THE INDEPENDENT

From Minnie to Mickey (and all they did was turn off a gene)

Simple technique changes sex of a mouse – and reveals the gender war that rages in all of us

By Steve Connor, Science Editor

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The battle of the sexes is a never-ending war waged within ourselves as male and female elements of our own bodies continually fight each other for supremacy. This is the astonishing implication of a pioneering study showing that it is possible to flick a genetic switch that turns female ovary cells into male testicular tissue.

For decades, the battle of the sexes has been accepted by biologists as a real phenomenon with males and females competing against each other – when their interests do not coincide – for the continued survival of their genes in the next generation. Now scientists have been able to show that a gender war is constantly raging between the genes and cells of one individual.

One of the great dogmas of biology is that gender is fixed from birth, determined by the inheritance of certain genes on the X and Y sex chromosomes. But this simplistic idea has been exploded by the latest study, which demonstrated that fully-developed adult females can undergo a partial sex change following a genetic modification to a single gene.

The findings suggest that being male or female is not a permanently fixed state but something that has to be continually maintained in the adult body by the constant interaction of genes to keep the status quo – and the gender war – from slipping in favour of the opposite sex.

The results could explain some of the great mysteries of human gender, for instance why some women after the menopause develop male characteristics, such as facial hair and deeper voices, or why other people are so unhappy with the gender they were born with that they seek hormone therapy and radical sex-change operations.

Scientists said that the study also contradicted another biological dogma – that the "default" gender is female, with all embryos starting out as female unless they possess a male sex-determining gene. Although this remains true in terms of how gender is determined in the womb, the latest findings show that it is still possible to convert an adult female's ovaries into testosterone-producing testes.

The study was carried out on mice but the implications are relevant to humans, the scientists said. By switching off a gene called FoxL2, which exists in all mammals, the ovary cells of adult female mice developed spontaneously into the fully developed, testosterone-producing cells found in male testes, although they could not produce sperm.

"We take it for granted that we maintain the sex we are born with, including whether we have testes or ovaries," said Robin Lovell-Badge, from the Medical Research Council's National Institute of Medical Research in north London, who was part of the international team led by the European Molecular Biology Laboratory in Heidelberg.

"But this work shows that the activity of a single gene, FoxL2, is all that prevents adult ovary cells turning into cells found in testes. If it is possible to make these changes in adult humans, it may eventually remove the need for surgery in gender-reassignment treatment," Dr Lovell-Badge said. "If this does become possible, it's likely that while treated individuals would make the right hormones for their new sex, fertility would be lost. It's still very speculative, but it's possible

that this approach could produce an alternative to surgery and the removal of gonads – ovaries and testes. It's a little more natural, but of course anyone undergoing such a sex change would be infertile," he added.

The study, published in the journal Cell, found that the female-promoting FoxL2 gene works by suppressing a male-promoting gene called Sox9. In the adult female mice where FoxL2 was artificially switched off, the Sox9 quickly took over, sending chemical signals that converted the ovary's female cells into the testosterone-producing cells normally found only in the testes. The female mice produced levels of testosterone normally found in male mice – 100 times higher than the concentrations found in ordinary female mice.