Genetic Technology in Animals: An Ethical Study

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Abstract

Genetic technology involves the alteration of the genetic constitution of cells or individuals by directed and selective modification, insertion or deletion of a gene or genes. The Genetic technology is materialized using the Recombinant DNA Technology. Recombinant DNA technology deals with the isolation of useful genes from a variety of sources and the formation of new combinations of DNA called recombinant DNA. The organism carrying foreign DNA is termed as transgenic or a genetically modified organism.[i] *Thus genetic technology is defined as a technique for artificially and deliberately modified DNA to suit human needs. It is essentially a "cut, paste and copy" mechanism. The gene to be transferred is first cut out from the DNA of the donor organism. It is then pasted into an intermediary DNA molecule called a vector. The vector carries the gene into a host organism like a bacterium or yeast, where it is copied many times as the host organism replicates. Nowadays every technological development cultivate an over scientific temper without considering the importance of humanitarian values. So this paper exposes the importance of ethics and values in genetic technology.*

Genetic technology has been performed for centuries in animals by selective breeding. It is now become possible to manipulate specific genes at a molecular level, using laboratory procedures on material taken from living organisms, which can be replaced in the organism, or put into a different one. In principle, this ought to be much more specific than selective breeding, but the uptake of the relevant modified gene is often quite low, particularly in animals. It also allows the creation of transgenic organisms, where a short section of genetic material from an unrelated species can be introduced into another.

With some notable exceptions, it has not proved as straightforward to produce transgenic animals as originally thought, but various manipulations have been performed, many of which are still at a fairly early stage of development. Human growth hormone was introduced in mice and pigs in early experiments, but many problems were found and this work has mostly been discontinued. In general, attempts to genetically modify farm animals to enhance production - more specifically and rapidly - have not been promising. At present the best prospects for this type of "production" genetic technology seem to be mainly in fish. Most of the applications of genetic technology in animals have been in finding novel uses for the animal.

By far the largest of these has been in producing transgenic mice to "model" human diseases. Sufficient similarity has been found that once a human gene has been identified, one of the easiest ways to find out its function is to disable the equivalent gene in a mouse and observe the effect. Alternatively mice have been produced which contain a genetic defect which is likely to produce the symptoms of a human disease, like cystic fibrosis and many forms of cancer. The first and most famous of these was the Harvard "oncomouse". This caused immense controversy when the mouse became the subject of a patent application. Partly this was over the patenting of an animal as such and partly because of the inevitable suffering which the animal would undergo.

Generally less controversial has been the novel idea of genetically modified mammals so that in their milk they produce proteins of potential medical benefits as pharmaceutical products. The leading example of this is the production of alpha-1-antitrypsin in the milk of a sheep called Tracy[ii] and her progeny in Edinburgh. Sufferers from the lung disease emphysema have a deficiency of this protein, and this method is being developed as a convenient source of it in fairly large quantities, which appears to have no ill effects on the sheep and which has the prospect of being safe from the cross contamination which can arise if human blood is used as the source.

A third novel area is to xenografting where there is a significant shortfall between patients and realistic potential donors. By genetically technology a pig's heart with a human gene, researchers at Cambridge hope to produce a "layer" of proteins around the heart which would send the signal "human". This might be able to convince the human body not to put into action the rapid rejection of tissue belonging to another species. No one knows whether this will be successful. There would still remain a number of other problems to be solved, including the need to suppress the body's slower rejection that is familiar in human-human heart transplants.

Genetic modification animals involve the addition or deletion of part of the genetic code of an animal in order to change the animal's characteristics. Change in phenotype[iii] can be brought about either through expression of introduced DNA, or through addition, deletion or substitution of some part of the animal's own genetic material. The aim is usually that the genetic alteration should also be present in the germ line cells, so that the changes can be passed on from generation to generation. A range of methods is available for altering the genetic material such as the techniques of pro-nuclear micro-injection, embryonic stem cell manipulation, and the ability to modify farm animals by nuclear transfer etc. So range of benefits is sought from genetic modification of animals. Most work is basic or applied medical or biological research, aimed at understanding gene function and regulation, or studying human or animal disease. The ability to replace or alter individual genes, or delete them, can assist in investigating the natural functions of a gene in health and disease, the factors within the body that control it or interact with it, and the interplay between genes and external factors, such as diet or environment. So in genetic technology animals are used for:

- Research and testing
- To synthesize medically important proteins;
- In developing animals which might, in future, be used as sources of organs and tissues for xenotransplantation;
- As farm animals modified to have increased 'productivity' or disease resistance etc.

I. ETHICAL ISSUES

Alongside the potential benefits, genetic modification of animals raises a variety of ethical concerns. The concern may be

A. Objections to the use of animals in general:-

Most people, nowadays, would agree that animals can have 'interests', but there is considerable debate about whether, and to what extent, these interests may be forfeited for human interests. Many arguments about consciousness, self-consciousness, cognitive ability, language capacity, moral sense, quality of life, and evolutionary status, have been used in attempts to find morally relevant differences or conversely, similarities between humans and animals which could justify treating animals as means to human ends. None of these arguments so far has succeeded in attracting general philosophical agreement. There is a spectrum of opinion regarding the relative weightings that should be accorded to human and animal interests. At the ends of the spectrum are the absolutist positions - that human interests are always sufficiently important to outweigh animal interests, or that they are never sufficiently important. The latter view, at its simplest and strongest, is that if it is wrong to conduct certain experiments on humans, it is also wrong to conduct them on animals. Some animal welfarists object to any experiment which causes animals pain and suffering, whereas some advocates of animal rights object to all human uses of animals, whether or not pain and suffering is involved.

B. Objections to the genetic modification of animals in particular

A different kind of moral objection is specifically concerned about the nature of genetic modification. The concern may be expressed, for example, by objecting that genetic technology is 'unnatural', that it amounts to 'playing God' and that it 'debases animals' by treating them as 'commodities'. A related view is that there are special moral objections to the creation of animal strains which suffer throughout their lives because of their genetic make-up.

C. Concerns about the consequences of genetic modification of animals

The argument that it is acceptable to use animals as means to at least some human ends usually appeals to the benefits of that use - that, in at least some cases, the benefits of using animals can outweigh the harms that are caused. Here, therefore, the main ethical concerns are about the consequences. In the case of genetic modification, there may be concern about consequences for the welfare of modified animals, and about the harms caused during their production. There may also be concern about the hazards which modified organisms might pose to human and animal health and to the environment. Or, there may be concern about the balance of harms and benefits arising from genetic modification.

D. Fundamental Moral Objections to Genetic Modification

Fundamental moral objections to genetic modification may be expressed in the argument that genetic technology 'fails to respect the genetic integrity' of animals, because it involves 'mixing' of genetic material between different species and even between different Kingdoms. Anxiety, distaste, or even revulsion, may be expressed about the 'unnatural' mixing of kinds - about creating chimeras, about altering the of species , about crossing the species barrier, and about the mixing of genes between humans and other animals. These moral objections may arise, for example, from widely held philosophical or religious world-views, or from deep-seated emotions or aesthetic values. Associated with these fundamental objections may be consequentialist fears that limited experiments in such areas can lead down 'slippery slopes', perhaps culminating ultimately in ethically indefensible human eugenic practices, or creating bizarre animals or treating animals as mere commodities.

In response to these objections it can be argued that talk of 'mixing' genomes does not reflect the nature of genetic technology as currently practiced. Although there is a random element, present practice usually involves the relatively precise transfer of only one or two genes - a small fraction of the genome of most recipient organisms. Each gene codes for a specific protein, and it is only the combined effects of expression of a multitude of genes within the living organism that confer.

However, transfer of a single human gene into a pig can result in expression within that pig of something typically human - a human protein, such as human growth hormone. The human protein may be only very slightly different from the pig protein but nevertheless it is found naturally only in humans. Furthermore, whilst currently it is feasible to transfer only a few genes between species, in future it may be possible to transfer many more genes - and we therefore need to be alert to the biological implications and related ethical concerns that might arise.

A further response to fundamental objections to genetic modification is the argument that talk of 'transgressing the species barrier' is inappropriate, because species boundaries are not necessarily hard and fast - species change naturally through evolution, for example. Similarly, the characteristics of many animal and plant species, traditionally, have been altered artificially through selective breeding, so it can be argued that direct genetic modification is merely an extension of these traditional breeding techniques, and thus poses no new fundamental ethical concerns. Thus, if genetic modification of animals falls prey to charges of 'playing God', 'unnaturalness' and 'treating animals as commodities', and these same charges should be levelled at selective breeding.

However, although species change through natural events, it is extremely difficult to challenge species boundaries in selective breeding. Direct genetic modification is different from both these processes in that, potentially, it offers limitless possibilities for transferring specific genes between widely different species. Genes can also be transferred from a variety of different species into the same animal, and such genetic changes can be achieved within a single generation.

Value judgments are inevitable in ethical discussions: different people respond to the same situations in a variety of ways, and arrive at different conclusions. With regard to genetic technology of animals, moreover, perception of the fundamental issues can be complicated by concerns about what will be possible in the future, and whether scientists can be trusted not to stray into ethically controversial or objectionable territory. The latter concern, in particular, is fuelled by worries about the pressures brought to bear by increasing commercialization of such research, or from questions about the ethics of research raised in the media.

In some cases, genetic modification appears to have some benefit but in most of the cases there are certainly adverse welfare effects. In any case of genetic manipulation, unintended deleterious or harmful side effects can occur. Such side effects may be caused when the new genetic material is expressed, and unpredicted physiological changes occur; or they may be caused when the introduced DNA disrupts the function of one or more of the animal's own genes. The latter is a result of randomness of integration of the new genetic material into the recipient animal's genome, in particular when the pro-nuclear micro-injection technique is used. Many such disruptions prove fatal to the developing embryo. When the effect is not lethal, the welfare of the resulting animal can be seriously compromised.

Consideration of the consequences of producing and using genetically modified animals is complicated by the difficulties involved in predicting both the welfare 'costs' to animals, and the benefits likely to be afforded by the modified phenotypes. As in other research areas, it is possible that potential costs and benefits can be accessed from scientific understanding and previous experience (including the results of similar experiments), but in this area much new ground is being covered rapidly and the potential effects of the procedures are often uncertain. It is therefore especially important that the justification for such work is reassessed as the work progresses: that is, as it becomes more possible to predict likely costs and benefits from experience of previous related work. On the welfare side, it is important that the effects of genetic manipulations are documented in as much detail as possible - and, equally, on the question of benefits, to record whether the desired benefits actually are achieved.

Databases on the characteristics of genetically modified animals tend not to indicate welfare problems. Some effects - the more 'cryptic' abnormal effects, such as changes in behaviour - may be difficult to spot, and 'tolerance' of adverse effects can depend on the scale of animal use, and the size of animals involved. For example, some people may have relatively little interest in the apparently minor side-effects of genetic manipulations of a few mice used in laboratory research, whereas in larger-scale production of farm animals there will usually be an attempt to assess all possible effects.

There is a need for greater awareness of the welfare problems posed by abnormal effects, improvement in surveillance and data gathering on such effects, and improvement in data sharing. In particular, there is a need for:

- Greater commitment to monitoring, collecting and reporting data on adverse side effects of genetic manipulations. Good practice should be followed, in that adverse effects should be looked for actively and data gathering should involve people with responsibility for the husbandry of the animals. Welfare problems should be recorded in databases on the characteristics of genetically modified animals, and journals should require scientists reporting novel genetic manipulations to document fully the effects on the animals of the procedures. Reporting should include aspects such as deaths occurring during production of genetically modified animals, as well as adverse effects experienced by the resulting animals. The latter should include any morbidity or mortality, changes in health status, changes in weight or growth of the animals, behavioural changes, changes in breeding success, and results of post mortem examinations of gross morphology;
- Assessment of actual outcomes of experiments, for example, analysis of the results of experiments in order to find the proportion in which the desired phenotype actually is achieved.

E. Concerns about Safety

A utilitarian justification for producing and using genetically modified animals must take into account potential risks to humans and other animals, as well as to the wider environment. While this is a major concern of regulatory bodies, these vary in scope and efficacy between countries, and much more research on safety aspects is needed to inform their decisions. There are several concerns about the safety such as:

- concern that modified animals might 'escape' and breed with other domestic or wild animals, so transferring the new genes to other populations;
- concern about risks from the use of retroviruses as DNA vectors during production of genetically modified animals: e.g. risks that genes might inadvertently be transferred to other individuals or species, or that retroviruses might infect other organisms;
- concern about possible risks to human and animal health from consumption of genetically modified animals and their products;
- concern about risks that drug resistance gene markers used in some genetic technology procedures might inadvertently be transferred and expressed;
- 'ecological' concerns, e.g. about the wider effects of producing disease-resistant animals;
- In xeno transplantation, concern about risks that human recipients of animal organs might become infected with animal viral diseases, which might then infect the wider population.

REFERENCES

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[3] [iii] Ruth Chadwick, ed., The Concise Encyclopedia of the Ethics of New Technologies (New York: Academic press, 2001), p.183.