplication, the unfertilized egg is first activated with a pinprick. After 15 minutes, the nucleus of the egg cell is removed with a fine tungsten needle. Donor cells are prepared by separating them from each other; this is done with a special solution containing an agent that removes the calcium and magnesium from the cement that holds the cells together.

The experimenter selects one of the cells under a microscope, breaks open the cell wall by sucking the cell up into a fine-tipped micro-pipette, and introduces the new nucleus into the egg in exactly the right position.

As far as biologists know, there are no fundamental obstacles to extending these methods to mammals. New techniques will be needed, however, because frog eggs are ideally suited to nuclear transplantation. They develop outside the body of the mother and carry their own food supply. They are large enough to be held in place with forceps and their nuclei can easily be seen under a low-powered microscope.

Cells from adult mammals are too small to be easily manipulated and micropipettes fine enough to suck them up one at a time present special difficulties caused by the effects of water surface tension across so narrow an opening.



Carnegie Institution

Human ovum and zona pellucida.

Dr. Hilary Kaprowski of the Wistar Institute of the University of Pennsylvania proposes fusion as a way around the problem as it is encountered in mammalian eggs.

Until recently, scientists have believed that a mammalian egg cannot live if the zona pellucida or surrounding membrane is removed. Now Dr. Kaprowski reports that if that membrane is removed by the enzyme pronase and the naked egg cells are kept in a temperature-controlled environment, they can survive. By lowering their temperature for 15 minutes and then raising it again, he reports, eggs can be developed to the 16-cell stage.

Theoretically, their nuclei then can be removed, not by mechanical means but possibly by injections of a chemical called colchicine. New nuclei could then be introduced by fusion. The important step taken so far, Dr. Kaprowski points out, is getting the egg cells to divide and survive without the zona pellucida. "Unless the zona is removed," he says, "they normally cannot fuse, so we had to achieve that step."

Fusion of mammalian eggs, in this case from mice, has been reported by Dr. Christopher Graham of Oxford. Using an influenza-like virus that for some unknown reason causes membranes to fuse, he has fused mouse egg cells with cells from mouse spleen and bone marrow, getting hybrid cells with double nuclei that may have undergone one cell division. But this has not yet been accomplished with denucleated egg cells, and no timetable is yet available.