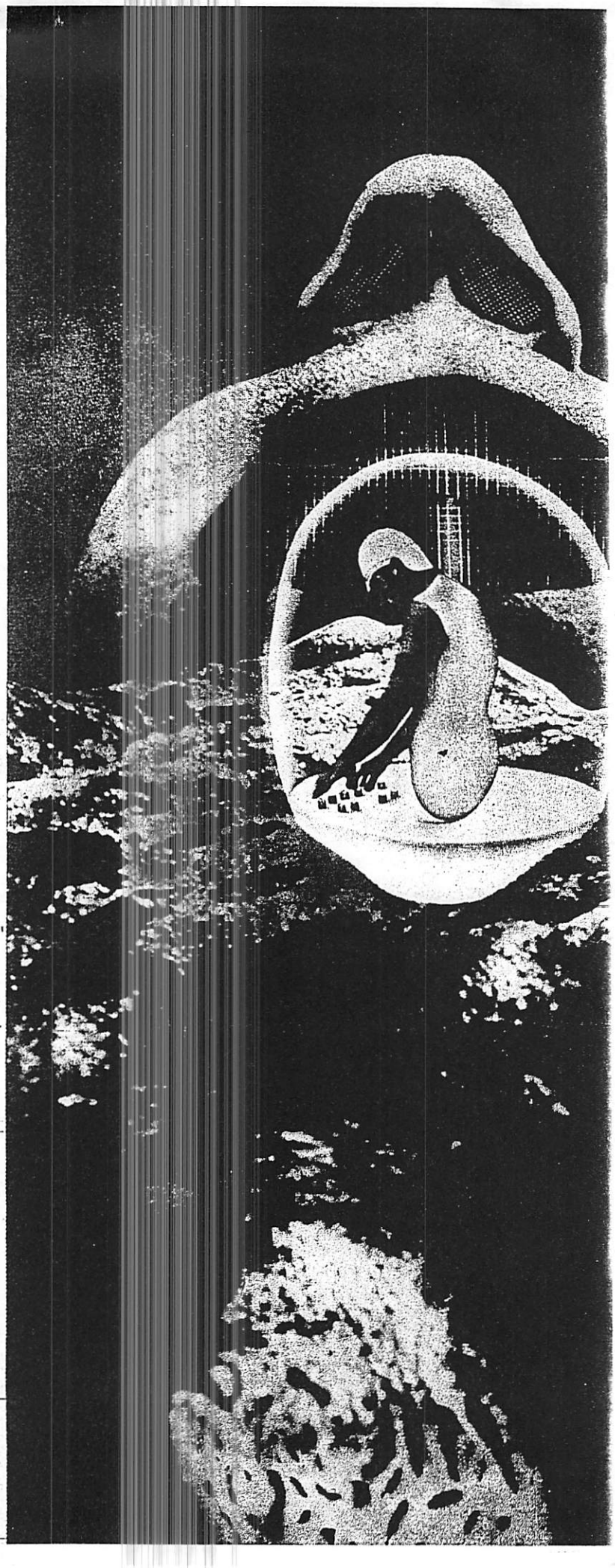
Making Men and Women Without Men and Women

by David M. Rorvik

Less fun, maybe, but more practical

Learn to love the five types you see cavorting around in this picture, because any one of them could be your grandchild, so leading scientists say, who will exist out in space colonizing, exploring and generally living it up. The man in the white suit pushing buttons will not be *born* exactly, but will be more or less manufactured here on earth, under pressure in an artificial womb after his genetic material has been altered by scientists using laser beams. He will be bred without legs, and he won't miss them. He will be an astronaut of the mid-twenty-first century, engineered to make long space journeys and legless because he will be expected to live for decades in a small capsule where legs would only get in the way. This man was predicted by the great British scientist, the late Dr. J. B. S. Haldane, one of the first to reflect on controlled mutation of humans. Haldane also proposed the "aseptic" man shown behind the astronaut. This creature, germ-free inside and out, will possibly have skin like a surgeon's rubber glove, a [illegible] filtration system of some kind for breathing, and no hair. He'll be a boon to germ-free planets but otherwise a problem; as Haldane says: "To an aseptic person, producing among other things inodorous feces, the rest of humanity will appear as stinkers and there will be grave emotional tensions, including a sexual barrier." Gravity varies sharply in space. On some asteroids the pull is so slight that a man could go scudding along the surface or drift out into space. Haldane suggests breeding prehensile feet and a tail for such cases (upper right). Elsewhere, as on Jupiter, gravitational pull is so heavy that only a short, dumpy, strong man could move easily. "I would back an achondroplastic [dwarf] against a normal man on Jupiter," says Haldane. An English philosopher, the late Dr. Olaf Stapledon, proposes a quadruped for Jupiter with eyes protruding so that he can see over his spider-like body. If you think all this represents the blue-sky ramblings of a couple of scientists after publicity, you're wrong. The serious work that will produce a world like this is well under way. Turn the page—and stand clear.



Birth without Sex

Whether you like it or not—and many people don't—the first scientific steps of separating sexual pleasure from procreation have already been taken. Artificial insemination accounts for about 10,000 healthy babies born in the U.S. each year. The process involves extracting sperm cells from genetically desirable males, freezing them in many cases, and introducing them by means of a syringe into the female during the period of ovulation. Frozen sperm banks exist today and the late Dr. H. J. Muller of Indiana University called for a nationwide, cataloged system of them. Muller's ideas are supported by many leading biologists including Nobel Prize winner Dr. F. H. C. Crick. Even more promising in scope is artificial inovulation, a process being investigated by Dr. E. S. E. Hafez at Washington State University. Already it has proved feasible in mammals. The egg, fertilized naturally or artificially, is flushed out of the female just after conception has taken place. The tiny embryo is preserved and implanted into another female for prenatal growth and eventual birth.

The problem—so far unsolved—is in freezing the embryos without damaging them. Dr. Hafez, confident the difficulty will be overcome, has succeeded in keeping animal embryos alive in cold storage for as long as twelve days. When the preservation techniques are perfected, any woman can choose her own offspring by "prenatal adoption," selecting from among the labeled specimens in an embryo bank.

Women who do not want to go through the rigors of pregnancy will be able to hire surrogate mothers who will have the baby but will contribute nothing to the genetic makeup of the implanted offspring. In a world of frozen sperm and egg banks, a man and a woman will no longer have to unite in either time or space in order to reproduce. Telegenesis—the mingling of sex cells derived from donors miles, even continents, apart—is already practiced. And paleogenesis—the mingling of sex cells produced on different days, even different years—is also a reality. A woman living two hundred years from now could, if she wanted, have Marcello Mastroianni's child; little Raquel Welches could abound a century hence, and Jean-Claude Killy's kids could fill an Olympic skiing team.

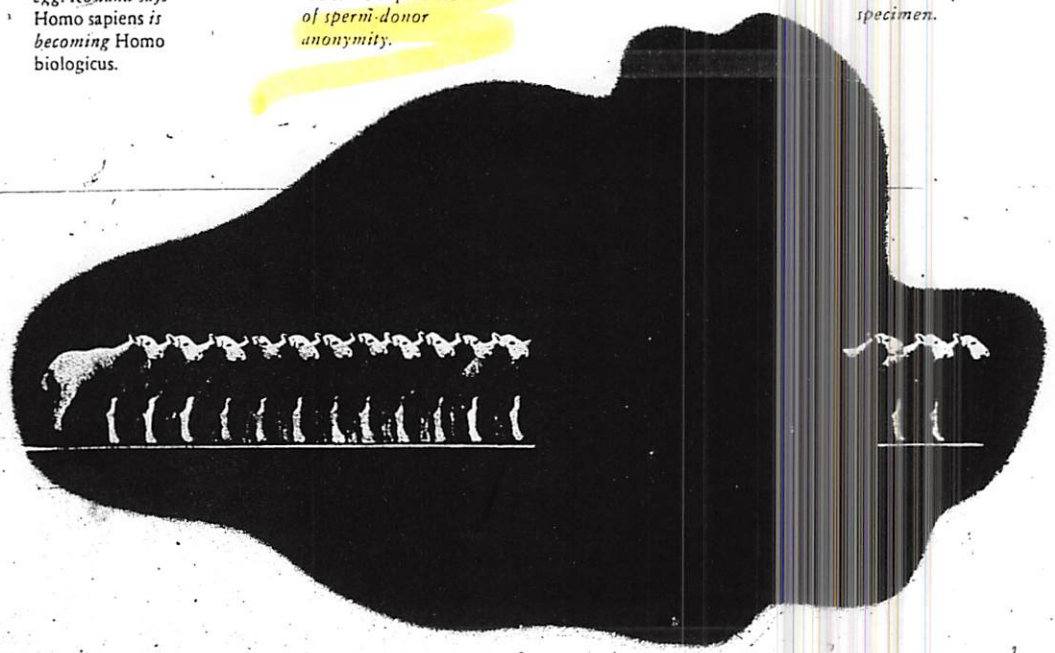
Eminent biologist Jean Rostand of the French Academy is one of the founders of the biological revolution. He jolted unfertilized frogs' eggs with chemicals, "tricking" them into doubling their chromosomal content. He thus effected parthenogenesis, the birth of a perfectly constituted living creature from a virgin egg. Rostand says Homo sapiens *is becoming* Homo biologicus.

Nobel Prize winner, the late Dr. H. J. Muller of Indiana University advocated "germinal choice," artificial insemination of women with the sperm of men "whose lives have given evidence of outstanding gifts of mind, merits of disposition and character, and physical fitness." He suggested banishing the current practice of sperm-donor anonymity.

Dr. J. K. Sherman of the University of Arkansas was the first to successfully impregnate women with sperm from stocks frozen for prolonged periods at 385 degrees below zero. He estimates several hundred babies now alive got their start in the deep freeze. The practice is expected to flourish in the near future.

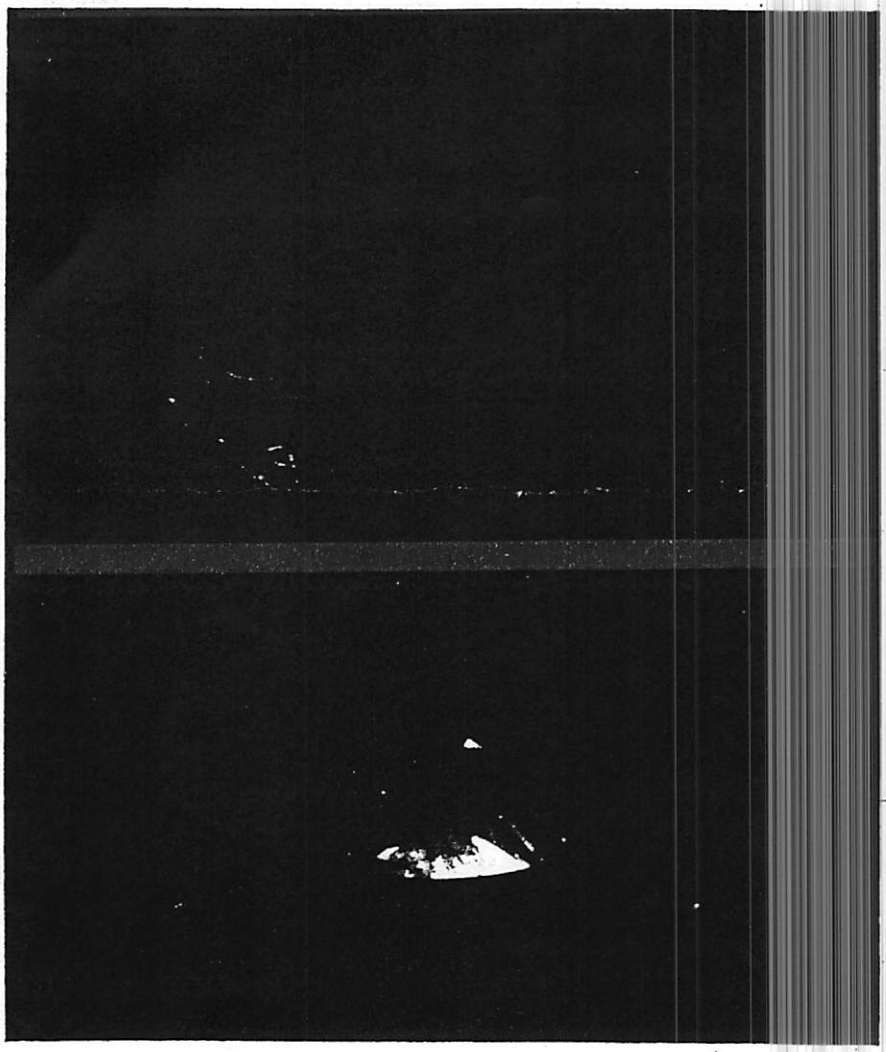
One of the practitioners of artificial insemination is Dr. Sophia Kleegman of New York University. She maintains anonymity of donors but tries to match donor's appearance and background with that of the recipient's husband. Donors, all fertile, intelligent men, produce sperm by masturbation and collect $25 per specimen.

Pioneering biologist Dr. E. S. E. Hafez of Washington State University uses hormones to induce superovulation—the release of perhaps a hundred eggs in a prize cow—artificially inseminating these with sperm from a top-grade bull. He then places one embryo in each of a hundred genetically less desirable cows who carry them through to birth.

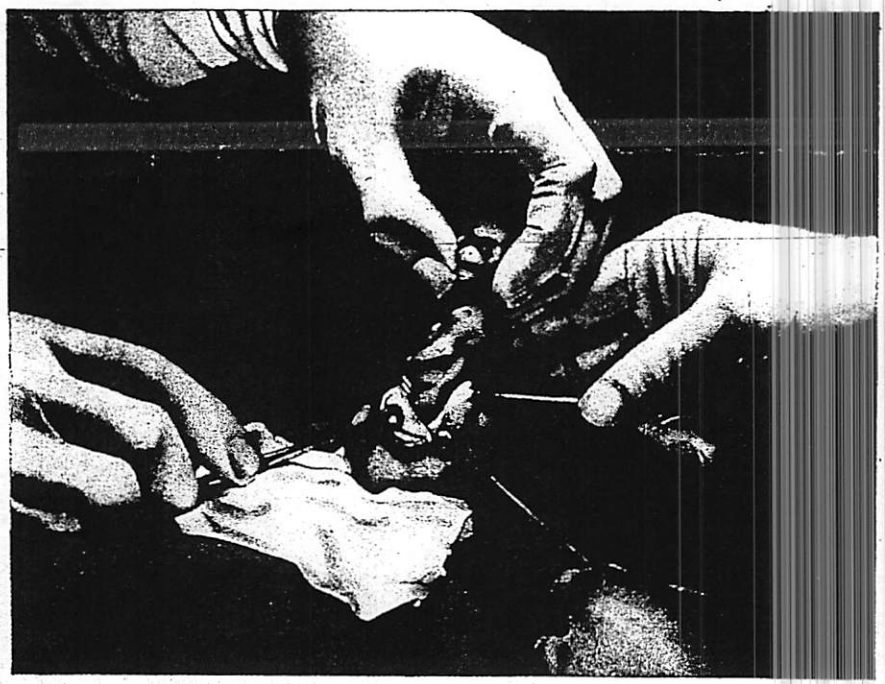


Recently biologists devised a plan to demonstrate the biological freedom made possible by artificial inovulation. They arranged for an entire herd of prize sheep to be air-mailed to them from Europe in the form of tiny embryos kept alive in the uterus of a single rabbit. The embryos were removed here and implanted into ewes while the real mothers grazed contentedly back on the continent.

Birth without People

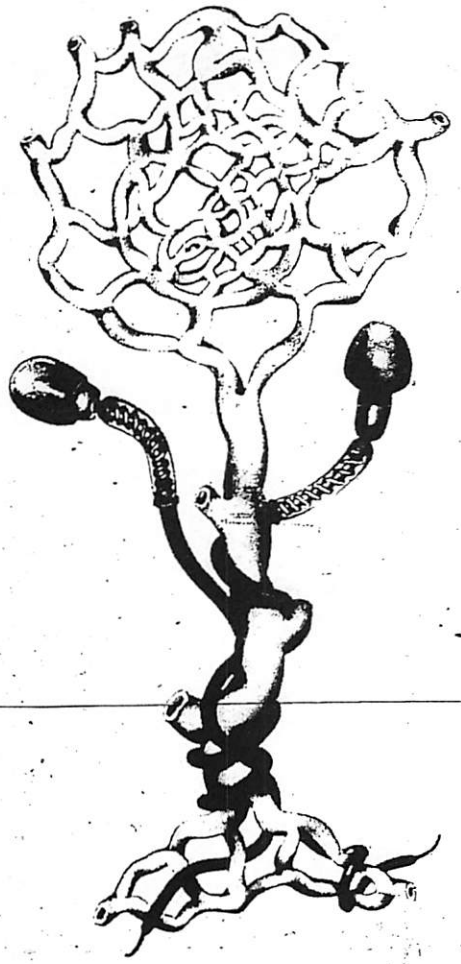


The crucial breakthrough will be creating life in a test tube, achieving an embryo outside the female. This is now a distinct possibility. Dr. John Rock of Harvard and Dr. Landrum B. Shettles of Columbia Presbyterian Hospital in New York grew human embryos *in vitro*, though none lived longer than a week. Dr. Daniele Petrucci of Italy (below) placed ripe ova between glass slides, fertilized them and grew an embryo that lived a month. (The Pope condemned his work.) In anticipation of the ultimate achievement of *in vitro* fertilization, Kansas University's Dr. Kermit E. Krantz and others are closely studying the functions of the human placenta. The idea is to build an artificial womb similar to one already constructed by Dr. Robert Goodlin at Stanford. The fetus will lie in an oxygenated saline solution inside a small bathysphere with porthole view (left), while tremendous pressure forces oxygen through the fetal skin. Though machines like this have had only limited success, scientists are confident that they will be improved to the point where they will eventually be able to carry the unborn all the way through to birth, thus making human motherhood obsolete.



When ectogenesis—test-tube birth and the artificial womb—becomes reality, the fetus itself will be the subject of as much medical inquiry as is the child and adult now. Thus, during the past few years, the new specialty called fetology has blossomed. Dr. Karlis Adamson at Columbia University and Dr. Sheldon H. Cherry at New York's Mount Sinai School of Medicine have developed techniques for observing the fetus, determining its sex and appraising its general health. Actual surgery before birth (left) is being tried experimentally on monkey fetuses by Dr. Ronald E. Myers at the National Institute of Health Laboratories in Puerto Rico. An interesting fetal treatment has been described by Dr. O. S. Heyns of South Africa. He discovered that when women, during the last stages of pregnancy, were placed in a special decompression chamber to increase the flow of oxygen to the fetus, they gave birth to superintelligent children. Many of the offspring were coherent conversationalists at eighteen months. Such techniques might well be applied to the artificial womb in order to breed a generation of geniuses.

Fewer men, please, and make them all redheaded



The babies that will emerge from artificial wombs will be smarter than you and I—and not only because of increased prenatal oxygen. The volume of the human brain, 1500 milliliters on the average, is dictated by the proportions of the female pelvis. Once we are free from that restriction, the geneticists say they could create cranial wonders beyond our present imagining. France's Jean Rostand suggests it might be a simple matter to induce one or more doublings of the fetal brain cells. He also says it will be "no more than a game for the man-farming biologist to change the subject's sex, the color of its eyes, the general proportions of body and limbs, and perhaps the facial features."

Scientists are unhappy about the current random production of male and female offspring and generally feel that the world could do nicely with fewer males. A. S. Parkes, physiologist at Cambridge, England, states that in Britain alone there are a million tons of excess "male biomass. One man," Parkes says, "could easily father five hundred children, or considerably more if he got himself properly organized." Thus, biologists are looking for ways not only to determine sex prenatally but to control it. Columbia University's Dr. Landrum B. Shettles, using phase-contrast microscopy, believes he has found an easy means of identifying the two kinds of sperm that determine sex. One type shows up with elongated oval-shaped heads (as in the one on the left in the picture) ; the other has more compact, round heads (on the right). The latter produces the male. Eventually it may be possible to separate the two types in the test tube before *in vitro* fertilization, either on the basis of their differing electric charge or their different mass. "Sex by sedimentation" has already been demonstrated with animal sperm and works this way: fluid containing the sperm is allowed to sit in a cooled container for twelve hours; the heavier female-producing sperm sinks to the bottom while the more buoyant male variety floats on the top. Rabbits artificially inseminated with fluid scooped off the top produce, in a typical experiment, seventy-seven percent males.

Actual genetic change, controlled mutation, will follow selection of sex. This will be accomplished by genetic surgery, which embraces the insertion of desirable genes, the deletion of unwanted ones and the manipulation of still others to change and improve the human genotype.

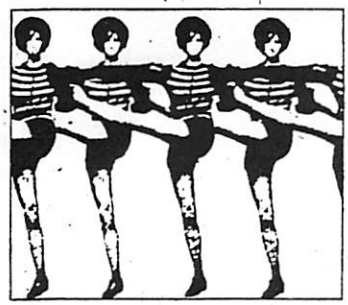
Stanford's Dr. Joshua Lederberg, a Nobel laureate, believes a strenuous effort could put genetic surgery within our grasp in as little as ten or twenty years. The tool needed for the surgical manipulation of D.N.A., the nucleic code of life, is already at hand in the form of the laser beam, which can be focused to a diameter as small as one-ten-thousandth of a centimeter. With this incredibly precise "editing" device, unwanted genes or, conceivably, even the much smaller nucleotides that make them up, could easily be erased. And synthetic viruses, some scientists say, will probably be used to carry genetic corrections into the proper niches. Dr. Edward Tatum, a Nobel winner at Rockefeller University, suggests "suppressor molecules" to prevent the functioning of certain genes and "nuclear additions" to impose new genetic traits. The feasibility of such additions has already been proved in experiments with microorganisms.

Dr. Robert L. Sinsheimer, biologist from Caltech, recently delivered a paper in which he called the possibility of genetic engineering "one of the most important concepts to arise in the history of mankind. For the first time," he said, "a living creature understands its origin and can undertake to design its future." All this could eventually produce the five human mutations shown three pages back, or it could simply mean that, should red hair, say, become the rage, a generation of redheads could be produced to satisfy the needs of the day.

A League of Joe Namaths

The phenomenon known as "cloning" may well be the geneticists' ultimate coup. It is based on the fact, established only recently, that *each cell* in the body, not merely the conjoined male and female sex cells, contains all the information necessary to create a new individual. Professor F. C. Steward demonstrated this with carrots in experiments carried on at Cornell. At Oxford, Dr. J. B. Gurdon removed cells from a frog's intestine and, with tiny surgical tools, managed to lift out the cells' nuclei. These nuclei contained the full genetic complement of chromosomes in the frog donor. Gurdon implanted them into unfertilized frog egg cells in which the female nucleus, consisting of but a half complement of chromosomes, had been delicately destroyed by radiation. The result was strange "virgin" eggs which now nevertheless contained all the chromosomes needed to produce new individuals. Many of them did produce tadpoles—and each tadpole was genetically identical to the original frog donor, a carbon copy, in fact. Stanford's Dr. Lederberg says, "There is nothing to suggest any particular difficulty about accomplishing [cloning] in mammals or man, though it will rightly be admired as a technical tour de force when it is first implemented." Any man, then, by giving up some of his body cells, can produce an exact replica of himself—or several or many hundreds of such replicas. New copies of extraordinary men can be produced before the original dies. Great beauties could be cloned to cheer a dismal world. Dr. Lederberg suggests that neurological similarities between cloned individuals would ease communications problems since each clone would quickly interpret the other's gestures and brief words. The technique would be admirable for those who must work in close harmony: astronauts, soldiers, underwater explorers, surgical teams.

Dr. Lederberg admits that cloning puts man "on the brink of a major evolutionary perturbation." His own opinion of it, in fact, is negative. It could, he says, replace racism, with huge clonish elements vying against one another for social, economic and political mastery. But if the War of the Clones can be forestalled, and if madmen and fanatics can be restrained from cloning themselves, the phenomenon could be of immense benefit. Jean Rostand proposes storing body cells as insurance against mutilating or fatal accidents to men of remarkable attainment. Doctors could simply replace the revered individual with another one. Dr. Lederberg notes that the similarity of minds between clones would facilitate discourse and negate the generation gap that plagues conventional education. Dr. Haldane called for cloning centenarians and people with resistance to radiation or with a high pain threshold. The effect upon future entertainment and sports could be astonishing, as you can see below.

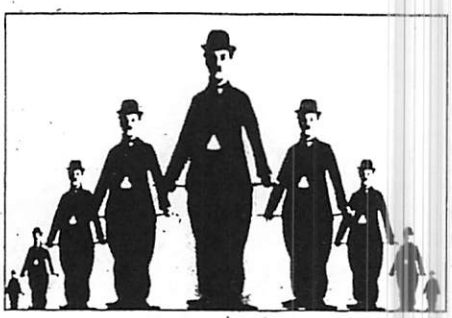


Clone Streisand and hybridize her with the best Rockette. That *will be a chorus line.*

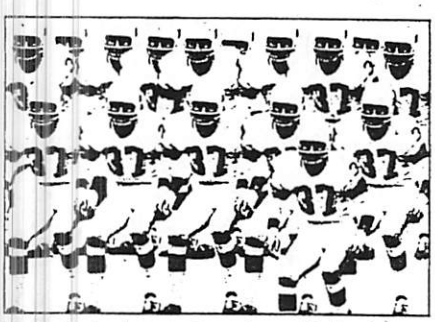
Multiple Bonds would make for faster action and a swifter plot. Bye, bye Smersh.

Dancers like Nureyev should clone themselves young so they can instruct offspring.

A few Mahalia body cells in storage now would assure us of a chorus for all time.



Outstanding artists will use their retirement to train replicas in style and technique.

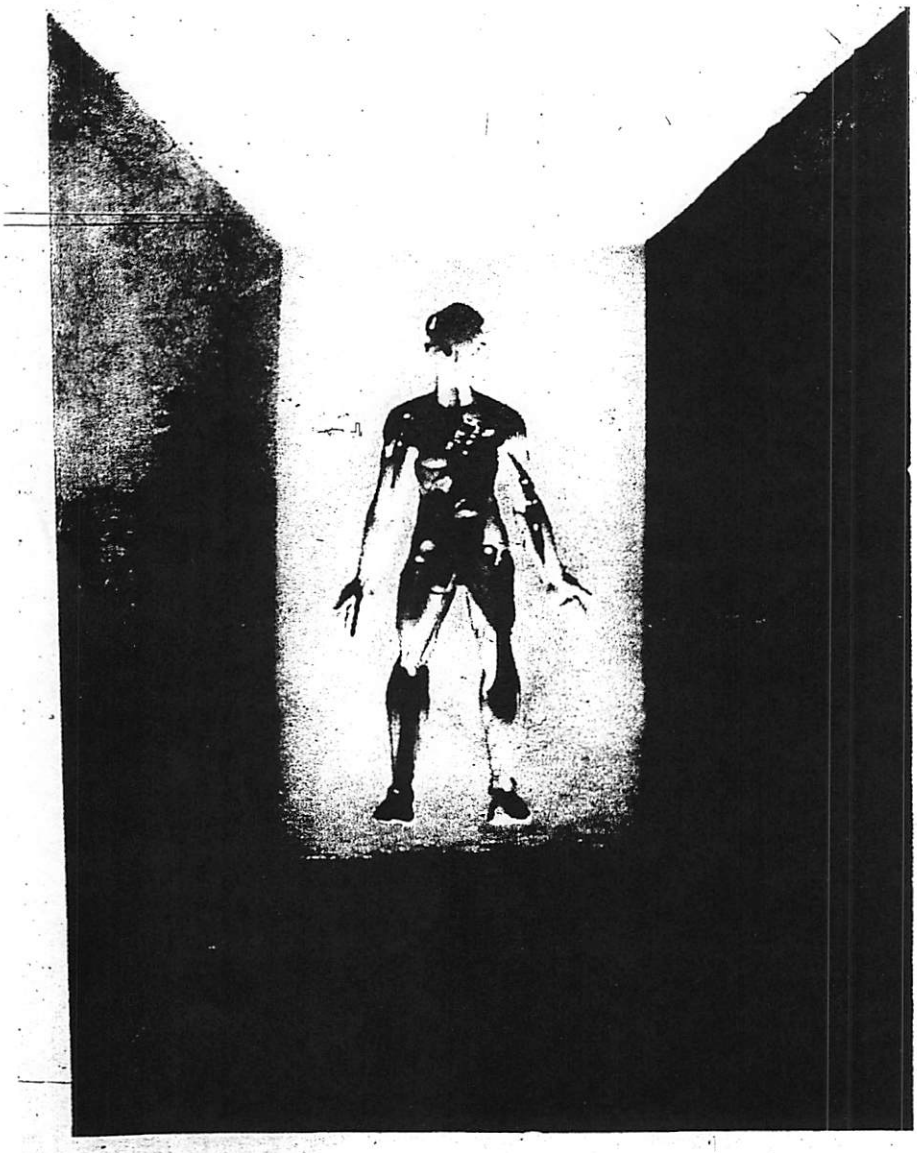


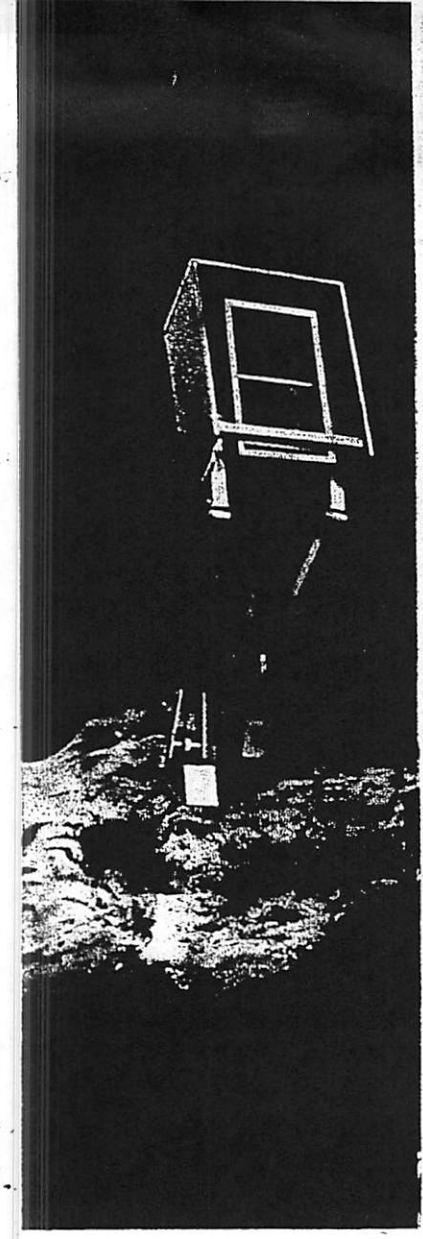
Namath is okay, but madmen (below) must never be allowed to clone themselves.

Wanted: Capable Ape To Do Janitor's Work

Scientists predict man eventually will mix human genes with animal, making para-human "slave" animals to do low-grade labor.

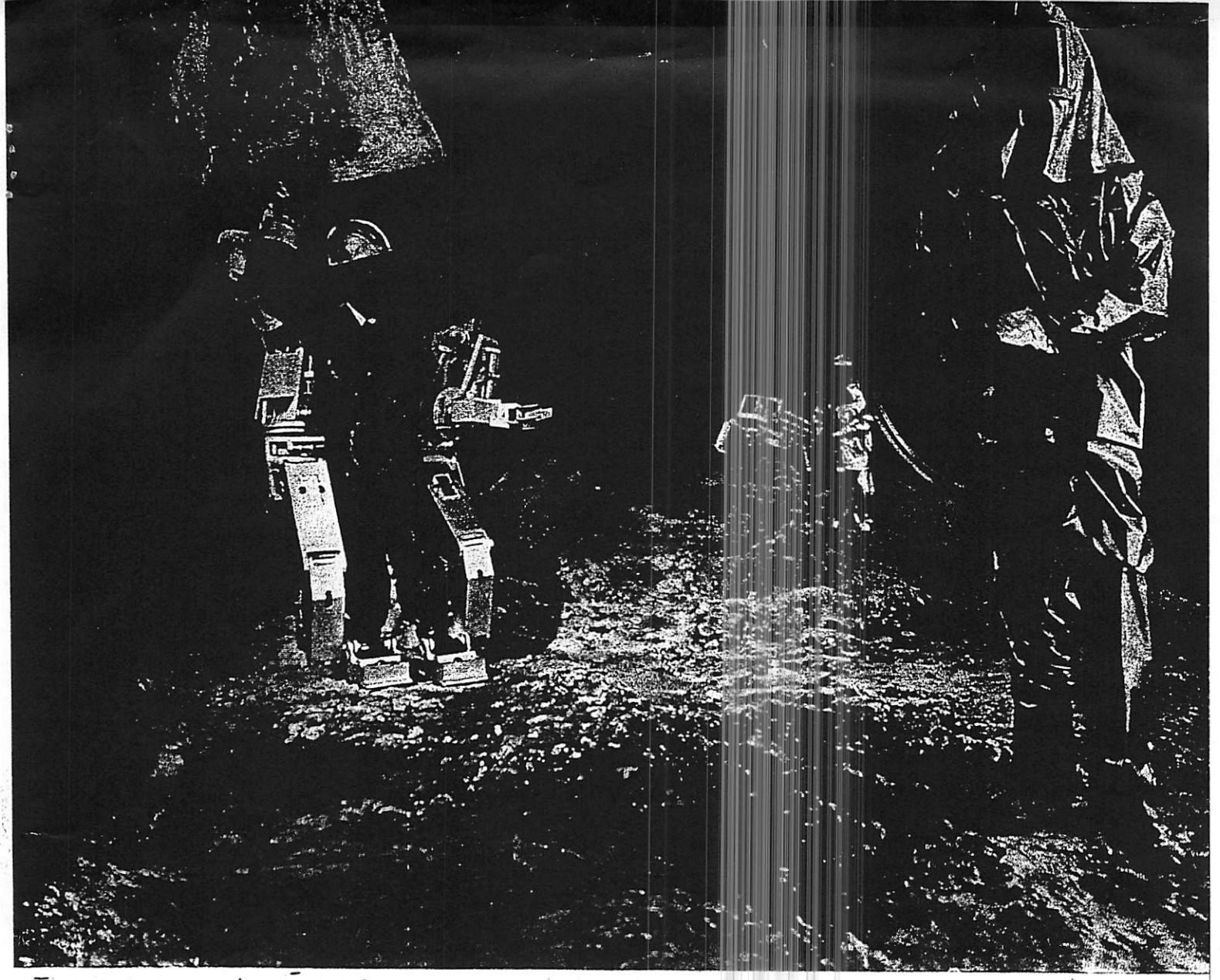
Culture experiments now going on combine human nucleic material with that of other animal species. The brains of the mouse or the gorilla, for instance, may be developed beyond their present capacities by dosages of the human twenty-first chromosome. Stanford's Dr. Lederberg believes the day will come when the laboratory will produce man-animal mixtures, or chimeras, of "varying proportions of human, sub-human and hybrid tissue." This could create a unique labor force (left) or provide a ready supply of organs for transplanting when laboratory animals are bred with organs readily acceptable in the human body. Other biologists are at work on the possibility of inducing the human body to regenerate its own new parts to replace damaged or surgically removed organs. There is some reason to hope that this avenue will prove fruitful because frogs, which normally have no regenerative abilities, have been "taught" to regrow missing parts in the laboratory.





Sticks and stones won't break these bones

Dr. Manfred Clynes and Dr. Nathan S. Kline, both of Rockland State Hospital, N.Y., coined the term "cyborg" (for cybernetic organism)—part man, part machine. A man walking around with a pacemaker in his chest is on the way to becoming a cyborg; medicine has many other man-made parts already at its disposal or coming soon, as shown at left: Dacron arteries, ceramic hip joints, metallic bones. Many scientists are convinced man will eventually discard *all* his bodily parts, subject as they are to disease and death, keeping only his brain to be implanted in a super-efficient mechanical body.



Making Machines into Men and Women

Perhaps the ultimate extension of the genetic revolution will be a new breed of humanlike machines. General Electric experimented with a balancing machine like that at far left in the picture above. A man stationed in the box fifteen feet above the earth could, by his own body movements, make the machine stand, bend, flex. The hope is that this will lead to "walking trucks" for military or space use (one of them is seen in the background of the picture). More advanced in development is G.E.'s Hardiman (second from left above). This is an "exoskeleton," a machine literally worn by a man. It follows his own movements and amplifies them greatly so that a man can lift fifteen hundred pounds. Ralph S. Mosher, who directs research on this project, says the symbiotic relationship between exoskeleton and operator is so intimate that the man "subconsciously considers the machine a part of himself."

Other, more intricate cyborgs will be remote-controlled machines, or telefactors as they are called by William E. Bradley of the Institute for Defense Analyses. These man-made men will be linked electronically to their human counterparts. The human operator will sense everything his "double" senses—within the limits of safety—via a sensory feedback system. Thus, slave-doubles or man-multipliers could be used in hazardous work on earth or in space, as shown at right above. In a study for N.A.S.A., scientists Edwin Johnsen and William Corliss predict miniature man, a slave-double built smaller than man "able, in turn, to build a smaller replica of itself, and so on, smaller and smaller, until the descendants reach atomic dimensions." Your great grandchild might be able to send a carbon copy of himself inside his brain to see what is causing his headache. Which brings us, once again, to your progeny. Don't wish them luck; you'll need it worse than they will.

A timetable for you on your way out

You're okay by us, reader, just the way you are, but all good things must end. What follows is based on a number of scientific forecasts including one done for RAND Corporation. In just two years you'll be able to choose the sex of your offspring. As for the rest:

Artificial inovulation in humans	1972
Genetic surgery	1995
Routine animal cloning	2005
Widespread human cloning	2020
Routine breeding of hybrids and specialized mutants for space	2025