Genetic modification

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Genetic modification in humans, non-human animals, and plants gives rise to a range of philosophical and ethical issues. There are a range of techniques and applications for genetic modification, but all are intended to change the genome within the cells of an organism. This poses problems to do with interfering with the natural, safety and risk considerations, impacts upon welfare and social justice, and determining whether genetic modification is needed or merely wanted. Within these broad areas, there are also particular issues regarding definitions of health and disease, employing a precautionary stance, and determining which perspectives are over- or under-estimated in debates.

Bioethics; Gene therapy; Genetic engineering; Genetics; Genomics; Justice; Nature; Necessity; Precaution; Risk.

Classifications: Moral philosophy and applied ethics.

1 What is genetic modification?

All biological entities consist of cells. Most cells contain a genetic material known as DNA, which is organised into genes, which in turn sit on chromosomes. Genes direct the production of materials called proteins that allow cells to grow and make the components necessary for survival. Sometimes, an error occurs in these processes, which can be trivial or serious depending on where the error lies and how many cells of the organism it is present in. Additionally, some of the cellular processes that exist in nature may be inefficient. When such errors or inefficiencies exist, the question of whether genetic modification should be used to change or ameliorate them arises. What constitutes a serious or inefficient outcome of gene expression is itself an important philosophical question. It raises issues about welfare, justice, relationships between human persons and the environment, and whether there are any biological norms by which genetic goals might be directed.

At its broadest, genetic modification means altering the complement of genetic material (also known as 'genetic makeup') within a cell of an organism. The intent of such an alteration is to augment the function of the cell, or the function of the organism to which the cell belongs. Such changes can include adding, removing, or substituting genetic material. Depending on the technique employed, this change could take place at the level of a DNA base (via recombinant DNA technology, which involves breaking apart and reassembling strands of DNA), via changing a whole chromosome, or by swapping either organelles (so-called mini organs within a cell, such as mitochondria) or an entire nucleus. Genetic modification is a species-neutral term and as such can be used to describe this activity in humans, non-human animals, plants, or microbes.

In philosophy and bioethics, the most common usage of the term genetic modification is to describe a direct and intentional intervention, used with the aim to create a genetically modified organism (GMO). This action can introduce genetic material from the same species, a different species, or novel genetic material not otherwise found in nature. Some have also classed activities such as selective breeding (also known as controlled breeding) or the occurrence of

spontaneous (naturally occurring) changes to the genome as being genetic modifications. These have existed for thousands of years. For the purposes of this chapter, genetic modification is taken to mean direct (intentional) interventions, initiated by humans, that change a cell's genome. That is, genetic modification is taken to mean an action that renders the total genetic complement of a cell different from that prior to the intervention occurring. In recent years, scientific techniques to allow these kinds of direct change have become faster, cheaper, and more accurate. This brings with it novel (or at least more pressing) ethical challenges.

Genetic modification is also related to a number of other terms and is often used synonymously with them. For example, an organism may be said to be 'genetically engineered' once genetic modification has taken place. In humans and some non-human animals, the term gene therapy is also often applied to describe a process of genetic modification that is intended to reduce or remove the chance of a genetic condition arising.

Some may distinguish between genetic and genomic modification (e.g. Resnik and Langer 2001). *Genetic* modification includes changes made at the level of DNA. *Genomic* modification includes a change made at the level of the genome, but which does not necessarily intervene at the level of DNA. For example, a change made to a human oocyte using gene editing to remove a mutation that will lead to a serious genetic condition developing in the resulting child would be genetic modification; while applying techniques of mitochondrial donation to create a new oocyte – intended to prevent the transmission of serious mitochondrial disease – would be genomic modification. For the purposes of this entry, genetic modification denotes both genetic and genomic modifications.

In humans and some non-human animals, another distinction is often drawn between somatic and germline (or inheritable) modifications. A somatic modification is made in a cell where there is no intention that the change will then be present in offspring of the being whose cell is changed. A germline modification is made in reproductive cells (oocytes and sperm cells) and will go on to be inherited by future generations. Traditionally, germline interventions have served as an ethical dividing line (Rasko et al. 2006) between what is permissible and impermissible. However, this distinction is not always clear-cut (Newson and Wrigley 2017), and arguments are emerging that germline changes may be countenanced when certain other considerations are satisfied (Nuffield Council on Bioethics 2018).

While the term genetic modification was once reserved for interventions in non-human animals and plants, it is now also well embedded in discussions of changes to human cells. That said, in certain nascent applications of genetic modification – particularly those for use in humans – there have also been some recent moves away from the use of 'genetic modification'. For example, more specific terms such as gene editing or mitochondrial replacement are now in wide use. This move reflects and distinguishes technological developments but is also perhaps a mechanism to distance certain interventions from other more controversial applications.

Genetic modification is thus a broad term. This general nature can be advantageous, because its scope can encompass many different activities with a common component. However, it can also raise some problems, due to ambiguity or concerns over its pejorative implications – some genetic modification activities may be considered as ethically problematic merely because of an association with another contentious activity.

2 Applications of genetic modification

Genetic modification has many methods and applications, a comprehensive description of which is beyond the scope of this chapter (but see Bioethics; Cloning; Genetics and ethics; Reproduction and ethics; Genetic modification of animals). It is, however, worthwhile to briefly outline some of the predominant ways that genetic modification occurs (or may occur

in the future), as these can help inform how the relevant philosophical and ethical issues arise and are understood.

As discussed (see §1), the term genetic modification can be applied to a range of (direct and intentional) interventions that change the genetic complement within a cell. The first GMO, a novel strain of bacteria, was produced in 1973 by US scientists Herbert Boyer and Stanley Cohen. They used recombinant DNA technology to isolate and move a gene from one bacterial strain to another; conferring antibiotic resistance. The following year, the same techniques were used by a different team to produce genetically modified mouse embryos. At the advent of the recombinant DNA revolution in the 1970s, following these early experiments a decision was taken by the scientists themselves to invoke a moratorium on further genetic modification – an early example of industry self-regulation.

The first application of genetic modification in human medicine was introduced in 1982, with the release of an insulin-like product for people living with Type 1 Diabetes: humulin. Twelve years later – and with significant public controversy – the first genetically modified food was made available. The Flavr Savr tomato contained a modified gene intended to invoke a longer shelf life and better flavour. In the years since, more genetically modified foods have been approved and introduced in countries like the United States, with modifications to soybeans and corn among the most prevalent. Intentions behind plant genetic modification have included enhancing nutritional value of foods such as rice, or making crops more resistant to pests – as has occurred with cotton planted in North America. In contrast to the permissive approach taken in North America, the European Union enacted a moratorium on GM crops from 1999 to 2004. Restrictions on GM crops persist in several EU countries.

Genetic modification remains rare in the production of non-human animals for human food consumption. At the time of writing, just one GM animal – the AquAdvantage Salmon – had received regulatory approval, but only in North America and it is not yet sold to consumers. However, several initiatives to bring genetically modified livestock to market are ongoing and genetic modification of animals in the research setting is routine. One research application of GM in non-human animals is the production of animal models for human diseases, in the hope of generating new or better treatments. Future possible uses of genetic modification in non-human animals are broad and include ends that could be said to benefit humans, non-human animals, or the environment. For example, a particular pest could be modified to extinction, or an animal used in agriculture could be altered to have a lower environmental impact. DNA extracted from the remains of deceased species could even be used for so-called de-extinction (Kaebneck and Jennings 2017). These applications of genome modification raise ethical concerns over instrumentalisation of non-human animals (see Animals and ethics), among other issues (see §4–7).

Applications of genetic modification relevant to humans include: modifying viruses for use in human vaccines or to prevent infection, *in vitro* modification of human tissues (for example, to create chimeric embryos, which contain genomes from more than one type of organism), gene therapies intended to cure or prevent disease, or enhancing interventions (see §7). One ethically relevant distinction in human genetic modification is between somatic and germline interventions (see §1). Despite its more benign ethical status (as changes are not intended to be inherited), somatic genetic modification has not been without controversy. Concerns have arisen when human participants in gene therapy clinical trials have been harmed, or have died. This raises the ethical question of when a genetic modification should be deemed safe; what threshold of risk is acceptable; and who should determine this (see §5).

Thus, just as genetic modification is a broad term, so are its current – and possible future – applications. This breadth of typologies and uses also means that genetic modification in plants, non-human animals, and humans gives rise to a wide range of ethical and philosophical issues.

3 Ethical and philosophical issues in genetic modification: overview

Genetic modification raises a number of interesting and demanding philosophical and ethical issues, particularly regarding the acceptable limits of its use. Some of the issues and concerns are more general in nature; while others are specific to certain applications or techniques. While some prevalent ethical concerns with genetic modification have traditionally been used as thought experiments, scientific and technical advances mean that previously theoretical analyses now have direct practical relevance. For example, advances in techniques of genome editing have made targeted human germline genome editing more feasible. Additionally, new issues have arisen that simply weren't recognised previously, such as facilitating the creation of a human with a genetic complement from more than two people, as occurs in mitochondrial donation (see Reproduction and ethics).

These examples illustrate a problem with attempting to discuss the philosophical and ethical issues of genetic modification; namely, that predicting what issues may arise can be difficult. The relentless pace of progress achieved in scientific and technical research in this area is likely to outstrip the ability to pre-emptively conceive of the relevant issues that will arise. As such, while some issues will likely remain at the heart of debates surrounding genetic modification, others may be superseded by, for example, newer scientific developments; or become redundant through, for example, resolution of concerns over issues such as safety. Some issues may also never come to be realised; and yet others still may bring new issues that we had never previously considered.

This mix of concerns is further increased when the breadth of genetic modification is considered – it can be carried out on any entity that has genes. This means that issues must be accounted for not only in humans, but also in non-human animals and plants. Inevitably, some of the concerns over the effects on humans may not be considered relevant or as significant when applied to these other areas, or, conversely, may be considered amplified or more significant.

4 Interfering with nature

A major ethical concern in genetic modification is whether modifying genes is somehow intrinsically wrong. This often stems from the criticism that scientists are 'playing God' or that they are 'interfering with nature'. The playing God criticism tends to be a criticism of the decisions and actions of an individual, in that they overstep the boundaries of their authority or role. However, this often then collapses into a concern about interfering with nature, on the grounds that the scientist is seen to be playing God precisely because they are interfering with nature.

Although interfering with nature concerns are prevalent in many areas of applied ethics (see Environmental ethics §1) and bioethics, they remain difficult to pin down as the basis for a rigorous form of philosophical criticism (Sheehan 2009). For genetic modification (as defined; see §1), the interfering with nature concern arises from two premises: (1) that genetic modification in some way makes changes outside a perceived natural order of things, and (2) that there is a particular value attached to naturalness. However, both premises themselves are open to reasonable contestation. There are differing conceptions regarding whether a natural order exists, as well as debate over whether interference with it goes against some value. Given the vast array of unnatural interventions in other areas (such as clinical medicine) that have not resulted in any claim to some intrinsic wrongness occurring, the onus would be on proponents of this view to make a convincing case that genetic modification *per se* is somehow wrong on the grounds of unnaturalness.

While it would seem easy to dismiss, or at least very demanding for a proponent to adequately support, there is no doubt that interfering with nature arguments have had a profound influence on philosophical and ethical debates over genetic modification. Multiple attempts have been made to account for a philosophical foundation for these arguments. These include accounts as to the concept of nature itself, either in terms of theological Natural Law accounts (such as those of Aquinas (1268–71); see Aquinas, Thomas) or in terms of human agency and activity (Hume 1739–40; Mill 1874; see Mill, John Stuart; Hume, David). Such accounts of nature then also require additional support, by appeal to a normative position as to the wrongness of actions falling outside what is natural.

Perhaps the most developed attempt at an account of the wrongness of acting beyond an account of what is natural is offered by Norman (1996), through his appeal to 'background conditions' of human life. These conditions are what help to give life explanation and meaning. Whenever there is a perceived threat to these background conditions, this equates to an interference with nature and threats to life's meaning. Nevertheless, considerable scepticism remains as to whether appeal to such reactions, no matter how reasonable their formation might be, could constitute a sound moral basis (Blackford 2006).

5 Risk and precaution

Perhaps the most overriding ethical concerns over genetic modification are those of risk and safety (see Risk). There is a clear link between how harms, benefits, welfare, etc. can be accounted for, and the value placed on risks. Decisions over how to proceed in the face of risk generally involve weighing-up the possible scope and scale of any potential harm or benefit. This includes considering the potential magnitude, intensity, duration, and distribution of any foreseeable harm or benefit.

What constitutes a harm or benefit is also an important question. This can incorporate physical, psychological, social, emotional, or moral aspects. In the case of plants and non-human animals, consideration is also given to whether benefits for humans should outweigh the interests of other entities – raising questions of anthropocentrism in our ethical evaluations.

Although concerns over risk and safety can be broken down into numerous, more refined issues, two basic questions about risk always initially arise. The first is how risks should be identified, and the second is what level of risk might be deemed acceptable.

These two questions have led to a widespread adoption of what has become known as the precautionary principle. The precautionary principle is a general approach towards risk management and harm reduction. Broadly speaking, it requires society to delay or forego the use of potentially risky new practices until there is a better developed idea of the potential harms that might arise from the practices in question. It has strong and weak forms, depending upon the level of risk and the quality of the evidence surrounding that risk. Strong versions tend to require prevention or regulation where there is a lower threshold of risk of harm (and those harms are more severe). Weaker forms tend to be less restrictive in the face of uncertainty about risks. They also place the burden of proof onto those advocating the use of the principle, in that it is up to them to show there is a potential risk and that the principle should be invoked. Note that the principle itself says nothing about what constitutes a risk or harm, as this is determined by the context in which it is applied.

The precautionary principle has been regularly appealed to over the use of genetic modification in humans, non-human animals, and plants. In humans, the focus has been on the potential for the modification to cause irrevocable harm to future generations, for example, a modification introducing a deleterious change to cause a new disease. Discussions have drawn in particular on the uncertain and unpredictable effects of genetic modification technologies, such as where

the modified genes turn out to be important for other human traits and functions, or where the desired effect does not arise from the modification.
In plants and non-human animals, different emphases arise regarding risk and precaution. The use of genetic modification in humans is, at least at an early stage, unlikely to limit species diversity to the point of endangerment. However, previous techniques of selective breeding and other agricultural practices have already led to a dramatic decrease in biodiversity in both plants and agricultural animals destined for human use and consumption. This has been driven by (potentially problematic) human desires for plants and agricultural animals that have a particular appearance, yield, or disease resistance. If more radical genetic modifications were to be employed in these circumstances of already decreased biodiversity, the potential for catastrophic outcomes through iatrogenic risk (that is, a risk caused by the intervention itself) is significantly increased. On the other hand, genetic modification could be used to introduce or increase biodiversity or other advantageous features where they are missing.
Whether this risk-averse approach of the precautionary principle is genuinely prudential or whether it is too conservative and likely to stifle scientific progress has been at the heart of much debate (Harris and Holm 1999; Hughes 2006). Being overly risk averse (say, in terms of scope and scale of harm), invoking precautionary measures that are too demanding, or requiring too strong an evidence threshold as to the safety or harms of an activity, may impede scientific progress or even cause harm by preventing benefit. On the other hand, adopting an approach which rejects restrictions unless there is a high degree of evidence for potential harms, will likely enable faster innovation but will also give rise to increased risk. Considerations of public trust are also relevant to whether it is appropriate to invoke the precautionary principle. A cautious governance model may engender higher public trust than scientific self-regulation of genetic modification.
A concept related to those of risk and precaution is dual-use. Genetic modification technologies have the potential to be used in a way deemed as fruitful or useful to all. Yet the same technologies could also be put to other, less desirable, uses. This is known as the dual use problem (Rappert and Selgelid 2013). Although concerns and risks surrounding dual use of developing technologies arise in many areas, the dual use problem in genetic modification is seen as particularly pressing because of the potential risk should a particular modification become a weapon or be used to alter heritable traits of a species in an unregulated way that could have a global impact.

6 Welfare and social justice

Some of the arguments advanced in favour of genetic modification claim that it has the potential to reduce human suffering and improve quality of life. That is, genetic modification may improve welfare. This welfare increase would be for both existing and future humans, non-human animals and plants. Assessing this claim requires an account of welfare (see Welfare).
Quite what constitutes welfare, as well as determining when welfare is increased or diminished, is philosophically demanding. Very generally, welfare is concerned with well-being or what could be said to be good for someone (or some thing). Different theories of welfare involve different ways of establishing these goods, for example, by appeal to subjective preferences and desires, or to perceived objective goods, such as health, freedom from pain, functionality, flourishing, etc. that are often considered to be universal aspects of well-being (Sumner 1996). When it comes to genetic modification, welfare might be thought of (rightly or wrongly) as something determined by what is good for humans. This means that, for example, determining welfare for a plant involves asking whether it exhibits the properties humans wish it to have (such as high crop yields). However, this might be seen as

collapsing questions of welfare into those of (human) value. Alternatively, an appeal could be made to some form of species typicality (those traits, functions, behaviours, etc. that are possessed or exhibited by a typical member of a species) and so not be viewed through the lens of what properties something might possess that are valued by humans. Such an appeal would be particularly useful if welfare judgements were based on objective goods, as welfare would be seen as biologically determined by reference to this species typicality rather than simply determined by human values.

Some appeals to welfare (which support the development and use of genetic modification techniques) are based on the potential for providing treatments or therapies for conditions perceived to be harmful to live with. Such conditions are often referred to simply as 'harmed conditions'. The aim of treating or ameliorating a harmed condition is usually taken to be what justifies the distinction between a therapeutic use of genetic modification from other uses, such as enhancement (see §7). However, it is not always obvious what might constitute a genuine harmed condition because there are multiple different accounts of health, disease, illness, and disability to draw from. Such accounts include, among others, medical models, social constructions (e.g. Boorse 1977), and feminist accounts. If the development and use of genetic modification techniques are justified on the grounds that they are therapeutic, determining whether something is a genuine harmed condition becomes central to many appeals to welfare.

Genetic modification may also have implications for the welfare of particular future individuals. However, establishing that it is possible to harm or benefit as yet non-existent future people through genetic modification has generated one of the most interesting and puzzling philosophical issues of the late twentieth century – Parfit's Non-Identity Problem (1984). The problem applies to several scenarios, including the impossibility of harming or benefiting future children through genetic selection, so long as they have a life worth living (see Future generations, obligations to; Reproduction and ethics). Parfit's argument is based on how any choice affecting the originating gametes of an individual would have resulted in an entirely different person coming into existence. Hence, it is impossible to make comparative welfare claims between the individual who is born and an entirely different individual who would have been born if different genetic selection choices had been made. These arguments have been widely discussed (e.g. Velleman 2008) and met with counter-arguments, including that such choices can lead to harm or benefit (Wrigley 2012), or that other factors, such as the motivation of the person undertaking the modification, matter morally too.

Welfare considerations in genetic modification also arise in arguments that this technology will decrease welfare. Scholars who argue for the relevance of disability considerations in these debates claim that genetic interventions can over-emphasise both a narrow conception of health and the place that a particular disability has in a person's identity (e.g. Asch and Wasserman 2015). The wide availability of genetic modification can also stigmatise those who live with a condition. If disability is considered a harmed condition that can be treated or even eliminated through genetic modification, then it takes on an even more undesirable status, leading to disabled people being seen as less desirable sorts of people through this association.

It has been recognised that the use of genetic modification to eliminate disability might lead to social injustices. One approach to considering this problem comes from feminist philosophy, where it has been argued that disabled people frequently experience epistemic exclusion (Scully 2019). This occurs because disabled people are regularly excluded from contributing to social knowledge, or their accounts can be seen to have less credibility (known as testimonial injustice). Such exclusion, in turn, further devalues their lives by distorting society's knowledge base (known as hermeneutical injustice) and adding to the perceived undesirability of living with disability (Scully 2019, applying Fricker 2007).

If access to genetic modification becomes more widespread, these problems have the potential to cause detriment and wider injustices. A skewed social perception of disability could create a society where diversity is not valued, or where only a narrow range of human traits are considered to be acceptable. Disability ethics scholars also contend that disability considerations can assist in enriching moral understanding, through highlighting how experiences of impairment themselves shape approaches to ethical analysis. Rather than being seen as a problem to be solved, a focus on disability serves to highlight how bodies and experiences can be normalised or otherwise taken for granted (Scully 2008).

Social justice issues also arise in genetic modification, particularly in terms of the equity of distributing benefits that arise from the use of these technologies, or the problems that can occur when a modification technology disrupts or overtakes a previous (non-genetic) technology (see Development ethics). If access to the benefits of genetic modification are restricted through things like cost or nationality, then there is the potential for stronger divisions to form. Feminist scholars are among those who have highlighted how genetic modification may not impact all groups equally, and may further marginalise systematically disadvantaged groups, such as women or ethnic minorities, who may not be able to access them due to already existing disadvantages they experience, be it in terms of financial access or in terms of developing relevant modifications (e.g. Tong 2006). Justice considerations in genetic modification are relevant at both individual and group levels, and addressing them will not be simple (Chapman, 2003). Of particular relevance are considerations of global equity, including how genetic modification will impact those living in low- or middle-income countries.

Matters of commercialisation are also a significant justice concern, whereby economic and resource control of genetic modification technologies offer huge advantages to those possessing them over those who do not. This can be seen, for example, in farming and agriculture, potentially jeopardising the employment of many smaller farmers unable to compete with the genetically modified livestock or plants on offer in terms of yield, nutritional value, microbial or pest resistance, and so on (see Agricultural ethics).

7 The aims and goals of genetic modification

Cross-cutting all philosophical and ethical debates in genetic modification is a question regarding the end for which the modification serves as a means. Conceptual issues around the goals of the technology, the necessity of an intervention, and the validity of the aim it is intended to achieve are all relevant.

In plant and agricultural genetic modification, there has been sustained and polarised debate regarding necessity. It has been questioned whether genetic modification provides the best solution, or whether other actions such as better land management or improving food supply channels are preferable.

In human genetic modification, debate is ongoing over a distinction between wants and needs, and whether it is justifiable to provide genetic modification when it is wanted, but not necessarily needed (see Needs and interests). For example, Baylis criticises the provision of new reproductive technologies when their necessity remains under debate (Baylis 2017). She draws on Aristotle's distinction between natural desires (needs) and acquired desires (mere wants). A natural desire is innate or inherent, shared by all humans. It is a mistake, she argues, to classify a (mere) acquired desire as a need when that desire can be met by other means – especially if those other means do not require the use of genetic modification technologies.

A related concern is the technological imperative, a concept that arises in criticisms of genetic modification (among other technologies). Highlighting technological imperatives

serves to show how questions about interventions such as genetic modification can be driven by the availability of the technology itself, rather than a recognised need for the use of that particular technology (see Technology and ethics).

A further issue in genetic modification is whether a modification that aims to enhance rather than treat can be justified. The distinction between treatment and enhancement (the subject of a large literature, see Juengst and Moseley 2019) can be difficult to sustain. Two elements of the debate are particularly relevant: (1) whether there can be a valid distinction between a treatment and an enhancement; and (assuming such a distinction can be drawn) (2) whether it is acceptable to use genetic modification to enhance rather than treat. These questions have largely been used in debates on human genetic modification (see Enhancement in sport), but could also apply to non-human animals or plants.

Debates over the aims or goals of genetic modification should therefore critically engage with the ultimate purpose for which any particular modification is being proposed. In so doing, ethical aspects such as necessity, health and disability, and social justice are all relevant.

See also: Agricultural ethics; Animals and ethics; Aquinas, Thomas (1224/6–74); Bioethics; Cloning; Development ethics; Enhancement in sport; Environmental ethics; Future generations, obligations to; Genetic modification of animals; Genetics and ethics; Hume, David (1711–76); Mill, John Stuart (1806–73); Needs and interests; Reproduction and ethics; Risk; Technology and ethics; Welfare.

References and further reading

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Parfit, D. (1984) *Reasons and Persons*, Oxford: Oxford University Press. (In this highly influential work of later twentieth-century Philosophy, Parfit covers issues of ethics, rationality and personal identity. It is divided into four parts. The final part, on our responsibility towards future generations, advances arguments concerning the Non-Identity Problem and its application.)

Rappert, B., and Selgelid, M.J. (eds) (2013) *On the Dual Uses of Science and Ethics: Principles, Practices, and Prospects*, Canberra: ANU Press. (An edited collection considering the ethical and practical elements of the dual use problem. Contributions consider this problem in numerous contexts, discuss relevant ethical principles and frameworks, and consider practical aspects.)

Rasko, J., O’Sullivan, G., and Ankeny, R. (eds) (2010) *The Ethics of Inheritable Genetic Modification: A Dividing Line?* Cambridge: Cambridge University Press. (Edited collection that considers the science and ethics of genetic modification in humans. Includes chapters on animals, disability, and feminist accounts, among others.)

Resnik, D.B., and Langer, P.J. (2001) ‘Human Germline Gene Therapy Reconsidered’, *Human Gene Therapy 12*: 1449–58. (Discusses several conceptual distinctions in the gene therapy debate, including boundaries between treatment and enhancement, somatic and germline and between genetic and genomic. One of the first papers to suggest the term ‘genome modification’ for humans.)

Scully, J.L. (2008) *Disability: Moral Bodies, Moral Difference*, London: Rowman & Littlefield. (In this preeminent work on the place of disability in bioethics, Scully brings together ethical reasoning and disability studies to show the complexity of questions of disability in bioethics. This includes how society detrimentally focuses on difference.)

Scully, J.L. (2019) ‘Epistemic Exclusion, Injustice and Disability’, in *The Oxford Handbook of Philosophy and Disability*, ed. A. Cureton and D.T. Wasserman, Oxford: Oxford University Press. (Discusses social epistemology and epistemic injustice, as experienced by people living with disabilities. Sets out a challenge to mitigate harms from the unprecedented potential for epistemic injustice for disabled people, in a climate of enthusiasm for genetic technologies.)

Sheehan, M. (2009) ‘Making Sense of the Immorality of Unnaturalness’, *Cambridge Quarterly of Healthcare Ethics 18*: 177–88. (Considers the nature and validity of claims that

something is interfering with nature. Sheehan considers the problem, and critically evaluates a number of different conceptualisations of what it means to interfere with nature. He then offers an account of interfering with nature that appeals to transgressions of the limits of human activity.)

Sumner, L.W. (1996) *Welfare, Happiness, and Ethics*, Oxford: Clarendon Press. (Recognising that welfare is both important to ethical debates but contentious as to its meaning, Sumner considers a range of theories of welfare (objective, subjective, and hedonistic) before arguing for an account of welfare founded on life satisfaction. Sumner concludes that welfare is the only basic ethical value.)

Tong, R. (2010) 'Traditional and Feminist Bioethical Perspectives on Gene Transfer: Is Inheritable Genetic Modification Really the Problem?', in *The Ethics of Inheritable Genetic Modification: A Dividing Line?* ed. J. Rasko, G. O'Sullivan, and R. Ankeny, Cambridge: Cambridge University Press, 159–73. (Critically considers the place of feminist bioethics scholarship in debates over genetic modification. Tong highlights the impact of these technologies on women, questions the degree of freedom that people have in choosing to use genetic modification, and sets out how feminist ethics can contribute to these debates.)

Velleman, D. (2008) 'Persons in Prospect', *Philosophy and Public Affairs 36*(*3*): 221–88. (A collection of three papers, originally written for an undergraduate philosophy course on Future Persons. The three papers claim that we cannot harm or benefit future generations; that an obligation to future generations mandates taking due consideration for human life and that future persons can rationally feel resentment towards their progenitors.)

Wrigley, A. (2012) 'Harm to Future Persons: Non-Identity Problems and Counterpart Solutions', *Ethical Theory and Moral Practice 15*: 175–90. (Identifies the philosophical theoretical assumptions upon which Parfit relies in order to support his Non-Identity Problem. Argues there are clear alternative philosophical foundations that would undermine Parfit's conclusions, thereby eliminating the problem of how we can attribute harm or benefit to future generations.)