

Introduction to Part I

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The weight, value and transformative effect of scientific research are greater now than they have ever been. The nature of the moral scepticism that underpinned much late twentieth-century liberalism now bows to a scientific culture, where scientific method and the reliability of peer-reviewed results bear directly on our ethical norms, our national and supranational laws, and on social activities as diverse as farming, medicine, insurance and city planning. Science has thus changed the world, and has changed, as some of the authors discuss in this collection, even our cognitive and moral abilities.

The idea of writing this book was formed a long time ago, in April 2014, after the Third World Congress on Freedom of Scientific Research, held in Rome and organised and sponsored by the Luca Coscioni Association. The editor of this collection, John Harris and Lucio Piccirillo have collaborated with the Luca Coscioni Association and participated in the conference, either as speakers or organisers. But the origins of this book are even older.

The World Congress on Freedom of Scientific Research is an international ongoing forum, which was formed in 2006 in response to concerns in the international scientific community that scientific freedom might be hindered by ideologies that do not stand up to moral or rational scrutiny. In the early 2000s, part of the international scientific and bioethics community was responding with profound concern to innovations in embryological science; the European Union decided to take time to think about the matter, and first imposed a moratorium, and then a series of limits to the funding of scientific research involving human embryos. A heated debate followed regarding the likely repercussion upon the development of regenerative medicine.

Marco Cappato, in Part II of this volume (Chapter 12), discusses the international reaction to ‘human cloning’ (more properly, cell nuclear transfer) following the announcement of the birth of Dolly the sheep in 1997. In response to the virtually unanimous ban on ‘human cloning’, and on the restrictions imposed all over the world upon stem cell research and,

consequently, upon regenerative medicine, the United States Coalition for the Advancement of Medical Research, the Genetics Policy Institute, together with several Nobel Laureates and a number of representatives of patients' associations, scientists and politicians, including Members of the European Parliament, united in The World Congress for Freedom of Scientific Research.

This book makes the results of this intellectual enterprise available to the international academic community and to the general reader, bridging the gap between communities that often work in isolation from one another: the scientific community, the political community and the academic community. But we aim at making the discourse on the politics of science available and accessible to the general public, attempting to explain how decisions that affect us all are taken, and thus how science and politics function in contemporary society, and perhaps how they could and should function.

This book includes contributions by some of those who participated in the last Congress, as well as contributions by others who joined later. Obviously, the original papers have substantially changed, because a lot has happened since 2014. The focus of this collection is on the relationship between science and society, and its mediation through law, ethics and social, political and economic norms. The authors have the most diverse backgrounds, and therefore their style is diverse, and this comes across clearly; some of the contributors are scientists, others are philosophers, others are politicians or humanitarian activists; their nationalities are also different – some are European, some are not. So the way they convey their message and their writing style differ significantly, and it is hoped that this diversity will contribute to make this collection valuable and original. This book takes a multidisciplinary approach to the problems of scientific freedom. The methodologies used will therefore be those of discursive research in sciences, politics, law, philosophy and economics.

The notion of freedom is central to this book. This notion has evolved historically and has been debated widely over the history of Western thought (Arendt 1993). Depending on the context we may talk of 'freedom of the will', 'legal freedom', 'economic freedom', 'religious freedom' and so on. It may be possible, however, to distinguish or identify four broad meanings of the term 'freedom': *metaphysical freedom*, *negative freedom*, *positive freedom* and *civil and political freedom (or freedoms)*. This distinction is approximate, but it may be useful to identify the uses and meanings that tend to recur most often in the volume.

In the first sense (which I called metaphysical freedom), freedom refers to the ability of humans to act according to their own will (Mele 1995). This sense of freedom appears relatively recently in the history of Western thought. In Greek mythology and in a large part of ancient Greek philosophy humans are not 'free' in the way we would consider ourselves free today. In ordinary language, to say that I am free may mean, for example, that I am not enslaved, or very simply that I have the ability to choose, say, to

eat pasta or chilli con carne, or to go for a walk or watch a film. For many Greek philosophers, this freedom is an illusion. It is ‘fate’ that determines our choices and actions. Even the gods are subject to fate. Gods and humans may have the sensation of being free to choose, but their life, death and destiny are predetermined. Thomas Hobbes observed that the notion of freedom for most Greek philosophers was a feature of the state (the polis), and was not a feature of individuals (Hobbes 1651: X, 8). For the Stoics, for Heraclitus and Parmenides, men were free insofar as they were able to accept their own destiny (Palmer 2013). A person is like a dog tied to his chain: he can freely run around, and enjoy his freedom, but only insofar as he stays within the length of his chain.

The first known discussions of freedom as we may intend it today, as free will and self-government, are found in the Sophists, and a precursor of this understanding of freedom can also be found in Plotinus, one of the most prominent scholars of Plato, who became a famous philosopher in Rome in his later years. The ideas of free will and moral responsibilities that he contributed to shape were later elaborated and became central to Christian theology. Most of the Western philosophers we know of – Leibniz, Voltaire, Spinoza, Hume, Locke, Condillac, Kant, Hegel, Kierkegaard, Marx, Jaspers, Sartre, to mention just a few – have developed theories of human freedom, intended as our ability to act according to our will, or our intellect, or our reason.

Although the other three meanings of ‘freedom’ will be more relevant to the contributions in this book, it should be noted that science is relevant to the understanding of freedom in the metaphysical sense. Neuroethics, for example, attempts to evaluate whether individuals form genuinely autonomous decisions, and thus also whether they should be held responsible for their choices and actions. The relevance of this to a number of contexts is remarkable: think of criminal liability. If people are not free in the relevant sense, how can they be held accountable and punished for their actions? Think of informed consent. Are there factors that render our choices non-autonomous? Some religious and cultural influences are regarded as rendering people non-autonomous, and thus as invalidating consent; this is why in the UK for example the Female Genital Mutilation Act 2003 prohibits excisions of labia majora, minora and clitoris for non-medical reasons, even if requested by adult consenting women. Yet in other cases religious beliefs are not regarded as invalidating people’s autonomy and their ability to give or withdraw consent to medical procedures – and this is why Jehovah’s Witnesses are allowed, in England and in many other countries, to refuse whole blood products, even if they will die as a result of their refusal.

There is another way in which this metaphysical sense of freedom features in this collection. As Corbellini and Sirgiovanni discuss (Chapter 13), science has an impact on our freedom, intended in this first metaphysical sense. The authors argue that the wider accessibility of scientific education has enhanced people’s ability to evaluate facts, to reason around them, to make

hypotheses, to think abstractly, to think critically and rigorously. These abilities can 'free' individuals from the grip of superstition or from the malice of deceit, as they allow us to reflect critically on what is in front of us, and to question what is said or offered to us. These abilities thus enhance our freedom and moral responsibility, even if we accept that our choices, actions and even preferences are largely determined by factors beyond our control (environment, genes, culture and so on).

Science enables us to know many things about ourselves. This raises other questions around freedom in this metaphysical sense, which are both theoretical and practical, and which are relevant to a number of domains, such as medical ethics, science ethics and even law. Once the information about us, that is precisely about you and about me, is available to you and to me, can we still be free if we refuse to receive it? For example, the sequencing of our whole genome is now possible, and through genetic tests it is possible to evaluate our susceptibility to develop certain diseases, or in rarer cases to establish the presence of genetic mutations that will lead to the development of certain diseases. Can we still be free, in this first sense, if, having this information made available for us, we decided to remain in ignorance? More broadly, what does it take to be free, in this first metaphysical sense? How much knowledge do we need to have about ourselves, how much does 'science' need to disclose about us, for us to be free?

These questions have engaged and divided bioethicists for over a decade now. Harris and Keywood argued that we cannot be free and we cannot make autonomous decisions unless we accept available knowledge about ourselves. Not only can we not be free unless we possess the available information: because without this knowledge we cannot be free, we cannot even freely refuse to obtain that information (Harris and Keywood 2001). Takala and Bortolotti objected that Harris and Keywood misinterpreted here the notion of freedom and autonomy. We can decide not to be told whether we carry a genetic mutation that may or will cause us to develop an illness later in life, and we can still live our life freely (Takala 2001; Bortolotti 2013).

When we apply these considerations to our relationships with children, dilemmas become perhaps even more acute. There has been a debate in the UK as to whether parents who have genetic disorders such as Huntington's chorea (a non-treatable and non-preventable disorder that appears in adulthood, and that is caused by a genetic mutation) could test their children for the disease. The UK Genetic Alliance's recommendation is that children should not be tested for these disorders, because this knowledge violates children's right to an open future. This notion of an 'open future' appears conceptually akin to the notion of freedom in the first metaphysical sense. The UK Genetic Alliance's position is that, as the conditions in questions are not treatable or preventable, knowing about them only limits children's right to an open future (and thus their freedom) (Genetic Alliance 2016).

But, conversely, it could be argued that without that knowledge, freedom is actually taken away from the child. If I have this information about my life as a child, this might allow me to shape my plans and my priorities; I may decide to give precedence to what I can realistically achieve in the time I have at my disposal and avoid long-term plans, for example. Likewise, parents may find that without knowledge there is no open future for their children, only a bet at best, and an inauthentic life based on false hopes at worst. Ignorance may shadow, rather than promote, an ‘open future’, or our freedom.

The second distinction mentioned earlier, between positive and negative freedom, is usually associated with Isaiah Berlin (Berlin 1982), although John Locke and Jean-Jacques Rousseau had already discussed these concepts. Berlin identified two ways in which the notion of freedom can be understood. One is ‘negative’: here freedom is freedom *from* (from interference or limitations). If I say, for example, that I am free to marry a person of my choosing, and that nobody should interfere with my choice, I refer to freedom in its negative sense. I am free, and should be free from unnecessary or unjustified external limitations. This sense of freedom echoes John Stuart Mill’s notion of liberty: individuals are sovereign over their bodies and their life, and the only purpose for which power can be rightfully exercised over a member of a civilised society against his will is to prevent harm to others (Mill 1859). Modern liberalism is largely based on this view of freedom; individuals can enjoy large spheres of self-government in their private life, insofar as they do not limit the equal freedom of others or do not hurt others.

Positive freedom, instead, is freedom *to*: this freedom usually requires that others provide to me with something so that I can exercise my freedom. If I have a freedom to, say, education, this entails that someone else has a duty to provide me with something so that I can exercise my right (e.g. that the state provides schools). This second sense of freedom echoes discourse of rights: right to education, for example, to work, to life and health.

Positive and negative freedoms are interrelated in many ways. For me to enjoy freedom in the negative sense, it is usually not sufficient that others do not interfere with my choices and actions. Usually it is also necessary that others provide certain things to me. To give an example, suppose that I choose to terminate a pregnancy, and that I live in a country in which this is legally permitted. Negative freedom means that others cannot ethically seize me and force me to keep the baby; they can try to persuade me, to convince me, but they cannot physically interfere with me to prevent me from acting in the way I choose. But in order for me to exercise my freedom, it is not sufficient that others do not interfere with me directly: it is also necessary that the healthcare system provides accessible services. If, say, in rural areas abortion clinics are not available, and women do not have the resources to access available centres, then women are not free, even if their negative freedom is respected.

This is important to the purposes of this collection. If individuals have a right to life and to health, as protected and defended in virtually all declarations and conventions of human rights, this means of course that they ought not to be deprived of their life (unless perhaps they so wish – as in cases of assisted suicide or euthanasia); and of course it means that they should not be exposed to preventable harm, diseases and illnesses (they should not be deliberately infected with transmissible diseases, for example, and they should not be physically assaulted or harmed). This is why many liberal states recognise forms of liability for murder and physical assault, but also for accidents recklessly caused to others. This is also why many liberal states adopt routine or compulsory vaccination programmes, and why in many liberal states healthcare services are made available to all citizens. The provision of these services may cause some restrictions of other freedoms we may also enjoy: for example, the provision of publicly funded health services causes people to pay taxes, and thus limits their freedom to dispose of all their earnings. Some restrictions are usually regarded as proportionate and justified, because of the good that they protect and promote. Your right to life is more important than my claim to be able to drink and drive. It could be argued that if this is true, then limiting the ability of scientists to pursue research into certain areas of medical science is limiting the right to life and to physical integrity of those who would benefit from this research. This is an argument that the reader will find in this volume (see, for example, Chapters 11–12). It makes no sense to speak of negative freedom unless certain barriers that can limit the enjoyment of that freedom are removed. Thus, one could argue that if, for example, stem cell research offers the prospect of treatment for spinal cord injuries, there is little point in saying to a person who is paraplegic that she has a right to non-interference, if the parliament of her country prohibits stem cell research, or if funding for that research is not made available. To say this, it could be argued, is similar to saying to her that we respect her negative freedom to non-interference, but then we do not provide her with a wheelchair. It could be argued that if it is cruel to say to this person that she can rightfully exercise her freedom from interferences while at the same time denying her the available wheelchair, it is similarly cruel to prevent scientific research that is likely to lead to the discovery of treatment for her condition.

Thus, it becomes clear that what it takes to respect people's negative freedom relates very closely to what should be provided for them so that they can actually exercise their freedom. And it is here that complexities arise in the context of freedom of scientific research; in this context the values, priorities and demands are multiple and diverse; how these should be balanced and ranked, and how our most fundamental freedoms should be protected, in order for them not to be mere unfulfilled words, is central to this collection.

In the fourth sense, freedom can be intended as civil and political (in this sense it is more appropriate to talk about *freedoms*). In this sense we refer to freedom from oppression, freedom from coercion, freedom of association, of speech, of movement, of the press; civil and political freedoms are those that many of us relate to as what citizens of liberal democracies enjoy, as opposed to the limitations that characterise totalitarian regimes.

Civil and political freedoms are those that a state cannot legitimately restrict without good reason. Most contemporary states have documents (in the form of a constitution or bill of rights) which state what the basic civil and political freedoms of citizens are. There are also supranational documents, which have similar content, and which can be ratified by individual states, such as the European Convention on Human Rights, or the International Covenant on Civil and Political Rights; these will be discussed in various chapters in this collection.

Although this book is not primarily a book of political philosophy, it is still a book about freedom; in particular, the notions of negative and positive freedom and civil and political freedoms will recur in the works presented here. The notion of metaphysical freedom will probably be less prominent. Freedom of scientific research can be understood as negative freedom (questions here concern the degree of freedom from interference that scientists should enjoy) and as positive freedom (questions here concern the infrastructures and legislative frameworks that should be provided in order for science to operate). Scientific freedom can also be understood as a particular type of civil and political freedom, or as an enterprise that has direct impact upon people's civil and political freedoms.

The support and limits that should be given to science require constant evaluation: priorities need to be set, scarce resources need to be allocated, competing principles and faiths need to be accommodated, obligations and responsibilities need to be distributed among societies' members. Questions about freedom of scientific research are also questions about how free science truly is or can be (Vattimo and Cavalli Sforza 2006). Science is an enterprise, and as such it is directed (at least to an extent) by the political agenda, which, in turn, also determines how funding is allocated. Even in liberal democracies, where parliaments and governments are democratically elected, political agendas do not always reflect the priorities of the people; but of course it may be debatable whether or not it is the priorities of the people, even of the majority of the population, that should steer political agendas and scientific research.

The ethical properties of science are inherently subject to controversy and debate. As we will see in this volume, some areas of biomedical science are by some considered outright wrong. But on the other hand, other areas of research that may appear morally neutral can still be used for morally dubious purposes (see Chapter 6 on bioterrorism in this volume). Other areas of science and technology may be seen as morally neutral, but may

be expensive and may not promise immediate ‘returns’. Questions may thus be asked about whether it is ethical to invest in these areas of science, in a context of limited resources.

This book will not offer a coherent or conclusive notion of freedom. It rather wants to promote a space for cultural exchange – on paper of course, just with a book – and critical reflection on issues that concern scientific research, its boundaries and who should be setting those boundaries. This collection tries not to be skewed in one direction, but we recognise that a liberal, progressive spirit has moved the World Congress and thus also inspires this book. However, we don’t wish to indoctrinate the reader – we believe that within the spirit or culture that has inspired this collection it is possible to reason about the advantages and disadvantages of certain scientific developments and about certain regulatory mechanisms. We recognise that we are probably all somehow ‘indoctrinated’, whether or not we are willing to admit it. But our aim is to promote a debate, which of course moves from a certain perspective, and which sometimes proposes a certain point of view, but which wants to remain informed and responsible. With this in mind, we have decided not to attempt to level either the style or the voice of different contributors, because we wanted this collection to reflect the pluralism that inspires the enterprise of the World Congress of Scientific Freedom. Our aim is to provide and show the value of different intellectual and practical endeavours, and not to yield a unified message to the reader.

Part I of this collection discusses some of the ways in which science is changing the world. The first two chapters discuss the impact of science (particularly immunology) on human life. Sir Peter Lachmann (in Chapter 1) provides a fascinating overview of the milestones in the immunological sciences and the effect these have had on the duration and the quality of human life. Overall, humankind has lived longer and better since at least the 1900s. But ‘all that glitters is not gold’, wrote Shakespeare in *The Merchant of Venice*. And Lachmann concludes by unveiling the other side of the coin: the growth of world population is simply unsustainable. CO₂ emissions and indiscriminate use of scarce resources are likely to put humankind at new risks of global deaths and even extinction. Life extension and overall population growth call humans to new levels of responsibility towards the environment and towards each other. These new and more demanding levels of responsibility are the price we need to pay for our longer and healthier lives, and they are the only way to ensure that what is a blessing to many does not become a curse for the generations to come.

My contribution (Chapter 2) continues the discussion on the curses and blessings of scientific progress. I take a different angle, though, and consider the challenges that life extension presents for humankind, particularly in middle- and high-income countries. I consider philosophical and metaphysical concerns around life extension: some thinkers see death, the inevitable death of humans by ageing (not just their inevitable vulnerability to accidents

and illnesses), as an inherent feature of humans. The ever-growing ability to delay death, to slow or even reverse the process of ageing, and the possibility of replacing ‘old’ body parts with younger ones, and even animal or artificial ones, for some changes the very essence of what it is to be human. Some find this trajectory repugnant, unnatural. I propose that life extension is *not* changing the nature of humans – and this is so for the simple reason that it is unclear what this inherent universal and eternal essence of humans is supposed to be; on the contrary, the ability to extend life, or postpone death, are to be celebrated as one of the greatest triumphs of humankind. In practical terms, this means that the growing presence of older people in our societies is also to be honoured.

Similarly to Lachmann, I highlight that social changes are, however, necessary to make population ageing sustainable. These changes include the modification of working patterns, retirement age, city planning and much more. There are also changes in individual lifestyles that need to be responsibly implemented in order to make the most of a long life, and to prevent what is a triumph from becoming the worst of all nightmares for ourselves and those who will come after us. The danger, here, is becoming prey to the old argument that wanted to make people ‘responsible’ for their own ill health, and thus placed people higher or lower on the scale of healthcare rationing depending on ‘how well’ they had led their life. The focus, and the responsibility for sustainable population growth, should not exclusively fall upon individuals. There are shared responsibilities, which are social and political, which need to tie in with personal responsibilities.

Science thus changes population structures, demographics, the planet and human life as a whole. But it also changes intimate and private aspects of our lives. Daniela Cutas and Anna Smajdor (Chapter 3) explore some of these transformations in what for centuries have been regarded as natural and thus immutable relationships, namely the relationships between parents and children. In particular, developments in reproductive technologies have created new types of connections between parents and children. Social or legal parenting and genetic parenting have never necessarily coincided, as exemplified by cases of adoption or, traditionally, by cases in which children are raised by, say, grandparents or other members of the extended family. But reproductive technologies, such as *in vitro* fertilisation, allow a woman to give birth to a child who is not genetically *her own*, or to a child who bears genetic material from both herself and another woman (via, for example, mitochondrial DNA transfer). A man can become at the same time a mother and a father (as in the case of the transman who has oocytes harvested prior to transition, or as in the case of the transman who does not seek genital confirmation surgery and thus retains the uterus and ovaries – biologically these people are mothers to their children, but socially and legally they are fathers; or as in the case of people who transition to the other gender after having had children – in these cases they will be biological fathers and social mothers, or vice versa). Women are now able to bear

children way past the age of fertility. Perhaps, in the future, a woman will be able to give birth to a child who is genetically *only her own* (via solo reproduction with *in vitro*-created gametes or human cloning). Gamete donation and surrogacy bring about legislative challenges that many legislatures are still trying to sort out. Some people will find these new possibilities marvellous and amazing; some will find them disturbing. Cutas and Smajdor point out that the changes of the last decades are harder and harder to reconcile with the still pervasive *nuclear family* expectations in ethics and regulation. They show how many legislatures across the world still regulate medical care, by limiting access to it, on the basis of an ideology according to which a nuclear family, constituted by a man and a woman, possibly married, conceive children who are genetically related to them. The diversification of genetic parentage itself (alongside a host of other sociocultural changes) pushes the model further into what some may see as the *crisis* of the family.

There is a question to be asked here, namely whether this ‘genetic jealousy’ has anything to do with the atavistic tendency to tenaciously preserve economic assets within family lineages. It is a question that Cutas and Smajdor do not openly address, and one for which it would be difficult to provide a substantiated answer, but it is a doubt that arises from reading their informative chapter. There is another interesting aspect of the regulation that Cutas and Smajdor highlight: norms and assumptions concerning the structure of the family *constrain* the direction of scientific progress in the area of human reproduction. It is one’s family status that determines whether one’s reproductive aspirations are classified as medical needs and thus eligible for treatment, or, put differently, as *just personal preferences or desires*. In turn, *needs* (deemed eligible for medical treatment) form the basis of future research priorities. *Desires* do not give impetus to research priorities in the same way. The chapter challenges our assumptions relating to the boundaries of human reproduction, and calls for adjustments in ethics and law to make space for more realistic perimeters of human parenting, and thus for greater freedom of scientific research in the area.

In Chapter 4, Selvaggi and Aas consider another development of scientific research and technology, which raises again a number of issues relating to reproductive ethics, as well as to the ethics of scientific freedom. They focus particularly on recent developments in uterus and penis transplantations. They point out that these types of transplantations, unlike other types, are not primarily meant to save or lengthen the patient’s life, but to improve their quality of life by increasing reproductive and sexual function. Also for this reason, they raise questions relating to the ethics of surgical research, when innovative treatment may enhance patients’ quality of life if successful, but also expose patients to high risks, including risks of immunological rejection and even death. They go further though; so far, both penis and uterus transplantations have only been performed on cisgender people, that is, people whose gender is congruent with their birth sex. For example,

penis transplantations have been attempted on men who have lost their penises due to illness or accidents; uterus transplantations have been performed on women with health problems, who could not bear children. These techniques, however, are in principle viable options for transgender men, that is, women who transition to a male gender, and could represent an alternative to penis reconstruction, which is often unsatisfactory to patients. Uterus transplantations could be utilised to allow transgender women, that is, men who transition to female, to bear children. If these forms of surgery had to be utilised in this population of patients, further challenges, in addition to those highlighted by Cutas and Smajdor, would arise for the law and social policy around who has ethically legitimate claims to reproduce. But Selvaggi and Aas also point out other issues: how are benefits and risks to be judged? And who should make the judgement? Also, importantly, whose organs should be used? In the case of penis transplantations, cadaver organs are normally used – would it be possible to have live donations from transgender women? They discuss the surgical and ethical issues that would need to be addressed in order to answer this question. Finally, they pose a broader question. These are expensive and non-life-saving procedures. Is this a good use of scientific effort?

Another relatively novel development in reproduction is mitochondrial DNA replacement. The issue was in the spotlight in 2015 and 2016 around the world. Iain Brassington explores the ethical issues around this technique in Chapter 5. He explains the technique and its therapeutic goals. Although these are now widely known, there is an interesting aspect of mitochondrial DNA replacement that Brassington examines: namely the relationship between this technique and the broader issue about the ethics of freedom of scientific research. Mitochondrial DNA replacement is in effect a germline modification: an alteration that will be passed down the generations. Hence its promise is potentially double-edged: it may improve future lives significantly over the run of several generations; but if it turns out to have undesirable sequelae, it might cause several generations of harm. This raises questions about the freedom to pursue potentially harmful techniques – not just in relation to this particular case, but across the board. Moreover, some worry that the human genome, or nature, has a value that will be undermined by interferences such as this. But scientific freedom is also valuable. Can we measure one against the other? Finally, what about the freedom *not* to investigate? In a world where the scientific community chose not to pursue such innovations, would that be a proper use of scientific freedom? Brassington argues that scientific freedom includes the freedom *not to pursue research*; in this, he represents a somewhat dissenting voice in the volume. Most of the contributors stress the importance and value of scientific research, in various areas and aspects (Piccirillo considers physics, Mertes and Woolley make quite a strong appeal to ethics in justification of freedom of science, particularly in the field of regenerative medicine; see Chapters 8, 11 and 15, respectively).

Although Brassington notes that there are no particular reasons to be concerned about certain types of germline modifications, such as those brought about by mitochondrial replacements, there is no moral obligation to pursue research, even if it is aimed at preventing potentially serious diseases, such as mitochondrial diseases. Brassington here seems to discount what is known in applied philosophy as the ‘equivalence thesis’; according to this thesis, acts and omission may have the same moral weight. There are caveats to the ‘equivalence thesis’ but at its minimum it states, somewhat convincingly, that harming someone with a positive action is *not necessarily* worse or morally more repugnant than procuring the same harm through an omission. So Brassington leaves unanswered the question of whether deliberately failing to prevent a child from being born in a harmed condition is equivalent to causing that harm. The discourse is complicated further by what philosophers call, after Derek Parfit, the problem of ‘non-identity’; in the choice between bringing into the world *two different children*, each child has only got that specific chance of existence. Therefore, if a child is brought into the world with a mitochondrial disease, who would have not been born otherwise, that child is neither harmed nor wronged by being brought into the world. The ‘non-identity’ problem suggests that a child is not harmed by being brought into existence, even if he or she has a disability or a medical condition, if *he or she could only be born in that state* (unless his or her life is so overwhelmed by suffering that it would be preferable for him or her to have never existed in the first instance).

But there are two problems here. One is this: even admitting that the ‘non-identity’ problem applies here, one could still say that philosophers seem to be the only category of people who are not concerned about whether a child is born with a serious medical condition or not (provided he or she is not overwhelmed by suffering). The second is perhaps a more compelling problem. As Brassington notes, the mitochondrial DNA represents such a tiny portion of the whole DNA, and indeed of the oocyte, that the problem of ‘non-identity’ is not likely to apply. If the ‘non-identity’ problem does not apply, then the ‘equivalence thesis’ applies. If Brassington is right to say that the mitochondrial DNA is such a tiny portion that it does not affect the identity of the child, then a child, *the same child*, is likely to be born, whether the portion of faulty mitochondria in the egg has been substituted or not. Therefore, it would be true to say that *a child (the same child)* will be brought into the world, either suffering from mitochondrial disease or clear of mitochondrial disease. It would not be true to say in this case that *one* child would be brought into the world who suffers from mitochondrial disease, or *another child* would be brought into the world clear of mitochondrial disease (as it would be if one embryo rather than another had been implanted). Thus the ‘equivalence thesis’ is still relevant here, but Brassington leaves the reader to make up their mind about this thorny issue.

The interest of applied ethics and bioethics in science has traditionally been raised mainly, though not exclusively, by scientific research that impacts upon human health – genetic and genomic research, for example, regenerative medicine research, embryonic stem cell research, and research that uses humans or other animals as research subjects. In this collection we wanted to cover science more widely, at the risk of sacrificing perhaps some depth to that purpose, and the rest of Part I of this collection is devoted to areas of scientific research which seem less directly involved in the protection or promotion of human health, but which, instead, as the authors show, are likely to have a profound impact on human health and welfare.

Catherine Rhodes discusses scientific research in relation to biosecurity (Chapter 6). Her chapter is (sadly) very timely, given the increasing global threats of attacks involving pathogens. She stresses that scientific freedoms are to be exercised within the context of certain responsibilities, which in some cases justify constraints on those freedoms. Responsibility to prevent certain threats from materialising falls on a large pool of actors, she argues: scientists, but also journal editors, scientific academies and national and international policy groups. Scientific research on pathogens is afflicted inherently by a profound tension: scientific work on pathogens yields huge public health benefits, but the same public health protection calls for a restriction on such work, or at the very least tight control of the release of information. International and national policy, Rhodes points out, increasingly hold scientists responsible for public health protection; but, as she notes, there must be recognition of reciprocal responsibilities of scientists and policymakers, to develop effective international policies that can mitigate the tension inherent in this area of scientific research.

David Lawrence in Chapter 7 focuses on robotics and artificial intelligence. After the Industrial Revolution of the 1800s, we are now used to the idea that machines carry out tasks traditionally performed by humans. Experimental robots are extremely impressive devices. We know already that they are widely applied to surgery, but, as Lawrence explains, it is possible now to emulate proprioception, tactility, visual processing, object recognition, walking and running. As with other areas of scientific research, the results are received either with enthusiasm or with worry. Automation is perceived by some as a threat; many human professions, it is feared, will disappear, being replaced by ‘better robotic versions of ourselves’. The work market will be steered to make space for electronic engineers and similar professionals, to the detriment of the variety of what individuals, with their own unique talents and skills, can offer to society. The prospect of the development of conscious, thinking machines is even more disquieting. Artificial intelligence challenges regulation and policy around liability, ownership, employment and more. But Lawrence points out another preoccupation, which links his chapter to my earlier chapter. Scientific development challenges what it is to be human. I posed the question of how much of ‘us’ can be substituted by, say, robotic parts, before ‘us humans’ become something

else. Lawrence poses the corresponding question: how much should an artificial life, a robot, understand, feel or think before it is regarded as ‘one of us’? This metaphysical question raises a number of moral questions relating to how beings ought to be treated, moral questions about where on the ladder of moral status a being should be before it is entitled to equal concern and respect.

Part I of the volume concludes with Chapter 8 by Lucio Piccirillo. Piccirillo offers some reflections on the importance of science and freedom of scientific research, considering some of the important discoveries in the field of physics. In this chapter he takes on a role which, he argues, many scientists should take on in society, that is, to explain in plain and accessible language what their job is. He focuses on the Large Hadron Collider as an example of big science and on the Markov chain as an example of small science; first he explains what these are and what their purposes are, and then he offers some reflections on freedom to pursue both big and small scientific projects. He makes two seemingly straightforward points: the first is that insofar as science can yield advantages for humankind, science is a *prima facie* good, and thus scientists should enjoy a significant degree of freedom. The second is that in order to obtain this degree of freedom, society at large must receive clear and accessible information about the purpose and methods utilised in various scientific disciplines. So far so good, but as Piccirillo himself recognises, both arguments raise a number of complex issues. On the first point, Piccirillo distinguishes two types of impediments: financial constraints on the one hand, and ideologies and fears on the other. He discounts the latter as inherently detrimental to science, but accepts constraints based on resource rationing. But on the vexed problem of how scarce resources should be allocated, Piccirillo does not offer a solution or a method to begin to frame possible solutions.

On the second point, there are also questions to be asked. One is again about resources, and perhaps responsibilities. Is it really the job of scientists to communicate with the general public? Or is it the job of science correspondents, who often work as a liaison between scientists, on the one hand, and the public, through the means of the media? Corbellini, as we will see in Part II of this collection, raises doubts about whether it is scientists who ought to or are even best equipped to bridge the gap between science and society. Rather, the problem of the gap between science and society should be dealt with upstream, so to speak, at the level of public education in scientific disciplines and scientific methods. The public needs to be prepared to welcome and evaluate critically scientific discourses, and this cannot result from individual conversations of scientists, as clear as they might be, on specific issues. It is the state that has a responsibility to educate citizens, particularly during the phase of compulsory education, in scientific methods especially, in order to foster the analytic thinking that equips citizens to evaluate rationally facts, claims and scientific developments. Only this can protect us from various serious dangers, particularly from the exploitation

and false claims divulged in the guise of scientific truths for fame or financial rewards – think of homeopathy or untested stem cell therapies, with no proven benefit or scientific credibility, which have been and are administered, generating lucrative payments, to patients affected by various serious diseases (*Nature* 2015); or think of claims around the ineffectiveness or harmfulness of vaccinations. There is little that can be done to convince someone to change their belief, say, that genetically modified foods destroy natural equilibrium, or to persuade someone who believes that vaccinations are harmful to vaccinate their children. Normally people do not abandon their strong beliefs, even in the face of evidence that they are likely to be mistaken. They often instead manipulate the facts to reconcile the cognitive dissonance, that is, to reconcile the contradiction in their minds. Therefore, a one-to-one or one-to-many conversation on a specific issue (say, a scientist explaining the science of genetically modified organisms) will be able, typically at least, to convey the message only to those already open to ideas that may contradict their beliefs or predispositions to certain beliefs. But being open to ideas that may contradict our predispositions is a complex and sophisticated skill to be acquired and developed. Thus, the conversation between scientists and the public at large must be preceded by a certain degree of formal education in science and in its methods, so that people can develop the critical skills that may enable them to approach scientific developments rationally and critically and to form more reasoned or rational beliefs.

Many of the contributors here, as mentioned earlier, participate in an ongoing international forum on freedom of scientific research begun in 2006, and have participated in academic and political debate both before and since. So, with this volume we want to contribute to an ongoing international bioethical and political debate on the ethics and politics of scientific freedom. We do not offer a collection from academics who have ideological affinity with us: we want to provide a truly multidisciplinary and open perspective on scientific developments in society and a critical reflection on the regulation of science. We hope to provide a balanced but progressive collection, which will promote further reasoned debate on the gap between science and society and on how to correct it.

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