Two Mothers, No Father = One Embryo

One egg plus one egg equals a developing embryo, at least under special laboratory conditions. And eventually this may add up to animal husbandry without male animals. A successful first step in fatherless reproduction of mammals has been reported by Pierre Soupart of Vanderbilt University in Nashville. His findings have been submitted for publication.

Parthenogenesis (egg development without the entrance of a sperm) can occur in reptiles, fish and birds, but in no experiments with mammals have entirely fatherless embryos successfully reached birth, says Soupart. His recent experiments with mouse eggs, however, suggest that such an experiment may soon be successful. What Soupart has done is combine two unfertilized mouse eggs by a standard cell fusion technique (using Sendai virus). The resulting cell has the same chromosome count as a sperm-fertilized egg, but no other sperm factors, Soupart told SCIENCE NEWS. Even so, he found that the double-egg cell divides in the laboratory as if it were a fertilized egg and eventually achieves an apparently normal 64-cell blastocyst stage.

Ironically, this dual-egg conception came about during an attempt to learn more about the role of sperm. "What does the fertilizing sperm bring into an egg besides its chromosomes?" Soupart had asked. His experiment suggests that there may be nothing special that the sperm contributes, at least to early embryonic development, beyond chromosomes and a membrane perturbation.

The next step, if true spermless reproduction is to be achieved, will be to transfer the embryos to mouse foster mothers to see whether normal development will continue. To do that researchers must first improve the success rate of their egg-fusing operation. Soupart says they'll need to establish a reliable embryo "production line."

Animal husbandry minus males is one potential application of the egg-fusing technique—that is if the method succeeds in producing healthy offspring. Not only is no father required, but no sons would be born. Because each egg cell contains one X chromosome, the fused cell and its descendants would all bear two X's and thus be female.

Breeders, especially in the dairy industry, have long searched for practical ways to guarantee producing female animals. "You can kill a steer only once," Soupart says, "but you can milk a cow for years." That distinction is especially important in areas such as India where meat consumption is prohibited, but dairy products are consumed.

Soupart believes that fusing cattle egg cells and implanting the embryo in cow foster mothers is more promising for ensuring female offspring than is separating X-chromosome and Y-chromosome bearing sperm before artificial insemination. Animal producers are already freezing and transferring into foster mothers embryos derived more traditionally from egg and sperm (SN: 9/16/79, p. 203).

Lennart Nilsson, Vanderbilt

Pierre Soupart observes early embryos.

The egg fusion experiments add one more achievement to the rapid advance of embryo manipulations, some of which are useful for investigating parthenogenesis. Previously, researchers at Jackson Laboratories in Bar Harbor, Maine, showed that mouse eggs occasionally begin to divide spontaneously as if they had been fertilized. But these embryos either are rejected by the uterus or develop into tumors. If the early parthenogenic embryos are combined with a normal embryo, however, a mouse is born composed of cells derived from each embryo. Thus parthenogenic cells, when mixed with normal cells, can contribute to embryonic development (SN: 10/22/77, p. 263).

More recent work by Karl Illmensee produced all female offspring by a different manipulation (SN: 7/28/79, p. 68). He took fertilized mouse eggs and removed the pronucleus containing the chromosomes contributed by one parent. Then he chemically coaxed the cell to duplicate its chromosomal content. Because embryos containing two Y chromosomes do not survive, all offspring had two X chromosomes. The resulting viable embryos, although they may contain no chromosomes derived from the male parent, are not equivalent to the parthenogenic embryos for research purposes. Soupart explains, "Originally there was a sperm in the business." □

Molecular clouds: Birthplace of the stars

The realm of the stars and galaxies has been traditionally considered the playground of physics: general relativity, celestial mechanics, nuclear physics. In the last decade or so it has become clear as well that there is a sizable amount of chemistry going on there, and that the chemistry produces some fairly heavy molecules. Not heavy in the industrial sense, although some of the molecules found in tank cars are also found in the far reaches of the galaxy, but to many scientists surprisingly heavy for the tenuousness and coolness of the regions where they are found.

Chemistry does not take place in the stars, where conditions are much too hot for it, but in cool clouds located in the space between stars. Exactly how it does is still a matter of vigorous debate, but upwards of three dozen different compounds have been detected by their radio emanations. Most of them are in only a few locations. Molecular astronomers are always going back to the Orion neubula or the constellation Sagittarius.

Now Philip Solomon and David B. Sanders of the State University of New York at Stony Brook and Nicholas Z. Scoville of the University of Massachusetts report that such molecular clouds are much more common than astronomers have known. They told a Symposium on Interstellar Molecules of the International Astronomical Union that met at Mont Tremblant, Quebec, last week that their investigations of the millimeter-wave emanations of carbon monoxide have found an estimated 5,000 such clouds.

Observations with the two largest antennas in the United States designed specifically for millimeter-wave observations, the 36-foot paraboloid of the National Radio Astronomy Observatory located on Kitt Peak in Arizona and the 45-foot antenna at the Five College Radio Observatory in Massachusetts, indicate that such clouds form a belt around our galaxy. The ring lies in the inward parts of the galaxy between 12,000 and 24,000 light-years from the center (the radius of the galaxy is about 50,000 light-years) and between us and the center. On the average, a cloud would be 200 light-years in diameter and have a mass 500,000 times the sun's. That makes them the most massive objects in the galaxy.

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Clouds of this kind are believed to be the places where new stars form. These studies indicate that the clouds are held together by the mutual gravitational attraction of the gas molecules and dust particles that make them up, and that goes to support the belief that they are the birthplaces of stars. The formation of a star is supposed to begin with a collapse under mutual gravitation of this sort.

However, the age of the clouds determined by this study, which is 100 million years, indicates that something is slowing the collapse of the clouds, and therefore possibly inhibiting star formation. On the other hand, this figure, which is ten times the previous age estimates, is an aid to understanding the chemistry of the clouds.

These clouds are so tenuous that encounters between molecules in them have to be astronomically rare. This means that the formation of complex molecules is an extremely slow process. At the same time, the clouds are irradiated with ultraviolet light from nearby stars, which tends to dissociate complex molecules. The dust particles in the clouds shade the complex molecules partly but not completely from the ultraviolet. The balance among formation, protection and dissociation must add up in such a way as to build up the observed concentrations of various molecules in the clouds. It was hard to see how that could happen if the clouds were only 10 million years old. At 100 million years it's much easier to figure. □

Now it's in the Scotch

Beer enthusiasts recently pushed aside their mugs upon hearing that small amounts of nitrosamines had been found in their brew. Now Scotch whisky lovers may follow suit. Nitrosamine sleuth David H. Fine has announced the discovery of minute amounts (1.7 to 2.8 micrograms per liter) of nitrosamines in six of seven brands of Scotch: Chivas Regal, Black and White, J&B, Ballantine, Sandy Scot and Cutty Sark. White Label alone remained free of the chemical, which has been implicated in cancer of the esophagus.

Fine and E. Ulku Goff of the New England Institute for Life Sciences in Waltham, Mass., presented the findings in a report prepared for the National Science Foundation. In the screening of liqueurs, wines, whiskies, brandies and beer for nitrosamines, they used a "much simplified" gas chromatograph technique, sensitive to 0.2 micrograms per liter. English dark ale had the highest nitrosamine concentration, at 7 micrograms per liter — yet that was 20 times lower than the minimum level the Department of Agriculture will allow before it will start testing a product for dangerously high levels of nitrosamines. Such a small amount "cannot be considered a possible causative agent in alcohol related cancers," Fine says. □

Down's syndrome and cell division

Although only four percent of the babies born each year are born to women older than 40 years of age, 40 percent of those babies have Down's syndrome, or mongoloidism, a congenital abnormality characterized by mental retardation. The same is true of babies born to women under 17 years of age. In the past, scientists have attributed the syndrome to heredity, to damage to the uterus or to the ovum by radiation, chemicals or disease, and even to changes in sexual behavior. Children with Down's syndrome are marked by their appearance — a sloping forehead, a flat nose, low-set ears, epicanthal folds over the eyes — and by the presence of an extra 21st chromosome. Researchers at the University of Kentucky used the extra chromosome factor in combination with the known decrease in estrogen in women over 30 to provide new evidence for a hormonal explanation of Down's syndrome, as reported in the Aug. 2 NATURE.

Dushyant K. Gulati explains: At birth a female will have all the eggs she will get for reproduction. The eggs are developed only to the prophase stage of cell division until puberty, when the cyclic rise in estrogen triggers one egg, once a month, to ovulate or resume cell division (miosis). Estrogen controls the rate of miosis, and as a woman grows older, her estrogen concentration decreases, which decreases the rate of miosis. The problem arises when the chromosomes line up for cell division — side by side — and are held together at one or more points called chiasmata. The chiasmata hold the chromosomes (which tend to repel each other) together while the chromosomes align so the dividing cell's spindle can form to pull the chromosomes apart into separate cells. The chiasma travels up the length of the chromosomes to the end and "terminalizes". If miosis is too slow, the spindle does not attach to both ends of the chromosomes by the time the chiasmata have terminalized, and the dividing cells will have unequal numbers of chromosomes. The 21st chromosome is very short and only has one chiasma, making it especially easy to lose. A divided cell with no 21st chromosome will not survive. But one with three can go on to regular fertilization by the sperm, eventually resulting in an offspring with Down's syndrome.

Researchers Philip H. Crowley, Dushyant K. Gulati, Thomas Hayden, Penelope Lopez and Ruth Dyer tested for a correlation between the incidence of Down's syndrome and the changes in estrogen levels as they related to the age of the mother. They found it to be significant.

The hypothesis explains more than the high incidence of Down's syndrome among children of older women. Young women are also producing high numbers of mongoloid children. Gulati says that the menstrual cycles of young women are not fully stabilized until they are about 20 years old. The higher variability of their hormone levels also affects the rate of miosis in their eggs. □

California quake autopsy report

So far, there's nothing in the way of precursors from the data preceding the Aug. 6 San Francisco area earthquake to "rush out in the streets and shout about," says Barry Raleigh of the U.S. Geological Survey in Menlo Park, Calif. Even so, USGS scientists are happy — as only geologists can be — about the 5.9 Richter magnitude quake, which caused little damage and no reported injuries.

The quake, which originated near the small towns of Morgan Hill and Gilroy about 70 miles southeast of San Francisco, has had scientists scrambling through the last year or so worth of measurements from tiltmeters, seismographs, magnetometers, creepmeters and strainmeters in the heavily instrumented area. According to Raleigh, "no well defined short-term events" have been found — though radon emissions from the ground changed abruptly in some spots and not others — and data from the long-term are "not clear, though there may be things in the seismicity and tilt." Previous quakes in the area, such as ones near Hollister in 1962 and 1974, showed strong precursory signals.

The researchers' satisfaction, however, comes from "a tremendous wealth" of information from the strong motion instruments near the site — "the best data yet," says Raleigh. Strong motion instruments are triggered by and measure, among other things, the acceleration of the ground during a quake. The acceleration along that particular fault — the Calaveras fault, which branches from the San Andreas fault about 30 miles south of the quake site at Hollister and runs roughly parallel to it and northward — had been predicted by the USGS and used to establish structural requirements for the area. The strong motion measurements recorded near the site confirm the USGS predictions and add "a lot of confidence" about the ability to predict earthquake hazard, says Robert Wesson of the USGS in Reston, Va. (The maximum horizontal accelerations observed were 0.4 g. One g is equal to the acceleration due to gravity [32 ft./sec^2]; 0.4 g, therefore, is an acceleration 40 percent that of gravity, but occurring in a horizontal direction.)

In addition, Wesson notes, the observed cracks and displacements follow exactly the predicted fault line mapped by the USGS. "It was just what [was] needed" to confirm the accuracy of the maps, which are used to identify quake-hazardous areas. □