



Gene editing in animals

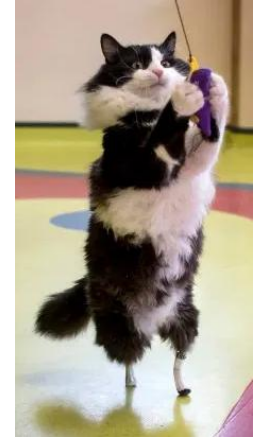
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Humans have been 'modifying' animals for millennia

- Training
- Selective breeding
- Surgical mutilations
- Administering drugs and hormones
- Therapeutic modification
- Mutagens
- Genetic technologies



**Does the use of gene editing raise
specific ethical issues?**

What is different about genome editing (GE)?

- Outcomes are **unpredictable**, even with 'more precise' techniques such as CRISPR
- Enables **instant, substantial and multiple changes** to the genome
- Genes from **different species** can be inserted, which would not be possible using conventional techniques
- It is being used in increasing **numbers of species**
- There are genuine and legitimate public concerns about '**naturalness**' and **animal integrity**
- These concerns are **not taken into account**



A researcher who helped to develop CRISPR says ...

I had been **astounded at how quickly** labs around the world had adopted the technology for applications across biology, from modifying plants to altering butterfly-wing patterns to fine-tuning rat models of human disease.

At the same time, I'd **avoided thinking too much** about the philosophical and ethical ramifications of widely accessible tools for altering genomes.

Like everyone else, **I wanted to get on with the science** made possible by the technology.

Time to reflect and reassess

- 'Polled' calves who had been edited using TALENS
- Recombinetics, Inc: the calves are 'precision bred'
- US Food & Drug Administration: they carry multiple antibiotic-resistance genes from bacterial plasmid vector and have widespread deletions and rearrangements
- **Multiple sources of stray DNA – plasmid vectors; culture media (e.g. bovine DNA in GE mice, from fetal bovine serum); pathogens**
- **It is unethical to continue using this technology without understanding these effects**



**Does the purpose of the genome editing
make a difference?**

Some purposes cannot be justified



- Genome editing companion animals, for appearance, behaviour or to address health issues
- Genome editing animals for food production
 - These animals are already pushed towards – or beyond – their biological limits, so GE to increase production is unacceptable
 - GE to ‘improve’ product quality, or improve disease resistance, are also unacceptable – **there are better approaches to achieving these goals, including ‘animal welfare’**

GE in animal research

- Directive 2010/63/EU permits harms to animals
- GE is a harm, even if the phenotype is below threshold
- GE has resulted in an explosion in animal numbers, due to the drive to create new lines and the inherent wastage involved
- Companies promote new animal 'models' (e.g. Surrogen's 'humanised swine')
- This treats animals as commodities and lessens the value of animal life



We use pigs as "oinkcubators" to grow human cells and tissues and

Societal concerns are important

- The public pays for GE research, directly or indirectly
- The drive to use GE technology is outstripping the public debate
- Many people are deeply concerned about the impact of GE on 'naturalness' and the integrity of the animal
- UK Royal Society survey (2017): participants 'not convinced of the need' for GE to increase yield and said it was a 'less acceptable' use of the technology



(un)natural

NUFFIELD
COUNCIL
BIOETHICS

Ideas about naturalness in public
and political debates about
science, technology and medicine

Public attitudes should not be manipulated

- Recombinetics: ‘precision breeding’, AgResearch: ‘smart’ cattle
- Roslin Institute/Abacus Bio survey on attitudes to GE food products
 - Gene-edited plants and animals were considered together
 - No opportunity to express concerns about animal welfare or ethics
 - Participants expected to accept that GE will always improve animal health
 - Respondents who did not buy meat products were excluded

Proper consultation is essential

- Public dialogue on Animals Containing Human Materials – concerns about potential impact on animal cognition
- **involve.org.uk** - *Rethink public engagement for gene editing*
 - A model for engaging ‘publics’ and stakeholders
 - [nature.com/articles/d41586-018-03269-3](https://www.nature.com/articles/d41586-018-03269-3)

Fully informed public consultation, including risks, harms, ethical issues and alternative approaches

A moratorium

Gene editing animals for all applied purposes should **stop** until the **risks have been rigorously characterised and assessed**, and the public has been properly **informed and consulted**