



## Transgenics with teeth

Transgenics is a relatively new area of scientific inquiry that involves the mixing of genetic material between species. There is not only a perceived need for transgenic methods to be developed for a range of medical applications like making animal organs immune from rejection or producing human insulin in bacteria. Transgenics is also an area of fascination for scientists, some of whom would like to know just how far certain interspecies boundaries can be pushed. In this respect scientists have imaginations just as fertile as others who have gone before and dreamt up centaurs, X-men, mermaids or Dr Moreau's creatures. And while these may be fanciful, the difference now is that science may actually be on the threshold of developing some viable hybrids involving humans. Nevertheless, at this stage things look far more benign and involve human-animal hybridization at a far more modest level. Even so, groundwork in this area has the potential to open up a field that will be hard to regulate in the legislative environments of some countries.

The field of transgenics has a well-established history involving the mixing of genetic material between animal species including between animals and humans. Most of the human/animal work has involved the introduction of a single human gene into another species for the purposes of producing a human protein for a specified medical purpose.

The most recent example of transgenics is the introduction of human foetal brain cells into the brain of a mouse. In this experiment, the cells became widely distributed and apparently well integration throughout the mouse's brain. The work was carried out at Stanford University under the direction of Dr Irving Weissman to model human illness and injuries such as stroke, schizophrenia and Alzheimer's and Parkinson's disease. Although it is unclear what functionality the cells have in terms of connection with mouse brain cells, what is striking is how well the cells spread and survived.

But there is another example to show that human cells can in fact be quite functional in the body of an animal. The infamous Trounson's rat<sup>1</sup> was first treated with toxins to damage nerve cells in its spinal cord so it became paralyzed, and then injected with human stem cells derived from 5-9 week old fetuses. The experiment was conducted at the John Hopkins University. The rat regained partial control of its locomotion, presumably due to integration of the human cells into neural networks with the rat spinal neurons. What the experiment shows is that interspecies differences are not so great that cells from one species cannot function alongside those of another species in a living organism.

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<sup>1</sup> This is the rat that gained notoriety in the Australian Federal Parliament when its recovery from spinal injury was shown on video to MPs. The claim was made by Professor Trounson that the rat had been treated with human embryonic stem cells, when in fact it had been treated with cells from an aborted foetus.



An experiment with even more ethical twists and turns has been proposed by some stem cell researchers. That experiment would involve the introduction of human embryonic stem cells into the developing blastocyst of another species. The stem cell expert Irving Weissman is on the record for calling such an experiment "enormously important", but also noted that the result could be quite horrendous. While a mouse could hardly house a human brain, if the experiment were to be conducted using a chimpanzee blastocyst and full development allowed to proceed, although the result would be unpredictable, it is quite possible that a modified, more human chimp might one day stare back at us.

Other forays into transgenics include the various cloning experiments using animal eggs such as cow, pig and rabbit, into which an adult mature human nucleus has been transferred. In each case development was allowed to continue for some time before the early embryo was destroyed. While in these examples one would expect the developing organism to be at least 99% human, our limited knowledge of genetics cannot tell us the significance of that 1%. Our current knowledge at the very least tells us that single master genes can be very powerful in directing other genes, and therefore the development of whole structures, such as the eye in the fruit fly *Drosophila*. Experiments with these master control genes have produced, for example, fruit flies with eyes on the ends of limbs. So if 1% genetic modification were to include changing certain master genes, then the development of structures unique to one particular organism may be able to be reproduced in the environment of another quite different organism. From an ethical perspective the developing organism should be given the benefit of the doubt and accorded the same moral status as any other human embryo. Therefore this type of experiment should not proceed as it constitutes the deliberate production of a human being (possibly defective) that is destined to be destroyed for some other purpose.

Other recent experiments involving trans-species tissue transplantation include the transplantation of sperm-producing tissue from goat or pig into mice. If the same experiment worked using human sperm-producing tissue then mice could be made to host the production of human sperm. The proposed reason for doing this would be to protect the reproductive capacity of boys about to undergo therapy for cancer in which they would ordinarily be rendered infertile.

All transgenic experiments between animals and humans raise ethical concerns of varying degrees. While most people would find the production of a human animal hybrid such as a pig with visibly human features to be abhorrent, when it comes to placing in a sheep a gene for the production of a human clotting factor to treat hemophiliacs, most people would probably accept the experiment as justifiable. Indeed that experiment is old news and such factors are already being produced. More recently the genetic modification of pigs, so that their organs are not rejected by humans upon transplantation, involves the transfer of more than one gene. While the pig is ostensibly still very much a pig it is now, like the GM sheep, subtly more



human. The question is, is that difference of moral significance? Does the experiment affect human dignity? Is it an affront in any way?

The acknowledgement of a moral boundary between animals and humans is very deep-seated, and confusion of the identity of a living being that arises when the boundaries are blurred like this is ethically deeply problematic. Since the human rights movement depends upon humans simply being members of the human species for moral recognition, the difficult question raised by interspecies mixing is that the boundaries of that membership, whilst previously sharply defined, are now indistinct.

While there is a difference between adding a human gene to a bacterium compared with adding a human gene to a complex higher organism like a chimpanzee, where the line is to be drawn along the varying complexity of species is a difficult discussion yet to be had.