like," says Walker. In principle, such spin traps offer a kind of stored nuclear energy with no radioactive waste. "If you could make a kind of superbattery that you could take into space with you and power your space station for 5 years, all in a kilogram box or something, it would be pretty useful," notes Walker.

Almost by definition, however, trapped energy is hard to release, but that's where RNBs come in because of their ability to make new spin traps. "The ones we can make at the moment are not the best ones that are predicted theoretically," says Walker. Recent studies have hinted that it may be possible to create nuclear spin traps that could be triggered to offload their excess energy using a laser beam, he adds.

Such nuclear cookery—and much more—will be made possible with the extra ingredients provided by RNB machines of the future. And those same machines will show nuclear structure researchers just how the nucleus, that cauldron of nucleons, seethes and stews and, in some cases, boils over. **–ANDREW WATSON**

Andrew Watson writes from Norwich, U.K.

BIOMEDICAL RESEARCH

Ethical Loophole Closing Up For Stem Cell Researchers

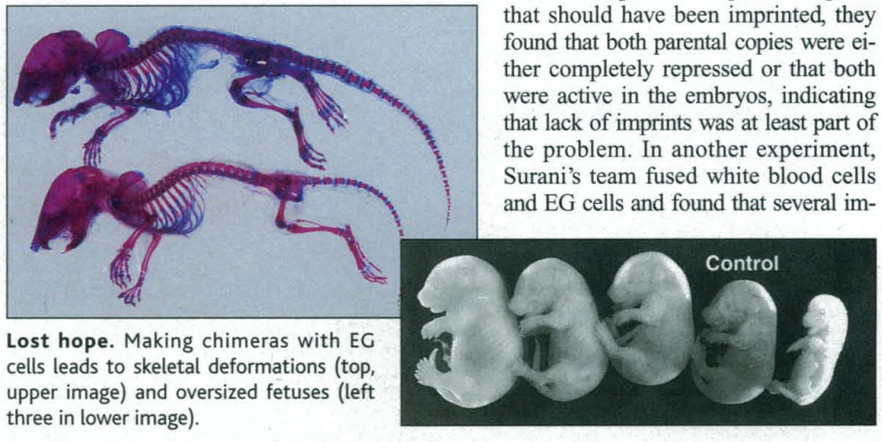
Embryonic germ cells, derived from fetuses, are less ethically contentious than their stem cell cousins. But they may not hold the same promise

MUNICH—In the rapidly growing field of stem cell research, the demands of science and those of medical ethics are colliding head on. Ever since U.S. researchers revealed last year that they had created "immortal" lines of human embryonic stem (ES) cells—a type of cell extracted from an embryo that can be tweaked to grow into any form of human tissue (*Science*, 6 November 1998, p. 1014)—teams around the world have been eager to use ES cells to grow tissues for transplant. But creating ES cell lines requires researchers to destroy an embryo, so research is either heavily restricted or banned altogether in many countries. One hope was that lines of embryonic germ (EG) cells, which are taken from aborted fetal tissue, could be used instead. But results presented at a workshop on stem cell and nuclear transfer research here last month have dampened those hopes.

EG cells are derived from primordial germ cells, which later in development give rise to eggs or sperm. Like ES cells, they regenerate seemingly forever, and researchers can coax them to differentiate into any type of tissue. Because of this apparent similarity between EG and ES cells, the DFG, the main research funding agency in Germany, where the production of human ES cells is banned, has advised scientists to use EG cells for their research.

But work presented by Azim Surani of the Wellcome/CRC Institute of Cancer and Developmental Biology in Cambridge, U.K., casts strong doubt on the assumption that EG cells can simply be substituted for ES cells. It shows that when mouse EG cells are implanted into early mouse embryos, the tissues containing the cells develop abnormally. This happens because the genes in the EG cells lack certain modifications needed for their normal activity during development. For many at the meeting, Surani's data cast doubt on the suitability of EG cells as a source of transplant tissues. "This report has discouraged German researchers from staking everything on this one chance," said Anna Wobus of the Institute for Plant Genetics in Gatersleben.

As part of his ongoing studies of germ cells, Surani had decided to test whether the development potential of EG cells is equivalent to that of ES cells. As a pioneer of research into a phenomenon called imprinting, he had reason to be concerned that it might not be. During the formation of the sperm and egg, some genes undergo a type of biochemical modification known as methylation that selectively inactivates the paternal or maternal copies of a gene, so that both are not active at once in the developing embryo and adult. The gene imprints imposed by the male and female are different, and both types must be present when the egg and sperm come together if normal development is to occur. But before that imprinting can occur, the original imprints inherited by an embryo have to be erased—a change that happens in the primordial germ cells. So Surani reasoned that if an EG cell line is derived from germ cells with their imprints absent, the cells may not develop normally. And that's what he and his colleagues found.



Lost hope. Making chimeras with EG cells leads to skeletal deformations (top, upper image) and oversized fetuses (left three in lower image).

CREDITS: A. SURANI, WELLCOME/CRC INSTITUTE OF CANCER AND DEVELOPMENTAL BIOLOGY

When ES cells are injected into early mouse embryos, the tissues appear to form normally. But when the researchers injected EG cells into the preimplantation embryos of naturally mated mice, the EG cells that became incorporated into the tissues of the developing chimeras caused them to grow bigger and heavier than controls and the embryos also suffered from skeletal abnormalities.

Hints that these problems are due to lack of imprinting in the EG cells came when Surani's team transplanted EG cell nuclei into egg cells that had their own nuclei removed. The resulting embryos were small and had abnormal placentas. When the researchers tested for expression of particular genes that should have been imprinted, they found that both parental copies were either completely repressed or that both were active in the embryos, indicating that lack of imprints was at least part of the problem. In another experiment, Surani's team fused white blood cells and EG cells and found that several imprints were erased from the blood cell nucleus—implying that EG cells can still erase imprints even in mature cells.

The question now is whether human EG cells will suffer from the same problems as the mouse cells. If so, it might be possible to avoid the problems by harvesting the cells while they retain their imprints. Despite that possibility, Surani's results came as a blow to German stem cell researchers for whom working on human EG cells is the only legally permitted alternative. DFG Vice President Rüdiger Wolfrum of the Max Planck Institute for International Law in Heidelberg says: "This may mean that certain research projects … have to be conducted abroad."

–SABINE STEGHAUS-KOVAC

Sabine Steghaus-Kovac writes from Frankfurt.