to the melt water; this area will be extremely vulnerable for about six weeks.

On March 20 the computers coughed out the first specific predictions of river height, given normal March precipitation and a moderate melt rate: in the basin of the Red River of the North, water cresting as much as 18 to 21 feet above flood stage; in the Missouri basin, rivers 7 to 12 feet over their banks; along the upper Mississippi crests 12 feet above flood.

Slower melt rates would of course give lower flood crests, and much higher rates would make flooding much more severe. Ice jams plugging up a waterway could raise water three to five feet above the predicted level.

The Army Corps of Engineers, responsible for flood control measures, says that while much of the threatened area is protected by dams, levees, and other installations, a significant proportion of the upper Mississippi valley is not protected adequately.

Six big dams and their reservoirs, built in the middle reaches of the Missouri now protect the lower 700 miles of the main valley, including Kansas City, devastated by floods in 1951 and 1952. These floods caused about $1 billion in damage.

The Corps, at the request of President Nixon, launched Operation Foresight as soon as the flood warnings were issued. In areas where permanent flood protection installations are not believed adequate, sandbags are being collected, heavy equipment lined up and other preparations made. In essence the Corps has always tried this when flooding was imminent. This year, however, it has had the time in which to do it.

From the standpoint of the economy of the threatened area, any flooding is a multiplication of a snow problem that already has many communities whipped. From northern Minnesota alone more than 50 communities have appealed to the Federal Government for aid in preparing for floods, on the grounds that their treasuries have been emptied in the attempt to dig out from the record snowfall.

Whether floods will actually result from the heavy snowpack will depend on several factors, some of which vary from day to day:

- There must have been enough soil moisture in the fall to freeze and form a frost cap. This cap of frozen ground doesn't thaw until the snow is gone, and so prevents melt water from seeping into the soil; it runs off to swell the rivers instead.
- The water content of the pack must be high. Very fluffy snow can be feet deep, yet contain little water.
- Melting must be rapid enough to cause a sharp peak in runoff.

So-called ripening of the pack bears on the rapidity of the melt. If late winter days are just warm enough to start top layers melting, yet the nights are below freezing, the melt water freezes again, still in the pack. This results in a much denser pack able to conduct heat better. When the full spring thaw arrives, this ripened pack melts much faster. If warm spring rains fall during the thaw, they will not only speed it up, but will add to the flood water. And finally, the state of health of vegetation in the area is important, since if vegetation is dry it is able to soak up immense amounts of water that otherwise would run off.

While some hydrologists expect the 1969 spring floods to set hydrological records, it is not at all certain that any damage records will be set. Most of the cities and towns heavily damaged in 1952 and 1965, as Kansas City, now are better protected than they were then, and have had a month to prepare.

In fact, to the national economy, the threatening snowpack may be a boon in disguise. One official has estimated that the flood waters will fill every river, reservoir, pond and puddle in the Midwest, the Pacific Northwest and the ever-thirsty state of California, and that the dollar value of this water will equal or exceed any damage.

Another boon will be to prairie nesting waterfowl. These ducks and geese have been on the decline because the small prairie ponds in which they nest have been drying up (SN: 9/14, p. 270). These ponds, or potholes, now lie under the record snowpack in Minnesota, the Dakotas and Canada, and are sure to be filled.

Many of the dried-up potholes have been ploughed up and planted with crops. Refilled, they will be mudholes for a while, without the vegetation or insect life to support ducks. But by next year they should be good nesting areas.

SPACE DECADE

Balanced and solid

Space agency officials this month began trooping through the halls of Congress to justify, defend, haggle over and plead for funds that will be spent almost entirely after the first U.S. astronauts have landed on the moon. By the time Apollo 11 touches down on the lunar surface this summer, almost $25 billion will have been spent to get it there, making that week-long mission one of the most single-mindedly pursued goals in the history of exploration.

If they can ever be so narrowly aimed again, they will have to come to terms with the edicts for the next decade in space as laid out by Presidential Science Adviser Lee A. DuBridge: "a balanced program" that is "really solid."

In fiscal 1966, the space agency's richest year, more than 70 percent of its $5.933 billion budget was aimed directly at achieving the manned lunar landing. As Congressional money-givers now see it, a balanced program means that such a pursuit will never take place again. Diversity is the name of the game; a variety of unmanned planetary probes will replace a few expensive manned missions, and efforts will be bent toward reaping the benefits of space technology on earth.

There are signs, however, that NASA, inspired by the unbroken successes of its Apollo flights, is trying to capitalize on desires for "really solid" programs by building manned flight activities back up from the plateau toward which they have started to level off.

Until recently, plans had called for the Apollo program to include three manned lunar landings following the initial one, extending into early 1969. Recently, however, NASA revealed plans to expand the schedule to 11 landings, which would put flights all the way into 1974 and pave the way for a small, manned lunar surface laboratory and ultimately a permanent station. To do this, NASA plans to ask Congress for an additional $100 million this year to cover scientific experiments, a new and more flexible space suit, and modifications to the lunar module to increase its surface staytime to at least three days.

In addition, the agency's proposed fiscal 1970 budget contains, for the first time, an $11 million request for studies of lunar exploration. Surface and flying vehicles, as well as new research goals, are under consideration.

During the 1970's, a major emphasis is likely to be on unmanned spacecraft and satellites. The influential Space Sciences Board of the National Academy of Sciences and many individual scientists have been unambiguous in support of unmanned probes to provide far greater scientific return for the money than can manned missions with similar goals.

The earth resources program, in particular, is in the ascendant. It has the distinction of being one of the few items for which Congress wants NASA to take more money than it is asking. Last December, the House Subcommittee on Space Science and Applications issued a report that made no bones about its feelings. "No project (of the NASA Office of Space Sciences and Applications) has had a comparable history of delay as has the earth resources satellite," the document stated. "It is

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.

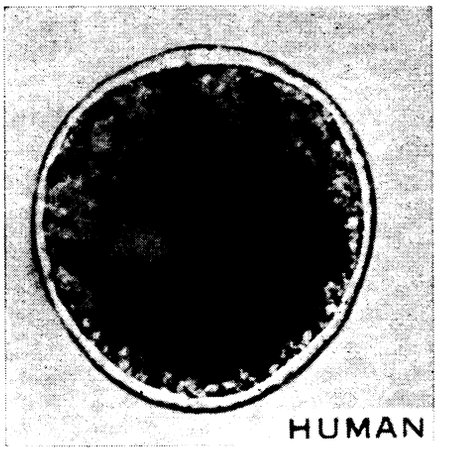
The earlier work, by Dr. J. B. Gurdon of Oxford University, has shown that the nuclei of unfertilized frogs' eggs can be replaced by nuclei from tadpole intestinal or kidney cells. A few of these eggs develop into tadpoles and ultimately into adult frogs. These frogs are exact genetic duplicates of tadpoles 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.