SCIENCE ETHICS AND SOCIETY

Scientific Freedom

Edited by Simona Giordano,
John Coggon and Marco Cappato

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Scientific Freedom

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Scientific Freedom

An Anthology on Freedom of Scientific Research

Edited by Simona Giordano,
John Coggon and Marco Cappato

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To Luca Coscioni

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Perché gli scienziati non sono pericolosi. Scienza, etica e politica (Longanesi, 2009). In 2007 he co-edited with P. Donghi and M. Massarenti, *Biblioetica* (Einaudi) then staged by Luca Ronconi. A forthcoming book, entitled *Science and democracy. A naturalistic approach* will be published by Einaudi in 2011. He is co-director of the cultural-scientific journal 'Darwin' and he writes for the Sunday cultural supplement of *Il Sole 24 Ore*.

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Author of over 1,200 scientific publications and seven monographs, Djerassi has also written five novels (*Cantor's Dilemma; The Bourbaki Gambit; Marx, deceased; Menachem's Seed; NO*), short stories (*The Futurist and Other Stories*), poetry (*A Diary of Pique*), two autobiographies (*Steroids Made It Possible; The Pill, Pygmy Chimps, and Degas' Horse*), a memoir (*This Man's Pill*), a docudrama (*Four Jews on Parnassus*) and eight plays (*An Immaculate Misconception*, Oxygen (with Roald Hoffmann), *Calculus, Ego, Phallacy, Taboos, Foreplay*, and *Insufficiency*). A member of the National Academy of Sciences, the Royal Society, the Leopoldina, and other foreign academies, he is the only American chemist to have been awarded both the National Medal of Science (for the first synthesis of a steroid oral contraceptive) and the National Medal of Technology. He is the recipient of 27 hon. doctorates and numerous honors, among them the first Wolf Prize in Chemistry (1978), the American Chemical Society's Priestley Medal (1992), the "*Österreichische Ehrenkreuz für Wissenschaft und Kunst*" (1999), the "*Grosse Verdienstkreuz der Bundesrepublik Deutschland*" (2003), the Erasmus Medal of the Academia Europeae (2003), the Serono Prize for Literature (Rome, 2005) and the Great Silver Decoration for Services to the Republic of Austria (2008). In 2005, the

Austrian Post Office issued a stamp in his honor. He is the founder of the Djerassi Resident Artists Program near Woodside, California, which since its inception has provided residencies and studio space for over 2,000 artists in the visual arts, literature, choreography, and music. (*There is a website about Carl Djerassi's writing* at http://www.djerassi.com.)

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John Sulston is a Fellow of the Royal Society and an Honorary Fellow of Pembroke College, Cambridge, and the Chair of the Institute for Science, Ethics and Innovation (iSEI), which was established at the University of Manchester with the mission to observe and analyse the role and responsibilities of science and innovation.

John Sulston was awarded the Nobel Prize for Physiology or Medicine in 2002 jointly with Sydney Brenner and Bob Horvitz, for the work they had done in understanding the development of the nematode (worm) *Caenorhabditis elegans*. For more than twenty years, John worked on the biology of *C. elegans*, studying particularly its cell lineage and its genome. Collaboration between his group and that of Bob Waterston in St Louis, Missouri resulted in the publication of the nematode DNA sequence in 1998. John was the Founder Director of the Wellcome Trust Sanger Centre from 1992 to 2000, where one third of the task to sequence the human genome was completed. In 2002 he co-authored with Georgina Ferry *The Common Thread*, an account of the science, politics and ethics of the human genome project.

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Dick Taverne is a member of the House of Lords and a former Treasury Minister who now concentrates on science policy. In 2001 he founded Sense About Science, a charity which promotes respect for evidence in the discussion of science issues. He is the author of *The March of Unreason – Science, Democracy and the New Fundamentalism* (OUP 2005). In 2006 the Association of British Science Writers voted him 'Parliamentary Science Communicator of the Year'.

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Professor Wolpert's publications include *The Unnatural Nature of Science*, Faber, 1992; *Principles of Development* with C. Tickle, OUP, 2011; *Positional information and patterning revisited*, Journal of Theoretical Biology 269, 2011, 359–365; *The public's belief about biology*. Biochem Soc Trans. 2007, 35:37–40, and *Six impossible things before breakfast – the evolutionary origins of belief*, Faber, 2006.

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Foreword

By John Sulston

Scientific freedom and responsibility

Through science we explore our world, and we can use the knowledge to produce useful things. That much is well known, and part of the daily news. Less talked of is the role of science in improving understanding of the human condition, but many philosophical advances of the last 2,000 years are based on the deep knowledge of the world around us and of ourselves that has been acquired by scientific method. On both counts, freedom in the practice of science is of the highest importance to human wellbeing.

The International Council for Science, in a statute rather quaintly called the Principle of the Universality of Science, expresses the matter in this way:

> The free and responsible practice of science is fundamental to scientific advancement and human and environmental well-being. Such practice, in all its aspects, requires freedom of movement, association, expression and communication for scientists, as well as equitable access to data, information, and other resources for research. It requires responsibility at all levels to carry out and communicate scientific work with integrity, respect, fairness, trustworthiness, and transparency, recognizing its benefits and possible harms.

Some scientific freedoms are internal to the practice of science: freedom to do research, exploring wherever paths of discovery and understanding may lead; freedom of movement and association; freedom to access and use the work of others; freedom from personal discrimination. Others are outward looking, and are important to society as a whole: freedom of communication; freedom to disseminate and discuss scientific findings without censorship or fear of reprisal. Both sorts of freedom come with corresponding responsibilities: integrity in internal practices; accurate communication; and care to maximize the benefits from scientific research.

Why might there be any constraints on these freedoms?

Internally, research is subject to ethical constraints, which are subject to debate: most people would agree that experiments that damage human beings, or that cause intense suffering to animals, should not be allowed under any circumstances; on the other hand, constraints that rely on particular religious viewpoints (for example concerning human stem cells) attract differing opinions. It is useful to distinguish between the pure process of discovery that goes on within the laboratory, which should be limited as little as possible, and the subsequent rollout into society of inventions resulting from that work.

Some funding constraint is inevitable, on the basis that whoever pays the piper calls the tune, but is counterproductive if research thereby becomes channelled wholly into areas expected to yield short term profit.

External communication is constrained from a variety of motives. One is to create scarcity value so that rent can be charged: patenting is deployed ever more widely to control the working of scientific discoveries, and copyright to control access to information; open access to scientific literature is resisted by commercial publishers, including learned societies, who wish to gain revenue from it. Another is that scientific findings are not always to the liking of those who sponsor research, and it is not uncommon for states or corporations to attempt suppression of unpalatable information. Another is concern for safety, where information might be misused - for example in weaponry. All such constraints have negative effects in the long term, and should be minimized.

Ownership of information in order to gain revenue has now become so prevalent as to be termed the 'knowledge economy'. This term originally referred to cooperatives, such as the free software movement, where people shared information freely in order to further their work, but has come to mean the opposite. What used to be open has been enclosed, and is called intellectual property. Globalization of the knowledge economy has led to scientific findings being used not only as useful tools but also as ways of gaining power and of setting trading rules.

To compete in this way is a natural human impulse, but without sufficient measures to encourage more equitable modes of interaction it leads to growing inequality between individuals and between states. Moderation or reversal of this trend will facilitate both scientific progress and benefit sharing; it will increase trust among nations, and will be conducive to achieving a more prosperous and peaceful world for all.

The freedoms of science do not exist in isolation, but are paralleled by and linked to freedoms of society as a whole. We cannot have one without the other, and both are essential to the future of humanity.

Acknowledgements

First of all, we wish to express our gratitude to all contributors to this volume. We are grateful especially considering the challenging task of writing in a simple way that will be accessible to the multi-disciplinary audience to whom this anthology is directed. We wish to thank John Harris and the Institute for Science, Ethics and Innovation (iSEI) at the University of Manchester for the support to this project. A special thank you goes to Sir John Sulston, who wrote the Foreword to this volume. We also wish to express our gratitude to Paul Muriithi for proof reading the work, and to Carmen Sorrentino for offering technical help and liaising between us and many of the contributors.

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Introduction

John Coggon, Simona Giordano, and Marco Cappato

Scientific freedom

In this introductory chapter, we describe briefly the nature of this book, before presenting some detail on its contents, and finishing by outlining what we take to be some of the most interesting themes and ideas that it presents. It is, of course, a collection of essays. There is therefore no single, common position that is defended throughout the distinct chapters. Nevertheless, it is interesting to reflect on matters that recur, often under different emphases. At times the different arguments suggest general consensus, at times radical disagreement. Unsurprisingly, as the detail becomes finer, greater contrasts present themselves. But before looking at some of this substance, we need to ask and answer two questions: why produce a book on scientific freedom; and why do so with authors from such diverse professional and academic backgrounds?

That scientific freedom should be a matter of critical social, ethical, and legal concern is not a new thing. In this sense, we join a large literature that dates back some time. However, whilst some principles may seem to stand outside of any historical context, each generation can be seen to bring its own controversies, social differences, practical possibilities, and legal and regulatory nuances. In this sense, there is always a need for careful evaluations of the proper limits and supports that should be given to science. Constantly changing contexts demand ongoing discussion of how priorities should be set, how competing principles should be accommodated, and how obligations should be distributed amongst societies' members. As with any generation of scientific possibility, the current one has its areas of controversy. We face, for example, troublesome arguments about the ethical propriety of conducting research in areas of biomedical science that some consider to be outright wrong. We also need to explore the cases for and against directing funds into morally neutral, but financially expensive, areas of scientific research, especially if this promises no immediate technological 'payback'. So we do not consider this anthology to contain the 'last word' on scientific freedom. Rather, it speaks to it at a point in time, and presents the wide-ranging contextual and social issues that must be accounted for in contemporary analyses of scientific freedom.

Why have such a varied authorship? Although there are some co-authored chapters, this is not strictly an inter-disciplinary collaboration. Rather, it is a multi-disciplinary collection, with a range of disciplines from across the natural sciences and social sciences and the humanities. Furthermore, we have invited contributions from authors with an interest in the regulation of science, who work, or have worked, in senior policy positions. It is our view that the intellectual insights and practical experience afforded by such a range of contributors lends the book considerable value. In part this is because of the natural divergences in approaches. However, beyond this it presents ideas in a way that is accessible to generalist readers, and allows critical reflection on the weight different writers give to different values and ideas. Some of the chapters carry strong normative messages; some are cast as more detached, analytic critiques; others still suggest practical means of effecting social and political change. These distinctions are part of what, we hope, will make this book an important, provocative, useful, and informative addition to the literature. Ultimately, the proof will be in the reading. Some will choose to view it as a whole, and read it from start to finish. Others will jump from chapter to chapter in a different order. We will give an overview here of the book's contents, and in so doing explain why the chapters are arranged as they are.

The structure of the book

The following chapters present both convergent and divergent themes. In collecting them, we have sought to provide a steady progression in substance and focus, and have divided the works into three Parts. Doing this may be seen to rely on a degree of artificiality, but our hope is that it highlights the flow of considerations that the book overall speaks to. We certainly do not mean for the Parts' titles to suggest exclusivity to their respective contents. Rather, they reflect to some degree the variation in focus taken by the book's contributors. In the remainder of this introduction, we will describe how the chapters progress before discussing the synergies and tensions that they suggest.

Part One, 'Understanding Science and Technology', serves several purposes. With five contributors representing expertise in discrete areas of science, it offers fascinating insights into the nature and value of scientific inquiry. There is discussion of how effectively to communicate scientific knowledge, but also how to begin to contextualize understandings of science. Chapter 1, by Carl Djerassi, emphasizes a distinction that some protagonists in debates on scientific freedom consider fundamental; the categorical differences between science and technology. The implications of recognising and accepting this distinction, it is argued, is crucial. However, the burden of the chapter lies in an engaging argument on the importance of communicating science to as wide an audience as possible, including to members who are cynical of science. Djerassi therefore speaks to the question of how to disseminate knowledge to people who do not have access to, or interest in reading, scientific journals and books. He is able to draw from his own experience of using art as a medium for doing this, specifically by use of science-in-fiction and theatre. It becomes clear how effectively Djerassi can convey the substance of developments in reproductive science and technology, in particular regarding the contraceptive pill and *in vitro* fertilization. The plays that he cites present the science itself in a clear and accessible dialogue, but also raise and allow audiences to contemplate complex ethical controversies, such as reproduction tourism, sex-selection, and the removal of gametes from dead 'donors'. Rather than develop long arguments on these, he provides a fantastic means of allowing a wide public to access understanding of the science, and to see the ethical issues that arise.

In Chapter 2, Lewis Wolpert picks up the theme that Djerassi begins with, arguing in favour of accepting a sharp distinction between science on the one hand, and technology and application on the other. By treating these differently, it is possible to conceive of science itself as value-neutral, whilst noting that the application of science can have profound social and moral effects. In Wolpert's views, scientists are not in possession of any intrinsic expertise to assess these moral issues. He thus cautions against complete self-regulation of scientists working towards controversial applications of science and new technologies. Rather, deference to the public, the wider community, through government is essential. However, he cautions too that whilst scientific knowledge is morally neutral, it can be perverted by political or social aims. He emphasizes the problems raised by simplistic arguments that make villains of scientists, and notes also the effect of self-interest on people's willingness to accept putatively ethical claims concerning the development of some technologies.

In Chapter 3, Lucio Piccirillo presents a challenge for researchers, and society more widely, in considering the value of 'blue skies research'. He provocatively asks, at least where it is funded by public money, why invest in basic research instead, for example, of paying for a new hospital? He also stresses how important he thinks it is to ask his new students each year to ponder this. Piccirillo seeks to answer the question by considering what may be described as the 'real politics of science'. Although in principle we are all 'free' to be scientists, an issue that he raises is that some positive conditions are necessary if people are practically free to engage in scientific research. Thus he explores two important questions: how are scientists chosen?; and how are scientific problems chosen? He describes how he perceives the reality of breaking in to the scientific community, and receiving sufficient favour and recognition to sustain a career in science. His argument is that the power of 'oligarchs' within the research community is not to be doubted, meaning there are two layers of 'real politics' to consider: one is external to the scientific community, in the form of governments or other funding bodies empowered to allocate funds; the other is internal to the scientific community, comprising the leading scientists with the greatest power to adjudicate on worthwhile *versus* non-worthwhile, or non-credible, science. Continuing the theme of distinguishing basic research and technological research, he notes that whilst both are needed, it is clear that funders may be keener to fund the latter. So can 'blue skies research' justifiably result in claims for public money? Much such research comes practically to nothing, but many of the great advances have followed from discoveries in 'blue skies science'. Given this, Piccirillo hints to arguments rooted in intergenerational justice demanding investment in basic research, even at the cost of immediate life-saving, a suggestion that is thought provoking and ethically challenging.

In Chapter 4, Luca Belelli Marchesini presents the facts about, and effects of, global warming over the past century. He is able to demonstrate scientifically how the rate of global warming is attributable to human activity, and is not just a natural occurrence. His arguments involve a discussion of the 'Anthropocene', a term attributed to Paul Crutzen that denotes a geological era in which 'human activities are significantly modifying the great natural cycles of carbon, water and nutrients, together with climate biodiversity and other properties of the state and function of the earth system." This scientific groundwork leads to discussion of political recognition of climate change within the European Union, and the targets that that organization sets to reduce carbon emissions. It is crucial, Belelli Marchesini argues, that the scientific community researching climate change should understand the roles of natural and human-caused changes to the climate, quantify the effect of human activities, and understand probable natural responses to them. He therefore spells out the research priorities for climate science, as well as urging the continuing importance for policy responses as the science becomes clearer. One of the fascinating, and testing, questions is that climate change is a global problem, and thus demands a globally coordinated response. This is true both socially, but also amongst the global scientific community, who must share their data through effective dissemination, and create networks of observation sites. Such a coordinated role for science, is not however limiting of scientific freedom; it increases it. But this freedom is only maximized and sustained if scientists recognize obligations to each other within the community, and with a shared purpose. Furthermore, political support is needed internationally. This raises difficulties where observations are required in states that are unwilling to allow scientists to come and conduct research. There is therefore a need for financial investment, political action, and the need for effective communication of the science to everyone, so that citizens and politicians can take their responsibility.

Finally, Chapter 5, by Jim Falk, suggests that a distinct geo-political context exists now, and this historical setting has important implications for discussions of concepts of scientific freedom. He begins by noting how '[s]cientific freedom is of course many things: a normative code, an objective, a central feature of a methodology, an ideology and even, at times, a rallying call.' Falk, however, would understand it as a practice of governance, found within a broader and highly complex context. That context can, for simplicity, be designated as appearing across three overlapping sectors: state, market, and civil society. Science is not an isolated, self-regarding, activity. It happens in this context, and thus scientific freedom is qualified accordingly. The network of actors implicated in the governance structures of which science forms a part, from individuals through to supranational organizations, necessarily gives a distinct content to the contemporary understanding of scientific freedom. To understand 'the relationship between the historically established concept of scientific freedom and the current struggle to shape governance to a form which will produce an adaptative future', Falk discusses the disaster at the Fukushima Daiichi nuclear power plant as a case study. His chapter demonstrates the massive range of scientists involved in the nuclear industry. It shows too how a whole range of institutions house the scientists, and potentially suggest reasons why different curbs might be placed on the views they would express. Normative objections to constraints on scientific freedom (for example, ones in favour of free expression) may founder in the face of considerations about an institution's purpose and ends. Fukushima Daiichi illustrates this well. It demonstrates how 'scientific freedom is but one strand of the broader question of nuclear and energy governance.' Good governance suggests a need for greater transparency, so outsiders can scrutinize policies. Falk therefore advances and defends the thesis that we should aspire to the (probably unreachable) ideal of 'holoreflexivity': a position that assures 'all parts of the system being able to know and reflect on the component parts, but also on the whole.' The chapter presents a strong case for the need to study questions of scientific freedom in their historical context.

So in Part One, we already find a whole range of provocative questions concerning regulation and ethics, from how effectively to engage and inform the public, to the possible roles and responsibilities of scientists. These and other themes are picked up in Part Two, 'Science and Society: Law and Regulation'. It starts with Chapter 6, by Amedeo Santosuosso. Santosuosso argues that science is intrinsically universal, yet it raises many tensions. These are in part financial. As suggested in Part One, funding is a problem, particularly in an era when many governments are slashing budgets. Also, though, intellectual property regimes raise incentives that seem anathema to free science. Tensions are also in part due to special interests based on ideologies. Against this backdrop, the chapter considers how constitutional law in various jurisdictions in Europe and North America protects scientific freedom.

Santosuosso compares two approaches: in some European jurisdictions we find an enshrined right to scientific freedom in teaching and research; by contrast, in North America we find no specific constitutional protection of scientific freedom, but some derivative protections of it through constitutional protection of free thought and expression. Regulatory protections of scientific freedom might arise in three ways, Santosuosso suggests. First, it is protected (everywhere) by generic basic protections of free expression. Second, it may receive explicit recognition (Europe). Third, it may be bolstered by the positive support of states promoting research (everywhere). The important question his chapter raises is whether the formal legal differences reflect distinctions in the normative content of laws. In Europe, the right to scientific freedom is qualified by an overarching and supreme duty to protect and respect 'human dignity'. This leads to problems given the difficulty of establishing a robust definition of human dignity and politically it leads us to the question: who gets to define dignity? He argues that even if dignity is not a constraint on scientific freedom, further tricky constraints are imposed by the 'harm principle', and notes the importance of distinguishing a lack of support of a particular branch of science through the withholding of public funds, and the prohibition (eg by criminalization) of a practice. He then moves to a discussion of the ongoing *Myriad* litigation, and the regulatory impact of intellectual property. The chapter has obvious bridges from Falk's chapter, again emphasising the relevance of the wider regulatory context, and of competing political claims other than scientific freedom.

The nature and processes of assuring and changing the regulatory context is taken up in Chapter 7 by Charles H. Baron. His arguments are informed by his personal experience in the United States, where, as elsewhere, people hold deep commitments to competing, contradictory values. He explores how scientific freedom might be maximized in this sort of context. In interesting parallels with Chapter 1, Baron considers the importance of public understanding. He advocates a position where respectful dialogue takes precedence over distrustful confrontation. This means emphasising the virtues of self-doubt, openness, recognition of people of different views as fellows in society, and of sustaining good faith in debate. Dialogue is not just about persuading others, but also understanding their views. Drawing from references to particular instances in Baron's considerable personal experience of policy, we find a clear argument in favour of a process of dialogue that seeks mutual understanding and discussion rather than hostility and mutual distrust. Baron recognizes and respects great pluralities of fundamental views, and the role of the law given them. He also speaks to the real politics of policy-making: legislators want to be re-elected, and will appeal to polarising issues to achieve this, bringing out otherwise lethargic voters. He argues that we should note too, therefore, the power of the courts as a means to change the law or secure people's freedoms. Amongst other things, judges do not suffer concerns about re-election. Furthermore, law reform litigation can raise public awareness. However, Baron cautions against too strong a role being given to courts, citing the famous case of *Roe* v *Wade*. The effect of this case on public debates on abortion, he argues, demonstrate why courts should not 'overuse' constitutional principles to achieve controversial ends, or their doing so will vex the public and stifle meaningful, constructive dialogue. The chapter offers carefully considered insights into the need to be strategic when urging law reform, and to remember that short term victories can have a negative long term cost if they mean problematic polarization amongst a people.

In Chapter 8, Sarah Devaney introduces a distinct perspective on the regulation of science, and the legitimacy of scientific freedom. Like earlier authors, she notes the tensions in the positive claims that may be inherent in a concept of scientific freedom; namely, the need for positive protections of the conditions in which research can be conducted, and access to the means to conduct research. Devaney's argument is an exploration of an interesting problem from the perspectives of law and justice. She considers whether individual contributors to scientific research, parties needed to allow research to happen, are due recompense. The case study she employs is of contributors to stem-cell science; specifically women who make their ova available for stem-cell research. Stem cell science, of course, can not happen without contributions of tissue samples. Devaney suggests that contributors are justifiably due payment, and that existing legal barriers to this should be removed. Her position is not that regulation is unnecessary, but that it should serve to enhance the freedom and claims in fairness of the women, rather than crush their freedoms and (moral) rights. She addresses commonly raised concerns, such as worries about exploitation, but notes that proper regulation can overcome these without problem. Her chapter draws out the important point that whilst scientific research is important, people have important rights that will not justifiably be overridden simply because of the goods that science leads to. Justice and good regulation allow the distinct interests to be harmonized.

In Chapter 9, Dick Taverne discusses the threat that dogma poses to science. Historically, he argues, the dogma have come from religion. The last century has seen it come from political ideology. To begin with, he accepts that generally scientists have great freedom today, and science flourishes more than ever. But there are some *areas* of science that are beset by problems based in ideology. The most problematic anti-science dogma of the moment, Taverne suggests, is 'eco-fundamentalism'. His reference to fundamentalism is sustainable because some of the anti-GM movement are fundamentalist, in the sense that no amount of evidence will shake their views on the harms and dangers of genetically modified crops. Following some factual detail about GM, he shows that eco-fundamentalism impinges on scientific freedom in various ways. First, it does so through violence and intimidation. Taverne's sentiment is strong: 'These vandals are the modern equivalent of book burners'. Second, there is the effect of finance: products made from GM crops can not be commercialized in the European Union. Globally, this causes considerable harm, though perhaps that is not a sufficiently pressing concern for rich, well-fed Europe. The third problem is that research on GM is inhibited by over-regulation. Particular problems arise with the risk-aversion dictated by the quasi 'eleventh commandment' that is the precautionary principle. Taverne sees the problems as existing on a two way street. He voices concern too at dogma in favour of suppression of voices expressing scepticism of climate change. Tolerance is vitally important in a liberal democracy, and must work both ways.

In Chapter 10, the final chapter of Part Two, Emma Bonino and Simona Giordano discuss the politics surrounding claims for and against greater or better supported scientific freedom, and issues about making progress and achieving compromises. Their arguments focus on embryonic stem cell research and cell nuclear transfer research, matters on which there is apparently intractable moral disagreement. But rather than rehearse the ethical arguments, their focus is on the nature of political decision-making in the EU context, including on the funding of controversial research. Bonino and Giordano start by asserting that science is a fundamental good, and that scientific research is protected by justiciable rights entrenched across legal systems. Yet they note too that some research proves highly controversial, particularly where it is seen (by some protagonists in the debate) to threaten 'human nature' or the environment. They also reaffirm the importance of ethical structures constraining scientists' freedom, and note how these serve further to enhance human rights. However, echoing concerns raised earlier in the book, they consider it important to distinguish genuine and meaningful concern about people, which provides reasoned grounds for limiting scientific freedom, and ideology, which does not. Within a political and regulatory system, a crucial role of political leaders is to ensure clear understanding of the science, especially where controversy arises. The bottom line for politicians is not an ideology, but the good of the people. In this sense, it is vital to recognize the strength and importance of political compromise, even when the final position seems not to accord with the logic of the views of participants of either 'side' of particular debates. Politics, especially in a liberal democracy, provides the basis for recognising pluralism, yet also puts constraints on what people can do notwithstanding their plural positions. In such a system, part of the politicians' role is not to let ideology (even their own) stand in the way of benefits to others. Another part, again as emphasized in other chapters, is the duty to ensure sound and balanced communication of the issues to the people. This applies as much to eradicating misinformation or unrealistic hopes about the benefits of science as it does to eradicating bogus or irrelevant ideological arguments against science. As Bonino and Giordano's case-study shows, a crucial part of this political process involves bringing in a great range of 'stakeholders' – including patients, scientists, politicians, ordinary citizens – and ensuring that their voices are heard.

Part Three of the book, 'Science, Ethics, and the Politics of Scientific Research', develops the regulatory, contextual, and ethical arguments that are raised earlier in the book, and places them in frames of moral and political philosophy. In Chapter 11, Gilberto Corbellini and Elisabetta Sirgiovanni address a theme that is raised but not so systematically explored in earlier chapters: the relationship between science and democracy. They begin by describing the ways that science is portrayed as an affront to democracy, caricatured as the struggle between the expert and the common man. They detect a sense that since the 1960s across the Western world science has been cast as a threat to democracy. However, in response to this position, they aim to show that science is essential to democracy. To do so, they employ the case study of Italy, where they show considerable resistance to scientific freedom through institutional and political interference. Problems come for scientists trying to communicate the value of scientific freedom from relativistic positions (there is no truth, *ergo* there is no scientific truth) and from contraposed dogma (eg religious claims that some activity will offend God). Studying the weakness of science's position in Italy requires recognition of multi-factorial causes, including a historical lack of cohesion of the scientific community, political and legislative interference, lack of transparency, nepotism, and decreasing quality amongst the national, political and intellectual elites. Specific instances are given to reinforce the arguments. In particular, a conspiracy of influence from the Vatican and widespread scientific illiteracy have proven problematic for scientific freedom. Public engagement is a crucial part of the process in which scientific freedom can be assured. Corbellini and Sirgiovanni demonstrate, in rebuttal of those who see a tension between science and democracy, that there was a causal relationship between the rise of modern science and the rise of modern democracy. Furthermore, scientific understanding allows us to understand the function of our brains, how we have evolved, the effects of our brains' functions on our rationality, and the inherent biases they give rise to. Educating people to be able to think scientifically helps them understand the world, and combine normative and empirical approaches rationally. They conclude: 'Science provides individuals with autonomy, self-determination and critical thought, which are the basis for protecting democratic thought and political pluralism. And this is exactly what we mean when we say that freedom of science *means*, rather than threatens, democratization.'

Chapter 12, by Søren Holm, stands in interesting contrast. Whilst some chapters in this book suggest reason to be cautious, or even cynical, of the strength and legitimacy of religious reasoning where it bears on the practical freedom enjoyed by scientists, Holm mounts a forceful defence of the protections due to alternative liberties to scientific freedom. He specifically defends protections of religious freedom within secular democracies. His is not a defence of the position that religion should alone determine science policy, but the more modest claim that it has a legitimate *role* in determining it. And whilst issues such as stem-cell research suggest (from advocates of greater scientific freedom's perspective) that the influence of religion on science policy is unwelcome, we can also find examples where religious leaders positively advance the cause of scientific inquiry. To understand and evaluate the competing claims that may be under issue, Holm examines justifications of scientific freedom, and their implications for the legitimate scope of scientific freedom. First, we need to distinguish negative and positive scientific freedom. The former denotes freedom to be left alone, the latter entails positive claims for material support for scientific activity. Unlike some negative freedoms, Holm argues, scientific freedom is extremely important, and thus worthy of special protection. Nevertheless, where it clashes with other special freedoms, it will sometimes have to yield. Likewise, the grounding of positive scientific freedom is also found in the intrinsic and instrumental values of science, and again is subject to limits. But of course, without more we can accept that competing values will limit scientific freedom without taking it that religious values can. So he continues his argument by taking as his context a real-world democratic system (i.e. not some idealized abstraction such as we find in Rawlsian or Habermasian philosophy). Holm argues that it is not possible coherently to rule out one sort of comprehensive world view that provides positive arguments in policy (religion) without also excluding others. This suggests that we should after all let religious ones remain, just as we do others. Otherwise we end up in a very limited political system where few positive protections and rights exist. Nothing other than self-identification as religious worldviews provides a relevant commonality to religious worldviews, or relevantly distinguishes them from other comprehensive worldviews that do have standing. As long as democratic societies exist in the non-ideal frame, pressure groups have a legitimate role. Again, there is nothing that singles out religious pressure groups suggesting they should get special (negative) treatment.

In Chapter 13, Malcolm Oswald emphasizes the positive claims intrinsic to full scientific freedom. Being left alone is not always enough to allow scientific inquiry, and thus competition will arise for finite resources. Oswald suggests that scientific knowledge is, in economists' terms, a durable public good. Because of the need for money, and the incentives at play, a range of factors interfere with the purity of scientific freedom. Real world limitations of many varieties serve as partial bars to scientific freedom, and that should be taken as a given. However within real world constraints, he asks, should we seek to maximise scientific freedom? He considers arguments for funding to be allocated according to the wisdom of a body of scientists, rather than a political body, for what Braben labels 'transformational research'. It is demonstrable that basic research contributes to economic development: scientific freedom contributes to prosperity. However, as seen above, it is also controversial to divert funds to 'blue skies research'. Oswald makes clear why this is the case. Cost benefit analysis raises problems for allocating funds to basic research, given that they could go elsewhere, especially where the goal of the research is knowledge: there are no guarantees that knowledge will result; it is hard to value the knowledge, especially in advance; and given conditions of scientific freedom, it will be hard to know a lot about the nature of the knowledge the scientists are pursuing. So, asking public bodies to allocate funding, essentially in blind faith, to exceptional scientists presents real problems. Oswald notes various reasons to suggest ethical side-constraints on scientific freedom, especially harm to others reasons, and competing claims for public money. Even scientific self-regulation may be a bad idea, depending on matters such as public distrust. Nevertheless, the benefits of science should not be overlooked, even as we acknowledge that limits should be put on scientific freedom. Oswald urges that there are good arguments in favour of allowing exceptional scientists considerable latitude and support in their endeavours.

Chapter 14, by Michael Boylan, explores what limits may ethically be put on scientific freedom by combined reference to recent historical examples and the principle of plenitude. This principle, attributed to Lovejoy, holds that 'what can be known, should be known'. In line with other contributors to the book, Boylan quickly accepts that of course there should be limits to the exercise of scientific freedom, to the principle of plenitude. He suggests that there are two qualitatively distinct bases of side-constraints on science. The first exists where the means of acquiring knowledge would be unethical, the second where the context in which the knowledge will exist is itself immoral. On the first, Boylan makes two further distinctions. On one hand, we find things that right now can only be achieved by immoral means, but given means that are currently unavailable would be perfectly acceptable. For these, the limits to scientific freedom are not absolute, but rather contingent on practical possibility given background side-constraints. On the other hand, Boylan argues that some things are in principle just wrong. In this regard, the problem is not that we currently lack the means to conduct the research ethically, but that the research could *never* be ethically sound. Having illustrated well these differences, he then moves to the (perhaps more controversial) discussion of limits to scientific freedom given the context in which information will come to exist and be used. In possible contrast with some earlier contributors, he argues that scientists can not plead irresponsibility for the foreseeable outcomes or applications of their science. Awareness of the context in which the science is undertaken requires responsibility for the work in that context and its consequences. Boylan's use of a range of real examples, both past and contemporary, demonstrates clearly the different categories of ethical concern represented in claims to scientific freedom. He provides some arguments too in relation to the role of regulatory reasoning, with specific reference to people serving as physicians and researchers, and asking whether these roles should not be simultaneously held by the same person.

In Chapter 15, John Coggon ends Part Three with an argument that considers scientific freedom as a 'claim to the protection or assurance of the conditions in which scientific inquiry may be undertaken.' This definition combines the negative and positive freedoms alluded to in earlier chapters. Coggon's analysis begins with science understood on its own terms, suggesting that a free scientist properly understood is not anarchic: science dictates its own norms. However if we look outside of science, is it always supreme? Again echoing earlier chapters, the answer is clearly no and in tension with some earlier claims, Coggon expresses doubts about how useful or meaningful it is to separate categorically science and consequent technologies, or contemporary or consequent applications. If science is good in the sense that it demands positive measures to protect and support it, this is largely down to its consequences.

A protagonist can not claim the good without also taking responsibility for the bad. Nevertheless, scientific freedom may be conceived as special, and requiring protection, insofar as the public interest permits and demands. The question then is: do legal systems with no specifically enumerated right to scientific freedom automatically fail in best protecting scientific freedom? This question is usefully asked in the context of politically ordered human societies that present moral pluralism. Coggon's answer is that it is not a weakness not to have an enshrined right to scientific freedom. Rather, he suggests that even in a system that works on the idea that different basic freedoms are offered protection, albeit in 'competition' with each other, it is arguable that scientific freedom is better protected as derivative in different instances from other more fundamental rights. 'Science' denotes such varied things that a unitary 'right to scientific freedom' may limit or circumscribe scientific inquiry in so narrow a way that it would diminish overall the protection of science. From a practical perspective, the abstract concept 'scientific freedom' can not denote a consistently or universally supreme value. We therefore need to be able to defend particular instances on a case-by-case basis.

Synergies, tensions, and the road ahead

In the volume's concluding chapter, we describe how the project that gave rise to this anthology all started with a marathon. That provides a good metaphor too for the nature of inquiry undertaken in this book, and the future debate it might provoke. The great variety of perspectives and experience represented by the contributors suggests that the directions of the road ahead may be unclear, and that there is a long way yet to travel. A clear advantage of drawing from a wide range of disciplinary and professional outlooks, and drawing from an international authorship, is that we find a clear presentation both of synergies and tensions in thought on scientific freedom. In this final brief section, we will mention five points that seem particularly to stand out when reading this collection.

First, it is interesting to compare the arguments of authors who would distinguish science and technology, and those who see the divide as formally valid but practically not so useful. In arguments directed to the maximization of scientific freedom, it is clear that this division can have both positive and negative effects. On the positive side, it suggests the legitimacy of very few restraints on scientists' freedom, provided we allow that as soon as science is 'done' – that experiments are performed – the likelihood of ethical concerns appears. On the negative side, by separating science from its consequences, we deny the positive value that these add to the worth of science.

Second, a recurring point is that claims to scientific freedom often entail both 'negative' and 'positive' rights. Although it is not hard to frame arguments that people should be left alone to do as they wish, provided they harm no-one else, it is much more complicated to develop an argument that places positive demands on others. Why should any of us pay taxes to fund 'blue skies research' in astrophysics? Or support a government that funds research that we consider to be intrinsically immoral? As soon as the claims to scientific freedom become positive ones, protagonists must open up arguments in moral and political philosophy, and be able to defend their claims against competing positions.

Third, the related themes of democracy and sound communication are striking. The 'scientific literacy' of the public seems to be of crucial importance, but so is the willingness of scientists to frame their ideas in ways that make them accessible to as broad an audience as possible. There seems to be general acceptance of the idea that where science is to be limited, this is in accordance with justifiable political limits. In a political democracy, this means accountability to the people, and requires the possibility of discourse across society. Contributors have emphasized the need to be able to communicate both to those who are (as yet) uninformed about issues, as well as to those who are informed but fundamentally opposed.

Fourth is a brief but important point. Science is a global phenomenon. The scientific community is not defined by membership of a nation state. There are clear benefits to cross-national collaborations and communications. Furthermore, some of the problems that we would wish science to address, perhaps most pressingly climate change, require international cooperation from governments as well as scientists.

Finally, many of the chapters suggest an importance in contextualising analyses of scientific freedom. This means being able to explain and defend the very defining of 'relevant context', and being prepared to give reasons for why a principled view is pertinent. The contexts here may be, for example, historical, social or regulatory. Combinations too can fruitfully exist, and perhaps reaffirm the great merit in drawing collaborators from a range of disciplines, backgrounds, and parts of the world.

In sum, it is our view that the subject of scientific freedom is of such importance that there is considerable value in public discussion of how it should be defined, assured, and limited. We hope that the following chapters contribute well to the sometimes heated debates on these questions.

PART ONE

Understanding Science and Technology

1

Can Research Be Forbidden?

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When I agreed to speak in Rome at the 2006 World Congress for Scientific Freedom on the topic 'Can research be forbidden?' I did know that Lewis Wolpert would speak before me. This led me to focus on a more personal aspect of my assigned topic because I more or less knew what his opinion would be and that I was likely to agree with his conclusions. I was sure that he would take care of logical arguments – flavoring them with the humor and emotion that I would not employ – concerning the common confusion between science and technology and the impossibility of forbidding scientific research, since that would be equivalent to banning human curiosity. Moreover, in basic scientific research one never knows what to forbid until it has actually been discovered. If one knew the answer ahead of time, he or she would not be doing research in science but in something else which may also be reasonable and even intellectually satisfying but something that is not basic research.

Since Wolpert's chapter in this volume, as well as other contributions, cover these points, I shall start with an example from my own research – the development of oral contraceptives, with its components of basic research and subsequent applied technology – and then switch to the relationship between reproduction and sex and the impact of medically assisted fertilization on the consequent separation of coitus and reproduction. However, the manner in which I will present my conclusions will differ in one major respect from that of all of the other contributors to this volume. Over the last two decades, I switched my mode of communication from the standard academic discourse of scientists to fiction and, more recently, to play-writing. Readers may well wonder why a chemist would wish to write novels and plays. Quite simply, I wanted to become an 'intellectual smuggler.' I am interested in smuggling ideas, which I consider important, into the mind of a public that either does not know about these issues or does not wish to listen to them. So writing a standard scientific article, or giving a standard lecture, is really useless as far as the public that I wish to influence is concerned. People who go to such lectures or read such articles or chapters are already engaged in the topic. I want to engage the huge numbers who do not go to lectures or read academic articles or are even afraid of them. Smuggling important ideas into their minds in the guise of fiction (using 'science-in-fiction' rather than science fiction) or through the medium of the theatre ('science-in-theatre') interests me greatly. Since, during the past dozen years, I have focused especially on the theatre, I shall end my chapter with relevant excerpts from two of my plays.

Let me start with one very important point. Certain circles, notably in Europe and the United States, now exert open pressure to forbid some kinds of research – with stem cells, cloning and genetic engineering of foods being typical examples – because they fear that such technological advances will deleteriously affect their current life style and values. Note that I speak about 'technology' since it is the application of research. It is technology, and not basic research *per se* (i.e. the search for new knowledge), that will impact on our lives, although, as Piccirillo[1] points out in this volume, basic research *per se* may also affect our lives rather directly, due to issues of resource allocation.

The fact that new technology frequently has an enormous impact on everyday life is, of course, true as demonstrated by the introduction of the computer or cell phones. But few seem to consider the opposite argument: that at times, it is social changes that create the demand for new technologies or make possible their rapid adoption. If such new technology is desired because of social changes but is not yet available, then societal pressure is exerted for doing the necessary research to eventually enable such technology to be exploited. In my opinion, sex and reproduction are excellent examples of this.

Sex and reproduction as relevant examples

Following this preamble, I am now ready to start with the contraceptive pill. Most people, when learning that I had something to do with its invention, say, 'How do you feel about causing the sexual revolution of the 1960s?'

I would first qualify my answer by stating that I was associated with the first chemical synthesis of an oral contraceptive and not with the biology and subsequent clinical testing. Of course, it all had to start with chemistry since, without the actual chemical substance, no biological or subsequent clinical research could have been conducted. However, if I really have contributed to the sexual revolution, I would say that I am pleased but was the pill really the causative factor of the sexual revolution as so many insist? What really happened in the 1960s?

In that decade, four movements simultaneously flowered in the United States: drug abuse, hippie culture, the rock and roll music scene and, most importantly, the women's movement. All four of them were different, yet all involved some sort of sexual liberation, if not increased promiscuity. What the pill did was to remove the fear of unwanted pregnancy. If social mores are simply to be maintained through the fear of pregnancy rather than through some fundamental teaching of morality, then such mores are not worth maintaining. In other words, the pill greatly facilitated the sexual revolution, but the conditions for its use were ripe through the concurrent rise of these four social developments that had nothing to do with the actual technology of oral contraception.[2]

In fact, I have specifically raised[3] the 'what if' question: if the pill had never been discovered, what would sex have been like in the year 2000? In my opinion, sexual behavior would not have been different in the period 1970 to 1985 prior to the AIDS explosion and the increasing concern about sexually transmitted diseases. What would have been different in the 1960s and 1970s, when abortion was still illegal in most countries, is that there would have been hundreds of thousands of illegal abortions. Preventing them was clearly one of the benefits of the pill, in addition to offering women the ability to control their own fertility in private by deciding whether and when to become pregnant. Some people claim that the pill was one of the worst things ever discovered.[4] I obviously don't believe that, and if I had to live my life over again, I would have done it in the same way with only one difference: encouraging the clinicians to have women be much more involved in the decision-making process at the very outset of the clinical studies. Their sidelining was largely due to cultural factors; at that time, particularly in the medical establishment, phallocentricity reigned – with most obstetricians and gynaecologists having been men.

Sex and reproduction were always linked throughout human history. It is not surprising that scientists in the late nineteenth and early twentieth centuries focused on endocrinology, on sex hormones, and really on how the entire human sexual reproduction process worked. In the 1920s, a physiologist in Catholic Austria, Ludwig Haberlandt, was the first[5] to explicitly recognize that the female sex hormone progesterone is nature's contraceptive: women do not become pregnant during pregnancy. Why? Because that is the only time when women produce progesterone all the time. Already in the 1920s, Haberlandt suggested that a progesterone pill be used for oral contraception in women.[6]

However since at that time progesterone had not yet been isolated or synthesized, he used glandular extracts containing progesterone and even coined a commercial name: Infecundin,[7] but he died too early (1932) to pursue these plans – actually through suicide prompted by the relentless critique to which he was subjected in conservative Catholic Austria.[8]

A couple of years later, the structure of progesterone was established by chemists in Germany and then made available through synthesis. By the end of the 1930s, progesterone had already entered medical practice for the treatment of menstrual disorders and infertility, since there are women who can become pregnant but cannot carry the pregnancy to term because they do not produce enough progesterone to maintain the proper endometrial environment for the continuing development of the fetus. Even if Haberlandt had lived to pursue the contraceptive applications he predicted, he would have found that they would not have worked since progesterone is not orally active. Hence the medical uses of progesterone that I just mentioned were all implemented by injection; and daily injections for contraceptive purposes would have been totally impractical.

Nearly twenty years after Haberlandt's death, in 1950, I was associate director for chemical research at Syntex, a small pharmaceutical company in Mexico City that was interested in developing new proprietary drugs related to steroids. One of the research topics we selected was the attempted synthesis of a steroid which does not exist in nature but which would mimic the biological properties of progesterone and be orally active. We accomplished that aim on 15 October 1951 by synthesizing a substance, norethindrone, which was more active than natural progesterone, yet effective by mouth.[9]

Why would one even think of prospectively forbidding such research, research that led to approval by the Food and Drug Administration (FDA) in the United States in 1957 of norethindrone for the oral treatment of menstrual disorders and the oral treatment of infertility? Or possibly even applicable to the treatment of cervical cancer – a possibility then under investigation? The answer is both obvious and foolish. Because norethindrone was subsequently also found to be the answer to Ludwig Haberlandt's dream of a contraceptive pill based on the properties of natural progesterone, and critics condemning such use wished that this Pandora's box would never be opened through the type of research we as chemists, and subsequently biologists and clinicians like Gregory Pincus[10] and John Rock[11] performed.

FDA approval for extending the use of such synthetic steroids to oral contraception occurred in 1960 and within a couple of years two million American women were already using this method of birth control – a figure that no drug company or physician anticipated. It was primarily the desire of women to accept such a birth control method separated from the coital act rather than the companies' marketing skills that led to such a rapid rise in oral contraceptive consumers by the mid 1960s; a figure that has now reached the 100 million mark worldwide, with the pill being the most popular method of birth control in over seventy countries. Space limits do not permit me to delve into further aspects of the pill which I have covered in great detail in three books.[12,13,14]

The divorce of sex from reproduction

I would now like to pursue a related topic that is currently the focus of my lectures and writing: the impending separation of sex and reproduction. Sex in the usual places and as usual motivated by love, fun, lust, or curiosity, but reproduction planned and, even more significantly, increasingly dependent on assisted reproductive technologies 'under the microscope.' The *de facto* separation of sex and reproduction is most dramatically illustrated by Catholic countries like

Spain or Italy where the average family now has 1.1 to 1.2 children. Surely many Spaniards or Italians have sex hundreds of times after they have had that small number of children without any intention of increasing the size of their family. The reasons have very little to do with the pill as demonstrated by the fact that the situation is not much better in Japan, where the pill was only legalized in 1999[15], but rather with social, cultural and especially economic factors. Still, fertile people resort to ordinary unprotected intercourse to eventually have the one or two children that are now so common in these countries, but what of the total separation between coitus and fertilization, namely fertilization that takes place not in the bedroom but rather under the microscope in the absence of sexual intercourse?

This was realized in 1977 through the invention of in vitro fertilization (IVF) by Edwards and Steptoe in the United Kingdom and belatedly recognized by a Nobel Prize in 2010. As a consequence, during the past three decades, three or more million births have occurred without sexual intercourse to parents with impaired fertility. The proposition I would like to raise is that, in the future, increasing numbers of fertile people will resort to this approach and that this will be especially facilitated through an IVF procedure called ICSI (intracytoplasmic sperm injection) that was invented in 1991 by a group of Belgian researchers headed by André van Steirteghem.[16]

Science-in-theatre as a means of information transmittal

Instead of continuing in my present mode, let me now illustrate how I have smuggled this issue into the awareness of a general public through my play, *An Immaculate Misconception*.[17]

This title is not translatable into any other language. Only in English does 'misconception' mean misconception as well as 'misunderstanding'. I emphasize this point because I do not want people to think that my title is meant as a blasphemous allusion to the religious concept of the 'Immaculate Conception' but how did I explain the meaning and mode of operation of ICSI in a theatre play? Let me illustrate this through excerpts from two scenes between 'Melanie' (a reproductive biologist who in my play is the inventor of ICSI) and 'Felix' (a medical colleague whom she wishes to enlist as a collaborator).

FELIX: *You said it was hot stuff.*

MELANIE: *It is.*

FELIX: *So let's hear it.*

MELANIE: *I finally managed to work it all out in hamsters.*

FELIX: *What's next?*

MELANIE (*triumphantly*): *Fertilize a human egg! Just think of it: by directly injecting a single sperm!*

FELIX: *Intracytoplasmic… sperm… injection.*

MELANIE: *Exactly! (Spells it out slowly): I…C…S…I… (Then quickly, as one word): ICSI. And if it works, that acronym will be in the next edition of Webster's Dictionary!*

FELIX: *ICSI even sounds like a kid's name… something that my patients can identify with. (Pause). If they knew what you were up to in here… they'd be breaking down your door. Men with sperm counts so low they can never become biological fathers in the usual way. They won't care if egg penetration is performed under a microscope or in bed… just so it's their own sperm.*

MELANIE: *Frankly, I was thinking of women… specifically this one.*

FELIX: *I can understand that. You'll be famous… world-famous… if a normal baby is born through ICSI. So far, of course, a big if!*

MELANIE: *Then forget about fame. What about ICSI and motherhood?*

Now that I have explained what the acronym ICSI stands for, let me illustrate through another brief excerpt from my play what this method represents operationally.

MELANIE (*bends over microscope*): *We've got seven first-class eggs harvested – all from the same woman. Let's see how I do with the first couple of eggs. If everything works out, I'll let you do the next two. I'll then finish with the rest. Here we go. Felix… would you start the VCR? I want you to follow on the monitor what I'm doing here under the microscope.*

(Felix pushes the button and turns toward the screen. Both are completely silent as the screen lights up. Melanie is hunched over the microscope, both hands manipulating the joysticks on each side of the microscope).

MELANIE: *Ah… here we are. (Startled). God, this sperm is low-grade stuff. But these two are swimming – a good sign….*

FELIX (*with sarcasm*): *Great… two real machos…*

MELANIE: *With my ICSI, I need only one…. But first I've got to crush its tail so the sperm can't get away… (Quickly moves pipette toward sperm and sounds jubilant as the injection pipette crushes the sperm's tail). Gotcha!*

FELIX: *Ouch! Be careful! I bet you hurt him!*

MELANIE: *That's what you think! Sperm have no feeling. Now comes the tricky part. I've got to aspirate its tail first…. As soon as I get close enough, just a little suction will do the trick…. (Screen image displays the sperm, tail first, being sucked into the pipette). Hah! Gotcha!*

FELIX: *Not bad! Not bad at all.*
(Silence for a few seconds until image of egg appears)

MELANIE: *Here we are. Isn't she gorgeous? Just look at her… my precious beauty… now stay still while I arrange you a bit… while I clasp you on my suction pipette… (Egg on screen is now immobilized in precisely the desired position for the penetration). Felix, now cross your fingers.*
(He leans forward, clearly fascinated. Injection pipette containing sperm appears on image but pipette remains immobile.)

FELIX: *Just push the capillary in!*

MELANIE: *It's just doing the very first human ICSI experiment with this sperm into… this egg…*
(Melanie lets out audible gasp of relief as pipette penetrates the egg).

FELIX: *(Makes sudden start, as if he had been pricked): My God! You did it! Superb penetration! (Image shows pipette resting within egg). Now shoot him out! (Points to sperm head in pipette).*

MELANIE: *Here we go. (Image shows sperm head at the very end of the injection pipette emerging on the screen from the pipette into the egg cytoplasm). Ah, that's a good boy. (Carefully withdraws pipette).*

FELIX (*excited*): *You did it, Melanie! Look at him… just look at him! Sitting in there. (Approaches image and points to sperm head on screen. Calmer voice). It's amazing. That egg looks… what shall I say? Inviolate, almost virginal.*

MELANIE (*looks up for first time from microscope*): *It better not be... I violated it very consciously and tomorrow I expect to see cell division…. Felix (points to VCR), turn off the VCR.*
(He does so).

FELIX (*turns accusatory*): *But Melanie, whose crummy sperm are you using here? They were barely moving…. You could hardly have chosen worse.*

MELANIE (*bantering*): *I could have picked sperm from a dead man.*

FELIX: *Are you implying that ICSI could be used with such sperm? Or are you just joking?*

MELANIE: *Just speculating. If the sperm from a dead fertile man is aspirated within a few hours post mortem… maybe even after 24 hours… just so we still have some twitching sperm... one could preserve such semen for months, if not years and then still use it for ICSI.*

FELIX: *And you think that's okay?*

MELANIE: *You asked whether ICSI fertilization with the sperm of a recently deceased man were possible and I said, yes. You didn't ask whether it was OK.*

FELIX: *I am asking now! Would you use a dead man's sperm and, I suppose, a frozen egg of a deceased woman to generate instant orphans?*

MELANIE: *No… I wouldn't go that far.*

FELIX: *But somebody else might.*

MELANIE: *Kids need at least one parent… preferably two.*

FELIX (*ironic*): *I'm relieved to hear that. (Pause). So who is the father?*

MELANIE: *There isn't any father in the usual sense of the word.*

FELIX: *An immaculate conception?*

MELANIE: *You know… in a way that's true. There was no penetration of the woman, no sexual contact. In fact, at that moment, there was no woman, no vagina… nor a man (pause)… The only prick (pause)… was the gentle one by a tiny needle entering an egg in a dish, delivering a single sperm. (Laughs). Even that prick was provided by a woman. (Pause). If this ICSI injection works… and we'll find this out in a couple of days… I want you to take the developing embryo, insert it into a woman… and then treat her kindly for the next 8 or 9 months until delivery of the baby.*

FELIX: *Where did this egg come from?*

MELANIE: *From me.*

FELIX: *What? Experiment on yourself?*

MELANIE: *Why not? It's not as if there isn't a tradition of self - experimentation in medicine.*

Clearly, this mode of presentation works. Since its premiere in 1998 my play has been translated into twelve languages as well as broadcast by the BBC (world service), WDR (Germany), NPR (USA) and the Swedish and Czech radio. While *An Immaculate Misconception* has not yet been translated into Italian, a pedagogic wordplay I wrote subsequently on this subject for use in schools has been[18][15] together with a CD containing the just described ICSI injection. In 2004, this wordplay was presented by some Italian students at the Italian Science Festival in Genoa.

ICSI was invented in 1991 in Belgium for the treatment of male infertility associated with oligospermia (insufficient number of sperm) by the direct injection of a single sperm into an egg. Since 1991, it is estimated that 350,000 or more ICSI babies have been born throughout the world. Clearly the genie is out of the bottle and it is thus patent nonsense to attempt to forbid this in some countries, since it would simply breed medical tourism and thus reinforce the disparity between the rich, who can afford such reproductive travel, and the poor who cannot. Of course, the treatment of infertility in general may be an appropriate question for ethical debate: should one consider infertility a disease that merits treatment? Many societies have answered that question in the affirmative and the National Health Service in the United Kingdom even covers such treatment under its national health insurance. Yet one could argue that such treatment transcends evolutionary barriers that took hundred of thousands of years to create, and for very good reasons, but that fundamental ethical issue is beyond the much narrower focus of my current chapter and I shall not discuss it further.

Some of the uses of ICSI raise ethical questions that go way beyond the fairly straight forward one of whether infertility should be treated. An example is cited in the above play excerpt by referring to the possibility of using the sperm of a recently deceased man. In point of fact, this is not just a possibility but has actually been realized a number of times in recent years. It is only one step beyond the much more common occurrence of storing a man's sperm for months or years and then using it for artificial insemination even after the donor's death with his written permission. Should this be legally forbidden or left to individual choice? If that choice were available during the Second World War, is it not likely that many married soldiers would have elected to preserve their sperm as a form of reproductive insurance in case of death and should this be prohibited to his widow?

If such stored sperm came from a fertile man, it would not be necessary to use ICSI for the artificial insemination. Now let us proceed one step further and examine the question of sex predetermination. Here ICSI would be needed because only one sperm is used. The sex of the offspring is always controlled by the sperm, with a Y chromosome-containing sperm leading to a boy and an X chromosome sperm to a girl. The fundamental research in this field, notably the separation of X and Y sperm by flow cytometry, was performed in the cattle industry where the exclusive generation of either females (dairy industry) or males (beef cattle industry) is associated with economic rather than ethical issues. I doubt whether there was any clamor to prohibit this type of animal research, but the technology is equally applicable to humans, and here we can easily visualize horror scenarios if this approach were to be used on a large scale in countries such as China or India where cultural factors would lead to a predominance of male babies with horrendous consequences. So what about the family that has three girls or three boys and only tries for another child because they wish for at least one of the opposite sex? Should such a technological application be prohibited? These issues have been covered in ethics literature.[19,20,21,22]

Another case history from science-in-theatre

Here is an example of how sex predetermination was handled in another play of mine[23] that deals predominantly with some of the contentious ethical problems raised by assisted reproductive techniques. The speakers are Harriet, a physician who became pregnant by ICSI and donated some of the excess embryos to Cameron, a devout (and fundamentalist) Christian. Priscilla, Cameron's wife, is infertile and hence needed a surrogate embryo in order to give birth to a child of her own.

CAMERON: *How do you know they'll both be sons?*

HARRIET: *Because I wanted mine to be a son.*

CAMERON: *But that's no guarantee. God decides what we get and we'll be grateful for whatever blessing He bestows.*

HARRIET: *Cam, I don't want to argue religion with you. This is biology. (Beat). We used ICSI for the fertilization, right?*

CAMERON: *Right.*

HARRIET: *Injecting one sperm into each egg, right?*

CAMERON: *Right.*

HARRIET: *The sex of the child is always controlled by the sperm. A Y chromosome-bearing sperm leads to a boy, an X chromosome-bearing sperm to a girl. I'm sure you learned that in high school – even in Mississippi.*

CAMERON: *So what are you telling me?*

HARRIET: *That the technology… it's called flow cytometry… has now been developed to separate X – from Y – sperm –*

CAMERON (*taken aback*): *And you used separated sperm?*

HARRIET: *Yes.*

CAMERON: *And you didn't tell me?*

HARRIET: *That wasn't part of the bargain. You wanted to have a child with your wife. There weren't any more eggs of mine left for new ICSI injections. I was generous enough to give you the remaining embryos and all of those were potential males.*

CAMERON: *Jeez!*

HARRIET: *Cam, stop using that word. It's driving me crazy. And what's wrong with your having a boy?*

CAMERON: *Nothing.*

HARRIET: *You see!*

CAMERON: *But picking the sex of the child is so…*

HARRIET: *Don't tell me… unnatural.*

CAMERON: *Unnatural, yes.*

HARRIET: *And you think ICSI is natural? Most of modern medicine is full of interventions and materials that cannot be found in nature. You think 'unnatural' is automatically 'unethical?' (He falls silent). But I wanted to talk about something else.*

Perhaps the most interesting application of IVF may occur in the near future among more affluent and highly educated fertile women who postpone childbearing until their late thirties or early forties. Such women are not prepared to make an earlier decision between profession and childbirth, an option that women never had before because they were not allowed to exercise it. Now when all kinds of professional opportunities are open to them, they would like to have these choices as a question of elementary equity for women. Many of the more worrisome applications of ICSI have become women's issues even though the invention of ICSI was initially aimed at men's infertility. However, all too often these women forget that by their late thirties, 90 to 95 per cent of their eggs are already gone, the remaining rapidly aging eggs then being associated with impaired fertility as well as genetic problems in their offspring (for example, greatly increased incidence of Down's syndrome). Since in IVF, and especially with ICSI, several eggs are fertilized, it is possible to screen through pre-implantation genetic analysis of a three-day embryo containing sixteen cells for mutations that hitherto were only detected by amniocentesis in the twelth week of pregnancy with abortion then being the only resort. Again quoting from my play, TABOOS, here is the dramatic equivalent of the above factual information:

SALLY: *So you want a baby?*

HARRIET: *You really want to know? I'd like to start the procedure soon.*

SALLY: *How soon?*

HARRIET: *Well it's going to take at least two months' preparation because I'd like to use IVF. I just need to see how the superovulation will go. I'm now 37. Not too old to have a baby provided I'm fertile… but old enough to take precautions.*

SALLY: *You mean amniocentesis?*

HARRIET: *No… I don't want to take that route. Then… if anything is wrong… abortion would be the only alternative, because I'd already be three months pregnant. I'm opting for pre-implantation genetic screening of the embryos.*

The real issue with assisted reproductive technology is the set of non-scientific, social problems it raises with respect to parental rights. I shall illustrate a couple of these problems through two final excerpts from the play TABOOS. The first takes place between Max, the brother of Harriet, and Harriet, the mother of an ICSI baby. The sperm donor was Cameron, whose infertile wife, Priscilla, then received some of Harriet's excess embryos.

MAX: *Why, for heaven's sake, didn't you have some legally binding agreement with Cameron?*

HARRIET: *For what? For asking him to lend me a few sperm for injections into my own eggs?*

MAX: *'Lending?' It was an irrevocable transfer of title to property … property that you made much more valuable as a consequence of the use to which you put it.*

HARRIET *(angrily)*: *There was no agreement about that property being returned upon request! And when I gave him the rest of the embryos, it was a gift… an unrestricted gift. I didn't even want to know what he'd use them for.*

MAX: *How could you not want to know?*

HARRIET *(increasingly angry, bordering on guilt)*: *For me, an embryo in a Petri dish or in a freezer is an abstraction… a clump of 8 or 16 or 32 cells… nothing more, It's only when that abstraction is transferred into a woman and implants are we dealing with reality. And I was focusing on my own uterus…*

MAX: *Some legal journal will have a field day, reporting this if it ever comes to trial.*

The final excerpt between the fertile egg donor, Harriet (mother of Jan) and Priscilla, Cameron's infertile wife and now mother of Ashley emphasizes the problems of the definition of 'motherhood' between a biological and surrogate mother:

PRISCILLA: *It was your embryo… but my baby.*

HARRIET (*sardonic*): *Why don't you go back to the Internet to see what you can find under 'genes'?*

PRISCILLA: *I don't need the Internet to tell me about my child. For nine months, Ashley and I formed a relationship. You understand? A relationship that'll last until death! I talked to Ashley while he was in me… when you didn't even know what had happened to your embryo! Sure, I'll always be thankful to you for that gift… but I'm not just an incubator for your embryo. Ashley is my child. He's been baptized (Almost hysterical). Baptized! Do you hear that? This child was born again when he was 10 days old!*

HARRIET: *Whatever. I hope you don't think you have any rights to my child?*

PRISCILLA: *To Jan? No… I don't have any.*

HARRIET: *Well that's a consolation.*

PRISCILLA: *But Cameron's the father, so you'd need to check with him.*

HARRIET (*explodes*): *I see. You think I have no rights with respect to Ashley as the egg donor, but your Cameron's puny little sperm will give him rights to my son?*

Rather than continuing, let me summarize what I have attempted to accomplish in this chapter. While research in reproduction opened up possibilities for technological advances that are now creating a host of complicated problems, most of these are associated with societal changes of women in the more advanced industrialized countries. These revolve around individual choices – choices of women and choices of couples – that in my opinion are not controllable by legislative or religious edicts (if they were controllable, why does the highest number of illegal abortions occur in Catholic Latin America where both the governments and the Church prohibit it?). The technological advances in assisted reproduction that occurred during the past thirty years were hardly predictable, so how could the underlying research have been prohibited? I also wanted to illustrate that non-orthodox methods of information dissemination – such as my choice of 'science in-theatre' plays – could play a useful role in raising the intellectual level of public debate which these days is so sorely needed.

2

Is Science Dangerous?

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How free should science be? Does it present any dangers? The idea that scientific knowledge is dangerous is deeply embedded in our culture. Adam and Eve were forbidden to eat from the Tree of Knowledge, and in Milton's Paradise Lost the serpent addresses the Tree as the 'Mother of Science'. Moreover, the archangel Raphael advises Adam to be lowly wise when he tries to question him about the nature of the universe. Indeed the whole of Western literature has not been kind to scientists and is filled with images of scientists meddling with nature with disastrous results. Also the persistent image from the arts is that of scientists as a soulless group of males who can do damage to our world. An important exception is Michael Frayn's play *Copenhagen,* which deals with physics and the atom bomb.[1]

There is some fear and distrust of science, genetic engineering and the supposed ethical issues it raises; the effect of science in diminishing our spiritual values even though many scientists are themselves religious; the fear of nuclear weapons and nuclear power; the impact of industry in despoiling the environment. There is something of a revulsion in humankind's meddling with nature and a longing for a golden Rousseauish-like return to an age of innocence. There is anxiety that scientists lack both wisdom and social responsibility and are so motivated by ambition that they will follow their research anywhere, no matter the consequences. Scientists are repeatedly referred to as 'playing at God'. Many of these criticisms coexist with the hope, particularly in medicine, that science will provide cures to all major illnesses, like cancer, heart disease and genetic disabilities like cystic fibrosis. It is worth noting from the start one irony; while scientists are blamed for despoiling the environment and making us live in a high-risk society it is only because of science that we know about these risks, such as global warming.

The media must bear much of the responsibility for the public misunderstanding of genetics as genetic pornography is, unfortunately, widespread – pictures and stories that titillate.[2] A widely publicized picture of a human ear on the back of a mouse is a nice, or rather a nasty, example. This was just ear shaped cartilage stuck under the skin for no obvious scientific reason – not an ear at all and just consider how the press dealt with genetically modified food crops, referring to the results as Frankenstein food.[3]

Yet science provides the best way of understanding the world in a reliable, logical, quantitative, testable and elegant manner. Science is at the core of our culture, almost the main mode of thought that characterizes our age, but for many people, science is something rather remote and often difficult. Part of the problem is that almost all scientific explanations go against common sense, our natural expectations, for the world is just not built on a common sense basis.[4] It is quite 'unnatural', to think of the earth moving round the sun or that we come from a single cell, the fertilized egg, to take two very simple examples, but there are many others, like force causing acceleration, not motion, and the very idea of Darwinian evolution, that we humans came from random changes.

Technology

A serious problem is the conflation of science and technology. The distinction between science and technology, between scientific knowledge and understanding on the one hand, and the application of that knowledge to making something, or using it in some practical way, is fundamental. Science produces ideas about how the world works, whereas technology results in usable objects. Technology is much older than anything one could regard as science and unaided by any science. Technology gave rise to the crafts of early humans, like agriculture and metalworking. Science made virtually no contribution to technology until the nineteenth century[5] and even the great triumphs of engineering like the steam engine and Renaissance cathedrals were built without virtually any impact of science. It was imaginative trial and error and they made use of the Five Minute Theorem – if, when the supports were removed the building stood for five minutes it was assumed that it would last forever. Galileo made it clear that the invention of the telescope was by chance and not based on science. The industrial revolution was not dependent on science.

Much modern technology is now founded on fundamental science and it is technology that generates ethical issues, from genetically modified food, industrial pollution, to cloning a human. However, the relationship between science, innovation and technology is complex. Basic scientific research is driven by academic curiosity and the simple linear model which suggests that scientific discoveries are then put into practice by engineers is just wrong. There is no simple route from science to new technology and there are surprising examples of how basic science has lead unexpectedly to new technology.

In contrast to technology, reliable scientific knowledge is value-free and has no moral or ethical value. Science tells us how the world is. That we are not at the centre of the universe is neither good nor bad, nor is the possibility that genes can influence our intelligence or our behaviour. Dangers and ethical issues only arise when science is applied in technology. However, ethical issues can arise in actually doing the scientific research, such as releasing dangerous chemicals or bacteria into the environment, doing experiments on animals and early human embryos, and selection.

However, are scientists responsible for the technological applications of their science? In an issue of the journal Science the 1995 Nobel Peace Prize laureate, Sir Joseph Rotblat, proposed a Hippocratic oath for scientists.[6] He is strongly opposed to the idea that science is neutral and that scientists are not to be blamed for its misapplication. Therefore, he proposes an oath, or pledge, initiated by the Pugwash Group in the United States. 'I promise to work for a better world, where science and technology are used in socially responsible ways. I will not use my education for any purpose intended to harm human beings or the environment. Throughout my career, I will consider the ethical implications of my work before I take action. While the demands placed upon me might be great, I sign this declaration because I recognise that individual responsibility is the first step on the path to peace.'

These are indeed noble aims to which all citizens should wish to subscribe, but it does present some severe difficulties in relation to science. Rotblat does not want to distinguish between scientific knowledge and its applications, but the very nature of science is that it is not possible to predict what will be discovered or how these discoveries could be applied.[7] The poet Paul Valery's remark that 'We enter the future backwards' is very apposite in relation to the possible applications of science. Scientists cannot easily predict the social and technological implications of their current research. It was originally argued that radio waves would have no practical applications, and Lord Rutherford said that application of atomic energy was moonshine. It was this remark that sparked Leo Szilard to think of a nuclear reaction, which lead to the atom bomb.[8] There was again, no way that those investigating the ability of certain bacteria to resist infection by viruses would lead to the discovery of restriction enzymes an indispensable tool for cutting up DNA, the genetic material and which is fundamental to genetic engineering. Cloning, also, provides a nice example. The original studies related to cloning were largely the work of biologists in the 1960s. They were studying how frog embryos develop and wanted to find out if genes which are located in the cell nucleus were lost or permanently turned off as the embryo developed. It was incidental to the experiment that the frog that developed was a clone of the animal from which the nucleus was obtained.

Social responsibilities

The social obligations that scientists have as distinct from those responsibilities they share with all citizens, such as supporting a democratic society and taking due care of the rights of others, comes from them having access to specialized knowledge of how the world works, not easily accessible to others. Their obligation is to both make public any social implications of their work and its technological applications and to give some assessment of its reliability. In most areas of science it matters little to the public whether a particular theory is right or wrong but in some areas such as human and plant genetics, it matters a great deal. Whatever new technology is introduced, it is not for the scientists to make the moral or ethical decisions. They have neither special rights nor skills in areas involving moral or ethical issues. There is in fact a grave danger in asking scientists to be more socially responsible if that means that they have the right and power to take such decisions on their own. Moreover, scientists rarely have power in relation to applications of science; this rests with those with the money-industry and government. The way scientific knowledge is used raises ethical issues for everyone involved, not just scientists.

In relation to the building of the atomic bomb the scientists behaved morally and fulfilled their social obligations by informing their governments about the implications of atomic theory. The decision to build the bomb was taken by politicians, not scientists and it was an enormous engineering enterprise. Had the scientists decided not to participate in building an atomic weapon it could have led to losing the war. Should scientists on their own ever be entitled to make such decisions? No! Scientists have an obligation to make the reliability of their ideas in such sensitive areas clear to the point of over-cautiousness, and the public should be in a position to demand and critically evaluate the evidence. That is why programmes for the Public Understanding of Science are so important.

Eugenics

It is not easy to find examples of scientists as a group behaving immorally or in a dangerous manner but the classic was the eugenics movement which is the classic immoral tale of science being dangerous. In 1883, Darwin's cousin, Francis Galton, coined the word from the Greek 'good in birth'.[9] Eugenics was defined as the science of improving the human stock by giving 'the more suitable races or strains of blood a better chance of prevailing speedily over the less suitable.' Would it not, he conjectured, be 'quite practicable to produce a highly gifted race of men by judicious marriages during consecutive generations?' The scientific assumptions behind this proposal are crucial; the assumption is that most desirable and undesirable human attributes are inherited. Not only was talent perceived of as being inherited but so too were pauperism, insanity and any kind of so called feeblemindedness. The eugenicists considered many undesirable characteristics like prostitution as being genetically determined. As Kevles points out in his book *In the Name of Eugenics* the geneticists warmed to their newly acquired priestly role. Between 1907 and 1928 about 9,000 people were sterilized in the United States on the general grounds that they were 'feebleminded'.

The ideas of eugenics received support from a wide group of both scientists and non-scientists. An American, Charles Davenport, was particularly influenced by the ideas of eugenics and in 1904 he persuaded the Carnegie Foundation to set up the Cold Spring Harbor Laboratories in order to study human evolution. Davenport collected human pedigrees and came to believe that certain undesirable characteristics were associated with particular races; Negroes were inferior; Italians tended to commit crimes of personal violence and Poles were self reliant, though clannish. He expected the American population to change through immigration and become 'darker in pigmentation, smaller in stature, more mercurial, more given to crimes of larceny, kidnapping, assault, incest, rape and sexual immorality'. He therefore proposed a programme of negative eugenics aimed at preventing proliferation of the bad. He favoured a selective immigration policy to prevent contamination of what he called the germ plasm – the genetic information parents transmitted to their offspring.

Davenport and his followers viewed genetics in terms of the action of a single gene, even though they knew that many characters are polygenic, that is they are influenced by many genes. The eugenicists considered many undesirable characteristics like prostitution as being genetically determined even though they had no evidence. The geneticists warmed to their newly acquired priestly role. The list of distinguished scientists that initially gave eugenics positive support is depressingly impressive enough.

In the 1930s the geneticists who included Huxley, Haldane, Hogben and Jennings began to react and resist the wilder claims for eugenics but it was too late, for the ideas had taken hold in Germany. As the geneticist Benno Muller-Hill[10] puts it: 'The ideology of the National Socialists can be put very simply. They claimed that there is a biological basis for the diversity of mankind. What makes a Jew, a Gypsy, an asocial individual asocial and the mentality abnormal, is in their blood, that is to say in their genes'. One can even detect such sentiments, regrettably, in the writings of the famous animal behaviourist, Konrad Lorenz 'It must be the duty of social hygiene to be attentive to a more severe elimination of morally inferior human beings than is the case today' and then argued that asocial individuals have become so because of a defective contribution.

In 1933, Hitler's cabinet promulgated a Eugenic Sterilisation Law which made sterilisation compulsory for anyone who suffered from a perceived hereditary weakness, including conditions that ranged from schizophrenia to blindness. This must rank as the outstanding example of the perversion of science and it can also be regarded as leading directly to the atrocities carried out by doctors and others in the concentration camps.

With the somewhat smug wisdom of hindsight, we may think how misguided were many of the eugenicists. Many of the scientists may well have been honourable, and in some respects, good scientists but they were bad scientists in terms of some of their genetics and more significantly, in relation to their social obligations. They could perhaps plead ignorance with respect to their emphasis on genes determining so many human characteristics, but they completely failed to give an assessment of the reliability of their ideas or to sufficiently consider their implications. Quite to the contrary, and even more blameworthy, their conclusions seem to have been driven by what they saw as the desirable social implications. The main lesson to be learned from the story of the eugenics movement is that scientists can abuse their role as providers and interpreters of complex and difficult phenomena. Scientific knowledge should be neutral, value free. When mixed with a political or social aim it can be perverted.

Terrible crimes have been committed in the name of eugenics. Yet I am a eugenicist. For it now has another, very positive, side. Modern eugenics aims to both prevent and cure those with genetic disabilities. Recent advances in genetics and molecular biology offer the possibility of prenatal diagnosis and so parents can choose whether or not to terminate a pregnancy. There are those who abhor abortion but that is an issue that should be kept quite separate from discussions about genetics. In Cyprus the Greek Orthodox Church has co-operated with clinical geneticists to dramatically reduce the number of children born with the crippling blood disease thalassemia. This must be a programme that we should all applaud and support. I find it hard to think of a sensible reason why anybody should be against curing those with genetic diseases like muscular dystrophy and cystic fibrosis.

Reproduction: cloning, genes, and stem cells

Mary Shelley could be both proud and shocked. Her creation of a scientist creating and meddling with human life has become the most potent symbol of modern science, but shocked because her brilliant fantasy has become so distorted that even those who are normally quite sensible lose all sense when the idea of cloning humans appears before them. The image of Frankenstein has been turned by the media into genetic pornography whose real aim is to titillate, excite and frighten. The bio-moralists are triumphant with the aid of genetic pornography to titillate and frighten purveyed by the media.

Ironically, the real clone of sheep has been the media blindly and unthinkingly following each other – how embarrassed Dolly ought to be. The moral masturbators have been out in force telling us of the horrors of cloning. Jeremy Rifkin in the United States demanded a worldwide ban and suggests that it should carry a penalty ‘on a par with rape, child abuse and murder’. Many others, national leaders included, have joined in that chorus of horror.

But what horrors? What ethical issues? In all the righteous indignation I have not found a single new relevant ethical issue spelled out.

It seems distasteful but the 'yuck' factor is however not a reliable basis for making judgements. There may be no genetic relation between a mother and a cloned child, but that is true of adoption and cases of IVF. Identical twins, who are a clone are not uncommon, and this upsets no one except the hard stressed parents. What fantasy is it that so upsets people? Say that one could clone Richard Dawkins, who seems to quite like the idea, how terrible would that be? While genes are very important, so is the environment, and since his whole upbringing would be completely different and he might even have a religious disposition – clones might make very rebellious children. Indeed the feelings that a cloned child might have about its individuality must be taken into account. However, this is an issue common to several other types of assisted reproduction such as surrogate mothers and anonymous sperm donors. I am totally against cloning as it carries a high risk of abnormalities as numerous scientific studies on other animals show. Those who propose to clone a human are medical technologists not scientists.

The really important issue is how the child will be cared for. Given the terrible things that humans are reported to do each other and even to children, cloning should take a very low priority in our list of anxieties. Or perhaps it is a way of displacing our real problems with unreal ones. Having a child raises real ethical problems as it is parents who play God, not scientists. Here lies a bitter irony. A parent's relation to a child is infinitely more God-like than anything that scientists may discover. Parents hold tremendous power over young children. They do not always exercise it to the child's benefit.

Would one not rather accept a thousand abortions and the destruction of all unwanted frozen embryos than a single unwanted child who will be neglected or abused? I take the same view in regard to severely crippling and painful genetic diseases. On what ground should parents be allowed to have a severely disabled child when it could be relatively easily prevented by prenatal diagnosis? It is nothing to do with consumerism but the interests and rights of the child. The hostility to choosing a child's genetic make up – designer babies – ignores the possibility that quite unsuitable parents can have children even if they are child abusers, drug addicts, and suffering from disabling diseases like AIDS.

It is not, as the bio-moralists claim, that scientific innovation has outstripped our social and moral codes. Just the opposite is the case. Their obsession with the life of the embryo has deflected our attention away from the real issue, which is how the babies that are born are raised and nurtured. The ills in our society have nothing to do with assisting or preventing reproduction but are profoundly affected by how children are treated. Children that are abused grow up to abuse others.

So what dangers does genetics pose? Bioethics is a growing industry but one should regard the field with caution as the bioethicists have a vested interest in finding difficulties. Moreover, it is hard to see what contribution they have made. Some of these common fears are little more than science fiction at present, like cloning enormous numbers of genetically identical individuals. Who would the mothers be, and where would they go to school? In fact it is quite amusing to observe the swing from moralists who deny that genes have an important effect on intelligence to saying that a cloned individual's behaviour will be entirely determined by the individual's genetic make-up.

It is all too easy to be misled as to what genes actually do for us. There is no gene, for example, for the eye; many hundreds, if not thousands, are involved, but a fault in just one can lead to major abnormalities. The language in which many of the effects of genes is described leads to confusion. No sensible person would say that the brakes of a car are for causing accidents. Yet, using a convenient way of speaking there are numerous references to, for example, the gene for homosexuality or the gene for criminality. When the brakes of the car which are there for safe driving fail, then there is an accident. Similarly, if criminality has some genetic basis then it is not because there is a gene for criminality but because of a fault in the genetic complement which has resulted in this particular undesirable effect. It could have affected how the brain developed-genes control development of every bit of our bodies or could be due to malfunction of the cells of the adult nerve cells.

A report by the Nuffield Council on Bioethics[11] emphasises that the whole human be viewed as a person, and in doing so may have neglected to explain just how genes affect all aspects of our life, not least our behaviour. They thus have leaned somewhat towards a holistic anti-reductionist view of human psychology and made no attempt to respond to the anti-reductionist approach which even goes so far as to oppose genetic research into mental disorders. I would argue that all of science is essentially reductionist. In failing to make this clear they may have done bad service to genetics, developmental biology and neuroscience.

Gene therapy, introducing genes to cure a genetic disease like cystic fibrosis carries risks as does all new medical treatments. There may well be problems with insurance and testing but are these any different from those related to someone suspected of having AIDS? Anxieties about designer babies are at present premature as it is far too risky, and we may have, in the first instance, to accept what Ronald Dworkin[12] has called procreative autonomy, a couple's right 'to control their own role in procreation unless the state has a compelling reason for denying them that control'. One must wonder why the bio-moralists do not devote their attention to other technical advances like that convenient form of transport which claims over fifty thousand killed or seriously injured each year. Could it be that in this case they themselves would be inconvenienced? Applications of embryology and genetics, in striking contrast, have not harmed anyone.

Stem cells, cells that can give rise to a wide variety of different cell types, have the potential to alleviate many medical problems from damaged hearts to paralysis due to damage to nerves. The best stem cells can be obtained from early human embryos but as this causes the death of the embryo, there are those, mainly for religious reasons, who oppose this method as they see the fertilised egg as already a human being. There is no justification for this view as the early embryo can give rise to twins and so is not in any way an individual.[13] Also IVF involves the destruction of many embryos and one could oppose this very valuable treatment as well as getting embryonic stem cells, but ethically they are indistinguishable. The same is true for therapeutic cloning to make stem cells that would not be rejected by the immune system of the patient. However, it is now possible to make pluripotent stem cells from normal tissues.

Politics

John Carey, a professor of English in Oxford, writes 'The real antithesis of science seems to be not theology but politics. Whereas science is a sphere of knowledge and understanding, politics is a sphere of opinion.[14]' He goes on to point out that politics depends on rhetoric, opinion, and conflict. It also aims to coerce people. Politics, I would add, is also about power and the ability to influence other people's lives. Science, ultimately is about consensus as to how the world works and if the history of science were rerun its course would be very different but the conclusions would be the same – water for example would be two hydrogens combined with one oxygen and DNA the genetic material though the names would not be similar.

There are surveys that show some distrust of scientists particularly those in government and industry. This probably relates to GM foods and so one must ask how this apparent distrust of science actually affects people's behaviour. I need to be persuaded that many of those who have this claimed distrust would refuse, if ill, to take a drug that had been made from a genetically modified plant, or would reject a tomato so modified that is was both cheap and would help prevent heart disease. Who refuses insulin or a growth hormone because it is made in genetically modified bacteria? It is easy to be negative about science if it does not affect your behaviour.

No politician has publicly pointed out that the so-called ethical issues involved in therapeutic cloning are indistinguishable from those that are involved in vitro fertilisation, IVF. One could even argue that IVF is less ethical than therapeutic cloning. However no reasonable person could possibly want to ban IVF that has helped so many infertile couples. Where are the politicians who will stand up and say this? Genetically modified foods have raised extensive public concerns and there seems no alternative but to rely on regulatory bodies to assess their safety as they do with other foods and similar considerations apply to the release of genetically modified organisms. New medical treatments, requiring complex technology, cannot be given to all. There has to be some principle of rationing and this really does pose serious moral and ethical dilemmas much more worthy of consideration than the dangers posed by genetic engineering.

Are there areas of research that are so socially sensitive that research into them should be avoided, even proscribed? One possible area is that of the genetic basis of intelligence and particularly the possible link between race and intelligence. Are there then, as the literary critic George Steiner has argued, 'certain orders of truth which would infect the marrow of politics and would poison beyond all cure the already tense relations between social classes and these communities.' In short, are there doors immediately in front of current research which should be marked 'Too dangerous to open'? I realise the dangers but I cherish the openness of scientific investigation too much to put up such a notice. I stand by the distinction between knowledge of the world and how it is used. So I must say 'No' to Steiner's question. Provided of course that scientists fulfil their social obligations. The main reason is that the better understanding we have of the world the better chance we have of making a just society, the better chance we have of improving living conditions. One should not abandon the possibility of doing good by applying some scientific idea because one can also use it to do harm. All techniques can be abused and there is no knowledge or information that is not susceptible to manipulation for evil purposes. I can do terrible damage to someone with my glasses used as a weapon. Once one begins to censor the acquisition of reliable scientific knowledge, one is on the most slippery of slippery slopes.

To those who doubt whether the public or politicians are capable to taking the correct decisions in relation to science and its applications I strongly commend the advice of Thomas Jefferson. 'I know no safe depository of the ultimate powers of the society but the people themselves, and if we think them not enlightened enough to exercise that control with a wholesome discretion, the remedy is not to take it from them, but to inform their direction.'

So how does one ensure that the public are involved in decision making? How can we ensure that scientists, doctors, engineers, bioethicists and other experts, who must be involved, do not appropriate decision making for themselves. How do we ensure that scientists take on the social obligation of making the implications of their work public. We have to rely on the many institutions of a democratic society: parliament, a free and vigorous press, affected groups, and the scientists themselves. That is why programmes for the public understanding of science are so important. Alas we still do not know how best to do this. The law which deals with experiments on human embryos is a good model: there was wide public debate and finally a vote in the Commons leading to the setting up of the Human Embryology and Fertilisation Authority, but this may be disbanded.

At a time when the public are being urged and encouraged to learn more science, so scientists are going to have to learn to understand more about public concerns and interact directly with the public. Also, it is most important that they do not allow themselves to become the unquestioning tools of either government or industry. When the public are gene literate, the problems of genetic engineering will seem no different in principle from those like euthanasia and abortion since they will no longer be obfuscated by the fear that comes from the alienation due to ignorance.

3

The Cosmos Above Me, and the Moral Maze Within Me

Astrophysics and Basic Research – Some Reflections

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The discovery of a new dish confers more happiness on humanity than the discovery of a new star. (The physiology of taste. Brillat-Savarin)

Scientific discovery and scientific knowledge have been achieved only by those who have gone in pursuit of it without any practical purpose whatsoever in view. (Where is Science Going? Pt. 4. M. Planck)

Introduction

I think I belong to a privileged class of men and women who materialized their dream work. I always wanted to be an astrophysicist and I consider myself very lucky to have a University that pays me to do what I love: research and teaching. My research consists mainly in developing new instrumentation for making more and more sensitive and accurate astrophysical measurements. My teaching keeps me in contact with the new generations with their incredibly fresh minds and novel ideas. Every year the first day in class I ask the new coming students a few questions. Why did you choose to study physics? What job would you like? And a few other questions of a similar tenor. The last question that I pose is slightly different because it is somehow unexpected and usually forces the students to think on the spot. The question is: 'Why should the government invest 30 million pounds in an astrophysics experiment instead of building a new hospital?' At this point most of the faces turn to me with a different light in the eyes. They certainly did not expect *this* question. I am sure I triggered in their mind some ethical questions.

Is it a good thing to invest in basic science while we have people struggling with basic needs? I will not even touch the political issues involved, mostly because I feel I am not qualified. I just point out that governments set the budget destined for basic research. Scientists write proposals and apply for their research funding from a fixed pot whose content is decided by governments. Although somebody else has the authority to decide the overall budget destined for science, I still think it is not only morally acceptable to use resources for basic research but overall is one of the best ways of using time and money.

Organization of science

Before giving my reflections on the last issue above, it is important to clarify how science is organized. This will help in understanding the mechanisms involved and, ultimately, the dynamics of science. After all, science is a human endeavour aimed at understanding the world around us in an analytical way.

My personal view of the organization of science is probably different from what most non-scientists would suppose. I agree with the chemist Michael Polanyi[1] who looked into the mechanisms of scientific research. He described a 'republic of science' composed of free men and women not bound by any limitation of race, origin, religion etc. There are a few questions that Polanyi asks and that I will try to answer, limiting myself to my research field. It is important to note that scientific research today is very much diversified. It is quite possible that different scientific/technical fields require different questions and answers. Think, for example, how diverse basic research in astronomy and biology and medicine are. Astronomy and cosmology have as their objective the studying of systems that are several orders of magnitude bigger than – and therefore 'distant' from – human beings. The universe as a whole – in its origins and evolution – is subject to careful investigations using mathematical and physical tools. Compared to astrophysics, biology and medicine are certainly capable of attracting all sorts of different questions that can 'touch' us more directly. This is because the investigation comes closer and closer to human beings. Investigations in astrophysics, on the other hand, tend to go away in time and space from us. It is therefore quite ironical but perhaps not unexpected that there are scientists today advocating the 'anthropic principle' according to which the Universe is compatible with the conscious life (us) observing it. In other words, the Universe has the exact age and values of the physical constants to allow the arrival of the human race. Therefore it should not be a surprise that we are here now.

Let us go back to the organization of science: I will limit myself to questions in the field of astronomy. The first question is: 'how are scientists chosen?' The second is: 'How are scientific problems chosen?' I will deal with the first question here, and with the second question in the next section.

The approach to physics and astronomy differs over time with a different degree of increasing complexity, from the simple everyday physics understood by small children, to some general simple physics for pupils in school, to the more rigorous basic physics of University graduates. Each of these groups comes closer to a more modern understanding of the natural world. If you want to become an active researcher you need to step up one more level. To become a scientist you need to be in touch with the people who are active in research. Your first step is to look for a PhD thesis: you are now looking to become part of an inner circle of scientists with an international reputation. It is like an 'initiation' with its own rites. In astrophysics, you need to choose (or be chosen by) a good PhD supervisor. Your future is now in his/her hands. After having worked very hard on your thesis you must publish your results and give presentations at international workshops. However be careful not to go too far against the flow and, more importantly, do not go against the current 'fashion' theories and/or experiments. These fashion theories/experiments are normally supported by those few powerful big names with a lot of influence in directing the scarce funds available in your research field. After your successful PhD defence, you need to look for a job, first a fixed-term contract as Post Doctoral Research Assistant (PDRA), and then as a lecturer or assistant professor. You succeed and become a PDRA. Your destiny is in the hands of the academic in charge of the funds from which your salary is paid. You work very hard and, only if you are very good and lucky, you are now allowed by the academic staff of a certain University to become a young lecturer. You are chosen to become an academic staff member because you are good at your research. At this point, you discover that you do not have enough time to do the research that you are good at: you now have to teach, supervise students and participate in the administration of the department. Therefore, to keep your scientific production you apply for funds to employ PhD students and PDRAs to help you with your research and so on...

The process that I just described is obviously simplified and certainly not comprehensive but it probably gives an idea of the process of selection of scientists. It is by acceptance by your peers into an inner circle of initiated scientists. It is thus an oligarchic process, the one through which scientists can do their job. The arena where this initiation takes place consists of international journal papers, workshops and internet publication of pre-prints. The real power resides in a group of established scientists that are called to be part of the process of distribution of government resources in the form of panels or reviewers of proposals. Above them, there is certainly the politics that establish how much money will be available in each discipline – if any. Once your scientific result is passed through the opinion of the big names in your field, then the validation of theoretical studies or experimental data is a real democratic process. The entire community expresses their views on the material published. The value of the results emerges naturally although, in some cases, if they are too revolutionary, it will take some time to pass a very close scrutiny by the scientific community. In this sense, scientists are very conservative and I would like to add, rightly so! There are cases of exaggeration of conservatism when the new results are in clear conflict with the scientific reputation of some big names. If the name is particularly big, sometime it is necessary to wait for his/her retirement. Max Planck, the famous German scientist and father of quantum mechanics has expressed this concept in a very caustic but effective way: 'A scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die and a new generation grows up that is familiar with it.'[2] In other words, science progresses from death to death.

Relationship between science and technology

The question I posed above is: 'How are scientific problems chosen?' There is apparently a complete freedom in choosing the problems to be studied. In reality, however, scientists need funding to carry on their studies and therefore a first screening is always applied by your peers. Therefore, scientific problems are chosen with a similarly oligarchic process to the one through which scientists are selected. Both scientists and ideas are selected by peers, or, more properly, by the experts in the field. In this sense, this oligarchy 'justifies' the research. However, as I will discuss below, this does not fully resolve the moral maze I highlighted above. The very original ideas that have revolutionized the world quite often do not pass through this scrutiny: they might not survive it! Instead, scientists often piggy-back novel research on other funded research or – in a few cases – even with no funds. I am not sure if this is good or bad, but it is certainly the way it is today. I must mention that, in accordance with this model of regulation of funding, the number of scientific revolutions has decreased in the last few decades. Are we scientists becoming more traditional than our colleagues of fifty-plus years ago? Perhaps yes, in spite of the fact that the number of professional scientists has hugely increased in the last thirty years. I am not surprised because the amount of knowledge has also increased enormously. The more knowledge we accumulate the larger the boundaries to the unknown are and the more people are needed to keep pushing the ever-enlarging boundaries to the unknown. Basic research is the science located close to these boundaries and pushing out. The inner science is more technological and directed at translating the scientific results into applications useful to human beings.

It is important to reflect on the relationship between science and technology, to begin to unravel the ethical issues around freedom of scientific research. Although basic science may appear not directly to affect human welfare, in fact many of the problems affecting society can be solved by operating on a twofold front: basic research and technological research. This may begin to explain the ethical importance of basic research.

Basic research will open completely new directions to solve problems that more established research is struggling with. Current established technology is improving our standard of living on time scales that are more evident to our current generation. Basic research is more for the distant future while technology research is for today or the near future. It is evident therefore that economic interests will tend to favour technology research because of the potential near term financial returns. My point is that both research activities are needed to maintain our desire to improve our life and the life of the future generations.

The importance of basic research

Basic research is curiosity driven, blue-sky research that sometimes might lead to big discoveries but most of the time the outputs remain relegated to some technical journal unknown to the general public. Scientists involved in basic research should therefore sometimes feel the moral obligation to justify the resources used. My view is that this research is always justified by the potential huge advantage that can result in the future. Almost all the big discoveries resulted from blue-sky research and there is no indication that this is not going to be the case for future discoveries. Let me mention just a few: maser/laser, Mendeleev periodic table, transistor, optical microscope, X-ray diffraction which led to medical screening and discovery of the DNA structure, steam engine, electricity and magnetism. These are only a few examples. Scientists should continue putting their best efforts into basic research being aware that their work is not only a service to human knowledge, but potentially can help solve bigger problems such as, for example, the energy sources of the future. It is absolutely vital that we understand the value of the basic research that apparently will be relegated to technical journals with no immediate social application. People designing the first nuclear reactor, for example, made heavy usage of techniques discovered by basic scientists like Enrico Fermi. Fermi's scientific output was exclusively based on blue-sky research and relegated to technical journals. Even more representative is the understanding by astrophysicists of the process of nuclear fusion in stars. This discovery generated the thermonuclear bomb, which is massively more powerful than nuclear bombs, but also the potential of fusion reactors, which some hope will solve the energy problem of the future. It is important to realize that the current generation of researcher is building upon a huge amount of knowledge generated by the blue-sky research performed by scientists of the previous generations. Newton himself expressed this point very effectively when he said to Robert Hooke in a famous letter dated February 5, 1676: '*If I have seen a little further it is by standing on the shoulders of Giants.*'

In the past it was relatively easy to identify the big thinkers who started important scientific and technical revolutions – the Giants. Today, the Giants are composed of a collection of scientists standing on top of each other. The scientists on the top would not be able to see far without all the scientists whose work allowed them to make the important discoveries. It is a much more democratic view that shows the scientific progress as a synergetic endeavour of many scientists often working in different fields.

Basic research in astrophysics is about trying to answer the big questions about our cosmic origin. This research effort has apparently no connections with everyday life. In reality, increasing the knowledge in any field will generate more curiosity that, in turn, will trigger new discoveries in different fields. It is very important to always keep in mind that scientists are managing taxpayers' money. The ultimate judges are the people that contributed their hard earned money to allow us to do blue-sky research. We must therefore have rules of conduct to make sure that their money is well spent. Honesty in reporting experimental results or in reporting the output of very complex calculations or simulations is perhaps the most important rule of conduct. We scientists are trained to question very hard any result being discussed. There is always space for doubts in our minds even when we are reasonably sure that a certain result holds. After all, we will never prove that a theory is correct: we can only prove that is wrong!

Moral responsibility

After having explained how scientists and ideas are chosen, and having stressed the benefits of basic science, I will now turn to my original question: is it morally acceptable to spend money on basic blue-sky research instead of saving lives immediately by building more hospitals? Our generation is investing resources to improve the life of future generations. It is a natural force at work: we invest for our children. We want future generations not to go through what we went through. It is probably true that if we spent all the money destined to science into building hospitals or buying food we would save a lot of people from health perils and premature death. But it is also true that the scientific advances made in the past have saved a lot more people who would not have been saved if we had not invested. A very crude representation of this concept would be that the people dying today because of lack of resources are giving their life to make the future generations healthier and more comfortable. These people are the real modern heroes – and martyrs. I am not saying that this is right or wrong: it is not up to me to judge it and, in any case, it would be completely beyond my control as a scientist.

I have been trained as a scientist and not as a philosopher or as a sociologist and therefore my thinking might sound naive. However, I cannot resist mentioning that if we want to be effective for our current and future generations perhaps it would make more sense investing less in armaments and more in science rather than less in science and more in direct technological applications. Some scientific advances made via basic research can be effective even during the lifetime of a human being. Without antibiotics, discovered by Fleming in 1928, many of the people around us today would be dead – perhaps many of us or our own fathers or mothers. We understand better our world and contribute to a human endeavour that does not have limitations in terms of languages, skin colour or geographical location. Science is really a global effort at a world level with no limitation in space and time. Therefore, the life improvement and life saving that may result from basic science favours humanity as a whole, as compared to investments in technological applications, which may favour only selected parts of humankind. And this is another reason why it cannot be unethical in principle to invest in basic research, even if no direct application can be precisely predicted.

I would like to finally spend a few words on the moral responsibility of researchers when technology is used for applications leading to the construction of weapons or similar unethical activities. I think that there is no bad science or good science. There is just science. Scientists working in Universities and research labs are curiosity driven individuals. They have no responsibilities for the usage of the results of their research. Scientists discovering nuclear fission in all likelihood were not thinking about the bomb. The scientists that worked on the Manhattan project – the program that developed the first atomic bomb – on the other hand, knew what they were doing. They were using/developing the known basic research during wartime to create a weapon. I am pretty certain that if it were not wartime, then these scientists would never have worked to create such a horrible device, but in time of war every man and woman is confronted with very difficult moral questions: better to kill 1 today to save 100 tomorrow? This dilemma is a dramatic version of the dilemma posed previously about building hospitals versus funding basic research. They look to me as logically equivalent. This is not necessarily to suggest that investment in development of weapons is morally justified. This is instead to point out that the big decisions about budget spending of a nation have as a consequence that some people will die and some others will not. In a democracy, politicians are elected to represent people and therefore the responsibility of these ethical decisions belong to the voters and not the individual scientists or engineers.

A scientist like me when confronted with non-scientific problems, like for example social problems, is generally lost. I am not trained to approach systematically these classes of problems because I suspect that they are too difficult when compared with scientific problems. Corbellini, in his chapter in this volume, has delved into the relationship between democracy and science development in far greater depth than I could hope to. He stresses how freedom of science is needed in order for democracy to flourish, but clearly public consultation, and transparent methods of allocation, as Corbellini points out, is also a way in which we, scientists, can operate with some sort of legitimacy.

I would like to conclude with some wisdom coming from the accumulation of thousands of years of experience. I find the following Buddhist proverb very enlightening: '*To every man is given the key to the gates of heaven; the same key opens the gates of hell.*' Scientists study the mechanism of the key. Politicians use it.

4

Can Freedom Help to Tackle Global Climate Warming?

A View from Biogeochemical Research

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The climate we live in

Evidence of global climate warming based on the results of a growing number of scientific studies was declared by the latest Assessment Report of the International Panel on Climate Change[1] as unequivocal. Climate change is primarily manifested through a widespread increase in ocean and air temperature at a global level. Air temperature increased on average by 0.6°C during the last century (1901 to 2000), at a growing rate. The warming trend in the fifty-year period between 1956 and 2005 (0.13°C per decade) is almost double that for the 100 year time window between 1906 and 2005 (0.074°C per decade). More recently the World Meteorological Organization[2] pointed out that the ten warmest years since the beginning of global temperature records in 1850 all occurred after 1997 (Figure 1), confirming the Earth's significant long term warming trend particularly at higher northern latitudes.

Oceans have become warmer up to the depth of 3,000 metres by taking up over 80 per cent of the heat added to the climate system and consistently the sea level showed an increasing trend assessed in 31 millimetres per year for the 1993 to 2003 decade, which threatens the populations of coastal areas and islands. It is estimated that the thermal expansion of marine water contributed to just less than 40 per cent of observed sea level rise with the remaining part being caused by the melting of glaciers and ice caps and reduction of the polar ice sheets.

Remarkably, the Arctic sea-ice cover in September 2010 was the lowest of three consecutive recorded minima since 2007 when the ice retreat opened the Northwest passage,[3] the most direct shipping route between the Atlantic and Pacific Oceans, from Russia along the north coast of Canada to Europe, for the first time since satellite records began in 1978.

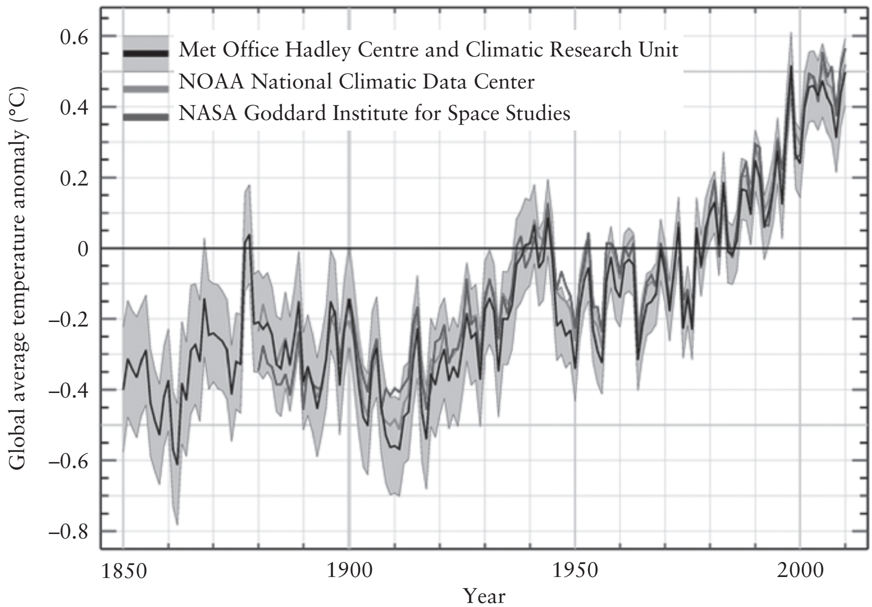

Figure 1 Global average temperature anomaly, compared with the 1961 to 1990 average result from three Global datasets: NOAA (NCDC Dataset), NASA (GISS dataset) and combined Hadley Center and Climate Research Unit of the University of East Anglia (UK) (HadCRUT3 dataset).
Source: World Meteorological Organization.

Climate changes include also long term variations of the precipitation regimes at different geographical scales (from continental to regional) and in the occurrence of extreme events. Over the 1900 to 2005 period, precipitation increased significantly in eastern parts of North and South America, northern Europe and northern and central Asia while it decreased all over the Mediterranean basin, in the Sahel and in southern parts of Africa and Asia leading to a likely enlargement of the areas affected by drought.

Heatwaves have become more frequent over most areas in the world, with the result of exacerbating the aridity of typically dry lands and generally enhancing the risk of fire. In this respect it is easy to recollect the catastrophic fires in Russia during July-August 2010, when temperatures exceeded 30°C during thirty consecutive days.[4] In other cases heatwaves are *per se* a threat to human health, as in the case of an estimated 52,000 deaths in central-southern Europe in August 2003 during two weeks of continuous extremely hot temperatures.[5] Extremes in the form of heavy precipitation events have also become more frequent over most areas in the world often causing destructive floods.

Drivers of climate warming

The climate system is driven by its energy balance, namely the absorption, scattering and emission of radiation within the atmosphere and at the Earth's surface. When these terms of the balance change, they produce a radiative forcing on the climate with either a cooling or warming effect on the climate system. Changes in atmospheric concentrations of greenhouse gases (GHGs) and aerosols, land cover and solar radiation are all factors which determine a modification of the energy balance.

Concentrations of GHGs such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) have increased due to human activities since 1750 at unprecedented rates. Global increases in CO_2, monitored with high accuracy measurements started in 1958 at the Mauna Loa observatory in Hawaii by Charles David Keeling, are caused primarily by emissions in the atmosphere produced by the burning of fossil fuels and secondarily associated to land use changes, mainly tropical deforestation. Data from the analysis of composition of the air trapped in bubbles in the Greenland and Antarctica ice cores showed that the range of variation of CO_2 in the last 650 thousand years has been by far lower than present concentration values.[6] In particular from ten thousand years ago to 1750, CO_2 abundances stayed at about 280 parts per million (ppm)[7], while as a result of human activities atmospheric CO_2 concentration rose exponentially up to 390 ppm in 2010.

The rise in CH_4 atmospheric concentration is attributed to fossil fuel use but also to agricultural activities, the latter being predominantly responsible for the increase in N_2O concentration as well. CH_4 concentration in the atmosphere was relatively constant at 700 parts per billion (ppb) from 1,000 years ago until the beginning of the industrial era in the nineteenth century, after which it started building up in the atmosphere up to 1774 ppb in 2005. Such a level was never experienced on Earth during the glacial-interglacial cycles in the last half million years when CH_4 concentration was within the range of 400 to 700 ppb.

It is a property of greenhouse gases that they absorb part of the outgoing thermal (infrared) radiation which the Earth's surface emits to space and re-emit it in all directions including back towards the planet's surface. The consequence of this natural process, well known as 'greenhouse effect', is to warm the Earth's surface and its lower atmosphere. The combined increase in GHG concentration in the atmosphere since the industrial era thus represents an additional energy load (positive radiative forcing) able to warm up the climate system with an estimated power of +2.3 W/m^2. CO_2 alone is responsible for 80 per cent of the growth in climate forcing. CH_4 and N_2O, despite their much lower abundance, have a warming potential 25 and 320 times higher than that of CO_2. Aerosols are small particles with very widely varying size and chemical compounds which can be of natural origin (mineral dust, sea salts, volcanic eruptions, biogenic emissions) or the result of fossil fuel and biomass burning or dust released by surface mining and industrial processes. Aerosols produce an overall cooling effect of the atmosphere by reflecting and absorbing solar and infrared radiation. Changes in the land surface mostly operated though changes in forests, pastures and croplands can exert a forcing on regional climate by changing the ratio of reflected to incoming solar radiation (defined albedo) as well as altering the water and energy balances. Overall, these changes resulted in a negative forcing with more solar radiation reflected by the surface of the Earth. Solar irradiance, on top of its cyclic changes following an eleven-year period, is estimated to have gradually increased since 1750, generating a small positive radiative forcing of +0.12 W/m^2.

However, considering all the forcing components acting on the climate system since 1750, human activities translated into a warming effect with a radiative forcing of +1.6 W/m^2 which is by far greater than the forcing arising from natural processes.[8] Both the magnitude and the rate of change are so great that the epoch since the start of the industrial revolution is often called the 'Anthropocene', according to the definition given by Nobel prize winner Paul Crutzen[9] at the beginning of present century, and considered as a new geological era distinguished from the preceding Holocene starting about 12,000 years ago. In the Anthropocene human activities are significantly modifying the great natural cycles of carbon, water and nutrients, together with climate biodiversity and other properties of the state and function of the earth system.

A recent survey concluded that biodiversity loss, disturbance of nutrient cycles (nitrogen and phosphorous) and climate change in that order are the three leading planetary systems which have already crossed boundaries for defining 'a safe operating space for humanity'.[10] Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the twenty-first century that would very likely be larger than those observed during the twentieth century.

Future climatic scenarios

Future climatic warming depends on GHG emission scenarios which have been developed by IPCC and issued in a dedicated report,[11] on the basis of different projections of demographic, technological and economic development at global level. Nevertheless, these scenarios do not take into account climate policies above those already adopted at the moment of the report's finalization. Future greenhouse gas concentration retrieved from SRES scenarios are used as inputs in climatic models of varying complexity which yield simulations of future changes in climate. The IPCC prediction from a range of emission scenarios is a warming of about 0.2°C during the next two decades. Even if the concentrations of all GHGs and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected.

Afterwards, temperature trends increasingly depend on specific emissions scenarios spanning 1.8–4.0°C. The range becomes even larger (1.1–6.4°C) if we consider the divergence in the results within each emission scenario given by the application of different models.

The European Commission, in recognition of the risk associated with the irrevocable consequences of climate warming, has tailored its environmental and energy policy on scientific grounds to limit global warming to a threshold of 2°C above pre-industrial levels, recognized as a safeguard point for the climate system. The acceptable warming level is thus 1.2°C above today's global temperature.

The EU members[12] are already on track to reduce their collective emissions in the 2008 to 2012 period to 8 per cent below 1990 levels under the framework of the Kyoto Protocol. Additionally the target to transform Europe into a highly energy-efficient, low carbon economy, is being pursued by the EU governments through a new unilateral commitment to cut emissions by at least 20 per cent of 1990 levels by 2020. This commitment is being implemented by binding legislation and is also meant to foster a new post-Kyoto global agreement, to become effective in 2013, targeted on a more ambitious reduction of GHG emissions by 30 per cent by major emitting countries.

In order to evaluate the potential efficacy of the political measures to tackle climate change, we can take advantage of the knowledge of the relation between the peak warming above pre-industrial temperatures, in other words critical temperature thresholds not to be overcome, and cumulative GHG emissions from human activities. This relation is at present considered statistically robust within quantifiable uncertainty bands.[13,14,15] To keep climate warming below the 2°C threshold, cumulative emissions should be maintained below 1,000 PgC (billion tonnes of carbon). Considering that cumulative emissions at the end of 2008 were about 530 PgC, it is evident how more than half of the 1,000 PgC quota has been used already. This means that assuming a realistic gradual decrease of future emissions forced by the application of global climate policies, we have already overcome the maximum allowable CO_2 concentration in the atmosphere.

However, emissions continue to rise and constitute an annual input of nearly 10 PgC every year into the atmosphere. The largest increase in fossil fuel emissions in recent years took place in developing countries, counting for almost six billion people driven by emerging economies of China, India and South Korea. Even if in 2009 as a consequence of the world economic crisis fossil fuel emissions decreased by 1.3 per cent, these emissions were the second highest in human history just below 2008 emissions while preliminary data for 2010 indicate a return to an increase of +3 per cent.[16]

On the positive side, changes in land use leading to net GHG emissions are in progressive reduction since the 1990s although they are still responsible for net emissions of 1.1 PgC in the last decade. The observed reduction trend is largely the result of the implementation of new land policies, control of illegal deforestation and regrowth of forest on previously deforested areas.

A helping hand from planet earth

Not all the CO_2 emitted by human activities remains in the atmosphere but only a fraction of 47 per cent, if considering the average of the last decade.[17] Atmospheric carbon is indeed part of a global biogeochemical cycle which involves also the oceans and the terrestrial ecosystems as other pools among which the carbon is exchanged through biological, geological and chemical processes. The actual global carbon cycle is not in equilibrium meaning that the increase of CO_2 in the atmospheric pool is partly offset by an uptake in the oceans and in the lands which act as carbon *sinks*. The oceanic sink of CO_2 is a physico-chemical response of the ocean to rising atmospheric CO_2, where the gas dissolves in surface water and is transported to the ocean depths by currents. The sink located over terrestrial ecosystems is determined by the net carbon uptake by forests and grasslands where additional carbon is stored in plants, biomass and soils. The average size of the ocean and land sinks during the last decade (2000 to 2009) was roughly equal and as large as 2.3 and 2.4 PgC yr-1 respectively, thus removing more than half of the anthropogenic CO_2 emissions.

The response of terrestrial and oceanic ecosystems to the increased atmospheric CO_2 has attracted major attention from the scientific biogeochemical community in the last twenty years. A fascinating hypothesis behind the observed sinks is the capacity of living organisms to regulate the Earth's environment maintaining the suitable conditions for life. This hypothesis, formulated in 1965 by J.E. Lovelock as the 'Gaia hypothesis' after the word used in Greek mythology for Mother Earth, compares our planet to a living being with a capacity of auto-regulation.[18]

The maintenance of physico-chemical properties at the Earth surface is generally performed though reactions (*feedbacks*) which contrast the changes in the initial conditions. A crucial issue in this respect is improving the understanding of CO_2-climate feedbacks. If Gaia is giving a hand in reducing the rising CO_2 concentration in the atmosphere and in mitigating climate changes through the uptake of carbon in the lands and in the oceans, we should understand for how long this process can be sustained in the future and what are the limiting conditions for its functioning.

Open questions and priorities in the carbon cycle science

The main need of the carbon cycle research community in facing the climate change challenge is to understand the role of the natural and managed carbon cycle in the dynamics of the climate system. This entails quantifying the effect of human activities, determining the response of natural ecosystems to the disturbed carbon cycle and forecasting future fluxes between the atmosphere, the land and the oceans. Currently a significant part (about 40 per cent) of the uncertainty on the magnitude and rate of climate change for the twenty-first century depends on the lack of understanding of the feedbacks between anthropogenic emissions, the carbon cycle and the climate system.[19]

Only after a breakthrough in the understanding of the processes underlying the carbon cycle will it be possible to explore strategies for the management of the carbon-climate-human system aimed at stabilizing atmospheric concentrations of GHGs. Research priorities are therefore represented by a better depiction of the contemporary global carbon cycle, including the quantification of carbon sources and sinks with a reduced margin of uncertainty, their geographical distribution and future dynamics. In particular the quantitative assessment of the anthropogenic disturbance on the carbon-climate system is needed to adopt efficient mitigation policies for a given target of acceptable temperature level above pre-industrial levels.[20]

Moreover, climate treaties need continuous improvement if tools based on sound science are to monitor and verify mitigation activities. The same is required by the emerging carbon market for which transparent and scientifically-based monitoring and verification of the results of emission reduction projects are crucial. A key development of biogeochemical research would be also the identification of climatic thresholds beyond which irreversible processes start to take place. For instance the potential thawing of permafrost (frozen soils at high latitudes containing massive amounts of carbon), the increase in fire occurrence and vegetation replacement due to the interactions between reduced rainfall and tropical deforestation, the drying of peatlands and associated fires, are all processes able to accelerate the climate warming by releasing extremely large quantities of carbon into the atmosphere and becoming uncontrollable once temperatures have passed specific thresholds.

The relevance of ethical and intellectual freedom in tackling global climate warming

Climate change is a global problem and ideally it should be tackled through an effort at a global scale. Certainly the search for and application of effective measures to mitigate climate changes requires a very large number of synergies at all levels of society. Synergies are particularly needed also within the research sector for a major advancement in this field of science and for several aspects, finding these synergies requires a certain degree of freedom for scientists. This freedom should be protected and promoted at at least three levels: implementation of a network of observation sites, freedom in data collection and sharing, and effective dissemination.

With regard to the first point, most of the scientific questions outlined before can only be answered through the implementation of an optimal carbon observation system based on a network of observation sites all over the globe. Regional networks of field sites for the measurements of climate, GHG fluxes and the main ecosystem attributes already exist and have increased in number, reaching more than 500 sites worldwide at present. A growing bulk of sites and relative data poses the problem of the standardization of measurement methodologies and data processing, an issue currently being addressed by projects such as FLUXNET, which coordinates the analysis of fluxes of CO_2 at a global scale. Standardization is a necessary aspect to come up with aggregated figures of the global carbon cycle and to deliver routine updates of carbon budgets: this standardization may appear to limit the ethical freedom of scientists, who can in principle use different methodological approaches when collecting measurements or treating data for their own specific research aims and submitting their results for publication. This, however, does not in reality limit, but enhances freedom of science, in that it allows scientists to operate on a global scale, and, as explained above, in this field of science operating on a global scale is essential.

Networks, however, are only meaningful and effective as long as a large number of scientists can coordinate their research plans. In this respect it should be mentioned that in the last decade many international programs have been initiated to try to develop a globally coordinated research strategy. The mission of research programs such as the GTOS (Global Terrestrial Observation System) or the ESSP (Earth System Science Partnership) has been to compile the essential knowledge on the functioning of the Earth, bringing together researchers from different fields of science all over the world. These programs facilitate communication and cooperation among existing projects and provide valuable information to researchers and policy makers who deal with environmental changes. The ethical choice of individual scientists to share their knowledge is here at the base of the success of such initiatives.

In order to provide the answer to the open scientific questions outlined above, and thus to respond effectively to the challenges posed by climate changes, it is also essential that scientists are granted the freedom, and are encouraged, to operate in key regions of the world and at an increasing number of locations, to collect data which can contribute to reducing the uncertainty in the state of the art knowledge of the global carbon budget and its year to year variation. Barriers in this sense are represented by restrictive national legislation of some countries controlling the access and the circulation of people through and within their national boundaries, the permissions to take measurements or biological samples and export them abroad to analyze them in specialized laboratories. Rather frequently barriers are nevertheless represented by severe financial constraints to the activity of researchers, with the exception of those countries where science is most supported by governments (USA, Japan, France, Germany and UK among those with the highest expenditures) and scientists can rely upon larger budgets to deploy their projects.

After that scientists should be in the position to share the data they collect in order to participate in research networks or contribute to databases, each of which is however usually managed applying a certain regulation, not necessarily limiting, in respect to the access and the use of data. Thankfully, data sharing policies are carried out in most of the leading countries in science and have lately been greatly advanced also in important emerging countries such as China where they were poorly developed only few years ago, and where in parallel an increasing share of the gross domestic product (from about 0.9 per cent in 2000 to 1.5 per cent in 2007) has been assigned to the sector of research and development.[21]

Finally, the results of a research project, even if very valuable, risk being under evaluated if they are not disseminated effectively, making the efforts behind them almost vain. Engagement in the climate change debate and alignment of research with policy processes are thus both critical for effective interactions between science, policy and society. Opportunities of disseminating at the international level are represented for instance by the participation of scientists in technical panels of the United Nations Framework Convention on Climate Change (UNFCCC) as well as with regional and national policy institutions. However, there is a growing need for engagement with the broader society, informing public opinion through media releases of new research findings and through an active participation in discussions about climate change. If on the one hand the evidence of a climate change and the responsibility of human activities are nowadays unequivocal for the scientific community, on the other hand the media also give space to arguments which deny the warming trend of the planet, minimize the risks associated to it and in any case clear the human society from being the cause of the observed change. According to research published in November 2007 by Maxwell Boykoff at the University of Oxford, UK,[22] the majority of US newspaper articles from 1990 to 2004 balanced the view that humans cause climate change with the opposite viewpoint going along with the media's need to appear unbiased. As a result of this attitude, journalists have been confronting science with scepticism, balancing evidence with emotion even when the very large scientific consensus on the topics could make the arguments conclusive.

The large majority of arguments against climate change are not based on scientific grounds and in many cases hide the interests of industrial lobbies in the exploitation of fossil fuels or their concern about the policy measures associated with a reduction of GHG emissions. For instance, in 2006 the UK scientific academy, the Royal Society, accused one of the world's major oil companies of funding thirty-nine groups that 'misrepresented the science of climate change by outright denial of the evidence' and later in the *Guardian* newspaper reported that the same company offered scientists and economists money for articles that attempted to undermine the scientific consensus on climate change by confuting the findings of the IPCC. For the public, however, it is very often hard to discern the solidity and credibility of contrasting arguments in the debates on climate change. This is not to deny that alternative opinions have legitimacy in science, or that freedom of expression should be limited. Scientific theories would be hardly accepted as credible if they were simply imposed. However, debates on climate change, as well as on any other area of science, should be informed and based on evidence, rather than on ideology or financial interests. A transparent and well informed debate that involves the public may also put people in the position to adopt virtuous behaviour and take action to reduce their level of emissions. Clearly, if every single person felt responsibility for climate change, and the power to interfere positively with it, the effects of the actions of every single person on a global scale would be significant.

An effective communication of science to the largest possible audience is needed, although it is difficult, given the degree of complexity of science itself. Improving the diffusion of a scientific culture among society should be a task for scientific communicators and journalists, as well as for the education system of a country. Only with such dissemination will all members of society be enabled to understand the facts and consequences of climate change, and called to form their own opinion in the most free but responsible way.

5

Scientific Freedom in an Evolving World

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Scientific freedom can be usefully understood as a practice of governance. That is, at least as my co-author and I develop the term 'governance' in a recent book, it lies within 'the complex set of rules, laws, practices and institutions which humans progressively develop as they set about the task of collectively organizing their affairs.'[1]

Scientific freedom is of course many things: a normative code, an objective, a central feature of a methodology, an ideology and even, at times, a rallying call. In Merton's characterization of scientific norms, the importance of scientific freedom may be found in the featured ideals of communalism (in which science is an open community), disinteredness (in which science stresses outward objectivity), and organized scepticism (in which all ideas must be tested and adjudicated by open scrutiny by the community of scientific practitioners).[2] As an ideology it became part of the underpinnings of 'the idea of progress' through which the emerging entrepreneurial merchants confronted the claim to legitimacy and power of the aristocracy.[3]

The concept that unfettered scientific freedom is central to progress (as advanced by scientific discovery) has been widely held by individual scientists. Thus for example, in 1972 Blisset reported on a survey of 800 scientists in which seventy-seven per cent agreed that 'The pursuit of science is best organized when as much freedom as possible is granted to all scientists.'[4] The views at the time went so far as to argue that 'A pure scientist must not deny himself a discovery by worrying about social consequences.'

As a rallying call the concept has also been insistently advanced by institutions of scientific researchers throughout the Modern period. Relevant institutions include universities (often couched in terms of 'academic freedom'), government research institutes, and the academies of science and technologies in many countries, and even research journals. A passionate example is provided by the Editor-in-Chief of *Progress in Physics*, who wrote in 2005 in a 'Declaration of Academic Freedom':

> The aim of this Declaration is to uphold and further the fundamental doctrine that scientific research must be free of the latent and overt repressive influence of bureaucratic, political, religious and pecuniary directives, and that scientific

creation is a human right no less than other such rights and forlorn hopes as propounded in international covenants and international law.[5]

However, social practices, norms and institutional approaches to shaping the future are not static. These are cultural processes which evolve dynamically as existing institutions change in their effort to meet challenges – those challenges themselves not infrequently arising out of the individual or collective actions by those same institutions. Thus for example, the governance innovation of the nuclear non-proliferation treaty and its associated institutions, including the establishment of the International Atomic Energy Agency (IAEA), have arisen in the face of the challenge posed by nuclear weapons capability, developed in response to threats of war. Consistently with this a key dynamic to the evolution of governance appears to be a process of challenge and response.[6]

For these reasons the concepts and practices of 'governance' can be considered to have co-evolved with other aspects of human society in a complex set of forms and practices, from the normative to the organizational, and from the scale of local community organizations through to the globally reaching institutions and activities of the United Nations, and across the various sectors of human activity, which for simplicity are frequently consigned to the (in part overlapping) categories of state, market, and civil society.

Practices of governance and institutions of governance have developed extending across physical and temporal scales from the local to the global as the challenges that they must respond to have increased in intensity and complexity. These challenges have themselves co-evolved with the ever extending presence of new technologies and scientific practices across human economic, cultural, organizational and political activity. The practices of science have also dynamically reshaped as the role of science becomes ever more central to the global economy, and the institutional forms within which science is practised correspondingly evolve. Much of the literature focuses on the stresses on scientific freedom posed as the organization of science is reshaped in a changing world.

Vincent Heath Whitney points out:

> In physical science, and increasingly in the social sciences, problems to be attacked are too big for one man. They require the approaches of several types of specialists, of men from several disciplines. They demand more knowledge than one man may possess or readily acquire. They cannot be answered without laboratories and computers and other types of equipment which are expensive and often not available to one investigator.[7]

Gordon, Marquis and Anderson observe that 'To obtain these facilities the scientist must become dependent upon large scale institutions such as universities, corporations, government, etc. To the extent that the scientist is dependent on these institutions, there is an inevitable loss in his freedom to choose research topics, to select methodological approaches, and to publish findings.'[8]

In recognition that 'the production of knowledge and the process of research were being radically transformed', Nowotny, Scott and Gibbons have argued that there needs to be much greater recognition and development of expertise in 'Mode 2' science which is 'socially distributed, application-oriented, trans-disciplinary, and subject to multiple accountabilities.'[9] This in turn can be set within a shift towards 'post-academic' research, in which research is more focussed on problems of interest to industry.[10]

The concept of scientific freedom and its interpretation and application is thus now required to serve in social, economic and organizational settings in which the roles of science and technology are rapidly changing and extending. It is therefore not surprising that the concept faces a similar challenge to that of governance itself (of which it is but one strand). This is the secular tendency within the Modern era, and the current period of transition, to increased complexity (in the sense of ever more interconnections between social actors – from individuals to transnational organizations – over all scales from the local to the global). The challenges associated with this complexification have been an important driver in shaping the evolution of governance as a whole.[11]

In response the evolution of governance has tended in a direction of 'papering over cracks' rather than wholesale revision. That is, it has tended to create new approaches and institutions without removing that which was already in place. The result has been the emergence of layers of governance innovation laid across prior legacy structures like the layers of an onion. Thus, whilst the presence of some prior forms may by now be vestigial compared with their earlier glory, all prior forms of governance from tribal to feudal, monarchic and theocratic, to democratic forms of governance may be found still distributed according to historical evolutionary circumstance across the planet.[12]

Taking the above into account scientific freedom can now be seen as one strand of a complex of governance approaches arising at a particular time in the face of a particular context. It was invented in a period of historical contestation between church, monarchy and an emerging merchant class. None of this is to say it does not still have relevance to this day, but the world in which it serves is vastly more complex, integrated and dependent on science and technology, and scientific and technological innovation, than it was when the idea first came to be advanced.

This evolving human world, marked as it is by increasingly intense, extended and complicated interaction between all sites of social, political and economic organization, spanning across all pre-existing jurisdictional boundaries, is a world confronted by an increasing challenge to a stressed governance system. The issues associated with seeking to control adaptatively (in the sense of with continuing viability) multiple global currents of increasing intensity – including, for example, the growing flows of money, pathogens, information, military and quasi-military threats, and greenhouse gases across the planet as they are shaped and broadened by the transforming political-economy and its technical infrastructure – create an increasingly formidable governance challenge.

It is this ever present challenge, co-evolving in dynamic interaction with the threats and opportunities, which in part emerge from existing governance failures, that suggests the planet is in a time of rapidly evolving transition between the verities and structures of the prior Modern epoch, to some new form. Only history will determine the extent to which what emerges will prove adaptative for humanity.

What is the relationship between the historically established concept of scientific freedom and the current struggle to shape governance to a form which will produce an adaptative future? By way of illustration it is helpful to consider this in the context of a concrete case study of a sector of human activity which exemplifies some of the ways in which the practice of science is evolving and broadening.

Nuclear power and Fukushima – challenges of governance

The development of the nuclear power industry, commencing in part as a counterfoil to the atomic bombing of Hiroshima and Nagasaki,[13] provides a potent example of science in context. As a sub-section of the global energy industry, nuclear power has represented the most technically challenging of all energy generation systems deployed to date, relying as it does on highly centralized systems involving very dense energy production using technologies deployed at the limit of the most advanced technical capabilities.

There is space here only to make a few points. First, the industry, worldwide, has employed thousands of scientists, engineers and other technical experts. Second, it has been the subject of vigorous international controversy over many aspects of its impacts, economics, potential contribution to lowering greenhouse gas emissions, and much else. As early as 1980 it was possible to detail significant nuclear power projects which had been stopped by citizen opposition (sometimes completed but unfuelled), governments which had been forced to and defeated at referenda over whether to embark on nuclear power construction, and nuclear power systems which had become so unpopular that governments had reshaped policy to a moratorium on further construction and phase out over time of existing reactors.[14]

In the course of these controversies it is not possible to characterize the role of scientists as having taken one side or the other. Nuclear engineers, radiation protection experts, biologists, nuclear physicists, statisticians, economists and many other types of experts could be found engaged in quite fierce controversy over whether this or that nuclear proposal should go ahead, or whether the nuclear industry as a whole was a sufficiently safe, viable or desirable approach to generating energy.

It is not unusual in scientific discourse for different scientists to be found aligning in contest over a vast range of issues – from the impacts of low level radiation to the safety of nuclear reactors in a loss of cooling accident. That is indeed an expectation within the norms of scientific freedom. However, this is not the end of the matter for, characteristically for the current period, scientists have been engaged in a wide array of different institutional settings. It is clear that many scientists in a particular setting might well feel inhibited in expressing contrary views to those of the perceived interests of the institutions in which they had become engaged.

What should the role of scientific freedom be in relation to this situation? The question could be posed normatively at the institutional level, perhaps seeking to create an adherence to principles of scientific freedom, by constraining institutions to allow their members to free themselves from institutional constraints. Such an answer however is confronted by a serious obstacle. Organizations are created precisely to achieve maximum collective effect. They frequently create constraints on their members precisely to advantage the collective effect of the collaborations within the institutions in competition with others in the broader world. From this point of view, the reasons for creating and maintaining an institution may be firmly opposed to norms and practices of scientific freedom. Also, as increasingly large numbers of scientific professionals are employed in these settings, the constraints are likely to grow.

The recent events at the Fukushima-Daiichi nuclear reactor complex[15] provide one (of many possible) helpful examples of these complications in modern scientific and technical practice as it now plays out through technological organizations.

Involving as it did possible leakage as a result of the earthquake,[16] followed by loss of cooling through flooding of the on-site generators, extensive core meltdowns in three reactors with the fuel assemblies being completely exposed to air for six to fourteen hours[17] and consequent hydrogen explosions, rupturing the containment vessels in all three, and a series of fires in the spent fuel pond of a fourth the accident, produced the greatest release of radiation from a nuclear plant since the accident at Chernobyl. The political and economic consequences for the local populations who were forced to evacuate and leave their homes and businesses for an indefinite period of time, and those who suffer the uncertainties associated with radiation exposure, and for the future of nuclear power itself as an energy source in Japan, and many other countries, were potentially profound.[18] Here it is enough to note that the role of professionals within such centralized and complex technologies seems so constrained and shaped by institutional location that the prime actors of interest are not so much scientists, whether or not enjoying some level of scientific freedom, but the institutions themselves. From this point of view the central issue was the scientific claims, arguments and associated actions with which key institutions sought to address the issues.

Some of the key institutional actors included the operating company (TEPCO), the Japanese local and national Government, the Japanese and multilateral regulating agencies (including the IAEA), the nuclear industry more broadly, a multitude of related or affected businesses, organizations of global and local civil society (such as local community groups in Japan, or Greenpeace International and its Japanese office) amongst many others. Consider, for example, the following features of the Fukushima reactors and the accident sequence:

(i) Before even construction began at Fukushima-Daiichi, design decisions with important technical implications for risk were shaped within institutional frameworks. Key to the accident was the decision of the relevant company (TEPCO) to plan, despite precedents of greater magnitudes, for a tsunami surge greater than six metres high (less than half the height of the tsunami that actually hit the plant), or for earthquakes at 8.9 on the Richter scale.[19] TEPCO of course would have weighed its own interests in making this judgement which included not only risk calculations but also the financial implications of different design alternatives.

(ii) The Fukushima-Daiichi reactor complex is one of the largest in the world. By siting some six large reactors together in one place (and not far also from other complexes such as Fukushima-Daini) the risk of chains of consequence leading to greater impacts was increased. Once again TEPCO would have been led in this direction by considerations of economic efficiency.

(iii) Despite decades of operation of the nuclear industry and several extremely serious prior nuclear reactor accidents (of which Chernobyl and Three Mile Island are the most publicized) preparation for the course of events as they actually unfolded was almost non-existent. Management relied on a ramshackle sequence of interventions, for example using fire engines, helicopters and even riot control vehicles to try to get sufficient water into the damaged reactors and fuel pond to reduce the level of meltdown already taking place.

(iv) The relationship between the national government, the nuclear industry and the regulational agencies in Japan has been notoriously close. Nevertheless the response was piecemeal with the Government complaining its information was insufficient and TEPCO frequently, especially in the critically important early stages of the reactor accident sequence, playing down the extent of the radiation releases, core damage and other safety concerns. Notable in the flood of multiple and conflicting information were the various estimates of the severity of the damage to the reactor cores, and the extent of radiation release and even the overall seriousness of the accident itself which was eventually rated as at the same level of seriousness as Chernobyl, but after much had already transpired and pressure was growing from many quarters for the seriousness to be recognized.

(v) The key technical need to monitor and inform vulnerable populations of how much radiation had been released was the subject of differing, and not infrequently conflicting information from the TEPCO, the Japanese Government, and officials from the nuclear regulatory agencies, consequent to levels of different sorts of radiation in different places. In order to rectify this a civil society organization – Greenpeace International – deployed its own team to monitor radiation and found significant hot spots of radiation in surrounding communities,[20] ultimately forcing further evacuation.[21] Other civil society organizations within Japan have taken on the task of measuring and publishing more systematic measurements. With the help of a web-site[22] volunteers had by August logged more than 500,000 data points across Japan with significant radiation levels being observed up to 200 km from Fukushima.[23]

(vi) Institutional considerations could also be seen in play in the scientifically controversial decision by the Government on 25 April to increase permitted levels of radiation for children (from the International Commission on Radiological Protection maximum dose for the public of 1 mSv/y to 20 mSv/y[24]) rather than order further evacuation. In some cases levels of radiation permitted to Japanese residents were above the levels at which the Soviet authorities had ordered protective evacuation around Chernobyl.

(vii) The judgement about whether nuclear reactors were an appropriate basis for future energy generation was seen being shaped in an interplay of conflicting institutional positions across all three sectors of society (state, market, and civil society), within Japan and elsewhere. The government was forced to step back from its previous stance of strong support for nuclear power.[25] In other countries a similar reconsideration was in play, perhaps most notably in Germany, with the government reversing its position and announcing a phase-out of nuclear power.[26]

(viii) At the time of writing there was emerging evidence of some efforts at government level to play down the severity of the on-going crisis at Fukushima with reports of a variety of measures by Japanese agencies to control information ‘harmful to public order and morality’,[27]

> a tantalising but so-far unconfirmed report of an agreement between the US and Japanese Governments to play down the severity of the events,[28] and revelations of decisions by the UK Government to launch a public relations campaign to play down any adverse implications of the Fukushima accident for new nuclear reactors in Britain.[29]

Much more of course could be said about the complex considerations and institutional forces brought into play by Fukushima, extending all the way from national political considerations, to potential impacts on the economic viability of nuclear power itself.[30] Enough has been said to show that the issues associated with the course of the damaged nuclear reactor complex and the management of its impacts are both scientific and institutional and stretch across many scales. So intertwined have been the two that the issue of scientific freedom is but one strand of the broader question of nuclear and energy governance.

More importantly, the sequence of events showed the sort of challenges for governance when there are close relations between powerful companies managing large-scale, highly-centralized technologies and centralized governance structures which are supposed to regulate the technologies. As in this case, these challenges can lead to a blind eye being turned to important and comparatively evident safety risks.

In this case a key missing factor was not the role of individual scientists but the extent to which institutions had been insufficiently subject to critical scrutiny, and failed themselves to account for the development of risks associated with their work which might manifest over long time-scales. Whilst it would not be a sufficient condition, one condition for more effective governance of such technical institutions clearly involves a much greater transparency allowing all affected parties to understand, monitor and analyse the impacts of decisions being made.

Science, governance, and the holoreflexive challenge

What can we draw then about what is required for confidence that the sorts of issues faced at Fukushima (and earlier nuclear accidents) will be adequately responded to? Clearly one pre-requisite is that all potentially affected parties, whether individuals or whatever their organizational structures, have access to information required for careful reflection on the implications of the nuclear industry. Clearly there also needs to be a capacity for their analysis and concerns to feed back into the shaping of energy policy. This is consistent with broader conclusions that we draw in *Worlds in Transition* about an overall trend in governance.

There is not room here to develop the full argument but it is possible to identify a few broad trends in the normative, legal and institutional architecture which from a planetary perspective, would seem to enhance the capacity of humans to manage adaptatively their social reality. That reality is, as already mentioned, characterized by an arrow of increasing complexity.

The trend towards increasing complexity has in part been driven by, and in part responded to, an equally clear trend in the enhancement of the speed, span and intensity of communication at all scales of human organization. This increase in communicative capacity has accompanied a similar development in human individual and collective reflexivity – that remarkable capacity of humans to contemplate and react to changes in each other and their environment utilising the full gamut of emotional and intellectual abilities.[31] From oral to written language through printing and then telecommunications and in its most advanced forms the complex intercommunication at lightning speed made possible by the Internet increased communicative capacity now stretching across the world has accompanied the development of reflexitive tools (such as global computer models, mathematical descriptions of the cosmos, and observational tools at the nano-scale) of unprecedented power and capacity. At the same time institutions have developed similar computer-based organizational, data processing and predictive tools enabling a powerful leap in institutional reflexivity.

In short we are in a period of rapid transition, which includes part as driver and part as response a dramatic transition in reflexivity. We have styled the ideal (if unachievable) end-point of such a transition as 'holoreflexive', that is in the direction of all parts of the system being able to know and reflect on the impacts of actions taken in any other part of the system not only on the component parts, but also on the whole. However, the development remains part of the two-edged sword of human technological and social progress, in that for each improvement in the capacity to respond to the increasingly complex challenges, new more complex and powerful challenges also emerge.

Human societies thus face challenges which are increasingly global and planetary in scope, yet must address them through a social order comprised of diverse cultures, societies, religions and civilizations. Addressing these challenges – to reconcile across all scales and sectors the one with the many – in this context is a, if not the, leading challenge of governance in the twenty-first century.[32]

It seems unlikely that any one governance structure can evolve, let alone be implemented in sufficient time, capable of meeting these daunting challenges. Rather, it must, in some way, be met in ways that build on what exists, resonates with local realities, but at the same time, satisfies the collective needs, from the local, all the way up in scale to the global.

Whilst clearly not the only thing needed, a prerequisite for creating a collective capacity to respond across 'the many' is a much heightened capacity for reflexivity at all scales of human organization. All sites in the society must be able to see, reflect and act (to the limits of their power and abilities) to a much greater extent than presently on the emerging state of the planet as a whole (and its constituent parts). They need to be able to see what needs to be done, understand how their actions may assist, and be able to understand the implications for them and those they care about of not acting constructively.

There is a potentially important parallel between the requirement for governance evolution in the direction of holoreflexivity and the earlier role of the concept and practice of scientific freedom. In each case a community is to be regulated by the collective efforts of its members and supporting institutions through an effort to maximise the capacity for critical reflection supported by access to the best analytic tools, and an open two-way process of communication. In each case this creates a process of collective self-regulation which supports the emergence of the best approaches. In each case the central tenet of highly reflexitive processes are supported by a normative commitment to the overall value of the enterprise ('communalism') and a series of methodologies (including the building of trusted forms of communication and processes of 'organized scepticism') in support.

The difference is that whereas the tenets of scientific freedom were to be applied primarily to individual scientists, the new requirements are for appropriate governance of a world of technologically powered organizations running across all three sectors of society (state, market and civil society). The need that was once expressed in terms of the scientific freedom for scientists is now in part incorporated into a need in the emerging 'layer' of governance at broader social scale, of holoreflexivity. In each case this is an ideal to be approached but perhaps never achieved, and in each case the need is enhanced by emerging challenges to which the society as a whole must find adaptative responses.

In Worlds in Transition we wrote:

> The gradual development of holreflexive capacities, we wish to argue is integral to the emerging pattern of human adaptation. Yet holoreflexivity is but a tendency. Potent though it is, it has to contend with a number of counter tendencies which may ultimately neutralize or substantially neutralize or substantially reduce its potency… Failure in this sense will probably mean societal and environmental breakdown of one kind or another. Success, as we define it, will permit a new and relatively stable balance to emerge in the organization of human affairs.

For individual practitioners of science the emphasis on scientific freedom has been a defining part of its claim to success. For the emerging world of scientific organizations and institutions similar considerations[33] lead to the conclusion that a (or perhaps the) defining characteristic of the present period of transition, and an important key to the outcome, is and will be the multidimensional contestation over holoreflexivity.

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PART TWO

Science and Society: Law and Regulation

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6

Freedom of Research and Constitutional Law

Some Critical Points[1]

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Introduction

Modern science is an intrinsically universal enterprise, which is at the center of many tensions. It requires huge investments, while governments are reducing funds for research activities. Intellectual property is in competition with openness and free exchange policies, and so on. A recent interesting document on stem cell research draws the following picture:

> Tension is increasing between fairly new and pervasive policies and practices governing data and materials sharing and intellectual property in science ("proprietary structures"), and norms of openness and free exchange. While intellectual property rights (IPR) can bring private investment into areas underfunded by governments and help bridge gaps between scientific invention or discovery and useful technologies, some new and emerging policies and practices risk slowing innovation in research.[2]

To the list of tensions we could add legislation and regulations that are inspired by strong religious or social ideologies and, as a matter of fact, change moral rules (which are binding only for individuals sharing those beliefs) into legal constraints. Further tension is caused by the specific nature of intellectual property rights, which are both a fundamental right, recognized by the *Universal Declaration of Human Rights* and other international instruments, and a vehicle of proprietary interests, which may reduce the circulation of information that is the basis for scientific developments.

In this paper, some critical legal points are presented and discussed, mainly from a constitutional point of view. Firstly, the question of what (if any) constitutional protection is reserved to the freedom of scientific research is addressed. Secondly, the balance of freedom of science with other fundamental liberties and rights, especially human dignity, is considered. Thirdly, some clarifications on the oppositions of observation v. manipulation and eugenics v. new eugenics are presented. Finally, the Myriad case on 'gene patenting' is discussed in the present status of pending appeal.

Modern constitutions and freedom of science: An overview

Is freedom of research protected at a constitutional level? The international constitutional experience is not unequivocal on the point and legal scholarship has not explored this issue deeply enough. Thus no obvious answer can be given.[3] Looking at the Constitutions of some European and Northern American countries, it is possible to immediately note that there are essentially two ways to deal with freedom of scientific research.[4] On the one hand, in Canada and in the United States constitutions have no specific provisions to protect freedom of scientific research. Thus such freedom ends up having to be protected as a specific aspect of the wider freedom of thought and expression (in the US protected by the First Amendment of Constitution and in Canada by Article 2 of the Canadian Charter of Rights and Freedoms).[5] On the other hand, some other countries' constitutional systems (particularly within Europe) expressly recognize freedom of research and teaching and the freedom of arts and science. For instance, Article 5 of the German Constitution states that '*Art and science, research and teaching are free*'; Article 33 of the Italian Constitution establishes that '*The arts and sciences as well as their teaching are free*'[6] and Article 59 of the Slovenian Constitution states that '*Freedom of scientific research and artistic endeavor shall be guaranteed.*'

More recently, Article 13 of the European Union's Charter of Fundamental Rights specifically addresses *Freedom of the arts and sciences* and states '*The arts and scientific research shall be free of constraint. Academic freedom shall be respected.*' Meaningfully, the explicative notes of the Presidium (widely recognized as the 'authentic' official explanation of the whole Charter) make clear that 'this right is deduced primarily from the right to freedom of thought and expression'.[7]

Within the group of European countries, some Constitutions limit their protection to the 'provision' of freedom of scientific research, while some other fundamental laws engage governments in promoting and supporting it. For example, the Italian Constitution states '*The Republic promotes cultural development and scientific and technical research*' (art.9); the Spanish constitution '*public authorities shall promote science and scientific and technical research for the benefit of general interest*' (art.44); and the Greek Constitution states that art, science, research and their teaching are free, and their promotion is mandatory for the State (art.16).[8] It has to be stressed, however, that the commitment to promoting research is often underestimated within the constitutional debate, because the corresponding position of who should benefit from this promotion is not so plainly visible or likely to be claimed by political initiatives. However this does not diminish the political importance that such a reference covers at the constitutional level.

In summary, within the European and Northern American constitutional panorama, several types of considerations (literally speaking) seem to be reserved to freedom of science: at a first basic level, this freedom receives the same kind of consideration given to all other fundamental rights included in the genus of freedom of thought and expression (and this is a basic point shared on both sides of the Atlantic Ocean); at a second level, we find a specific and explicit constitutional recognition for such a fundamental freedom (this is more the European experience); last, at a possible third level, some States are explicitly engaged in promoting scientific research. The first question that arises is whether differences in constitutional provisions and wording denote any difference in normative content.

Freedom of science and freedom of speech in the United States

In the United States and Canada, where freedom of scientific research is not explicitly mentioned in the Constitutions, it is the freedom of speech provision that guarantees a certain level of protection. However, whether the US Constitution guarantees a right to conduct scientific research and the extent to which the First Amendment protects the right to communicate the results of scientific research are both questionable matters. The basic question is whether 'there is something called "scientific speech" that merits distinctive constitutional treatment' and the answer of some authors is that 'there is no such discrete constitutional category of "scientific speech"'.[9] Uncertainty on this question is due to the fact that:

> whether the US Constitution guarantees a right to conduct scientific research is a question that has never been squarely addressed by the United States Supreme Court. Similarly, the extent to which the First Amendment protects the right to communicate the results of scientific research is an issue about which there is scant judicial authority.[10]

In very general terms, we can say that in US legal doctrine, there are two main attitudes towards scientific research and to what extent it is protected under the First Amendment. Some authors have no doubt (according to an *all-inclusive approach*) found that scientific expression is entitled to full First Amendment protection and stress that, even if the Supreme Court has never decided the question, under general First Amendment principles and prior assertions of the

Court as to the value of scientific expression, it is inconceivable that it would deny constitutional protection to such speech:

> The Court has generally taken an 'all-inclusive' approach to the protection of speech, asserting that all speech receives First Amendment protection unless it falls with certain narrow categories of expression that are of 'such slight social value as a step to truth that any benefit that may be derived from them is clearly outweighed by the social interest in order and morality'—such as incitement of imminent illegal conduct, intentional libel, obscenity, child pornography, fighting words, and true threats. Unlike these categories of speech, certainly scientific expression—considering its importance to the discovery and dissemination of certain truths about the world—contains sufficient social value to warrant First Amendment protection.

The Court has implied as much, as peculiar as it may seem, in cases dealing with the regulation of sexually explicit expression, by ruling that one important requirement for classifying such expression as obscene—and thus outside of First Amendment protection—is whether that expression, considered in its entirety, lacks serious 'literary, artistic, political or scientific value'. Relying on this basic rationale, most lower courts that have considered the question have concluded that scientific expression is entitled to full First Amendment protection.[11]

Other authors maintain that the *selective approach* gives a more accurate view of American free speech doctrine:

> This view posits that the level of protection afforded various types of expression depends on the free speech values that regulation of that speech implicates. Under this approach, speech will be rigorously protected only if its regulation threatens a core free speech value, not merely a peripheral one. Accordingly, in contrast to the *all-inclusive approach*, under which all content-based regulations (except for a few well defined exceptions) trigger 'strict scrutiny', only those regulations that implicate a basic free speech norm will be subject to such exacting judicial review.[12]

The two approaches respectively reflect the more common 'liberal' view, that sees rights as protections against social and political interference, and the 'republican' view, that conceives rights as claims to civic membership. From the republican perspective all citizens should enjoy a general right to free inquiry, but this right to inquiry does not necessarily encompass all scientific research. Because rights are most reliably protected when embedded within democratic culture and institutions, claims for a right to research should be considered in light of how the research in question contributes to democracy.

Despite the individualist-protective language of pre-political natural rights (used in recent claims for a 'right to research'), from a political point of view there is no general category of research and every scientific activity has to be carefully scrutinized, as 'the right to inquiry is stronger when the inquiry makes a distinct contribution to democratic processes than when it does not'.[13]

Observation vs. manipulation

The liberal and republican views are also evident with respect to the relationship between observation and manipulation in the scientific field. On some interpretations, protecting freedom of scientific research under the general provision of freedom of expression implies giving constitutional protection only to activities consisting in merely observing natural phenomena and diffusing the collected information, while not interacting with them. Consequently every research activity implying a 'manipulation' of its object (and genetic research is at the forefront), would not be protected under the First Amendment because of its nature of active intervention and manipulation (of living organisms). The Bioethical American Presidential Commission received this idea and stated, in the paragraph dedicated to freedom of scientific research, that 'most currently controversial biological research involves experimental manipulation of living matter, rather than theoretical exploration or mere observation of natural objects. It is therefore as much action as expression, as much creation as inquiry'. It continues by asserting that such an activity could hardly be classified as a form of expression: 'Scientists may have the right to pursue knowledge in any way they want cognitively, intellectually,' argues one observer, 'but when it comes to concrete action in the lab, that becomes conduct and the First Amendment protection for that is far, far weaker'.[14] On the other hand, freedom of manipulating matter using any kind of technique would not be absolute if compared with freedom of conscience: 'Something is not morally acceptable simply because it is technically possible.'[15]

Some criticisms can be made of this opinion. For example, it can be said that distinguishing between observation and manipulation, especially when referring to basic research, is conceptually groundless, because it is not possible to conduct research without interacting with the object of research and thus 'manipulating' it (using this effective metaphor). Even the simple observation is a form of interaction and therefore, after all, of manipulation/construction of the object. Furthermore, the contraposition between observation and manipulation does not stand the test of the facts. In scientific research activity there is no breaking point between speculative activities and activities that are more likely manipulative, because research in itself looks like a *continuum*: each phase implies the other ones and vice versa. Each stage of scientific research includes both authentic theoretical-observational and more practical-manipulative aspects in different proportions from time to time (let's not just think of the biological sciences, but also of chemistry and other scientific sectors).

It has to be noticed that no clear legal answer has been given until now to this interpretation, which is both highly controversial and leads to a very serious outcome: namely the discrediting of biological scientific research and excluding it from constitutional protection in those countries where there is no explicit constitutional provision related to scientific freedom and the only constitutional source is given by the freedom of speech.[16] A clear awareness of weakness in the observation-manipulation distinction and a clear affirmation of freedom of scientific research seem to be lacking in constitutional studies.

Balancing freedom of science in the EU: The case of human dignity

A very different scenario is that of countries where freedom of scientific research is expressly constitutionally protected. Different issues are at the center of debate. The crucial point is how freedom of research (which is assumed as an unquestionable constitutional provision) should be balanced with other fundamental liberties and rights, such as public safety, intellectual property rights and, most of all, human dignity.[17]

In the European jurisdictions mentioned above, the most frequently used concept to be balanced with freedom of scientific research in the field of biological sciences is *human dignity* and, thus, it requires some attention. As seen above, the European Union Fundamental Rights Charter establishes that '*The arts and scientific research shall be free of constraint.*' The explicative notes of the Presidium state '*It is to be exercised having regard to Article 1.*' Article 1 is entirely dedicated to human dignity and establishes that '*Human dignity is inviolable. It must be respected and protected.*' This provision finds its origin in Article 1 of German Constitution, establishing that '*Human dignity is inviolable. To respect and protect it is the duty of all state authority*', and it plainly has its historical basis in the political and cultural climate of Germany following the era of Nazism.

Once this is clear, we cannot avoid noticing that concepts of dignity and human dignity are elusive and hardly definable.[18] In constitutional legal terms the philosophical question about *what* is dignity and *how* it can be defined, turns into the following one: *Who has the power or the right to define human dignity?* States, representative political institutions, churches, scientists, physicians or anybody else?

The importance of this question and its answer is strictly related to how the relationship between human dignity and freedom is set up. If dignity encompasses liberty (so that it is correct to say that liberty is included in dignity), then whoever has the power to define human dignity has also the power of limiting the liberty of everybody else. Or in contrast, if we believe that *no dignity can be conceived without freedom*, human dignity becomes an essential attribute of freedom and the point of view totally changes. An idea of human dignity conflicting with freedom cannot be given, because without freedom everybody loses his dignity as well. Therefore, the only free subject is the one *who* has the power to define human dignity for himself.

From this second point of view freedom of scientific research (as an expression of the individual liberty of the researcher) is the rule and any possible limitation needs stronger and more specific arguments than that of human dignity, without any specification about the individual it refers to. One fair limitation to freedom of research can be found in the principle *not to harm others*. This principle '*requires liberty of tastes and pursuits; of framing the plan of our life to suit our own character; of doing as we like, subject to such consequences as may follow; without impediment from our fellow-creatures, so long as what we do does not harm them even though they should think our conduct foolish, perverse, or wrong*'.[19] However the principle not to harm others does not solve every problem as another problem arises as in Chinese boxes: 'Who are the others?' and 'How can harm be defined?'[20]

Finally the problem of *who* has the power to define dignity becomes more complex when powerful institutions that act as monopolists of dignity are against both scientific research in critical areas (such as embryonic stem cell research) and the autonomous decisions of the individuals in life and death matters. The balance's shift from individual rights to the power of institutions has important consequences on both the conceptual and the legal levels.

Rights from wrongs and a wrong theory about eugenics

From a historical perspective, constitutional provisions explicitly protecting freedom of research in several European countries look like a typical example of *rights emerging from wrongs*[21] of Nazism during the Second World War. Following Alan Dershowitz's opinion, it is essential to correctly identify the error that led society to affirm a freedom or a right. In the case of freedom of scientific research, the error is clearly identifiable in experimental practices carried out by Nazi doctors in concentration camps and in eugenics.

In my opinion we have to be very precise on this point and understand what made eugenics so unacceptable, whoever promoted it.[22] What is unacceptable in eugenics is not the fact of it being a *public health policy*, because also a mass prevention campaign against thalassemia would be such a public health policy, but eugenics is something more. It is a *coercive public health policy*. Removing one of these terms makes it impossible to exactly understand what is the focal and real basis of our rights and liberties as European citizens, and at the same time it makes it impossible to exactly understand what is the error not to be repeated: in the case of eugenics it is the coercive violation of personal integrity of women and men.

Recently some scholars have started to discuss a new danger or mistake: the so called *new eugenics*, which they foresee in certain medical techniques made available by science in recent years (like sex selection and others). They predict that individuals would be induced to utilize them under the pressure of fashion or marketing, producing an even more serious form of eugenics. In reality this fear of a new eugenics seems to be more likely a criticism of some contemporary psychological attitudes and lacks the negative characterizing element of the old eugenics: being a State coercive policy. The paradox is that the new eugenics has the aim *of protecting individuals* from being conditioned by allegedly imposed social models, but it ends up justifying laws, such as the Italian one on assisted reproduction, establishing the 'correct' approved way in which people must reproduce, under severe sanctions.[23] Ironically, the opposition to the *new* eugenics (and the related individuals' choices) turns into an old eugenic legislation founded on the illiberal assumption that only the State knows what is the right thing for citizens to do in their private lives and with their bodies. A document of the World Health Organization is clear on this point:

> We prefer the following working definition of eugenics: 'A coercive policy intended to further a reproductive goal, against the rights, freedoms, and choices of the individual [*emphasis added*]'. For the purposes of this definition, 'coercion' includes laws, regulations, positive or negative incentives (including lack of accessibility to affordable medical services) put forward by states or other social institutions. Cultures or medical settings may be implicitly coercive and are aware of the need for vigilance against tacit coercion, but considered such problems as part of the general social context rather than as eugenic programs. Under the above definition, knowledge-based, goal-oriented individual or family choices to have a healthy baby do not constitute eugenics [*emphasis added*].[24]

There is no doubt that science and law do not have the same reciprocal relationship and the same position in society in all countries, but the fundamental questions we ask ourselves are common. On closer examination, in fact, the above-mentioned American Presidential Commission report states principles not so different to the Italian law on assisted procreation. However the difference is that the American report aims to establish whether and how much specific research should be publicly funded, so not limiting (at least theoretically) private citizens' possibility of sponsoring research, while in Italy whatever the law does not expressly allow is forbidden under sanction. There is a great difference between the withholding of public funds in support of a practice, and the practice's criminalization.

Patents at the crossroad between IPR, Fundamental rights and scientific research

Freedom of scientific research has to be balanced also with intellectual property rights (IPR), a field which usually is at the center of great concern because of its related economic outcomes.

I think that, while dealing with the proprietary model connected with the IPR regime, we should not overlook that the real core of the patent regime is authorship rights (the right to see the products of one's own talent recognized). The Universal Declaration of Human Rights and the International Agreement on economic, social and cultural rights unequivocally recognize such a right to the protection of moral and material interests emerging from any scientific, literary or artistic production.[25]

Recently, the Myriad case[26] has heated the discussion about patenting of DNA, genes and, in general terms, living matter. The plaintiffs challenged the common practice of the United States Patent and Trademark Office (USPTO) of granting 'composition of matter claims' on genes if they have been 'isolated' from surrounding cellular material. The plaintiffs argued that isolating the gene does not change its function or informational value and cited cases finding that purification of a known material does not result in a patentable product, even if it is novel or useful in its pure form. The plaintiffs also challenged method claims (a claim which refers to an activity rather than to a physical entity) on the act of analyzing a claimed DNA sequence, or of comparing a DNA sequence to one claimed by a Myriad patent. Judge Sweet, a senior Second Circuit, New York District Court judge, ruled that 'isolated DNA' is not patentable subject matter as it is the same essential quality of DNA that exists in cells and, therefore, not markedly different from a natural product. Further, patent claims directed to isolated DNA are not patentable subject matter.

The decision shocked the biotechnology industry and Myriad promptly appealed. Currently the appeal is pending and many companies and commentators, who disagreed with the Judge Sweet's decision,[27] are confident it will be overruled. Meanwhile the United States Government provided a further shock: the Department of Justice filed an *Amicus Curiae* brief in the Myriad appeal, arguing that while the court was wrong in invalidating Myriad's particular patents, it was right stating that mere 'isolation' or 'purification' is not enough for a patent of something that is otherwise the product of nature. The *Amicus Curiae* brief maintains that the basic assumption of the seminal case of *Diamond v. Chakrabarty* (1980) is not under discussion ('anything under the sun that is made by man' is patentable). The only point is that the mere fact of isolation of genes is not enough (in terms of transformation of matter), according to the ordinary rules of patenting, in order to release a patent.

Needless to say, the relevance of the Myriad case exceeds the field of DNA patents and has effects on many other industries, particularly those that rely on extracted biomaterials. According to some authors, it is possible that, as genomic technologies move towards whole-genome analysis, policy arguments for patent protection for single genes become less compelling, and perhaps the intellectual property model challenged by the Myriad decision will have to be reconsidered. It will probably change how gene patents are written. The effects of the decision might be most strongly felt in the short term by clinical laboratories that develop new genetic tests based on single genes. However, evidence suggests that patents are less effective as an incentive to innovate in the field of genetic diagnostics than for pharmaceuticals.[28]

Other authors stress that DNA patent litigation is not novel, but this case is distinct from typical cases involving commercial rivals; heretofore neither side has an interest in the commercially suicidal attacking of the underlying concept of DNA patents. The American Civil Liberties Union (ACLU), representing the plaintiffs, has no such qualms and the ACLU, according to Dov Greenbaum, is 'fighting dirty': the United States patent system is effectively morally and social-context neutral, but the ACLU has succeeded in making social and political concerns the highlight of their legal case, even re-framing DNA as per our human understanding, as information, and as distinct from a simple double helical macromolecule.[29]

In general terms we might say that if the mere isolation of genes is no longer perceived as a sufficient transformative effect on the matter able to gain the patent protection it is probably true that another (the latest?) aspect of the era dominated by the idea that genetic information is inherently unique and should be treated differently from other types of information (genetic exceptionalism) has ended. Without having any regret.

An endless story

The issues discussed in this chapter demonstrate clearly the fact that scientific research is at the center of many contrasting forces and tension. Assuming the point of view of scientific research as a matter of freedom and of fundamental rights illuminates the whole field and provides the opportunity to see many facets and to deal with them. The high quantity and relevance of these aspects (economic, cultural, legal, constitutional and so on) makes easy the prediction that the story of freedom of scientific research is an endless story, having many turns, each of them with different content and balance.

7

Legal Methodologies for Maximizing Freedom of Scientific Research

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In 2006, I was invited to the First World Congress on Scientific Freedom, held in Rome and organized by the Luca Coscioni Association. I learned very much over the course of the conference, to some extent about what is happening in my own country – the work of Dan Perry, Bernard Siegel, the wonderful work done by scientists and people in the field of public policy in Italy and other countries. I was particularly impressed with the speech by Marisa Jaconi and with her success in Switzerland. There is one point she made that I particularly want to stress, and which may relate to the reasons for her success. That was her openness to opinions and values and arguments from the other side, the fact that she was willing, from what she said, to see her opponents as fellow human beings who just saw things differently. From what she told me in conversation afterwards, she was also open to her own doubts, admitting to which opened up her opponents to listening to her as a person of good faith who was willing to negotiate and who was willing to engage in dialogue.

Dialogue is what I would like to promote in this chapter, which includes not only attempting to persuade, but also opening one's own mind to what is going on with the people who oppose one. This is not just because I think it is right to do that – although I happen to think it is right and it seems to be my own natural predilection – but also I believe it to be essential to the process of persuasion. I think one is much more effective in persuading other people if one tries really to understand the other person's point of view, instead of assuming that he or she is your enemy holding diametrically opposed and unshakeable views.

The opposition to freedom of scientific research is very often identified with Catholics and the Catholic Church. I, myself, am as Catholic as Ariel Sharon, but my wife is an Italian American who was raised as a Catholic. I am much more tolerant in my dealings with people who have strong Catholic views than she is. I think this is in part because of her experience in being raised as a Catholic. My experience in dealing with Catholic legislators, with Catholic policy-makers in the United States leaves me feeling differently, in part perhaps because I teach at a Catholic Law School. I have for thirty-six years taught at a Jesuit University, where many of my colleagues are Catholic, some of them Jesuit priests. Many of my students and many of my colleagues are Catholic and I have found that they come in different shades of grey, that they do not all hold the same ideological views.

What I will discuss in this chapter, although this is all from the point of view of the legal system of the United States – and I do not mean to suggest that I can generalize beyond that – is how I think legal institutions, at least in that country, can be used, not to impose our pro-science position on other people but as institutions for encouraging and refining dialogue. John Harris suggested that the way to deal with these problems is for the most part not to struggle with them in the form of large, conceptual battles, but rather to deal with them on a case-by-case basis, trying to reach a compromise in one situation after another and gradually developing principles for making future decisions out of the decision-making process.[1] I will discuss how that works in more detail in the United States by talking about not only the legislative process, but a process, which is at least as important in the United States, that is the development of common law by our courts.

First, I think it is not at all odd that it should be Western democratic societies, rather than repressive, centralized regimes, like that in China, that raise the most questions about the propriety of various forms of research with human tissue. I do not find that surprising at all, because people in democracies are used to being listened to, people in democracies are used to thinking that their values count and that they should be able to express their values in law.

In the United States in particular, in a field I know much more about than scientific research – the field of patients' rights, in which I have worked as a lawyer, as a teacher and writer doing law and medicine and law and bioethics – the phenomenon we have experienced over the last thirty to forty years has been one in which physicians, who were sure they knew what was best for patients, have gradually had to accept the fact that patients are going to want to decide for themselves what is good for them. The oncologist, who forty years ago would say to a patient 'unfortunately, you have cancer, we are going have to start chemotherapy' is not likely to say anymore 'we are going to have to start chemotherapy'. The oncologist is forced to discuss with the patient whether the patient wants to start chemotherapy – once the patient has had explained to him what the likely costs and benefits are. And oftentimes a patient will decide 'if I only have six months to live, I would rather live those six months without the side effects of chemotherapy.' Although the doctor may know what is medically rational, although the doctor may think he or she knows what is good for the patient from a medical point of view, the patient is the best candidate for determining what is important to the patient, and the patient may not place medical science, medical successes, and longer life at as high a level as the doctor does.

There is also the fact, of course, that it is possible for a patient to believe that the 'medical point of view' may be skewed by human biases that influence physicians as they do all human beings. About ten years ago I was diagnosed with prostate cancer. My urologist scheduled me for a prostatectomy to take place five weeks later. I had five weeks to decide whether I was going to go ahead with prostate surgery, or radiation, or some other sort of treatment. During that period my wife and I sought advice from a number of physicians – surgeons, radiologists, and oncologists. In every case, the consultant recommended that the proper way to treat the cancer was with the treatment practiced by that consultant's specialty. It was hard not to conclude that even men of science can have their scientific opinions influenced by their own peculiar perspectives and interests.

What I want to suggest is that in the United States a lot of this carries over into attitudes towards research. To understand what is going on there and to better deal with it, I think we have to put ourselves in the shoes of those people who are objecting to some types of research. We have to do a better job of figuring out what is going on in their heads. If we do, I think we will find there are as many answers to that question as there are people who are objecting. What I have found in other areas is that different fact situations and different people present different problems and that, although there may be people who are ideologically driven, whatever that means – like the Jehovah's witness who takes advantage of his legal right to refuse a blood transfusion the doctor thinks he needs to save his life – there are many other people who are concerned about stem cell research for the same reasons that centuries ago people rallied to end slavery. They believe such research to be morally wrong, even though it may be to the advantage of many people in society. Despite potentially great benefits to patients, they believe we are inappropriately tinkering with human life and are undermining human values. Such people often express worry that we are on a slippery slope back to Auschwitz, to situations that will cause a loss of respect for human life. Our challenge is to be able to reach out and meet such opponents where we find them. Professor Wolpert argued that these are decisions for society – that the people in a free society must decide what they want to do with science.[2] He pointed out how necessary it was for us to involve ourselves in the legislative process for this purpose even though his one experience with legislators would not lead him to recommend the experience to others.

Happily I have had different experiences and I want to tell you about one which was reported about thirty-five years ago – in 1975 – in *Science* magazine.[3] That was back at a time when the concern in the United States was about fetal experimentation and about a growing movement to regulate or prohibit fetal experimentation, not only at the level of the federal government, but in the fifty states as well. I was involved in that process with a colleague of mine, a very brilliant, very devout Catholic professor at Boston College Law School by the name of James Smith, with a member of the state legislature by the name of William Delahunt – now member of the United States Congress – and with Dr David Nathan, then a brilliant young researcher at Harvard Medical School.

As reported in the *Science* article, a number of constituents came to Bill Delahunt complaining of horrible rumors they had heard about abuses occurring in the process of fetal experimentation in Massachusetts. Delahunt, who admitted in the article that he knew nothing at all about fetal experimentation and very little about medical experimentation generally, thought he was being alerted to a problem of brutality toward fetuses. Accordingly he proposed a bill in the state legislature that would have very severely restricted all fetal experimentation in Massachusetts – home to some of the most important medical research centers in the United States. People at Harvard Medical School found out about it, approached Bill Delahunt and his committee and raised their objections. I will not discuss the whole process, but in the end, as a result of the kind of legislator that Bill Delahunt was and is, somebody with ears as well as opinions, and as a result of the willingness to listen and compromise ultimately demonstrated by representatives of Harvard Medical School, a process of dialogue was developed which worked out a compromise that in the end was not entirely satisfactory to either side. Each side gave way. At the end the legislation turned out to be one of the less draconian, less strict statutes passed in the United States.

What also emerged from the process was an enormous mutual respect between the people on both sides of the negotiation – the legislators and the Harvard people. At the end, Bill Delahunt said he would be the first to admit that his original version of the bill would have been disastrous for research. He reported that his experience with the fetal research law was important to instruct him in the way of science and scientists. David Nathan ended up being a great fan of both Bill Delahunt and Jim Smith – my colleague at Boston College Law School. David Nathan speaks of his experience with Smith, Delahunt and the legislative process with great enthusiasm; he said: ‘At one point, when the fetal experimentation feud was at its height, I had Jim Smith come to speak at a meeting at the Harvard Medical Society. They thought they would make mincemeat of him. When he was finished with their questions, he had just destroyed their arguments. They really learned something.’[4] Nathan went on to become great friends with Bill Delahunt, who set up a committee that continued to deal with these issues. I played a small part in this process. It was exciting. It was a learning experience for everybody. So that is one way the legislative process can work. Of course, I realize that this is not the way it always works.

One problem with the legislative process is the strong leveraging effect it has on fervently felt moral beliefs that are held in any particular society. The highest goal of any legislator is to get re-elected. It does not take long for legislators to realize that the way to do that, since many people do not vote, is to take a position on some hot issue that he knows will turn people out at the polls who will vote to support him. As a result, very often, politicians in the United States will line up on issues like abortion, or stem cell research, or gay marriage, whatever it is, because they know it is an issue that will bring out voters. This may make it impossible to achieve reform through the legislative process, even when a majority of the people are in favor of reform. Those favoring reform may not be as ready to vote on the basis of that one issue as those who are opposed.

Luckily for us in the United States there is an alternative method for conducting legal dialogue and that is our process of common law development by the courts. It is a process of law reform I feel close to because I was a litigator and have been involved in litigating test cases in a few areas of the law. In that connection, I want to tell you briefly about the American experience with the development of the 'right to die' – a subject I have written about on a few occasions.[5] It starts basically in 1976, with the Karen Quinlan case,[6] a case very much like the Schiavo case in the United States.[7] Karen Quinlan was a young woman in a permanent vegetative state whose father wanted to be able to take her off life support. Mr. Quinlan was fearful that, if he did so, he would be charged with homicide. More important, the doctors who would be asked to take her off life support were worried they would be charged with homicide. Consequently they went to court, for essentially a judgment of the court that this would not be homicide. Of course they could have gone to the legislature to attempt to get the law changed, but it was very clear that that would be a hopeless task. One reason was that the case arose just three years after *Roe v. Wade*.[8] In the wake of the reaction to *Roe*, New Jersey legislators were very fearful of looking like they were taking an 'anti-life' stance. It was much better for them to just stay away from the issue – to just ignore it. But Mr. Quinlan knew that by going to a court he was putting his case before an individual who did not have to depend upon re-election. In addition, the judge could decide in favor of Mr. Quinlan on the facts of his case without having to make any sweeping pronouncements about the law that might govern future cases in a way that could not be reconsidered when those cases occurred. One of the most appealing aspects of the common law process in the United States and England is that judge-made law is developed one case at a time on the facts of the particular case before the judge. In deciding that it is acceptable to take Karen Quinlan off her ventilator, the judge will, of course, attempt to justify the decision on the basis of principles which are consistent with cases that have been decided in the past and which do not create too enormous problems for cases in the future. However there is always the possibility for a future judge to look back at the *Quinlan* case and say 'you know, the judge said there something which is too limited or something which is too sweeping. Now we are ready to go a bit further or ready to retract some of what we have done'.

This is what happened with *Quinlan*. There were many later cases following that rang important developmental changes – and not just in New Jersey. In the next year there was a famous Massachusetts case dealing with similar issues that achieved important progress.[9] There were decisions in other states as well. By the time the matter came up again in New Jersey some ten years later in another case – a series of cases – the law was changed even further.[10] In the meantime, the cases kept the public's attention drawn to the issues. This is another advantage of the common law court process. Public attention was focused on the Karen Quinlan case for decades. When she was taken off her ventilator, she did not die for ten years. Every once in a while, over that decade, the National Enquirer or some other tabloid newspaper would run an update story about Karen Quinlan. All these right-to-die cases – like the *Schiavo* case – have captured the attention of the public in the United States over a long period. So law reform litigation is, among other things, a very good strategy for raising and maintaining public awareness on particular cases. This may be a way of getting free publicity again and again, and at its core, it is a great way of gradually moving the law forward on a case-by-case basis.

One thing I want to warn against – and I think this is very important – is the overuse of constitutional principles to provide us with a victory in a way that causes deep-seated public resentment. We want to avoid ending dialogue on a particular issue in a way that bottles up arguments and causes a backlash. Unfortunately, I think that has been the case with the Supreme Court's treatment of abortion in the United States with its 1973 decision in *Roe*. I have believed from the moment it was decided that the decision was an enormous mistake. First of all, for reasons I will not get into here, I think it is a bad constitutional law – there was no constitutional basis for it.[11] I think what the Supreme Court of the United States did in *Roe* was essentially write one uniform statute for the whole of the United States, overturning the law in forty-six of the fifty states – including some of the laws which had made fairly recent reforms in the way that the criminal law dealt with abortion.

Most important, I think it was wrong because of the way it destroyed constructive dialogue. Prior to the decision in *Roe*, I had done some pro-choice work with an organization which was then called National Association to Repeal Abortion Laws. It is now the National Abortion Rights Action League. We were dealing with legislators, and it was my experience that many very Catholic legislators were open to discussion about why abortion should be allowed under certain circumstances, that they were willing to be reasoned with. Once *Roe* came down deciding that, as a matter of constitutional law in the United States, the fetus was not a person, they felt like the Court was telling them that their religious views were wrong – that they were wrong in believing that life began at conception. These people felt betrayed, they felt that they had been negotiating in good faith and that we had turned to the Supreme Court to unfairly impose overnight a rejection of their interests opposed to abortion.

In my opinion we have paid an enormous price since. In the United States at least, the resistance with respect to the right to refuse life-prolonging treatment, to the movement to legalize physician-assisted suicide, to the promotion of stem cell research, grows largely out of the distrust that followed on the heels of *Roe*. The simmering resentment and the constant effort to try to get *Roe* overturned has been sufficiently strong in the United States that it has not only blocked progress in these areas, it has resulted in Presidents being elected and it has given us, in my opinion, a Congress that people would never have voted for on the basis of other issues. So, sometimes you want to beware getting what you wish for too quickly, because it may, in the end – as a result of prematurely ending dialogue – result in ultimately putting you further behind than you were when you started.

8

Human Tissue Providers for Stem Cell Research

Freedom, Fairness and Financial Recompense

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In the attempt to ascertain whether stem cell science can fulfil its potential of creating treatments and cures for serious conditions, a variety of contributors have important roles to play. Scientists must use their own expertise and insight to explore how current knowledge about our bodies and their constituent parts can be used therapeutically. Increasingly, in the future, reassurances about the safety of resulting therapies will not be able to be given without the contribution of research subjects on whom such treatments can be trialled. Lawyers, ethicists and others will contribute to discussions about and the implementation of regulation to ensure that scientists' activities lie within appropriate bounds. However, in the stem cell research arena, none of this will be possible or necessary without reasonable access to human tissue samples. The freedom of scientists to explore the veracity of their hypotheses, to add to the body of scientific knowledge and to attempt to achieve therapeutic advances will be thwarted in its earliest stages if systems are not in place to facilitate access to such tissues. In this way, freedom on the part of scientists is intrinsically bound up with the freedom of tissue providers to make their tissues available.

Tissue providers will take into account numerous considerations in making the decision to contribute to the research endeavour in this way. In this chapter it will be argued that, where they decide to play this vital role, they should be provided with fair recompense for doing so. In making this argument, a specific category of tissue provider will be focussed on, i.e. women who make their ova available for stem cell research. Human ova can be used in stem cell research to create embryos through somatic cell nuclear transfer (SCNT, also known as therapeutic cloning). The techniques for this have not yet been perfected and many eggs will be required to be used if there is to be any hope of achieving scientific advances.[1] The argument that payment for the provision of ova to research would impair their ability to participate voluntarily by acting as an undue inducement will be considered. It will be concluded that they should have the freedom within appropriately regulated boundaries to play their part in stem cell research. Payment would allow them to contribute on a fair basis, and would not impair their ability to do so of their own free will.[2]

Recompense for ova in SC research

In the United Kingdom, the Human Fertilisation and Embryology Act 1990 (as amended) (the 1990 Act) governs the licensed use[3] and storage[4] of live gametes (eggs and sperm).[5] The Human Fertilisation and Embryology Authority (HFEA) is the regulator which oversees the lawful implementation of the 1990 Act. As part of this role it has explored the implications of and responded positively to scientists' indications that the success of some stem cell research depends on the ready availability of human ova.

In July 2005 it was reported that the stem cell scientist Ian Wilmut was considering asking women to provide ova for research purposes[6] while in September 2006 the HFEA revealed that scientists had made direct representations to it that SCNT research would benefit from a greater supply of ova and possibly also more recently collected ova than those available as a surplus from IVF treatment.[7] Between September and December 2006 the HFEA therefore undertook a public consultation on whether women in the United Kingdom should be permitted to provide eggs for research as non-patients, i.e. without this being linked to their own fertility treatment.[8] As a result it made a number of decisions, now incorporated into its Code of Practice,[9] permitting the provision of ova to SC research, whether connected to a woman's own treatment or not.[10] Ova provision, either through egg-sharing arrangements (in which some of a woman's eggs will be used in her own IVF treatment while the remainder will be made available for the treatment of others or for research) or as a non-patient, to HFEA-licensed research (i.e. research involving the creation and/or use of embryos) will be permitted, if considered to be appropriate by a Licence Committee. In doing so, the law has taken an important step towards facilitating women's freedom to make an important contribution to the scientific endeavour.

This author has argued that excised human tissue provided for use in stem cell research is a form of property for which appropriate recompense should be provided[11] and that ova providers in particular should receive fair recompense for their role.[12] Such recompense should be awarded on the basis of a tariff system which reflects the physical burdens which providers of certain types of tissues must undergo in the attempt to extract the relevant tissue.[13] The method of payment recommended is one based on a similar form of tariff system used as a starting point in personal injury compensation cases. The level of recompense provided would take into account the 'time, inconvenience, physical burden and risk' posed to the provider by the extraction of their tissue,[14] resulting in an award of £2,500 to ova providers.

Currently, all ova providers for research are entitled to capped reimbursement of any reasonable expenses they incur which directly relate to carrying out this role.[15] This reimbursement puts the woman back in the financial position she was in before the provision of her ova[16] and so cannot be classed as recompense for this provision. In addition, ova sharers may be entitled to a significant reduction of their own treatment fee where they choose to make some of their ova available for other purposes.[17]

The impairment of voluntariness – Undue inducement

The argument that women should be paid a reasonable amount for providing ova to stem cell research might give rise to concerns that the offer of recompense places women in a position of vulnerability by impairing their ability to make a voluntary choice about whether to expose themselves to the inherent risks. However, these concerns serve to highlight the dangers of an inadequate regulatory system, rather than being compelling arguments against recompense *per se*. A regulatory regime can include protections against such dangers so that they become irrelevant to the issue of whether or not payment is provided. To explore the validity of this argument, the concern that payment represents an undue inducement to provide tissue will be explored. The undue inducement argument posits that in making financial recompense available in return for ova provision, women will be induced to expose themselves to situations which they otherwise would avoid[18] raising the spectre of them choosing to provide ova in response to financial need, and to concealing information about their state of health.[19]

A simple inducement is 'the offer of a good meant to change our behaviour',[20] such as payment for products or services. This is generally regarded as acceptable; it would arguably be exploitative not to provide appropriate reward in such circumstances. In contrast, undue inducements involve two main elements: unacceptable risk and the removal of the ability to make a voluntary choice.

Women providing ova are exposed to a number of risks in doing so. To make their ova available, their reproductive cycles must be suppressed and then stimulated through medication.[21] Short-term risks include discomfort, mood swings, infections, bleeding and the risk of developing Ovarian Hyperstimulation Syndrome (OHSS)[22] but there is little information about the long-term risks of the drugs used to achieve these effects.[23] OHSS occurs in between 1–10 per cent of cases.[24] In its most serious form (occurring in approximately 1 per cent of cases of OHSS[25]) this condition has a mortality rate in the United Kingdom estimated at 1:30,000 cycles of IVF.[26] Minor additional surgical and anaesthetic risks are also inherent in the process of ova retrieval in which a needle is passed through the vaginal wall into the ovary.[27]

Thus, while the risks the process poses are rare, the most extreme form of complications is significant. Balen states that, 'there is insufficient evidence to suggest that women should not undergo altruistic oocyte donation because of the risk of OHSS. Indeed because of the self-limiting nature of the condition in women who do not conceive, those undergoing oocyte donation appear to be at lower risk than women receiving IVF treatment for themselves'.[28] Given that women are permitted to run such risks as part of their own treatment, and that the risks are arguably lower where the ova will be provided for research in the absence of their provider's own treatment, these risks can be deemed acceptable as long as the woman receives sufficient information about them to enable a voluntary choice.[29] It is for ova providers to decide, within an appropriately regulated arena, whether or not to expose themselves to risks in light of their wish to contribute to the aims of stem cell research[30] and that where they choose to do so appropriate recompense should be provided.

This leads us to the second element of undue inducement. The voluntariness of a consent to risk exposure can be impaired where individuals are incentivized by the offer of something desirable to expose themselves to excessive risks which in other circumstances they would not run, thus making their decisions less autonomous.[31] Payment to someone to assume reasonable risks does not necessarily raise ethical concerns, being comparable to the situation of workers in hazardous industries.[32] It is unreasonable to prevent an individual from taking such risks which they may see as being their only option to take action to improve their circumstances, for example by increasing their chances of conceiving a child through IVF.

Evidence exists that the provision of financial benefit is a significant motivating factor in the decision to donate ova generally.[33] Studies show that in the United Kingdom, Canada and Finland, where direct payment for ova is restricted, the number of women donating ova for reproductive purposes is less than half the rate of that in the United States where payment is permitted.[34] In one survey of women who had donated ova in the United States, 18.8 per cent of respondents had purely financial motivations.[35] However, altruism and the desire to help others was also a significant factor, with 32.2 per cent of respondents expressing exclusively altruistic motivations and 41.2 per cent expressing a combination of financial and altruistic motivations.[36] While this questionnaire related to women who had donated ova for reproductive purposes, in the United Kingdom, significant expressions of willingness to donate ova for research purposes have also been expressed by randomly selected survey respondents who were not receiving treatment for infertility.[37] The motivation for such willingness was said to be altruistic[38] but this was within a system where financial motivations would not be a factor as no such benefits are provided for non-patients.

In relation to egg sharers, although the reduction in IVF fees is not a direct payment, it has been reported to the HFEA that 'the vast majority of egg sharers are motivated by financial reasons'[39] although it is not clear from the limited statistics available on numbers of egg sharers whether the fee reduction has led to more women choosing to take this option.[40] Nevertheless, this observation appears to correlate with the experience in Belgium where, since a policy decision was taken to provide six free cycles of IVF, the number of ova sharers has fallen by around 70 per cent.[41] It can therefore be concluded that the UK policy of providing a reduction in IVF fees to ova sharers is a significant financial benefit, perceived as such by its recipients, which is not made available to non-patient ova providers and it is highly likely that this factor will be taken into account by ova providers in their decision-making process. On the basis of evidence from systems where payment is made for ova, it is not unreasonable to conjecture that were appropriate recompense available in the United Kingdom, this would provide an incentivising factor to provide ova to research in combination with the altruistic grounds expressed for this willingness.

An argument could be made however that such payments would represent an incentive to the poorest in our society. The fact that offering payment in return for contributing to scientific endeavour may lead to 'preferential enrolment of the poor'[42] applies in many commercial practices, not just those relating to human tissue.[43] Emanuel is of the view that this element is really an issue of justice, stating, 'when one is tempted to charge "undue inducement" because of too many poor people enrolling and the possibility of exploitation, the response should be to increase the inducement',[44] while Wilkinson queries whether there is a general duty on society to improve conditions for the poor so that they do not have to enter into such arrangements.[45] Guidelines provided by the International Society for Stem Cell Research suggest that payments to non-patient ova providers are acceptable as long as they do not constitute undue inducement to make such provision.[46] One criticism of this approach is that 'to avoid undue inducement, as required by the ISSCR Guidelines, one would have to insist that women from poorer nations be paid considerably less for their eggs than women from wealthier nations (or insist that all women be paid the same low amount, an unlikely scenario and an ethically troublesome one)'.[47] To follow the potential consequences of this approach, this may lead researchers to seek out those women to whom, under the guidelines, lower payments should be made in order to avoid undue inducement, thus encouraging their exploitation.[48] This leads to a vicious cycle in which:

> [T]o avoid unduly inducing women from poorer nations to undergo superovulation and egg retrieval, one would have to keep payments small; but in doing so, one creates the problem of these women being exploited. Yet by increasing payments to try to eliminate the exploitation, one reintroduces the problem of undue inducement.[49]

A consideration of mechanisms to improve the overall level of wealth within society is beyond the scope of this chapter. Suffice to say that if levels of risk to which tissue providers are exposed are judged by the regulator, after appropriate consideration, not to be excessive, it should not matter whether the tissue provider is wealthy or poor – both are entitled to the same levels of information, the same protection from exposure to unreasonable risk and the same opportunity to obtain financial recompense for their contribution. This financial recompense should fairly reflect the impact on their body which such provision has and, while having potential to act as an inducement, is not so large as to impair the voluntariness of their decision. The tariff system proposed recommends payment of relatively modest sums to ova providers, which would be unlikely to be such a strong incentive that it would cloud judgement about risk taking.[50]

In the clinical research setting, studies have led to the conclusion that although higher payment for participation in clinical trials also incentivized participation in this context, there was no evidence that this blinded subjects to the potential risks.[51] If the suggested tariff scheme was established, the amounts paid to tissue providers would not be so disproportionate to the risks posed that it was impossible for a potential donor to refuse to participate. Women who are provided with accurate information about the risks will therefore be able to make an autonomous decision[52] about whether to provide ova for research. Providing reasonable payment to women who make their ova available for others' purposes is part of ensuring that they are treated fairly.[53] Given that little is known about the long-term risks of ova stimulation and extraction however, where this is permitted for research purposes, the regulator should impose a burden on the researchers to collate information about the nature and extent of the risks that are realised so that over time an accurate assessment of all risks can be used in assessing the risk: benefit ratio.

Conclusion

Ova providers make a raw material available to science which is vital to the success of this type of research and without which, advances in stem cell therapies are unlikely to be made. In addition, the contribution they make is an intrinsic part of the facilitation of scientific freedom in this arena. This is not adequately acknowledged under the current regulatory regime in the United Kingdom. A carefully judged tariff system of recompense, while being one factor which women would take into account in their decision, would not put them in the position of being unable to refuse to participate in the fact of undue inducement. Rather, the provision of relatively modest sums, appropriately justified within a scheme monitored by the regulatory agency, would mean that women would have the freedom to choose whether or not to contribute to scientific research in this way and would be able to be reassured that they were being treated fairly in doing so.

9

Ideology, Fundamentalism and Scientific Research

Lord Dick Taverne
A member of the House of Lords and a former Treasury Minister

The Enlightenment was the glorious period in our history which laid the foundations of our present civilisation. Science was its main architect, because it challenged the superstitions that dominated life and rejected the authority of the church as the arbiter of truth. Before the Enlightenment Calvin could claim to refute Copernicus with the text: 'The world also is established, that it cannot be moved'[1] adding: 'Who will venture to place the authority of Copernicus above that of the Holy Spirit.' Galileo could be terrorised by the Inquisition into recantation. However, gradually it became accepted that the way to the truth about nature lay not through the Scriptures or the religious interpretation of heavenly portents but through the scientific method, through the freedom to experiment and rely on evidence, not authority. The tyranny of religious dogma was defeated.

Dogma has always been the principal threat to the freedom of scientific research. In the last century the threat to scientific freedom came from ideological rather than religious sources, although local restrictions on research using embryonic stem cells show that the influence of religious dogma has by no means disappeared. However, it was the dictatorships of communism and Nazism that most affected science. In the Soviet Union a rigid ideology that passed for thought among the ruling caste poisoned all science that did not relate to military purposes. Lysenko ruled in biology and under his influence, backed by Stalin, 'bourgeois, class-ridden' genetics was banished and the doctrine of Mendelian inheritance was denounced as 'the ravings of a monk'. Science fared little better under Hitler, who declared: 'We stand at the end of the age of reason. A new era of the magical explanation of the world is rising, an explanation based on will rather than knowledge.'[2] Science was not proper science if it was practised by Jews. Conventional academic medicine was replaced by herbs, homeopathy, sunshine and fresh air.[3] Indeed in some ways the Nazi regime was a distorted kind of green regime, which much favoured the 'Back to Nature' movement and also strongly opposed-vivisection. It is an irony of history that the SS were taught to show the deepest respect for animals.

Today it would be wrong to overstate the threat to the freedom of academic research in the developed world. On the whole science flourishes as never before. Yet there are dangerous undercurrents and in some fields powerful anti-science influences not only inhibit research but have caused major harm to the welfare of millions of people. Of these influences eco-fundamentalism is probably the most significant.

Fundamentalism is normally associated with a religion that bases its beliefs and actions on the literal interpretation of a sacred text such as the Bible or the Koran, whose truth cannot be challenged because it is the Word of God. In that sense there are no eco-fundamentalists because there are no sacred ecological texts. Not even Rachel Carson's '*Silent Spring*' has achieved such holy status.[4] However, some opponents of genetically modified crops have become so passionate in their opposition that no evidence can shake their belief that the crops are harmful to humans and to the environment.

For example during an inquiry by the Science and Technology Committee of the House of Lords into GM crops, the then director of Greenpeace UK, Lord Melchett[5] was asked: 'Your opposition to the release of GMOs, that is an absolute and definite opposition, not one that is dependent on further scientific research?' Lord Melchett: 'It is a permanent and definite and complete opposition.'[6] A belief that cannot be affected by evidence has all the characteristics of a religion and the actions of Greenpeace in preventing the cultivation of GM crops have so much in common with an evangelical crusade that its opposition can legitimately be described as fundamentalist. Unlike practical environmentalists, who take account of what is happening and see science and technology as allies, Greenpeace and its allies Friends of the Earth either ignore, or dogmatically contradict the record of GM crops so far. It is worth stating briefly what that record is.

GM crops are now cultivated in 29 countries on over 160 million hectares by 16.7 million farmers, of whom over 15 million are small-scale, resource-poor farmers in developing countries. The 94-fold increase of the area cultivated between 1996 and 2011 is the fastest rate of adoption of any technology in the history of modern agriculture.[7] The reason for this rapid growth has been its benefits: GM cotton farmers in China and India have seen their income increase and health improve because they have to spray less pesticide. GM crops generally improve yields and reduce the use of chemicals. GM crops have made no-till or low-till agriculture possible and since unploughed land is rich in organic matter and provides food for plants, as well as being rich in earthworms, insects and microbes, the environment and farmers benefit. Further, despite their world-wide adoption over more than a decade, there has been no evidence so far that GM crops cause any harm to human health or to the environment. That has been the clear verdict of every National Academy of Sciences in the world, the Royal Society, the American, German, French, Mexican, Chinese, Brazilian and Indian Academies of Science.[8] Furthermore the next generation of GM crops promises to help solve the growing crisis in world food supplies as the human population increases and good agricultural land and water become scarcer. Stress – and disease-resistant new plant varieties are in the pipeline which will not only increase yields but can off-set damage caused by climate change. Why do Greenpeace and Friends of the Earth reject this overwhelming evidence? Because their eco-fundamentalism tells them it cannot be true, just as the Pope's representative is reputed to have refused to look through Galileo's telescope at the newly-discovered moons of Neptune because his religion told him they could not exist.

However, does this eco-fundamentalism actually inhibit or suppress the freedom of research?

First, it does so through blatant violence and intimidation. Nearly every field-trial of a new GM crop in Europe has been trashed by anti-GM campaigners who do not wait to see what the experiments would prove. These vandals are the modern equivalent of book burners, or those who burned witches before it could be established whether they were guilty of the crimes they were accused of. Universities have stopped doing research because of intimidation. Two German universities banned crop trials because they had been damaged by green campaigners. The president of one university said 'We are no longer able to deal with the massive opposition. The university has a reputation which we cannot risk losing.'[9] It is a strange defence of a university's reputation for academic integrity that it is abandoning research because of blackmail by ideological extremists.

Research is also inhibited because any new GM crop variety that is its product cannot be commercially grown in Europe, and if cultivated in African countries which desperately need the benefits they can bring, cannot be exported to Europe. Ideological green campaigners have stirred up hysteria about GM food with cries of 'Frankenfoods' and have driven GM products off the shelves of supermarkets, not because their proprietors believe the products endanger customers' health, but because they reasonably fear damage to their shops. Several EU countries have banned GM crops altogether. Throughout the EU, imports of soya with more than 0.9 per cent GM content are banned.[10] The result is that agro-businesses have either left the EU or do no research and development in Europe related to GMOs. Some research continues in agricultural research institutes, but it cannot be denied that eco-fundamentalists have suppressed much valuable research into plant science in Europe.

Europe's rich consumers can perhaps afford to ignore the benefits of GM crops, although in time, when more nutritious and cheaper products come on to the market, attitudes will no doubt change, but the harm done in Africa by anti-GM NGOs, especially Greenpeace and Friends of the Earth is incalculable. It has been documented devastatingly in Robert Paarlberg's book, '*Starved for Science – How Biotechnology is being kept out of Africa*.[11] Today there is hope that the vital contribution biotechnology can make to Africa's desperate food problems will no longer be ignored, because the Gates Foundation is investing in several transgenic staple crops, such as potatoes, sweet potatoes, cassava, millet and sorghum, rice and maize. If introduced, they could boost the low productivity of most African farmers. The Foundation is also supporting local R and D by African biotechnologists. In the past, however, commercial trials of all these crops have been held up by political opposition from governments on advice from NGOs, whose influence in Africa is huge. Governments depend on them, partly because of the good work they do in providing education and healthcare. It is a tragedy that this good work is offset by the influence of eco-fundamentalists who have done everything they can to prevent Africa benefiting from the application of modern science.

Another way in which research is inhibited and suppressed is by the success fundamentalists have had in imposing a system of over-regulation of GM crops that does not apply to equivalent (and often inferior) conventionally-grown crops. It takes many years longer and costs at least ten times as much to bring a new GM crop to market as its conventional equivalent. The history of so-called ‘golden rice’ is a tragic example. By engineering a bacterial gene together with two daffodil genes into rice to make it synthesise the micronutrient beta – carotine, which when eaten is converted into vitamin A. This GM rice has the capacity to save millions of children in Asia from going blind from vitamin A deficiency, but its introduction has been delayed for many years by the regulatory requirement of a variety of tests designed to guard against every possible hypothetical risk, however remote. Other varieties of rice grown all over Southeast Asia have also been shown to be ‘genetically modified’, but accidentally as the result of mutations, chromosomal recombinations, translocations of pieces of DNA and even deletions of sections of DNA. These varieties were not required to undergo any laboratory tests imposed on golden rice. As Ingo Potrykus, the chief progenitor of golden rice, has observed, no scientist or scientific institution in the public domain has the funding or motivation to go through the process golden rice has had to go through which also applies to other new GM crops. Only large companies or very rich charities can afford to develop such crops, and large companies inevitably concentrate on those crops for the rich world that promise large profits.[12]

GM crops are a prime example of the way fundamentalists block research but ideological influence has a more general impact on other research and innovation, namely through the precautionary principle. Actively promoted by the greens, this principle has become embedded in several EU protocols and other EU legislation. It seems to be so widely accepted that it has almost become an eleventh commandment: ‘Thou shalt not take any unnecessary risk.’

The principle itself is more frequently invoked than defined. There are at least fourteen official definitions, none of them particularly helpful and some positively harmful if put into practice. When analysed they are either so obvious that they do not need stating: (‘Where there is serious risk of harm, be careful’), or so vague as to be meaningless, as in the Cartagena Protocol,[13] or in a form which counsels caution even when there is no significant scientific evidence of risk. Its most common form is: 'when an activity raises threats of harm, measures should be taken even if some cause and effect relationships are not established scientifically'. In effect this allows public opinion to decide whether an innovation that requires a government licence should be permitted. Fears may be aroused by green campaigns, television programmes, articles or letters in the press and may have no evidence to support them. Public opinion does not always show an understanding of how science works.

The precautionary principle is a major obstacle to innovation because it can be, and has been, invoked by those who seek to frustrate the development of anything of which they disapprove. All they have to show is serious concern about harm. It plays into the hands of scare-mongers. If innovation is affected, so is scientific research. Indeed the reality of the danger to research is underlined by the warning from Carl Djerassi, who developed the contraceptive pill, that in the present climate of widespread suspicion towards science he would never have been able to develop and launch the Pill, with its huge benefits for women's right to choose.[14] Finally, there is another threat, not from fundamentalists, but from scientists themselves. Having looked at the evidence I accept the assessment of the International Panel on Climate Change that there is a more than ninety-five per cent probability that mankind's activities make an important contribution to global warming.[15] I find the objective approach of the report of the scientific committee of the IPCC, which acknowledges areas of uncertainty (they have also admitted some mistakes) very impressive and convincing. I am disturbed that there is a sizable section of the public, not only in the United States, but also in Britain and some other parts of Europe, that is not convinced that there is a serious danger of a significant rise in global temperatures within a relatively few decades. It does not accept that it would be damaging to large areas of the world and would affect all our lives. However, the degree of consensus among climate specialists about what is happening, or likely to happen, should not discourage discussion of the prevailing orthodox view or even dissent. Yet some of the supporters of the majority view are so convinced of its importance that they call for dissent to be suppressed. There is more than a whiff of intolerance in the air.

For example, the *Guardian* columnist George Monbiot celebrated the 'recanting' of the *Sun* and the *Economist* newspapers when they appeared to retreat from their previous somewhat skeptical views about climate change.[16] 'Recanting' was forced on Galileo by the Inquisition. It means a public confession of error in matters of religion. Others frequently compare climate skeptics to holocaust deniers. One enthusiast for conformity, an Oxford academic Mark Lynas, has written: 'I wonder what sentences judges might hand down at future international criminal tribunals on those who will be partially but directly responsible for millions of deaths from starvation, famine and disease in decades ahead.'[17] Skeptics, he argued, would be just as responsible for future deaths as those who were responsible for the holocaust.

In my view this intolerance of dissent is dangerous. Some respected scientists too are among the skeptics. More important, what I as a non-scientist but a politician note and admire about science is that very few issues are ever settled and only when they have withstood every attempt at falsification. Evolution seems to be one exception and no one now argues that the world is flat. Even Relativity Theory has been the object of debate and, I understand, some emendation, but global warming is a complex issue and many aspects of it are still subject to some uncertainty.[18] Continued debate and questioning, even of conclusions for which there is a more than ninety-five per cent likelihood that they are correct, can surely be healthy rather than dangerous.

One of my heroes is the political philosopher John Locke, who can justly be regarded as the father of liberal democracy, not least because of his total opposition to dogma and extremism. He was a great admirer of the experimental approach of science and argued that rational beings should hold their opinions with a measure of doubt. We should be wary of imposing our opinions on others. He wrote:

> It would, methinks, become all men to maintain peace, and the common offices of humanity, and friendship, in the diversity of opinions; since we cannot reasonably expect that anyone should readily and obsequiously quit his own opinion, and embrace ours, with a blind resignation to an authority which the understanding of man acknowledges not. … For where is the man that has incontestable evidence of the truth of all that he holds, or of the falsehood of all he condemns; or can say that he has examined to the bottom all his own or other men's opinions?[19]

It is easy to denounce the intolerance of those with whom we disagree when they seek to suppress views that they believe to be dangerous. It is just as important that we are not indifferent to the intolerance of those with whom we may broadly agree and who seek to suppress views with which we also disagree.

10

The Future of Scientific Research

Compromises or Ways Forward?

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Introduction

'The future is not ours to see', as the song goes, and thus, it may be argued, the future of science is hard to predict. Yet politicians and policy makers[1] must attempt to predict the future or at least take measures to amend the mistakes of the past.

Scientific research is a good from which we all benefit. We all profit from living in a society that pursues scientific research.[2] Freedom of science is a prerequisite in the protection of fundamental human rights: for example, freedom from preventable diseases, the right to a better society, to health, and to knowledge. Therefore, in this chapter we argue that the future we should all strive for is one in which science can flourish to the benefit of all people.

In spite of its obvious value, scientific research is frequently the arena of acrimonious debates. These often occur in areas of science that involve the use of human beings or of human materials, and in those that promise (or, according to some, threaten) to modify human 'nature' (most often undefined) or the environment.

These debates are often useful to the ethical progress of science. For example, just after the end of the Second World War, various international organizations produced ethics guidelines relating to the balance to be drawn between scientific development and what can ethically be imposed on research subjects for that development to occur. Debates on the ethical principles that should guide science have imposed limits to the freedom of researchers, but have perhaps better guaranteed global standards of legitimacy and allowed science to progress with greater respect for human rights.[3,4]

On other occasions, however, debates seem informed more by ideologies or irrational fears, rather than by a genuine concern for the health and dignity of human beings (both those involved in research and beneficiaries of research). This seems to have been the case with some areas of medical sciences, in particular research on cell nuclear transfer and stem cells.

In this chapter, we consider how in Europe some sensitive issues around these areas of science have been addressed, and the way in which some compromises, or ways forward, have been found. We provide a brief narrative of the political debates around cell nuclear transfer and embryonic stem cell research, in order to highlight how divergences in political or ideological faiths may be balanced out for the benefits of science and society.

We shall argue that, in cases in which science raises important concerns and strong ideological opposition, it is crucial that politicians mobilize to divulge proper information about the methods and aims used in the areas of science under scrutiny, that they highlight the purposes of those areas of science and that they identify and address any serious concern that the public may express.

Politicians need to go beyond their ideologies, for the greater benefit of societies, and establish a synergy with experts, scientists, the media, groups with different ideas and visions, and engage in an informed and accessible way with the public. Politicians, because they are responsible for the public *res*, must remind themselves and each other that science is for the people, and this goes well beyond their particular political credo; scientists should also be accountable to the public, and politicians should favor a mediation between experts and lay people, in the interests not of their ideologies, but of the people.

On the freedom of scientific research

Defending freedom of research, in our view, is a part of a more general defense of people's freedom. Defending freedom of science is not akin to saying that there should be no control or no limits imposed on scientists. Science has to progress in an ethical way. Research subjects must be protected, be they human or non-human animals; money spent on research, rather than on other goods, must be justifiable to the public; scientists must be held accountable to the public as well as to the scientific community for the public money that they spend. Above all, the results of scientific research cannot be applied blindly, regardless of their consequences for human welfare. We are therefore not advocating unregulated freedom. We are, instead, emphasizing that it is in everybody's interests to live in a society that pursues scientific research. Life expectancy has raised and is rapidly increasing in many parts of the world; people's quality of life has generally improved greatly; many diseases that were lethal are now treatable. Of course this raises a further issue of global justice, in that the results of scientific research are often unevenly distributed.

This, however, is not an objection to science itself, but to how its results ought to be distributed. Because of the great benefits that each and all of us can draw from freedom of science, if and when such freedom is to be restricted, it has to be on stringent grounds. Freedom of research can and should be restricted when it is highly unlikely to yield benefits to the human kind, or when it is highly likely to yield significant harm. In all other cases, research is to be regarded as a public good, and as such, is to be defended and protected. If anything, the political debate should focus on how to ensure that disadvantaged populations or communities not be excluded from the good.

It is really surprising how as soon as research and the results obtained from it are in use, such as in treatments which are suddenly widespread and common, they are taken for granted, as though everybody has forgotten that they were the fruit of years of research, of freedom of research, of investment, of fundraising, of volunteers' support. In this light it was with the greatest anxiety that many awaited President Obama's decision to lift restrictions on federal funding of human embryonic stem cell research, so turning a new page after the somewhat destructive outcomes of the alliance of the Bush administration with other countries and institutions.

The opposition of the Bush administration was not, of course, an isolated case: embryonic stem cell research has been at the centre of many heated ethical and political debates. Many readers will also be aware of the bans against so-called 'reproductive cloning'.[5] We believe it is important to highlight some aspects of the political debate in Europe in the last decade on these areas of science, as one of the authors of this chapter has been directly involved in that debate, and in decisions relating to the European funding for research involving both the use of embryos for scientific purposes and for so-called 'therapeutic' cloning. We shall not discuss the philosophical and ethical issues around the moral status of the embryos or the logical stringency of the reasons against 'reproductive cloning'.[6] Also, we shall not discuss the scientific aspects of these two areas, as these go well beyond the remit of this chapter.

Sensitive areas of science: The case of cell nuclear transfer

As is well-known, after the news of the birth of Dolly the sheep, released by Nature in 1997,[7] international organizations came together to condemn the application of cell nuclear transfer (ordinarily known as 'cloning') to human reproduction.[8] Policy-makers promptly received the given advice: 'reproductive cloning' is now either illegal or in practice prohibited everywhere. The panic around it, also fed by fiction and false claims by pseudo-scientists of dubious credibility[9] in reality was also an expression of the ethical concerns surrounding 'non-reproductive cloning', and thus the technique of cell nuclear transfer in all its forms.

The opposition was fierce and came from different parts, but perhaps the United States and the Vatican, for once in concert, proved the most influential, at least from a political point of view. Opponents to cell nuclear transfer contested that the technique was unsafe, dangerous, that it would lead, across a slippery slope, to all kinds of manipulations of human nature as well as to macabre forms of exploitations of vulnerable humans. The main objections to cell nuclear transfer were that the refinement of the technique, even its therapeutic potential, would confer on scientists the powers of Gods, would enable unscrupulous scientists to create humans, perhaps to harvest their organs, or for reproductive purposes, thus at best endangering the genetic pool, violating people's right to genetic identity, and at worse creating armies of new Hitlers ready to conquer the world. We have witnessed a bout of catastrophic thinking at its very best in the debates around cell nuclear transfer.

To some, certainly cloning was opening a whole new era of unethical experimentation on human beings. But none of this has taken place. People have not been treated worse because of the refinement of the technique, improbable armies have not been created, and the tones of conversation have, with time, significantly quietened down.

Many argued right away that this was nonsense. One of the authors of this chapter campaigned,[10] with many others, to reject the proposal to ban all forms of cloning without making any distinction between 'reproductive' and 'therapeutic' cloning.

The opposition against 'cloning' was not only the result of ideology but perhaps, even more strikingly, of ignorance. For that reason, when in April 2004, the UN Commission on Human Rights gathered together in Geneva to discuss cloning, the Nonviolent Radical Party (NRP) chose to approach the Commission on Human Rights, rather than the Scientific Commission, believing that the issue related first and foremost to the right to knowledge. Four months of international mobilization, coordinated with the US-based Coalition for the Advancement of Medical Research and the Genetics Policy Institute, had the effect of substantially scaling down the proposal at the United Nations. The NRP appeal 'against an international ban on human embryonic stem cell research for therapeutic purposes' gathered more than 1,500 signatures of members of national parliaments, academics and scientists. Among them were 77 Nobel laureates.

Also thanks to this effort, in 2005 the UN General Assembly opted for a non-binding declaration on human cloning instead of a binding convention, due to a divisive vote on the question of human reproductive cloning being deemed different from therapeutic cloning.[11] As a result of this, research on cell nuclear transfer can go ahead, although it is declared that the 'entity' created by cell nuclear transfer (whether an 'embryo' or not)[12] cannot be implanted in a woman's womb.

This 'compromise' may not satisfy everyone. In the ethics literature, for example, it has been argued that there is no reason to ban 'reproductive cloning'.[13] Cell nuclear transfer may provide a useful method of reproduction to people who are unsuitable for IVF, may in theory prevent the transmission of inheritable gender-related diseases, and may give genetically related children to single parents and gay/lesbian couples without using donor gametes (and thus without donor's DNA).

However, given the technical problems that need to be resolved before cell nuclear transfer becomes a viable,[14] financially sustainable and ethically defensible reproductive method, arguably the 'compromise' allows for research to proceed, which would have otherwise be banned. The arguments in principle must thus be balanced with the serious concerns relating to the safety of the technique for any given purpose.

We believe it is important to bear in mind the importance of this compromise, as an example of how politics can and should pragmatically assess the problems raised by science, and make educated decisions based on proper information, seeking to weigh up diverse views. Serious concerns must be given due importance. This kind of compromise in public policy does not mean giving in to illogical arguments or superstitions, or ideology. On the contrary, it means assessing in a rational way the pros and cons of the various available options, and ensuring that the objectives that we pose to ourselves as policy makers (which should always primarily involve the protection and promotion of people's welfare and rights) are achieved, even if one step at a time.

The value of pluralism

Pluralism is one of the greatest achievements of humankind. Pluralism refers to a condition in which two or more principles coexist. It also refers to a form of society in which individuals, or groups of individuals, maintain their own independent traditions and values. The recognition of the equal value of all people, regardless of their gender, ethnic origins, age, religion or political views has been an accomplishment of liberal societies, and the value of diversity is rightly celebrated by virtually all conventions and declarations of human rights and fundamental freedoms.[15] Conflicts of values are to some extent the spontaneous progeny of pluralism, and in this sense, they should also be deemed important and beneficial.

Yet, the right to have one's opinions implemented is rightly limited when, in order to put those opinions into effect, it is necessary to harm others, or to deny them important benefits. For this reason it is arguably immoral to prohibit research on stem cells or cell nuclear transfer, which may yield great benefits to millions of people, just to respect the views of a section of society. That section has a right to peaceful opposition, to free speech and free opinion.

It has a right to try to persuade others that they are wrong, to confer with them, or, eventually, not to use the results of that research. Yet, if an area of science is likely to alleviate the suffering of many, to improve their quality of life, or to cure debilitating diseases, or to save people from premature death, it is a moral responsibility of policy makers to ensure that that area of science is supported, unless there are very solid reasons not to. Opinions, however loudly spoken, are not solid reasons. Policy makers must ensure that the views (even if their own) that may impinge negatively on others' welfare be not transformed into public policy or into law.

Pluralism and information

In the previous section, we argued that pluralism is a value, and it is a value that policy makers should protect. Clearly, pluralism that characterizes liberal societies means that, in some delicate areas of science, important conflicts of views arise. Policy makers need to balance out these views, in order to ensure that science may progress.

One of the most crucial tasks of politicians, in this effort of accommodating potentially conflicting values, is to ensure that the public is properly informed about science. Some of the concerns relating to 'cloning' for example, as pointed out earlier, are based on facts and are serious. Others, instead, are unmotivated, and derive from ignorance: these must also be addressed and corrected. For example, the idea that scientists may be able to allow dictators to replicate themselves,[16] and similar absurdities fed by the media and by fiction, must be clearly corrected, as they are seriously detrimental to science, and therefore, to society as a whole. Likewise, flamboyant promises that if you store the stem cells of, say, your umbilical cord during childbirth, you will be cured, should you later develop cancer, or even a ligament injury[17] should also be corrected.

Giving false hopes renders citizens vulnerable to exploitation by unscrupulous 'pseudo-scientists', who damage not only the people who are cheated, but science and society as a whole. Policy makers thus must ensure that proper information is disseminated to the general public about the most sensitive areas of science.

How political initiatives may change the direction of science

Let us now consider the case of stem cell research. Whereas the ethics debates relating to the moral status of the embryo are well known, perhaps the political vicissitudes are not as noted. In 2006 the European Parliament was discussing the 7th Framework Program for Research and Technical Development (7FP) that would establish the allocation of the European funds for the period 2007 to 2013. During a European Council of Ministers of Science and Research, representatives from Germany, Austria, Italy, Poland, Malta and Slovakia decided to oppose the funding of stem cell research. In this context, the Luca Coscioni Association established a Constituent Assembly of the World Congress for Freedom of Scientific Research. The Assembly met first in October 2004 and continued through the first meeting in February 2006. Through these initiatives, a petition was launched calling on the European Parliament to ensure that the 7FP confirmed, at least, the funding of research projects on stem cells obtained from supernumerary embryos and that eligibility to funding be extended to research projects on nuclear transfer. Those events were decisive for the success of the campaign at the United Nations against the proposal to ban embryonic stem cell research altogether, as well as for the campaign in favour of the financing of such research by the European Union.

In December 2006, the 7FP was approved and enforced by the European Parliament and the European Council. The 7FP decreed that research projects on stem cells might be funded, insofar as no further embryos are created specifically for research purposes. In practice, this meant that research may be legitimate only on spare embryos resulting from IVF procedures, or on stem cell lines already created. The 7FP also reiterated that research on human reproductive cloning and on germ line modification of the human genome would not be funded.

In January 2007, the European Parliament officially communicated to the Luca Coscioni Association that a big effort had been made to find what it called a 'just and balanced compromise'. Again, this was a compromise that represents a momentous way forward.

We believe it is important to describe these instances of political intervention at an international level for what they can teach us. When decisions have to be made on sensitive issues, especially issues that concern and affect the welfare of others as well as our own, it is important that a number of various actors and beneficiaries be engaged in an informed debate relating to the advantages or disadvantages of the various options open. Bringing together patients, politicians, scientists and ordinary citizens is a positive innovation, which can yield better results as compared with the usual way of campaigning, often characterized by an ideological quarrel that leads to either prohibition or dissatisfactory solutions for all. As Baron has pointed out in his chapter in this volume, political dialogue and the involvement of people can be much more fruitful than sheer opposition against what we disagree with, when, as politicians, we want to ensure the progress of science for the benefit of people. In other words, a pragmatic approach that takes into serious consideration the opposition, and the worries of the people, can prove useful to finding a way forward, especially insofar as sensitive issues are concerned.

Of course, as mentioned before, this rests on dissemination of proper information. In their contribution to this volume, Corbellini and Sirgiovanni have highlighted various examples of misinformation provided by the media to the general public, and the negative impact this has had on the health of Italian citizens.[18] We shall not revisit these issues, which have been extensively covered by Corbellini and Sirgiovanni. As they point out, not only people's health and welfare, but democracy itself is threatened when information about science is misguided. The media has an important responsibility to ensure citizens are properly informed, but also the scientific community has the responsibility to divulge the directions of science and address the concerns that people may have, and citizens themselves, especially in 'developed' countries, have the responsibility to be skeptical and inform themselves properly. Politicians and policy makers have the task of implementing the evidence available through laws and policies that best serve the welfare of people. It is only via this concerted assumption of responsibility that science can flourish. In order to favor scientific progress, and thus the welfare of the people, we need not only the commitment of the scientists but also the synergies which arise from other aspects of the social and political life of each country.

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PART THREE

Science, Ethics and the Politics of Scientific Research

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11

Science, Society and Democracy

Freedom of Science as a Catalyzer of Liberty

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Contemporary international political debates pick out a sort of tension between modern science and democracy which have been summarized as dilemmas between the symbolization of liberal-democratic values starting from the view of scientific community as an 'open society' (Popper) or 'Republic' (Polanyi) and the challenges of these values through scientific exclusivism and elitism. The caricature of science and technology as enemies of society gave rise to worldwide instrumental political interferences into the governance of scientific research that have been defined as 'epidemics of politics'.[1] During the last two decades, a series of manipulations and censorships of scientific information has become quite frequent and peculiar in Italy.

The idea that science might lead to an illiberal and technocratic society emerged as a consequence of the philosophical wars during the past half a century between two opposite trends often featured as *scientism* (which came to be a negative epithet and that is why *naturalism* is often preferred), according to which science is a value-free inquiry becoming political only in its application, *vs. relativism* which sees science as value-driven in terms of political power and interest. Such a representation translates a cultural and cognitive conflict between scientific expertise and *folk* intuitive skepticism about its limits. The unsuccessful or limited use of scientific expertise in public life depends mostly on the increasing specialization of sciences and their complex languages. Nevertheless this is not all of the story. The 'continual struggle between the expert and [...] the common man',[2] which philosopher Otto Neurath had identified as characteristic of democracy,[3] is almost always influenced by the social conservative functions of those religious faiths, philosophical views and political party lines, which are opposed to liberal values and implicitly or explicitly take empirical sciences, which produce knowledge and technique that expand human individual wellbeing and self-determination, as a threat to society and democracy.

Scientists working in different countries recently expressed their positions to appeal to scientific freedom over illiberal science policy. Since October 2004, the Italian '*Associazione Luca Coscioni per la libertà di ricerca scientifica*' promoted the *World Congress for Freedom of Scientific Research*. Three International workshops about the main political and religious controversies to limit scientific research freedom have been organized in 2004, 2006 and 2009. Since the *World Congress for Freedom of Scientific Research* arose in Italy as a reply to the assaults against freedom of science raised by the Catholic Church in the use of medical reproductive biotechnologies, mainly it dealt with the issue of the Italian and international controversies over religious censorship in Western countries with regard to embryo and embryonic stem cell research.[4] Under the George W. Bush administration, also the United States experienced several instrumental political interferences, and several politicians, associations, scientists, and scientific journals raised their voices against what was happening in the United States.[5] Current President Barack Obama built his electoral campaign in part by advising that he wanted to change the attitude of the US administration toward science in general and more specifically to allow the scientific investigation on human embryonic stem cells.[6] Appeals for scientific freedom produced positive outcomes in the United States[7] but deafness in Italy, a country where the situation concerning science literacy and the freedom of research (as well as the freedom of individual choice) has become more than just worrying.

The idea that science poses threats to democracy and personal freedom is a disturbing misrepresentation being spread above all in the Western world, especially since the 1960s. This idea considers religions and aprioristic philosophies to be the main cultural and political defenders of the true and special human nature under the concentric attacks of techno-sciences, and it was the cause of the increasingly controversial and conflicting relationships between society, politics and science. In this paper we will demonstrate how the history of political and economic freedom in the North-Western hemisphere shows the potential of science for democracy. The Italian case will be taken as an illustration of the dangerous outcomes of espousing the contrary view. So we will defend the right of scientific research, and argue that democracy can only benefit from the dynamics of scientific production.

The view we will defend in this paper is quite different from the one espoused by the sociologists of science who have been analyzing relations between science and society in order to frame policies about science in constructivist terms[8] or in deliberative democracy terms[9]. Those approaches set aside contemporary empirical knowledge on cognitive *biases*, which bar or influence individuals who have not got adequate levels of science literacy in the access to the scientific procedure functioning or in the assessment of technological innovation. In brief, newfangled sociological approaches play on ideas about the relations between scientific procedures and other dimensions of socio-economic-political reality. Those relations are a-historical and decontextualized. Therefore they turn out to be misleading for the understanding of the functioning of socio-psychological dynamics, which canalize policies about science in concrete reality.[10]

We are not defending the ingenuous view that 'if science were left alone to speak truth to power [or to citizens, one could add], it would exercise a purifying magic on the miasma of politics'.[11] However, the prevailing ideas among social scientists, that science must simply be 'socially robust' and it will necessarily be 'politicized wisely' is quite an idealistic one. So we are not asking for a technocratic political decision system, but we think that scientific methods and sound data should represent the solid foundations on which to build the social transactions or trade-offs that in complex societies are necessary to share risks and benefits resulting from science and technological innovation, according to the different preferences distributed within a society. Moreover, it is an empirical fact that science appears more socially robust in those countries, such as for example in Scandinavian, where the level of scientific literacy is higher.[12]

Science on Western trial

It is quite paradoxical that, wherever people's wellbeing has greatly increased thanks to scientific and technological progresses, distrust and cultural opposition towards science and scientists are also very common, especially in Western countries. Periodic surveys on public perception of science – especially the Eurobarometer surveys, which allow analysts to compare public expectations of scientific research within the more and less affluent European countries – show that there seem to be greater worries towards science and its consequences just in those countries where social wellbeing is more widely spread and where good quality science is produced. The citizens of those countries tend to focus more on the limits of science than on its potential and they believe that scientific progress dangerously alters those natural balances which are necessary for true human and environmental welfare.[13]

Current political controversies over scientific and technological advancements demand a new kind of strategy to question or manipulate science's authoritativeness. It is no more possible to question science by appealing to magic or spiritual arguments. So there are two sleights of hand to question science when politically or morally controversial issues are at stake (for example abortion, in-vitro fertilization, stem cells, nuclear power, GMO): one is saying that scientists disagree or that they are 'split' as far as the soundness or usefulness of a new innovation is concerned; the other is objectifying anti-science against the idea of science as generating universal knowledge.

The role of the media is crucial in boosting the common sense misunderstanding of science epistemology. In their effort to dramatize even the scientific debate, journalists usually present scientists as having contrasting visions on a given controversial issue, or they compare empirically established theories with theories that try to prove themselves by diverting the debate on an ideological level. Normally, in the media the tentative and provisional – but evidence-based – characters of scientific explanations are misrepresented as epistemological limits, while the illogical and populist demands for definitive answers or certainties are instrumentally emphasized. A relevant and somehow recent aspect of these attacks against science and scientists is the manipulation of science by some scientists that often cynically contribute to circulate misleading information or endorse interpretations instrumental to religious or ideological biases.[14] Both dispositions are consequences of a recurring *bias* in Western countries that consists in seeing science and its universal knowledge as static, despite the huge amount of evidence showing that science is a dynamic enterprise.

Yet in economically and socially less advanced countries, expectations towards science are indeed more optimistic. At the beginning of 2011 *Nature* announced the Tunisian scientists' rejoicing for the occurring revolution in terms of free thinking and innovation.[15] Obviously, in this and in more disadvantaged contexts the impact of scientific progress on people's wellbeing is more tangible as it provides the opportunity to go beyond the typical constraints of a nature-dependent life. However, the development of an internal political and cultural environment to promote investment in scientific education, basic research and innovation is a difficult goal to attain for these countries. Also, their development still relies heavily on the import of technology from 'advanced' countries, a condition that cannot help these countries move spontaneously – thus more firmly – towards democratic forms of government.

As a matter of fact, attitudes toward science and technologies in Western countries are heavily inclined to positively and quite uncritically address scientific achievements when they produce advantages, especially in terms of health improvements. See as a paradigmatic example the public attitudes of European citizens toward genetic testing, that was evaluated as very useful, not risky and morally acceptable.[16] On the other hand, criticisms arise when scientific progress does not immediately yield perceived functional implications or when it happens to contrast with embedded ideas of the local cultural anthropology or with what is intuitively conceived as safer, if not sacred (see debates about public attitudes of European citizens towards agricultural GMO, that are perceived as useless, risky and morally unacceptable, or over the access of non heterosexual people to assisted reproduction technologies, which is assumed to be unnatural and therefore immoral). The implicit or common sense idea of 'nature' is becoming increasingly important in the cultural and political definition of some ethically controversial issues arisen by the discourse over the possibility for scientific progress and its technological applications to improve the human condition, and on the related potential risks inevitably intertwined with any technological innovation.

From a historical perspective, scientists began debating the political issue of scientific freedom more than sixty years ago. Initially within the British scientific community that attended the controversy between the influential Marxist interpretation of the social function of science and a movement leaded by Michael Polanyi and opposing the politically functional view of science, which established in 1941–1942 the Society for the Freedom in Science.[17] Moreover, in the aftermath of the Universal Declaration of Human Rights and within the activities promoted by UNESCO to communicate principles and values established in the 1948 Declaration, scientists raised the issues that the emergence of totalitarian regimes between the two world wars had severely threatened scientific freedom in terms of an increased dangerous intervention of the State and politics into the organization of scientific research.[18] The conclusion which the debate came to was summarized by astronomer Bart Bok in 1949: 'Freedom of science cannot be maintained unless in the presence of a positive climate in world opinion.'[19] That is like saying that scientists must commit themselves to communicate to society that freedom of research is fundamental to achieve scientific and technological progress. That is why during the past half a century scientific communities became increasingly involved in science communication and in spreading the view that science relies on the best tools invented so far to solve problems in controlled and reproducible ways, or to increase the understanding of the natural phenomena. Unfortunately, results were fragile and uncertain. Science and scientists regularly face problems whenever new frontiers of knowledge open up but contrast, at the same time, the most popular and intuitive beliefs. As a consequence replies to defend such beliefs consist in joining either philosophical relativistic views ('there is no scientific truth since there is no truth at all') or religious dogmatic positions ('science leads to evil when it goes against God's precepts').

In the 1960s and at the beginning of the 1970s a number of prominent scientists were pondering the impact that the new biomedical knowledge and technology could produce on society and on the public understanding of science. Prestigious researchers such as Jacques Monod, Joshua Lederberg, Francis Crick, Peter Medawar, Salvador Luria, Konrad Lorenz, Jonas Salk, and many others, tried to build a bridge towards human sciences, claiming a cultural humanistic statute for science against the drift of a world of knowledge divided into the 'two cultures'.[20] Among the most important ideas of the time, that the scientific community sadly abandoned in the last three decades, we can see the demand for recognizing an ethical status of scientific knowledge. This claim was based on a tradition of sociological studies, which was theoretically much more solid and plausible compared with the most recent approaches inspired by the epistemological relativism of postmodern sociologists. In the light of the evolution of the relations between science and society Jacques Monod's message keeps, for instance, a non instrumental relevance to present – as he recognised it – an ethical choice in the scientist's support to the postulate of objectivity.[21]

In the past three decades, bioethics, postmodern relativist philosophies and humanistic sociological and political views have played a relevant role in trying to confine science and culture in a new totally marginal position within the latest debate about the regulation and the educational strategies which can guarantee and improve the contribution of science and scientists to the citizens' civic awareness and socio-economic progress.[22] Inspired by traditional or predominantly anti-naturalistic moral philosophies and above all by medical ethics based on abstractly defined absolute values, bioethics has probably run out of its propellant push.[23] In their turn, science and technology studies (STS), that is the sociological approaches inspired by relativist epistemologies, naturally evolved towards an explicit politicization which is getting very close to an extremist view of science converging with that of the antiscientific political movements.[24]

The UNESCO people are no longer defending scientific freedom. Obviously influenced by the new climate, UNESCO has issued two documents about bioethics in the last decades, i.e. the *Universal Declaration on the Human Genome* and the *Universal Declaration on Bioethics and Human Rights*. These documents strengthen a negative political and cultural perception of science since in some parts they exaggerate the risks related to genetic, genomic and cell biotechnology research developments which are in fact very minimal compared to the benefits that could be generated with regard to human life quality. This kind of position is voiced in most Western countries in debates on the social impact and ethical implications of biotechnologies. In Italy however, much more than in other Western countries, the attack against research freedom has become prominent and influenced by a series of legislative choices aimed at limiting freedom of scientific research and individual freedom at the same time. Over the last decades Italy has been suffering from a particularly severe form of political interference into various areas of science. This unilateral interference by politics into science deserves to be known.

The Italian nightmare

Italian science has often been the subject of political controversy since unification in 1861,[25] during the fascist regime,[26] and after the Second World War through the influences of Catholic and Marxist ideologies. The strong politicization and weak objectivity of Italian cultural or intellectual discussions prevented the rise of an autonomous scientific community so that Italian scientists had and still have little or no cultural or political influence. Nevertheless, the situation has been worsening since the early 1990s. Even though most of the political and legislative attacks against the freedom of research came from Silvio Berlusconi's center-right governments, the interposed center-left governments often did not reveal much more progressive political attitudes, as far as science policy is concerned. Indeed, many factors have come together to make Italian science prey to political influence, including the predominance of non-transparent and nepotistic approaches to the public funding of research, the chronic cultural and political impotence of Italian scientists, and the waning professional quality of the national political and intellectual élites.[27]

The following are some episodes that occurred in Italy, involving forefront scientific areas and testifying therefore the political reluctance to scientific procedures and evidence in a country where politics and humanities, or social sciences knowledge, counts much more than empirical science or experimental knowledge.

The Di Bella affair (1997–98)

As a consequence of populist media campaigning, a pseudo-cure for cancer called Di Bella Multitherapy (DBM) was provided by several local health authorities to patients despite the absence of any scientific basis or clinical evidence of its efficacy. Instrumentally supported by right-wing politicians and major media, the clinical experimentation of the supposed treatment was approved by the Italian Parliament despite most oncologists' holding the contrary view, and DBM's then being evidenced as therapeutically ineffective in 1999. Some people have died prematurely as a result of the fact that they accepted to enroll – by giving a consent that certainly could not be called 'informed' – in the clinical experimentation, and the Italian medical community got exposed to international scorn.[28]

Animal cloning: A five-year ban (1997–2001)

A few weeks after the announcement of Dolly-the cloned sheep's birth, the left-wing Government Ministry of Health imposed a five-year ban on animal cloning. The given justification was that animal cloning would have been the preliminary stage towards human cloning, and some leading Italian laboratories that cloned or hold the technology to clone animals for scientific or commercial ends endured police searches by the Italian military corps of Carabinieri.[29]

GMO research and commercialization boycotts (2000–2005)

In late 2000 center-left Minister of Agriculture Alfonso Pecoraro Scanio tried to legally ban GMO research for food and agriculture. In early 2001 Italian plant biotechnologists and most Italian scientists protested against Pecoraro Scanio's decree that would have banned funding for any plant research involving genetic modification. The decree was eventually withdrawn as a political move to prevent the opposition from exploiting the dispute. However, when the center-right coalition came to power later that year, the new ministry of Agriculture Gianni Alemanno carried on with a prohibitionist policy against GMO. As a result, research in the field of plant genetics remains virtually devoid of public funds in Italy, and a series of byzantine regulations still prevent Italian farmers from using GM seeds, without scientific evidence of their danger, despite the fact that the Italian law does not explicitly ban their use and that GM crops are imported to feed farm livestock.

Assisted fertilization bad practices and stem cell research prohibitions (2004–2010)

The Law 40/2004 on medically assisted fertilization enacted by the Italian Parliament under the second Berlusconi government limited not only scientific freedom but individual reproductive rights as well, and imposed on Italian physicians the use of a *bad clinical practice* in the field of assisted reproduction, that was strongly criticized by the European Society of Human Reproduction and Embryology (ESHRE). Beyond limiting access to artificial reproduction to heterosexual infertile couples (banning the access to non-heterosexual couples, single people and to couples who want to avoid conceiving a diseased fetus and then undergoing an abortion), this law prohibited gamete donation, cryopreservation of embryos, pre-implantation diagnosis and any kind of research on human embryos aimed at generating embryonic stem cell lines. So in Italy not only the ban of some technique denied safe benefits to sterile couples (as in the case of heterologous fertilization), but also exposed women to severe preventable harms (such as multiple pregnancies and repeated hormonal stimulations). A Referendum in 2005 promoted against this law was invalidated because of the unreached quorum, which was the outcome of a manipulation of the public debate by the Catholic Church. Law 40/2004 supporters adopted the strategy of denigrating the accountability of scientific methods and of manipulating scientific facts, by spreading misleading information like claiming that pre-implantation diagnosis did not work, that the cryopreservation of embryos was not clinically necessary, and that research with embryonic stem cells was pointless because adult stem cells had already proven effective for treating dozens of diseases.[30] Finally, in 2009 the law has been revised concerning pre-implantation diagnosis and cryopreservation of embryos, now permitting them under some circumstances, thanks to a series of decisions in the Italian Constitutional Court.[31] However, embryonic stem cell research is still stopped: in 2009 the Ministry of Health arbitrarily excluded projects involving human embryonic stem cell lines, the experimental investigation of which is not forbidden under the Law 40/2004, from a call for proposals on stem cell research funding.[32] As a matter of fact, because of the political influence of the Vatican and of a widespread science illiteracy, in Italy the research in the field of regenerative medicine is under a tight political control. For example, in 2010 the Ministry decided *motu proprio*, which means bypassing any peer review process, to grant €3 million to a private foundation that announced itself to have created human adult stem cells for treating neurodegenerative disorders.

These episodes, only briefly summarized here, highlight how and why the competitiveness of Italian research on the international stage has been dramatically jeopardized.[33] However, more importantly, they highlight an important issue relating to the procedures in which freedom of scientific research should take place. Among these, it is essential to scientific progress and to guarantee that science improve human condition and that a process of serious public involvement, based on proper information, and peer review, takes place. Since its very beginning scientific research has demonstrated to be safe and useful in those countries that allowed the scientific community to implement internal controls on the results of empirical investigations such as try to reproduce observations or regularly review the accountability of scientists who submit requests for grants to pursue researches.

Maybe few people in Western countries know that in Italy governments allocate chairs of public research institutions and scientific directors in research hospitals and that funding is often granted *top-down* by governmental decree to specific institutes, without resorting to public calls or peer review.[34] It is a fact that Italy lacks both an independent agency for research and compulsory, transparent and unbiased selection processes. As such, the risk of political interference depends on guidelines and criteria that determine which research activities receive public funding by the ministries and tend to favor research groups to which politicians often show conflicts of interest.[35] Whether or not the Italian circumstances are a mere case of local deterioration of the relationship between science and politics, the scientific community has been largely silent. In the next section we will contrast the ideological view underlying this state of affairs, according to which scientific freedom is a threat for democracy and society.

Science gave rise to liberal democracy: A defense of the right to research

The most relevant feature to be mentioned while dealing with science and democracy is their parallel, firstly as a *historical* one. The achievement of civil freedoms came after the revolution of thought brought about by the invention of modern science. However democracy – as today we understand it – was not *just* born at the time of scientific revolution. Better still scientific revolution actually promoted the rise of democratic values ('The science of Liberty', according to

Timothy Ferris.[36]) The main mistake shown by those who highlight a tension between the two is the oblivion of the *causal* relation which went from the rise of modern science to the rise of modern democracy itself.

The idea of representative democracy as equality under the law and in the access to power arose with modern science and took place not before the late Enlightenment, spread by the American and French Revolutions. Even if the etymology and concept of democracy had their origins in Ancient Greece and developed in Ancient Rome, those systems were not democratic in the present meaning. Among the missing features were exactly modern science ideals in terms of scientific method foundations such as reproducible experimentation and the peer review process. Ideals that translated in political terms mean anti-dogmatism, critical thinking and anti-authoritarianism for all of us.

Today the values of democracy are being exploited to distort science and its public perception, and in this way the grave of democracy itself is being dug. Scientific culture and education, as fathers of modern democracy from Spinoza to Thomas Jefferson understood, are the source of the fundamental values of democratic life. This also means that promoting scientific education and culture – that is, exporting science – is probably a much more effective, as well as less violent way, to spread well-being and democracy in the countries where they are still lacking.

At a political and social level few seem to understand that to preserve what has been achieved so far in the Western world scientific research must progress. The reason is retraceable in history, by looking at the dynamics which allowed science and its technological applications to free a significant portion of humanity from ignorance, poverty and disease. Politically limiting freedom of research by arguing that science is a threat to democracy means much more than a lower productivity of science and technology: it also leads to an impoverishment of the civic sense in the general population, which we can broadly understand as an awareness of having to respect some explicit social rules in order to better enhance individual freedom. Indeed, scientific information and education have a key role in the preservation and development of a clear perception that Western wealth depends on the superiority of constitutional or liberal democracy as political and economic value system. Admittedly, supposed tensions between science and democracy are also likely to be consequences of the poor impact of all the rational arguments presented in the last decades to refute prejudices against science in favour of the relativist 'demonizers of science'. It is to be thoroughly considered that the neuropsychological traits we possess because of our evolutionary origins may have a role in the general attitude to refuse or regard science as threatening to human dignity and democracy. In fact, if science is uncommon sense,[37] and also democratic values are in some ways unnatural,[38] it could be quite difficult for people who are illiterate about scientific epistemology and human socio-psychological nature to catch up with the tight connection between scientific and liberal thinking.[39] After all, in recent years cognitive and evolutionary psychologists along with neurobiologists have indeed been competing to highlight the limits of our much praised rationality.[40] Nonetheless modern naturalistic or scientific thought provided conditions to develop rational behaviours leading to the emergence of democratic forms of social organizations. In fact, adequate education fosters the level of individual autonomy needed to fully appreciate the advantages of freedom and self-determination. Consequently, underperforming educational systems, especially in the scientific training, which are typical of countries where education is led or influenced by religious institutions, do represent a relevant risk factor. That is the case in Italy where science literacy remains poor and debates' results are influenced by Vatican positions or by left and green technophobic ideologies. Sometimes in other contexts this may combine to maintain or to bring about totalitarian regimes and anti-scientific movements.

At present the ways religions or political ideologies confront themselves with science has become more complex. In other words the recallings of Galileo or Lyssenko stories as representative of science freedom censorship and antiscientific orthodoxy in general, turn out to be no more eloquent or effective in addressing the issues concerning the autonomy of science in the era of big science and knowledge-based economies.

Science and scientific culture have historically faced many hurdles throughout the modern and contemporary age. Such history shows repeating trends, like the anti-authoritarian and anti-traditionalist nature of science as a triggering factor of conflicts. Political, religious and cultural opposition thwarted scientific progress when it challenged cultural beliefs or grand visions favouring the acquisition of socially normative values, or when it had an impact on embedded cultural customs.

What should be clear is that science and democracy are not 'natural' needs. As human inventions they are products of a social evolution through cultural and economic processes. Besides they are interlaced enterprises. Since cultural developments do not integrate in the genetic heritage of species, with every passing generation some achievements may also get lost, especially in terms of capability to communicate the importance of both democracy and freedom of scientific research to society and to political actors. The advantages of being free to discuss everything and of not considering freedom of thought as an anomaly to retrieve, matches the role of science in society in terms of a lack of censorship and exploitation for illiberal plans, which happens only in totalitarian regimes. That is why the political exploitation and censorship of science endanger democracy itself. Scientists are called to protect not just scientific freedom, in order to guarantee the survival of science within society. They also have a higher duty, as they are called to safeguard the cultural conditions for the survival of democracy itself.

Given the view we are defending, it would be interesting to discuss Martha Nussbaum's thesis that liberal democracy needs the teaching of humanities, because such disciplines help students learn critical thinking and how to understand others, including others who are quite different from themselves.[41] We definitively disagree with Nussbaum's view, and think that modern cultural tools that help students to learn critical thinking and develop the capacity for tolerance are humanities plus scientific literacy. Humanities alone are not enough to protect or promote liberal democratic values. As a matter of fact, most attacks to those scientific and technological advancements which allow people to amplify their individual choices in emotionally laden events like reproduction, illness and death, come from religious, political and philosophical doctrines. In other words from intellectuals who are mainly educated in the humanities. In order to provide bad reasons to control scientific research, cultural and religious oppositions to science play philosophical tricks. Mostly they confuse science and technology. Freedom of scientific research does not correspond to bad applied science being imposed on society, but means a more effective possibility of finding limitations to some applications during research, which will improve safety technology. Besides these views in their relativistic expression aim to persuade people that political pluralism is threatened by science, which is not ontologically pluralistic (over *facts*). Yet they obscure how political pluralism and science belong to different domains and pertain to different kinds of investigations (normative *vs.* descriptive) over different objects (values *vs.* facts), and that at the same time science can provide tools to rationally deal with both.

Do we also have some reasons to be optimistic? Conceptual and methodological progresses of neurobiological, psychological and evolutionistic research offer considerable opportunities for science to gain a more functional and constructive relationship with human sciences. This is remarkable within the field of *neuroethics* where the most original and important developments do not originate from the so called reflections on the *ethics of neuroscience*, but from the *neuroscientific studies of ethics*[42] aimed at empirically investigating the origin and the physiology of human morality, also from the social psychology and evolutionistic point of view.

There are ways to stimulate a general debate about the freedom of scientific research by taking into account the differences. That is firstly scientists' duty. Those who are involved in scientific careers and institutions promoting science and its cultural implications should commit to socially useful values as a means of diffusion of individual freedom, trust and respect among people.

So, as an incidental comment, we would like to point out that the social historian of science Steven Shapin has recently shown how the uncertainties attending scientific research make the virtues of individual researchers more and more intrinsic to scientific work. In *The Scientific Life*,[43] he argues that the radical uncertainties of much contemporary science have made personal virtues more central to scientific practice than ever before, and he also reveals how such novel aspects of late modern science have deep historical roots. Shapin's history of the scientific career and character encourages the reader to reconsider the very nature of the technical and moral worlds in which we live today, and offers reasons to be more positive about the scientific life in our commercialized culture. Against Max Weber, Shapin illustrates that scientific entrepreneurs have, in common with early modern natural philosophers, a sense of vocation, and that their more altruistic ambitions (typically, to save lives) are counted in their favor when venture capitalists decide which business plans to back. Shapin stresses that like business life, scientific life depends deeply on personal relationships of trust. We have learnt from social psychologists that trust is rarely absolute, and in business and science as in most human affairs it is important to also develop a nuanced sense of when and how to withhold trust. For an outsider, however, it is difficult to know how seriously to take the scientists' avowals of intention to do good in the world.

Commenting on the views, especially coming from academic social scientists, that industry is a problematic environment for science, Shapin says that he is 'not at all sure that's right. If we compare, so to speak, apples with apples, and look at the pure research done in industry and that done in academia, many of the most popular contrasts describe the situation rather poorly. If autonomy is the issue, many industrial scientists from early in the twentieth century enjoyed as much of that as their academic colleagues. And the same applies to notions of secrecy and openness. A clear contrast of *quality* between university and industrial science similarly seems not to hold, while a presumption that applied research and development requires less brain-power than pure research is just dogmatic. But most of all, I am impressed that *both* industrial and academic scientists seem to want environments in which they can do *interesting work* and, perhaps, to enjoy a degree of freedom in doing that work. An apparently banal idea, but one which is very widely ignored. Many other commentators have also rightly pointed out that academia and industry have for some time been *converging* in their mores, structures, and conditions for doing science. I agree with that, but I also suggest that there are ways in which some sorts of modern industry can offer more propitious conditions for scientific inquiry than some sorts of universities and colleges. There are interesting implications here for the contemporary tendency to make universities more "business-like": we should have a better understanding of how industry now seeks to manage and motivate creative people. If universities, indeed, now see themselves as managing and motivating creative people, they might have much to learn from high-tech and biotech businesses, and academics might then have little to fear. What worries me is just that administrators' ideas of what it is to be "business-like" misrepresent pertinent business realities.'[44]

Scientific diffusion should provide citizens, especially children and adolescents, with cultural instruments to fully take advantage of civil rights, instruments to understand the terms of controversies and acquire the knowledge of the best procedures to deal with empirical problems as well as a way to evaluate scientific information once presented with it.

By declaring freedom of research as a fundamental right of individual researchers the contribution of science to democracy would be clear. How can we make it so? Before suggesting a solution, a further present difficulty about the social dimension of science should be taken into account. A couple of decades ago, some experts on the relationships between science and politics highlighted a problem that sees journalism playing a growing role within the prescriptive credit of political action and shortening this way the temporal perspective of politics itself.[45] Maybe journalism only acted as a catalyzer, but it is true that a peculiar aspect of today's political dynamics are very short time frames for the appreciation of any decision's practical outcomes.[46] This now represents a compulsory requirement also for science to justify its utility considering its great demand for investments. As a result, financing public bodies become very demanding about every research project, in terms of applicable outcomes and technological transfers having the task to solve some economic or social problems. However, this condition has threatened scientific authoritativeness at more than one level, including the reliability of internal professional standards.

In other words, the political perception of science is faced with the overwhelming tendency to assign a '*normative superiority of the present over the past and the future*'.[47] This kind of attitude surely facilitates the evaluation of the level of reliability with regard to democratic decision making procedures about social and institutional dynamics whose results are rapidly scattered. On the other hand, they also produce a condition of a-historical fallacy that culturally impoverishes science and misleads the perception of its epistemological basis. The a-historical fallacy, which can be seen as a diffused inability to perceive scientific problems within a wide temporal perspective, leading to the understanding of phenomena and a healthy sense of modesty in scientists, has become a chronic condition for scientists and a large part of the population making use of scientific information in different ways.[48]

Most experts debating the reasons for the fall of scientific vocations, the students' inability to understand how to scientifically face a problem plus the poor quality of scientific education, believe this fall to be due to the correlation between scientific education or communication and notions and facts.[49] There is a lack of cognitive tools to generate and assess scientific tests and explanations leading to a deeper understanding of the nature and development of scientific knowledge and a constructive participation to scientific communication and issues.

Sciences' communication and teaching should aim at improving young people's awareness when they are still in the course of their active cognitive development, that human judgments are 'naturally' *biased* because of the shortcut heuristics that biological evolution has wired in our brains.[50] Such an approach would be of a fundamental importance in providing the useful tools to appreciate the liberating value and effectiveness of scientific rationality, that is to say to make emerge a sense of autonomy and self-determination in individuals.

Conclusions

Scientists must become aware – and make Western citizens aware – that, for historical and other reasons depending on the behavioral predispositions of our species, freedom of scientific research and advancement of scientific knowledge and methods are among the essential requisites (together with others, of course) for the democratic functioning of political and social systems. Science provides individuals with autonomy, self-determination and critical thought, which are the basis for protecting democratic thought and political pluralism. This is exactly what we mean when we say that freedom of science *means*, rather than threatens, democratization.

12

Religion and Scientific Freedom

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> ... When people reasonably think that shared premises of justice and criteria determining truth cannot resolve critical questions of fact, fundamental questions of value, or the weighing of competing benefits and harms, they do properly rely on religious convictions that help them answer these questions.[1]

The two interrelated questions that this chapter will try to answer are deceptively simple 'Should religion play a role in determining science policy?' and 'Is religious influence on science policy inimical to scientific freedom?'[2]

Many scientists, including some writing in this book have immediate answers to these questions. Their answer to the first question is 'No!' and their answer to the second question 'Yes!' For them it is obvious that religious influence on science policy is a threat to scientific freedom, but this is perhaps too hasty.

It may be too hasty because 'play a role in determining' and 'influence on' are both read as 'DETERMINING' full stop; and the answers therefore are answers to different questions.[3] Or it may be too hasty simply in the sense that it is not fully thought through. As Campbell points out there is a profound difference between acknowledging and allowing for a legitimate influence of religion on policy making and ceding authority over these decisions to religion.[4]

In order to answer the specific questions about science policy and scientific freedom satisfactorily we therefore need first to answer two parallel, but more fundamental questions 'To what degree should religion play a role in determining any policy?' and 'What is the justification, scope and limits of scientific freedom?'

The focus for much debate about these issues recently has been in relation to human embryonic stem cell science, but the issue itself cuts across the whole of science policy. In 2001 the General Synod of the Church of England for instance:

> ... asked Her Majesty's Government to commission independent research which will lead to the identification of minimum income standards related to need and then bring forward the legislation that will put such minimum standards into effect.[5]

This was clearly a religious intervention in science policy, but perhaps one most scientists find more congenial.

The justification, scope and limits of scientific freedom

Let us start with the second of these more fundamental questions. Scientific freedom is undoubtedly a valuable species of freedom and is sufficiently separable from other valuable freedoms so that it can receive independent protection. However, is the justification for protecting scientific freedom just the same as the justification for protecting freedom in general, or is there an additional basis for protecting this specific freedom?

Let us first briefly remind ourselves of the difference between scientific freedom conceived as a negative freedom and scientific freedom conceived as a positive freedom.[6] Scientific freedom understood as a negative freedom or a liberty is simply the freedom of an individual researcher or a group of researchers to pursue any scientific question or research program without outside interference. Scientific freedom understood as a positive freedom is more difficult to define succinctly, but includes the claim that society should materially and in other ways support science. Society should remove obstacles to science and it should, within the general envelope of its resources also support valid scientific endeavours. Exactly how much material support that should be given to science in a given society is not easy to determine and the allocation to different areas of scientific endeavour is not straightforward either.

What reasons could we have for claiming that scientific liberty (i.e. the negative freedom) is more important than just the bare liberty to do anything a person wants to do?

The most obvious justification is that scientific liberty is more important because the goal of scientific endeavours is not trivial. Just as 'push-pin is not as good as poetry' science is more important than, say gardening.[7] Science is intrinsically important as a truth or knowledge seeking activity and the knowledge it produces is often also instrumentally valuable. Science is worth pursuing in itself and it has the potential to make the world better. Furthermore, it is exactly because science is a non-trivial, truth seeking activity that some may have a strong interest in restricting science. So, scientific liberty is strongly justified as protecting an important activity that may in certain circumstances need protection.

Just like other liberties, however, scientific liberty is not absolute. Even though the reasons adduced just above should lead us to think that scientific liberty is an important liberty, it does not show that it is the most important liberty or that it trumps all other ethical concerns. A scientist cannot simply in the name of scientific liberty claim an absolute right to perform scientific actions that harm other people or infringe their rights. Even on the most expansive reading of Mill's so-called 'harm principle' society can legitimately restrict the liberty of scientists to prevent harm to others, and if situations arise where scientific liberty is in conflict with some other liberty then it is conceivable that it is sometimes scientific liberty that must give way. If we take scientific liberty to be an important human right it still means that when it conflicts with other human rights an adjudication will have to take place concerning which right should yield. A current area of controversy in human rights jurisprudence is the conflict between privacy and freedom of speech which is resolved quite differently in Europe and in the United States,[8] but privacy can also conflict with scientific liberty and some balancing aiming at resolving this conflict is already taking place in research ethics.

Let us move on to the question of the justification, scope and limits of the positive side of scientific freedom. The justification for society having a positive obligation to support science is essentially the same as the justification for a strong scientific liberty. Science is both intrinsically and instrumentally valuable, but how much science should be supported is essentially a question of resource allocation. First science has to compete against all the other claims on a society's resources and then different research programmes have to compete against each other. The range of arguments that are relevant in these two stages of resource allocation is very wide, and go far beyond arguments only relating to the science in question. In deciding science funding policy a society will, *de facto* have much more legitimate latitude than in deciding on protections for scientific liberty.

Similarly in deciding exactly which obstacles to scientific endeavour a society has an obligation to remove, it is legitimate to consider whether the removal of a particular obstacle is justified when the general function of the obstacle is taken into account. A number of legal systems do, for instance not directly enforce contracts where a person is contracted to perform a specific task. If I am contracted to write a valedictory poem for your birthday, but decide not to do it the law will uphold a claim for compensation, but not a claim that I must write the poem. There are situations where it would be advantageous for researchers, and possibly research subjects if it was possible to consent not to withdraw from a research project once consent was given.[9,10,11,12,13,14] However current research ethics regulation enshrines an almost absolute right of withdrawal. In deciding whether to change current research regulation and allow binding research 'contracts' that makes it impossible to withdraw it is clearly not enough to point out that such a change would remove an obstacle to positive scientific freedom.[15] The decision would have to take into account the importance of upholding the general principle against enforcement of contracts for specific performance.

The argument so far only establishes that scientific freedom is not an absolute trump card in discussion about whether society can restrict scientific activities, and it only shows that if other important values are at stake they can outweigh scientific freedom. But what kinds of values are sufficiently important to potentially play this role and can there be religious values among them?

The role of religion in determining policy

Let us assume that we live in a representative democracy where policy making is performed in some complex interplay between the citizens, their elected representatives and the state bureaucracy, and let us further assume 1) that this democracy is secular in the sense that no representatives of organized religion have an automatic place in the legislature or in the state bureaucracy and that no religious representative can in any other way determine public policy, unless elected to do so and 2) that it is not a perfect deliberative democracy in a Rawlsian or Habermasian sense.[16,17,18,19] Our democracy is therefore not perfect but lies somewhere on a (possibly multi-dimensional) scale of imperfection. The imperfections vis a vis a perfect deliberative democracy may involve imperfections in involving citizens, allowing the bureaucracy too much influence, or allowing decision makers to make decisions that are not fully publically justified, not fully theorized or depend on world views that are not fully explicated and not shared by, or even intelligible to all.[20] I take it that all current democracies belong to this type of imperfect democracies.

The definition of secular is chosen to allow for a secular society to have, perhaps a majority of religious citizens (for example Turkey). If a secular society is defined as a society with predominantly secular citizens, then only a few societies if any are currently secular.[21]

Does religion have a legitimate role in policy making in such a society?

A number of philosophers have argued that in a secular society only secular arguments can have a role in public discourse. The reasons adduced for this proposition differ somewhat between different proponents of the view but all claim that religious arguments are either not accessible or not intelligible to all participants in public discourse. In a certain sense this is false, already on the face of it because it is open to everyone who is not religious to accept a religiously-based argument as valid (if it is) but not sound because the religious premises are false. So the idea cannot be that the arguments are not accessible or not intelligible *sensu strictu*. The idea must be that it is only legitimate in public discourse to use arguments that everyone would agree to be sound, if they are valid. This seems to be a very strange view (see more below).

John Rawls states that:

> What public reason asks is that citizens be able to explain their vote to one another in terms of a reasonable balance of public political values, it being understood by everyone that of course the plurality of reasonable comprehensive doctrines held

> by citizens is thought by them to provide further and often transcendent backing for those values.[22]

Robert Audi offers two principles.
The principle of secular rationale:

> ... one has a prima facie obligation not to advocate or support any law or public policy that restricts human conduct, unless one has, and is willing to offer, adequate secular reasons for this advocacy or support....[23,24]

The principle of secular motivation:

> ... one has a (prima facie) obligation to abstain from advocacy or support of a law or public policy that restricts human conduct, unless one is sufficiently *motivated* by (normatively) adequate secular reason....[25]

The principles are based on the following account of secular:

> These are secular in the sense that their justificatory authority does not depend on the existence of God – or on denying it[26] – or on religious scriptures or the views of religious authorities as such.[27]

And finally Ronald Dworkin states in a US context that:

> Americans have a constitutional right that government not infringe certain personal liberties when it acts to safeguard an intrinsic value. A state may not curtail liberty, in order to protect an intrinsic value, when the effect on one group of citizens would be special and grave, when the community is seriously divided about what respect for that value requires, and when people's opinions about the nature of the value reflect essentially religious convictions that are fundamental to moral personality.[28]

However, these arguments are problematic on their own terms,[29] and although they entail the exclusion of religious arguments from public discourse, they do not entail the exclusion of the argument of the religious. This second point is important to note. In so far as a secular argument can be made to reach the same conclusion as is reached on non-secular grounds a religious person or organisation can make that argument as a valid contribution to the public discourse in a deliberative democracy, if it also plays a role in their own motivation for holding specific views. Pope John Paul II[30] tried to convince people by secular argument that we live in a 'culture of death' and that this is a significant problem for society. If he had been successful then political decision makers who were so convinced would be justified in formulating policy on this basis.

Dworkin wants to go further than this and exclude arguments and reasons that 'reflect essentially religious convictions'. However this is clearly problematic since it would exclude almost any reason in a debate on almost any contentious issue of value. Whether an argument reflects a certain mental or epistemic state is to a large degree in the eyes of the beholder. All interlocutors can easily claim that the views of their opponents, although secular on the surface 'reflect essentially religious convictions', and if this is denied then their opponents are clearly suffering from self-denial. All of Dworkin's own arguments can for instance be seen as reflecting his essentially religious conviction that there is no god.[31]

One way of trying to circumvent this problem in Dworkin's position is to appeal to a thin principle of non-interference that can be claimed to be part of most (or less plausibly all) comprehensive worldviews. On this basis we could claim that religious arguments should be excluded, because they want to impose a specific positive morality on others, something that by implication we have to believe non-religious arguments do not do! This then sets up the second problem, because if we only have a principle of non-interference we have no moral resources left with which to set up positive obligations enforceable as public policy, we may still believe that we have obligations to help others, but on the very thin concept of non-interference we have it becomes illegitimate to force people to discharge these obligations and we end up in (right wing) libertarianism of the Nozick-Engelhardt type.[32,33]

Third it is performatively inconsistent with the actions of liberal bioethicists and liberal politicians. Liberal bioethicists are quite happy to advocate positive public policy, that society should fund certain kinds of research, that legal systems should be shaped so that they not only allow but actually promote certain practices, or that taxes should be raised for good ends. Many of these positive conclusions, and the similar public policies clearly rely on a comprehensive worldview (or more than one) and should therefore have been ruled out. If we allow room in policy making for any positions that would impose a specific positive morality on others, and all societies allow this, then we cannot rule out religious arguments on this ground.

There is thus a high price to be paid for excluding religious arguments from consideration in bioethical discussion and policy making.

What makes the arguments of Rawls, Audi and Dworkin problematic in general is that they overestimate the degree to which actual political argument can be detached from the underlying comprehensive worldview that sustains them. Imagine a debate between a Marxist and a Libertarian about the rate of income tax. How could any of them 'explain their vote to one another in terms of a reasonable balance of public political values', to use Rawls' terminology? Their comprehensive worldviews fully explain their balancing of public political values and also explains why neither of them can ever see the balancing performed by the other to be reasonable.

Unless we therefore exclude anyone with a strongly held comprehensive worldview from the public discourse, we have no reason to exclude the religious or their secularly stated arguments.

Having a comprehensive worldview is not peculiar to religious people. Everyone, including every bioethicist holds an explicit or implicit comprehensive worldview that is rarely or never questioned. Such a worldview includes an ontology, a view of what kinds of things that exist and are relevant in thinking and analysing, an anthropology, a view of what kind of beings humans are, what their essential constituents are; and an epistemology, a view of how we gain knowledge and what the status of that knowledge is. We live with and within our comprehensive worldview and often only notice its influence when we collide with people with other worldviews.

A well known example of a comprehensive worldview is the Marxist worldview. Marxism holds an explicitly materialist ontology, the only existing things and the only existing forces are material, a perfectionist anthropology and a realist epistemology. For a Marxist historical developments are driven not by changes in ideas or by the decisions of historical actors but by changes in the productive forces that are products of the relationship between the social classes.

It should be obvious that not all secular thinkers hold a Marxist materialist ontology. The German philosopher Friedrich Hegel, for instance, held that historical developments were not driven by material factors, but by changes in the 'Zeitgeist', the 'Spirit of the time.' The great British political philosopher Margaret Thatcher held that 'there is no such thing as society'; and the British evolutionary biologist Richard Dawkins has postulated the existence of 'memes', transmissible elements of culture and thinking that are in evolutionary competition. It is for Dawkins, partly, the evolution of memes that shape historical developments.

There are also many examples of differences in anthropology relevant to bioethics. Aristotle famously drew quite radical conclusions from a faulty anthropology where women and barbarians were defined as deficient in reason and therefore not as moral agents. A current example is the sharp distinction in anthropology between liberals and communitarians – are human beings basically individuals or socially constituted beings?

Are religious worldviews in some sense fundamentally different from non-religious worldviews? At first sight we might be tempted to say yes, but that is probably an artefact caused by the historical fact that the three largest religions in our part of the world all have very similar roots and therefore rather similar worldviews (including the very unusual feature of monotheism which is rare in religions). Each religious worldview has its own ontology, anthropology and epistemology; and if we look carefully at the range of religious traditions we will find that there are no elements of these that are shared by all. Not all religions do, for instance postulate any kind of supernatural elements in their ontology (some variants of Buddhism being cases in point). There is simply nothing that keeps together the class of religious worldviews, apart from the willingness to self-identify as such, but that can't provide any reason to treat these worldviews differently from other comprehensive worldviews.

Are religious worldviews less coherent than secular worldviews and thereby more contestable? All of us probably think that there is one comprehensive worldview that is more coherent and defensible than all others, i.e. the one we ourselves hold (otherwise we should probably convert to the best competitor worldview). At the same time, however, we are forced to admit that although the general belief in an optimally coherent worldview is shared, the specific identification of this optimally coherent worldview is highly contested. This is so, partly because most large sets of beliefs contain some incoherence, partly because our ontology, anthropology and epistemology also have to cohere with observations about the world that are in themselves contestable. There is no *a priori* reason to believe that religious worldviews are any more or any less coherent than other worldviews.

Maybe the problem is that religious worldviews are held in a different way than other worldviews? That because those who hold them believe them to be transcendentally justified,[34] they hold them with more fervour and are less willing to change? It is undoubtedly true that many religious believers hold their beliefs and worldviews in a rather intransigent manner and seem to be resistant to change by sound philosophical argument. However the same is true of many non-religious people who believe their worldview to be based on such obvious truths that they cannot understand that anyone can disagree with them. A belief in self-evidence can lead to exactly the same kind of argumentative intransigence that a belief in transcendence can. Similarly a belief in the immutability of certain values or prescriptions can arise with or without a belief in transcendent grounding. If it was the case that all religious people where argumentatively intransigent then we might have a reason to stop engaging with them in argument, since it would be pragmatically pointless, but it is clearly not the case. The moral theology of most of the major world religions is in a process of constant change and that process is not driven by new transcendent revelations or moral truth, but by reasoned argument.

What are the implications of this for public decision making? Let us first look at the implications for the religious person, then for the religious politician and finally for the religious organisation.

The religious person

What role can religion legitimately play in the personal decisions of a religious person? If we are discussing purely self-regarding decisions then there seems to be no restriction on the role religion can play. If I want not to pursue a specific scientific career because it would involve me in actions that are against my religion, then I should in general be free not to do so.[35] On the other side it seems equally clear that a bureaucrat with religious beliefs cannot let his personal religious beliefs influence the decisions he is empowered to make in his bureaucratic role. A religious head of a national research council should not let her decisions be influenced by religion, just like an atheist head should not let his decisions be influenced by his particular metaphysical views.

Then what about the many situations in the middle, for instance situations where a person acts as a citizen? Is it legitimate, for instance to vote for a politician who shares my religious views, or who promotes policies that are consistent with my religious views?[36] Or is it legitimate to direct my charitable contributions to an atheist research charity instead of a religious one, because I identify more with the aims of the atheist charity?

Even in an ideal deliberative democracy it would be legitimate to vote for a representative to the fully deliberative decision making forum on the basis that this representative shared my comprehensive worldview and/or promoted policies with which I agreed.[37]

If I believe that embryos have moral status and that there are good, secular arguments that can show this, then I can legitimately vote for a politician who holds the same views. It may not even be necessary for me, as a citizen to be able to produce the good secular arguments, as long as I am reasonably convinced that they are available. We would, I presume find nothing strange in someone voting for a politician on the basis that they agreed with her taxation policy, without fully understanding the economic theory of taxation or having full command of the details of the tax system.[38]

The religious politician

Can a politician who holds religious beliefs let those beliefs influence his decisions? We are here getting closer to the secular core of the secular society and if we maintain that in the deliberative forum of decision making only secular arguments can be used, then a religious politician should not use religious arguments and should only use secular arguments to come to the same conclusions if he is convinced that they are valid and sound. We should therefore hold politicians to a higher standard than citizens in relation to their understanding of the arguments they refer to.

Holding politicians to this standard does, however, create a potential problem in our less than ideal deliberative democracies. As a matter of fact many 'arguments' are routinely a part of political discourse in our parliaments that would be given no weight or would be deemed to be illegitimate in an ideal deliberative democracy. Many are simply invalid, others deliberately conceal important premises and some are of very questionable soundness. Which of the many arguments of this kind we should deem illegitimate now in our less than ideal situation is not easy to decide. Arguments that are invalid and cannot be reconstructed to achieve validity should obviously not be put forward as serious contributions to policy making, but it is much more difficult to say which of the potentially unsound or deliberately enthymematic arguments we should discount.

The religious organisation

Let us move on to the influence of religious organisations. One way to conceptualize religious organisations is as specific type interest groups. In the following we will mainly be focusing on the overarching religious organisations, like Churches with a big 'C', but it is important to remember that there are many other kinds of more focused religious organisations[39] that try to influence policy across the whole policy spectrum.

Churches and similar bodies differ from interest groups with a narrow scope because their scope is wide and potentially all encompassing, but they are in many ways similar to other interest groups with a wide scope.

People join interest groups with a wide scope for a range of reasons, many unrelated to any public policies and campaigns that the group is pursuing. But it can still be legitimate for such groups to pursue campaigns and for their leaders to claim to represent the membership, because members can exit the organisation if they are unhappy with its policies.[40]

In the United Kingdom the Women's Institute for instance defines its history and current mission in the following way:

> The Women's Institute (WI) was formed in 1915 with two clear aims: to revitalise rural communities and to encourage women to become more involved in producing food during the First World War. Since then our aims have broadened and we are now the largest women's organisation in the UK. We celebrated our 90th anniversary in 2005 and currently have 207,000 members in 7,000 WIs.
>
> We play a unique role in providing women with educational opportunities and the chance to build new skills, to take part in a wide variety of activities and to *campaign* on issues that matter to them and their communities. (http://www.thewi.org.uk/section.aspx?id=12)

The WI pursues a wide range of policies and campaigns from promoting 'Fairtrade' to campaigning for an end to custody for people with mental illness. Many women probably join the WI primarily because of its social aspects, but the organisation can never the less make some claim to speak for them on a quite wide range of issues.

In an ideal deliberative democracy we might conceivably not need interest groups, because every citizen would have equal actual opportunity to participate in decision making processes in society,[41] but in our non-ideal societies interest groups play an important role. They can be a focus for specific interests that are otherwise neglected and they can energise people to try to take an active role in promoting their own views. This is not to say that interest groups are always a force for the good, since they clearly are not. They often, knowingly or unknowingly portray the interest that they are promoting as more important than it really is.

Are religious organisations different from other interest groups in ways that would give us reason to specifically exclude them from influencing policy processes?[42]

A number of possible relevant differences are:

- Religious organisations are not democratic in their internal decision making;
- Leaders of religious organisations have power over their members;
- Religious organisations are inherently hierarchical and elitist;
- Members do not voluntarily choose to become members of religious organisations;[43]
- Religious organisations are not open to everybody, membership is restricted;
- The views of religious organisations are not determined by reason.

What can be said about these possible differences between religious organisations and other organisations?

The first thing to notice is that both individually and taken together there are non-religious interest groups that exhibit these features. They are not specific to religious organisations and if we use them as criteria to exclude groups from influencing policy making, then they need to be applied to all interest groups.

Many scientific organisations are less than perfect democracies and many promote views that are not fully determined by reason.

Second, each of these features characterize some religious organisations but not all. So they do not provide justification for excluding religious organisations as a class.

It is clearly problematic if a religious organisation or any other organisation of which politicians are members exploits its power over its members to try to determine policy. However, it is not immediately obvious that a religious organisation that publicly states that 'good members of our organisation will vote for this legislation' is doing anything that is fundamentally different and more problematic than the trade organisation which states that 'only politicians that vote for this legislation will continue to enjoy our financial support'. Both organisations attempt to use power in a space where only argument should be used.

What I am denying here is not that there are religious groups with characteristics that make them illegitimate participants in public policy making. What I am denying is that these characteristics are shared by all, or in many western societies even most currently active religious groups. So, we do again not have any reason to exclude religious organisations as a class.

Real politics?

The sections above can perhaps be accused of misstating what the problem with religious influence in policy is. Isn't the real problem that politicians, whether or not they themselves are religious take the pronouncements of religious figures too seriously and give religion a privileged place in public life?

There is much to be said for this view as an empirical account of what happens in some societies. Organized religion is in decline and politicians no longer need to take the views of religious figures as seriously as they did previously. The religious figures speak for fewer people and ignoring them is not as dangerous to a government's re-election prospects as it used to be.

One way of understanding this 'realist' description of the political situation is therefore that on a cynical Schumpeterian account of politics – parties do not get elected to pursue policies, they pursue policies to get elected – politicians in some countries have not yet realised that they do not, as a matter of political expedience, need to take religious views into account.

However the other side of the realist coin is that politicians in societies where religion is still important should take the views of religious figures seriously, even if they think the arguments don't hold up.

We could also read the complaint as a more principled warning against giving some organisations privileged status in public life. If 'privileged status' here really means 'unjustified privileged status' then we are close to a tautology, but if it is a placeholder for 'organisation a politician can legitimately take account of' we will need a more precise account of what creates such organisational legitimacy. Given the many similarities between religious organisations and non-religious organisations mentioned above, that account it unlikely to cut precisely at the religious/non-religious distinction.

Religion and science policy – Take 2

What are the implications of these arguments for religious influence on science policy in a secular society?

First it follows that if a religious person, organisation or politician influences science policy through arguments that are both valid and sound within a secular frame then seeking and potentially getting influence on science policy is completely legitimate and unproblematic, *pace* Dworkin.

Second it follows that any restrictions we want to apply to religious agents in debates about science policy will also have to be applied to anyone else who holds a deeply rooted world view. This also extends to the degree of suspicion of 'non-secularity' we can reasonably apply to agents, their motives and their arguments. If the mere fact that an agent is religious is ground enough for suspicion with regard to some hidden 'religiousness' in action, motive or argument, then the same hermeneutics of suspicion[44] must be applied to deep ecologists, Marxists, libertarians, feminists, one nation conservatives or any other participants in the debate who can be suspected of holding a world view. Their arguments must also be scrutinized for any remainder of ideology or world view that will entail that they do not solely rely on 'public political values'.

However what if the religious influence leads to a curtailment of either positive or negative scientific freedom? Will this not in itself show that religious influence is inimical to scientific freedom and make the whole argument above superfluous? If it is the case that scientific freedom is absolute and can never legitimately be curtailed, then the conclusion does follow, but the argument is invalid in so far as we have good reason to believe that scientific freedom while an important freedom is not an absolute freedom. If there are situations where scientific freedom can be curtailed legitimately, then what matters is that this curtailment happens by a legitimate process and based on legitimate and sound justifications. In a secular society the process and the justifications must be secular as discussed above and it is only if the religious influence has gone beyond this that it is inimical to scientific freedom in a problematic way.

Conclusions

This chapter has argued that certain kinds of religious influence on science policy are completely legitimate in a secular society, and that such influence is not necessarily inimical to scientific freedom.

More specifically it has argued that it can be justifiable to restrict scientific liberty to protect other important ethical freedoms and rights. This requires good justification, but is not excluded by the fact that scientific liberty is an important liberty. Further it has been argued that in relation to the more expansive conception of scientific freedom as a positive freedom society has greater latitude in deciding which of the many worthwhile scientific endeavours it wants to pursue. The mere fact that some piece of scientific work is important is, for instance not sufficient to create a non-rebuttable claim for funding.

In both of these areas of science policy the religious citizen and the religious organisation can legitimately put forward secular arguments for certain policy choices, and in so far as these arguments convince policy makers there is nothing problematic in making policy choices on these grounds.

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Should We Strive for Total Scientific Freedom?

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Freedom is a good that we all value. We have good reason to prize scientific freedom; that precious freedom to enquire has allowed scientists to understand so much of our world and allowed us to lead longer, healthier and wealthier lives. So should we, both scientists and non-scientists, strive for total scientific freedom? One scientist, Professor Donald Braben, thinks so.[1]

> Such abstract qualities as freedom are difficult or impossible to define… those exceptionally rare scientists whose revolutionary work can open new horizons can do so only if they have total freedom. The routes to new types of knowledge can be deceptively disguised, and may appear to ordinary mortals as unimportant byways leading nowhere. There must be no filters whatsoever on what they do, therefore, however well intended. Furthermore, their work is vital to future prosperity. In an increasingly complex and populous world, any attempt to limit it will lead us down the path to stagnation and pain.

This demand for total scientific freedom is a strong claim. Before we consider its validity, let us ask what total scientific freedom might look like. Unfortunately, there is no universally accepted definition.

What might total scientific freedom look like?

Braben identifies an important characteristic of total scientific freedom: that 'there must be no filters whatsoever on what they do, therefore, however well intended'. So scientific freedom means leaving scientists to pursue the projects they choose, and not regulating or otherwise constraining them. His concern is that scientists, or at least the exceptional scientists with whom he is concerned, should not have to conform to some narrow agenda specified by others, or deliver immediate quantifiable benefits. For Braben, scientific freedom means allowing creative scientists to pursue an understanding of nature.[2]

We could conceive of scientific freedom as economists might, as a free market, with knowledge (or information that can be turned into knowledge) as the main product. In that free market, we might expect to find the following conditions:

- freedom of any individual or organisation to pursue any scientific project and to produce and publish knowledge;
- full access to information, finance and other resources necessary to pursue the scientific project and to exploit the knowledge that results; and
- an open market in which to trade knowledge.

True scientific freedom would not restrict who can carry out a scientific project. On the one hand, we could imagine a highly knowledgeable and skilled university research team with access to the resources they need and pursuing the kind of revolutionary work Braben has in mind. On the other, imagine Femi, a young woman living in Africa. She has little money but was fortunate enough to go to school where she excelled at science, and she has a scientific project she wants to pursue. In a state of total scientific freedom, should she not also be able to pursue her research? Full freedom would mean that anyone would be free to pursue their own scientific research.

Why total scientific freedom is unattainable

Even in a free market, actors compete for resources, so freedom is inevitably constrained for some. The analogy between scientific freedom and a free market is imperfect; science does not operate like a free market. The production of knowledge differs significantly from the economic concept of a perfectly competitive market. Partha Dasgupta explains why.[3]

> Knowledge is not a homogeneous commodity. There are different kinds of knowledge and no obvious natural units in which they can be measured. Indeed, each piece of knowledge is a separate commodity. It is indivisible, in the sense that once a certain piece of knowledge has been acquired there is no value to acquiring it again: the wheel does not need to be invented twice. The same piece of information can be used over and over again, at no cost... In short, knowledge has the hallmark of a public good, a durable public good.

He goes on to explain that many economists support public subsidies for public goods such as 'blue skies' or basic research – the output of which is used only as an informational input into other inventive activities[4] – because other methods of funding are unsuitable.[5] However, making use of that information and turning it into knowledge will often require other information and skills, thereby restricting scientific freedom.[6]

Because knowledge is in economic terms a public good and not tradable, private firms require incentives to participate in research, and governments have invariably provided this either through public subsidy, or through intellectual property protection such as patents.[7] The latter inevitably restricts access to information for others, and thus scientific freedom.

However, our university research team might publish freely (subject typically to peer review). They might not seek income from the outcomes of their research, especially if it is basic research, but rather rely on funding from an external source. Whether the source is private or public, that funding will almost certainly come with strings attached, such as control of the research agenda, or pressure to produce results that benefit the funding source. For example, corporate interests can introduce bias to scientific processes to evaluate and test new drugs.[8] Powerful interest groups not funding science may also influence scientific research.[9] These factors all interfere with scientific freedom, and may undermine the reliability of research findings.

Access to resources will be unattainable for some. For an aspiring scientist like Femi who is outside the mainstream scientific community, there is a negligible chance that she will be able to gain the necessary access to skills, finance and other resources for her scientific project. In some areas of research, like particle physics, access to very expensive capital equipment like a particle accelerator may be essential. This acts as a barrier impeding scientific freedom.

Thus the real world inevitably presents many potential barriers to scientific freedom, a few of which I have touched on here. With so many potential limitations, it seems that total scientific freedom is unachievable, but should we strive to maximise scientific freedom – is scientific freedom even a desirable goal? Let us consider and weigh up the arguments.

Reasons to enable scientific freedom

Braben's reasoning

In his book on scientific freedom, Professor Braben seeks to persuade the reader that it is essential to the future of humankind that society enables scientists to pursue their research without external interference. His claims are strong, although he is not alone; his concerns are shared to some extent by other scientists,[10] and there is considerable public support for scientific research.[11] He argues that:

- in the past, many great scientists like Max Planck and Albert Einstein were given the freedom to explore their research and this resulted in ground-breaking discoveries that led subsequently to numerous technologies and sustained economic growth;[12]

- a significant change occurred around 1970, when scientists became constrained by externally-set research policies, the need to justify prospectively their research to their peers, and other fundamental impediments to scientific creativity and freedom;[13]
- as a result global economic prosperity and civilisation is now at risk;[14]
- creative scientists working within autonomous universities should be identified and funded to pursue transformative research according to their own agendas, and without having to demonstrate efficiency or accountability.[15]

Braben recognises that researchers require resources that will not be provided through market mechanisms, and that public subsidy normally will be required. Rather than following what he perceives to be the bureaucratic processes of research funding agencies, he advocates that grants for what he calls transformational research should be allocated by exceptional, creative scientists to other exceptional, creative scientists who should then be left to pursue their own projects. He does not consider this to be high risk, but rather a means of pursuing high-impact projects that have a high probability of success.[16] He backs up his argument with many examples of high impact projects where scientists have been given resources and creative freedom.[17] He also predicts that so few proposals from scientists would qualify as transformational research (TR) that only a small research budget would be required:

> it might be difficult to spend even 1% of a large funding agency's budget on TR if Planckian standards are maintained. If expenditure substantially exceeds that level, its strategy would almost certainly be wrong.[18]

It is clear that Braben's concept of scientific freedom is to be enjoyed by the very few. Our university research team is unlikely to qualify, and certainly not Femi in Africa.

Economic arguments

Dasgupta offers some backing for the argument to fund creative, exceptional scientists[19] but more importantly, it has long been accepted by economists that economic growth and prosperity rely on science.

In a review of the economics literature on science, Diamond confirms that since the industrial revolution, technological change has been the main driver of economic growth, and that technological change has relied on scientific progress.[20] In a broad review of the published econometric studies, surveys and case studies on publicly-funded research, Ammon Salter and Ben Martin found that research yields 'a positive rate of return, and in most cases the figure has been comparatively high'. Economic benefits extend to basic research:[21]

> although its economic benefits are hard to quantify, basic research is crucial for the strategic position of industrialised nations in the world economy, and

> for remaining at the leading edge of technology. This has been true in the past (especially in chemicals and pharmaceuticals) and will remain true in the future as new technologies draw increasingly on the outputs of basic research....

These economic benefits are realised in a number of ways, including 'spillovers' where scientific knowledge is applied by firms into productive technology adding significantly to economic growth.[22] Spillover effects have been found to be localised suggesting that nations cannot rely on exploiting publicly-funded research from other countries.[23]

The importance of basic research to economic development supports the claim that scientific freedom contributes significantly to prosperity.

Philosophical and ethical reasoning

Like Braben, Wilholt supports the idea that individual scientists should determine independently their own research projects and hypotheses, albeit for different reasons. He sets out an epistemological argument in support of scientific freedom, namely that it creates optimal conditions for our collective search for knowledge. The veracity of that knowledge relies on mutual criticism, which presupposes a certain degree of independence amongst researchers. He goes to provide a second argument for scientific freedom:[24]

> In making their political choices, citizens are in many ways relying on their beliefs about what the world is like, and ever so often they turn to science in order to resolve uncertainties. On the basis of this observation, it can be argued that the practices and institutions generating the scientific knowledge that citizens rely upon should enjoy independence from the major political powers. Otherwise, the democratic process would be undermined, in a similar fashion as it would be if the press, for example, was subject to the control of the government.

John Harris recognises there are occasions where the freedom to carry out scientific research should have been constrained for ethical reasons, such as the Tuskegee Study of Untreated Syphilis in which 412 poor African/American men were deliberately left untreated for forty years in order to see the effects of syphilis.[25] However, recognising the enormous benefits that science can bring (such as to cure people suffering from HIV/AIDS), he argues against the precautionary principle often cited by ethicists and in favour of a basic moral obligation to support science on grounds of fairness and to help other people in need. When carrying out research using human subjects, Harris, like some other bioethicists,[26,27] concludes that we must weigh the obligation to support research against the duty to protect vulnerable research subjects.

Lastly, we should recognise the inherent value of freedom, a concept highly prized by philosophers throughout history.

Reasons to constrain scientific freedom

Economic arguments

Because the output from scientific research is primarily knowledge, a public good, scientific projects are typically funded, or partially funded, from public monies. Projects effectively compete for these resources against other public projects and services, which may include health, social care, defence and the arts. Economists typically evaluate such projects using cost benefit analysis. There are many variants of such analysis as Amartya Sen has illustrated.[28] However, typically, cost benefit analysis involves:

- assessing, using the best information available, the expected values (typically in monetary terms) of the benefits and costs of a project or service and the timing of these costs and benefits;
- adjusting these values to reflect risk, and the probability that these costs and benefits will be realised;
- discounting future costs and benefits so that tomorrow's money may be expressed in its value today; and
- reaching a figure for the current (either positive or negative) value of the project or service.

This potentially enables a scientific research project to be compared to a proposed community arts event, or against a service to provide shelter to homeless people. An efficient public body would then allocate available funding to the projects with the highest positive value (in today's money). It will be apparent that in all of the cases mentioned, and indeed in most cases of publicly-funded projects, assessing future non-monetary benefits in monetary terms is likely to be difficult and contentious.

It is particularly difficult for basic scientific research projects, where the goal is knowledge rather than direct economic benefit. First, there is no guarantee that any new knowledge will result. There are many failures in the history of science. Second, valuing knowledge is very difficult. Third, if researchers are to be given scientific freedom, there will be little or nothing known about the nature of the knowledge being pursued when the case for funding is assessed. Simply trusting in exceptional, creative scientists is problematic for any public body that is accountable to citizens for the use of public funds.

Ethical reasons

Few people, including other scientists, would support Braben's claim that there should be 'no filters whatsoever on what they do, therefore, however well intended'. Most would accept that there may be ethical reasons to constrain scientific freedom. However, ethical concerns do not always arise. Many ethicists would support the conclusions of John Stuart Mill that people should be free to pursue their own goals without intervention unless their actions harm others or limit an equal freedom in others,[29] and some would want to include in 'others' future generations and other animals. On this basis, a scientific activity like dissolving sodium chloride in a bucket of water should be free from interference from outsiders. Similarly, the exploration of ideas and scientific theories like those pursued by Darwin should not present ethical problems.

There are, however, many situations where ethical dilemmas do arise. Numerous scientific projects pose a potential threat to populations and our environment[30] (The Bulletin of Atomic Scientists). Many scientific processes may well require the involvement of human subjects, or require access to resources pertaining to humans (such as human tissues, or medical records). Furthermore, although scientists may know the planned research process, by the very nature of basic research, they will not know everything in advance about its outcomes. Only where it is possible to confidently predict that the outcome will have no harmful impacts can we conclude that further ethical consideration is irrelevant (although where there is a possibility of harm it does not necessarily follow that scientific freedom must be constrained).

Ethical concerns may not arise regarding the process or outcomes of a project, but arise because it requires public funding.[31] Any project that requires use of public funds impinges on others and is everyone's concern; the money could be used for numerous other projects for public benefit (or indeed not collected so as to avoid diminishing private benefit). Furthermore, an important ethical consideration for publicly-funded projects is how the benefits of the project are distributed.

So, there are many circumstances where we would have legitimate ethical concerns about scientists pursuing their goals with total freedom. Could we leave individual scientists to self-regulate? Scientists understand better than anyone what the impacts of their work will be, how they might affect others, and thus could constrain their own actions according to their consciences. However, non-scientists may not trust individual scientists to assess the impacts of their work dispassionately. Their actions may affect us all and their values and ethics may differ from ours. Furthermore, scientists have done harm in the past. For example, we know from the Nuremberg trials[32] and other sources that scientists committed horrific war crimes as part of their medical experiments.

To summarise, there are likely to be good ethical reasons to constrain scientists in a wide variety of circumstances.

Weighing the arguments

Almost everyone would recognise and value the significant benefits that science has brought, and can bring, and would not want unnecessarily to obstruct scientific progress. However, most would accept that scientists cannot expect total freedom to pursue their research. In any case, total scientific freedom is likely to be unachievable in practice, especially for those outside the mainstream scientific community and with little access to resources. Even for employed scientists, there will very often be constraints on resources or interference in the scientific process.

At the stage of planning scientific research, and especially basic research, it is often not possible to understand where the research project will lead or the impact it will have. This poses particular difficulties. First, it means that we cannot predict and value the case for public funding, and second we cannot always predict the ethical implications of the research. Braben's answer is that we should pick exceptional, creative scientists but not interfere in any way with what they do – we must place public funds in their hands and trust that the benefits will follow. There is a good case for at least some public funds to be spent in this way because the potential benefits can be so great, although it is far from clear how these exceptional scientists are chosen. Many scientific projects will not be supported; there are many other good uses to which public funds may be put.

Where it is likely to impinge on the lives of others, there may be good ethical reasons to constrain scientific research. However, we benefit enormously from research, and these potential benefits ought to be weighed against potential harms when making public policy and law to constrain scientific freedom.

14

The Ethical Limitations on Scientific Research

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A perennial question that arises concerning the relationship between scientific research and society is whether there should be any limitations on scientific research and if so, what are the justifications and how far do they extend? Over the years such prohibitions have included sanctions against dissection of cadavers, invasive surgery, and the introduction of X-rays. From a modern perspective these prohibitions seem mistaken. In the twenty-first century increasingly we are bombarded by new biomedical technologies that confront us almost on a monthly basis. Most controversial among these are: A. scientific research trials (particularly pharmaceutical studies) that seem to offer hope for medical treatment but at the possible cost of ethically devaluing the participants, and B. protocols that would affect the germ line of humans, animals, and plants such that we may be in the process of altering life on earth in a significant way.

We, by our actions as humans, may become one of the most significant variables in how species on our planet evolve from here on out. This is an awesome responsibility. Are we up to the task? This is the question on most peoples' minds as they open the morning newspaper, listen to the radio, watch television, scan the home page of their web browser, or absorb the latest tweet. How should we think about such discoveries? If we're uncomfortable, is this just a sign of intransient, Luddite stodginess? Is our future mission on this planet one that mirrors the television show, 'Star Trek': to go forth (without restraint) and seek out new truths (civilizations) and to boldly go where no man has gone before?

In order to get a handle on how to think about this conceptual model, let us begin our interdisciplinary excursion by examining the very limits of science, itself. In order to achieve a perspective on the possible ethical restraints on new science, most of this chapter will cite examples in the recent history of science in order to make its point. A few contemporary examples will then be brought forward in order to match them against the derived ethical principles.

The structure of our short exploration will revolve around a foundational concept called the Principle of Plenitude. This concept is fundamental to our value-directed exploration of the work of science.

The Principle of Plenitude

Many readers will be familiar with the Principle of Plenitude as discussed by Arthur O. Lovejoy in his classic work, *The Great Chain of Being*.[1] Lovejoy intended a kind of 'possibility implies normative assent' thesis. This translates to 'what can be known should be known'. When one applies this to the scientific realm, it rings almost like religious dogma. 'Whatever can be known about the physical world should be known.'

I once quizzed some scientist colleagues at the US National Institutes of Health (a national research center in bio-medical research) about this principle and could not find a single objector to the proposition.

Who could argue with such a thesis? There have been some. In the seventeenth century it was an issue of contention. John Milton expresses this view in *Paradise Lost*:

> Heaven is for thee too high
> To know what passes there; be lowly wise:
> Think only what concerns thee and thy being. (Bk. 8, ll. 172–4)

The seventeenth century was the age of scientific revolution. Entire paradigms of thinking were altering.[2] As in all changes there is an 'upside' and a 'downside.' Some of the upside had to do with more accurate scientific theories that had greatly expanded explanatory power. From Galileo to Newton the century was alive with discovery.

The downside had to do with the social unrest that may have been a consequence of challenging established authority. The English Civil War and increased turbulence on the Continent are only two examples of what may be attributable to social unrest. The age of the magisterium of the Roman and English Catholic/Anglican Churches was matched by a corresponding emphasis upon the individual.[3] John Locke wrote about individual human rights that were logically prior to those that the State chose to recognize. The seeds of the American and French Revolutions were sown here.

Now many would say that such movements were very positive in the grand scope of things. They may have been, but there was much that was lost as well. Rapid change tends to reward first those opportunists who have established themselves in the vanguard. The ordinary people are often left in an onerous holding pattern (that may be worse than it was before) as things adjust.

The limits of science

It is characteristic of many scientists that they are consciously or unconsciously blind to the possible consequences of their actions. Since the mission ('What can be known, should be known') dangles before their eyes, they often feel that whatever it takes to get there (the means) is justified by the lofty goal (the ends). Few moral theories will say that the ends *always* justify the means. Not even utilitarianism professes this in every case (since such an action creates a precedent that, itself, can have severe negative utility).[4]

It is entirely plausible that the thesis of plenitude is not always true. There may be instances in which we should refrain from exploring certain research strategies. These include: (1) instances in which the means of obtaining the scientific ends are immoral; and (2) instances in which the ends themselves may clearly be seen to be involved in a larger context that is, itself, immoral.

Let us examine these in order. *First, there is the instance of immoral scientific means*. This, in turn comes in two varieties: relative immorality and *per se* immorality. In relative immorality one may not have the technological means to do something humanely at the moment, but 'in principle' it may be possible in the future. An example of this is the observation of human organs as they function within a living organism. In ancient times the only means available to obtain this scientific end was vivisection. Celsus reports that vivisection was performed by Erasistratus and Herophilus upon condemned prisoners.[5] The explicit purpose of vivisection (the surgical exposure of the internal organs of a live person without anesthetics of any kind) was to learn more about how the human organs functioned. This scientific end is indeed a valuable one. Under the plenitude principle what can be known should be known, ergo let's cut up another poor soul!

Of course, vivisection is cruel and inhumane – even when performed upon people condemned to death. This is because inflicting severe pain upon another human at will produces (from the recipient's point of view) gratuitous suffering. Inflicting gratuitous suffering upon any human, at will, is to fail to respect their dignity. This is because tied up with dignity is a fundamental sense of rights to primary basic goods of agency (food, clothing, shelter, and freedom from dehumanizing and degrading violence).[6] All humans have a claims right to the primary basic goods of agency.[7] Thus, to fail to provide another person with the primary basic goods of agency (when it is in your power to do so) or to deny another the primary basic goods of agency, is to fail to respect their human dignity. Since all people have a moral claims right to the primary basic goods of agency, then to deny another of her primary basic goods of agency is immoral. Therefore, since performing vivisection in ancient times was an instance of denying another of the primary basic goods of agency, then vivisection was an instance of failing to respect human dignity and thus immoral.

If performing vivisection is the only means of obtaining the scientific end, then that end should be forsworn. Scientists should decide that they will *not* pursue the end (contra to the Principle of Plenitude) because the only way that they can do so is to employ immoral means.

However, in this instance the immoral means are relative. That is, they are relative to a particular stage of scientific development. In Galen's time up until a little more than a century ago, it would have been impossible safely and humanely to surgically examine a patient in order to understand the physiology of his organs. Once the technology progressed to the point where surgery could proceed without being cruel and inhumane (thus failing to respect the human dignity of the subjects), then surgery could become a legitimate means of pursuing the end of physiological discovery.[8]

An example of a *per se* immoral means would revolve around cases in which the scientific end inextricably entails pain and suffering. For example, if a scientist wished to know the stages in which a disease killed people (in a controlled setting), then the means would necessarily require taking a group of humans inflicted with a fatal disease and watch them die without providing them with any real (available) cures or significant palliative care (such as they exist at some moment in time). This is because such 'intervention' might skew the pure view of the disease's progression and the effects upon humans. The researcher distances herself from the project and merely observes and records people in the various agonizing stages of death.

This scenario is not too far removed from the infamous Tuskegee experiment in which patients infected with syphilis were not properly treated so that they might be observed in their pain and suffering.[9] The scientific end of understanding the 'natural' progressions of a fatal disease among a large controlled sample group is a valuable one for advancing scientific knowledge. However it can only be achieved through immoral means. Thus, the scientists should have forsworn this research plan.[10]

Similar infamous research designs were carried out by Nazi Germany, Tojo's Japan, and Stalin's Soviet Union. In each case, scientific ends that *only* could be carried out by immoral means should have been avoided. This is yet another instance in which the Principle of Plenitude is flawed.

Henry Beecher also brought to the fore The Jewish Chronic Disease Hospital Case in which patients without known relatives or advocates were subjected to blatant deception in order to engage in cancer research and the mechanism of transplant rejection. These patients without advocates, who did not have cancer, were injected with live human cancer cells in order to view how the human body would react. Obviously, this put these patients at risk of getting cancer. This patent disregard for research subjects is reminiscent of the Tuskegee experiment.[11] Ezekiel Emanuel and Christine Grady show that the most egregious violations of research ethics occur under a worldview approach of *researcher paternalism*. Under this paradigm the 'what can be known, should be known' approach is unchecked. Ergo, the immoral means are allowed to go forward. The authors suggest that a check on these immoral means can occur through a mix of regulatory protectionism, participant access, and community partnership.[12] The result is some transparent accountability.

A final group in this category concerns scientific discovery in realms in which double blind testing creates an unethical context. The most common among this category comes from the pharmaceutical industry. A key example of this is the testing of HIV/AIDS medication in Thailand and some other Third World countries. Problems occur when: First, trial protocols give different groups who are at risk various mixtures of the AZT medication (in order to see whether lower levels of the drug might still work so that the more affluent countries of the world might be able to save money.[13] Stolberg 1997). Women were given progressively lower doses in order to discover whether the standard dosage could be lower and still work. Trials were continued even when the research subjects showed clear deleterious effects that included advancement to full-blown AIDS and death. However, proponents say this is the only way to be sure of the exact dosage necessary. The only way to get this exact information is to fail to recognize the dignity of research subjects, which is unethical.[14] In this case the means to acquiring scientific knowledge are unethical and should not be pursued in this way.

Secondly, a second breech of research ethics occurred when testing HIV/AIDS vaccines. In this case a sexually active population was chosen (also in Thailand and other Third World Countries). The trials were double blind. They were continued past the point in which in-progress results were not sufficiently positive to continue in the face of the demonstrable negative medical side effects to study participants[15] as well as probable negative social side effects.[16] In addition to these problems, putting research populations at risk when there is an available treatment just because they are of a lower socio/economic class or because they reside in a Third World Country and thus have no standing in compensatory law suits, is also unethical on the same grounds.[17] However, the benchmark for medical certainty (.05 of the null set) could not be achieved except by marginalizing these women. They were treated as 'means only' for the sake of a standard of medical knowledge. It is my contention that the use of these protocols is immoral. They disregard the dignity of the human research subject. All of these aforementioned examples are centered on HIV/AIDS vaccine trials in stages I, II, and III. The information necessary to create a vaccine for a world epidemic disease seems to involve unethical research methods if full double-blind testing is used as the model. Double-blind testing is the gold standard for medical research (if one wants to achieve the most reliable results). However, early testing of AZT in the United States used a rather more informal technique of clinical trial and error. The patient population was dying of AIDS. This group of patients would search for any hope and were ready to try an experimental drug. In this case the informal trial was successful. However, in the longer term this sort of research method in this context is more expensive and less reliable – because it yields less exact scientific knowledge. However, it is this author's opinion that ethics trumps efficiency. No scientific knowledge should be obtained via unethical means.[18] Less exact knowledge procured ethically is to be preferred to more exact knowledge procured unethically. This is a key limitation on scientific knowledge.

There are those who contend that some of these ethical-means problems occur because of the different roles of physician and researcher. The argument goes as follows. The physician is an advocate for her patient. However, the scientific researcher has a different imperative that is not patient centered.

It is, in fact, probably a better situation that the physician and the biomedical researcher be separate. This is because their respective missions are not identical. The physician is concerned with the well being of the patient and in doing no harm. Her duty is to focus upon the patient and his recovery. The researcher is concerned with expanding our understanding of nature and benefiting humankind. This mission may lead him in a different direction. The mission of the physician is different. When the physician and researcher are one and the same person, a conflict of mission may occur.

However, I am not advocating an absolute prohibition against the physician and researcher being one and the same person, but merely to point out that since the missions of each are different, potential conflicts may arise. For this reason, institutional review boards (IRBs) should take this into account using the following standard: it will be assumed, *prima facie*, that the researcher and attending physician will not be the same individual. One would need a compelling argument to get approval otherwise.

Obviously, this sanction would not apply to medical clinical research that is observational only: a physician reporting on his cases under the latitude of approved patient care. Because of this latitude, some modifications of care can be published as clinical research. It is only when the course of treatment becomes experimental (beyond the standard of approved patient care) that the two roles become controversial.

Conceptually, what stands behind this limitation on scientific research is that the means to some scientific truths are unethical. If one cannot know exactly *how* one dies from syphilis (for example) without setting up a situation in which individuals are allowed to go through all the stages of the disease to death (when there are effective treatments available), or how certain sorts of cancer spread (when there are effective treatments available), or creating an HIV/AIDS study to test a vaccine that requires a placebo group who will die (when there are effective treatments available), then – if this is the only way to acquire such scientific information – such knowledge should be outside our ken. Its acquisition can only be acquired by unethical means. It thus stands as an exception to the principle of plentitude.

The second category of exceptions to the Principle of Plenitude involves instances in which the ends themselves may clearly be seen to be involved in a larger action or context that is very risky to the public good to such an extent that it becomes immoral. This second category seeks to examine the character of the proposed end of the scientific principle being explored. Fundamental to the exploration of this second category is the admission that science does not exist in a vacuum. As much as many researchers might like to think of themselves as in a protective cocoon of pure intellectual speculation, this is really a pernicious fantasy that often blinds scientists to the actual uses of their research.

In this category I will examine two cases: 1. The proposed protocols for Germ-Line secondary goods Enhancement, and 2. The development of the Atomic Bomb.

In the first case we are involved with possible protocols for germ-line genetic secondary goods enhancement. At first blush, it might seem like genetic enhancement might be a good thing. We could create a new species, *homo melior.* These creatures could be the best possible of all genetically engineered hominoids. So, who could possibly have a problem with this? Doesn't this sound like the perfect actualization of the principle of plentitude?

Although the promise of improving humans in a number of areas sounds very fine, the devil is in the details, and the details are not as optimistic. First, one must remember that there is a difference between *somatic treatment* in which genetic engineering will seek a treatment or cure when otherwise there is no hope and *genetic enhancement* in which the germ line is altered in such a way as to affect future generations. When the risk factor is just a single individual, the stakes are different from risking countless offspring to come (potentially all of humanity over time). In genetic enhancement there is a new context that is being created. This context could be very deleterious. The reason for this is that genetics is enormously complicated. For example, what was taken as 'junk DNA sequences' just a few years ago now is seen to have some mechanical functions (though they are not very well understood). There have also been a number of unforeseen consequences in recent years during genetic therapy that have resulted in outcomes worse than the underlying condition and traditional treatments – including death.[19] If somatic genetic therapy is extremely risky, think of the extended unforeseen consequences when the germ line is affected. Each mistake will be multiplied many times over.

Despite the tight controls on genetic engineering for somatic treatment, the track record has not been sterling. The principle of precautionary reason would suggest in such a situation that researchers forego therapy except in otherwise hopeless situations until the level of science improves – a relative prohibition.[20] But genetic treatment or enhancement that would affect the germ line seems to this author as having enormous risk for unintended consequences. Is this just a case of science not being up to a possible new standard where all will be possible? Or is it a case of the three-ball problem in Newtonian physics (a conundrum with *per se* problems due to inherent complexity that can never be solved)? No one knows for sure. Because of this uncertainty, moving forward in this arena should deserve special analysis. In order to think about this let us separate two sorts of enhancements: (a) those that are concerned with 'knocking out' deleterious DNA base sequences that are responsible for genetically inherited diseases, and (b) those that seek to improve the species by adding new capacities.

In the first case, we may be in the situation of a relative prohibition (such as the prohibition of the surgical study of physiology above). The model is analogous to vaccine inoculations. Though the track record for genetic therapy has not been the best, we can imagine a future in which some skill might be obtained so that we might be able to eliminate Tay-Sachs, for example. This is logically possible, and it fits into the historical mission of medicine. However, because of the immense complications involved, at the very least if we are governed by the principle of precautionary reason, then we have voluntarily taken on many limitations upon the principle of plentitude. This means that we must proceed at a very slow pace that follows the highest standards of research ethics. It may be the case that we will never be competent enough to pull this off. It might be that we have a case of the 'three ball problem' in Newtonian mechanics. The use of 'knock-out' strategies in genetic therapy (except as an experimental last hope at this juncture in history) should be avoided. We will move forward (if at all) on the robust informed consent of those who feel they have no other options.

The second form of enhancement does not seek to protect from future harm (much on the model of vaccine inoculations), rather it seeks to improve us to *homo melior.* The strongest case against this is that it creates a context of typology (here understood as secondary goods).[21] We seek to create preferred *types* that represent the 'perfect' person. This drive toward homogeneity is radically against the acceptance of diversity among peoples and against the viability of those who have various forms of disabilities (now defined as against the perfect phenotype). Will everyone have a certain facial construction, skin color, sexual orientation, and brain configuration (including values and tastes)? Such a social context would be radically against diversity (considered by biologists to be essential to evolution and by some ethicists to be a key element in social justice).[22] Therefore, genetic enhancement for the sake of improving the capabilities of the species (as opposed to knocking–out deleterious genetic diseases) is a valid instance of a *per se* limitation on scientific knowledge.

The second case of a *per se* resultant immoral context concerns the research into weapons of mass destruction. In the United States, the former Soviet Union, and many smaller countries around the world there has been research into chemical and biological warfare.[23] Sometimes the country says to its scientists that they are investigating ways of deploying nerve gas or anthrax as a way to create defenses against such weapons that might be used against them. This is the ploy of many leaders: We only want to create an effective *defense*. No one wants to admit that they are engaged in anything that might be construed as *offensive*. When Nazi Germany invaded Poland it was on the pretext that they were responding to earlier injustices. Later conquests were likewise linked to past grievances that needed to be settled. Likewise, with so many other countries, the US invasion of Iraq, various conflicts in Middle East, wars in south central African, unrest between Pakistan and India *et al*. – all of these were sold to their peoples as being somehow defensive.

Who, after all, is going to approach his people and say, 'Today we are about to engage in a grand offensive land/property heist because I, as your leader, think it my manifest destiny to garner as much money and power as possible because that is my personal mission in life'?

A classic case that covers the essential elements in the weapons of mass destruction scientific paradigm is that of the Manhattan Project. If you were a scientist asked to head the atomic bomb project in the early 1940s, what *would* you say, and what *should* you say?

On the one hand, you might think that here is a chance to be funded to perform basic research that will alter how particle physicists understand the nature of matter. What a grand opportunity! We now have a chance to demonstrate that the very word 'atom' (meaning in ancient Greek 'un-cuttable') is wrong. The atom can be split, and you are on a research team that will do it. This is a chance to extend the boundaries of science: to know whatever can be known (the Principle of Plenitude).

On the other hand, you might realize that this research is for the purpose of creating a bomb that can have no other purpose but to kill civilian non-combatants – in unthinkable numbers.[24] This bomb is so devastating that it could never be used in accordance with the recognized 'rules of war' that assert that armies only attack armies. Non-combatants and civilians are not fair game in the rules of war, but since the atomic bomb's effects were so pervasive, it would not be possible to deploy it without violating these rules of war. Whenever it was used, it would be a weapon of mass destruction. As such, it would be a vehicle of killing that would re-define warfare. The way warfare would be re-defined is through the inclusion of mass killing of civilians on a scale that the world has never known before. What this means is this:

1 Warfare is morally justified only on the principle of generalized self-defense – Assertion

2 Self-defense is defined as committing minimal effective force against an aggressor to protect oneself – Fact

3 In the case of war, the aggressor consists of the attacking army and/or those civilians actively engaged in fabricating armaments – Assertion

4 Warfare only morally justifies the killing of combatant soldiers in the army and/or those civilians actively engaged in fabricating armaments – 1–3

5 Civilians living in the countries engaged in war are (except for armament workers) materially separated from the act of aggression – Assertion

6 Anyone materially separated from an act of generalized aggression is to be considered innocent – Fact

7 Civilians living in the countries engaged in war are (except for armament workers) are morally innocent – 5–6

8 Murder is defined as the killing of an innocent without just cause – Fact

9 The killing of soldiers or civilians engaged in armament fabrication can be morally justified in a defensive war, but the killing of other civilians is murder – 4,7,8.[25]

The practical end of the Manhattan Project was to create a weapon of mass destruction. A weapon of mass destruction will necessitate the deaths of thousands of innocent civilians. This entails that the practical end of the Manhattan Project was murder. Is being a part of the Manhattan Project as a contributing physicist something that *you,* as a scientist, should accept? You may pretend that you do not see the real end, but it is there nonetheless. One possible reason a scientist might blind himself to this intersubstitution of ends in the causal chain is because the scientist may view the proposition as opaque. However, this does not wash because we are not talking about mere substitution of terms, but of logical relationships that exist when anyone enters a causal process.[26] This point can be illustrated by the following example. If Mary is an accountant for a pharmaceutical company (that is adulterating its products with impotent fillers in order to make more money), and if Mary knows this (or could have reasonably figured it out), then she cannot throw up her hands and claim innocence when someone dies from taking the medication. She cannot say that all she was doing was keeping the books according to the highest standards of accounting practice and that one cannot connect her to the ultimate end because the context is opaque. No, Mary is responsible for understanding that she acts in a context and bears some responsibility for the reasonably foreseeable outcomes of that context. If the end leads to a foreseeable immoral outcome, then scientists should not join. On this line of analysis (instances in which the ends themselves may clearly be seen to be involved in a larger action that is, itself, immoral); no scientist should have signed on to the Manhattan Project (or other like projects that had immoral ultimate ends). Under this line of argumentation, the second limit of science is not to participate in research projects that will or probably will create an immoral context in their implementation.

There are, however, two rejoinders to my argument. A. What if the immoral ends are less immoral than some other end? B. What if an individual joined in the project that had an immoral end with the purpose of sabotaging it?

Both of these suggestions are challenging. Let us address each of these in order. The first suggestion is that there are gradations of unethical conduct. If one were to do x (where x is an unethical action), then x might be *less* unethical than some other consequence y. In this situation, one might be confronted with a dilemma situation (meaning that without any prior wrongdoing on the agent's part he might be put in the situation in which he must perform an unethical action). If one holds that dilemma situations can occur, then performing the lesser of two evils may be the most moral alternative. In order to enter this style of reasoning we have to consider all lives as equally at risk: combatants and non-combatants. Under standard accounts of just war theory combatants in war are fair game while non-combatants are not, but under this rejoinder, that sort of reasoning is rejected.

Returning to our example, if creating an atomic bomb that will kill more than three hundred thousand people,[27] is compared to a land invasion that will mean the aggregate deaths of two million people, then (if human life is additive) it would be better to drop the atomic bomb than to attempt a land invasion.

This style of analysis is highly dependent upon a consequentialist calculation that ignores the distinction between combatants and non-combatants. It assumes that the rightness or wrongness of any given human action depends upon the net result of utility consequences as seen over a reasonable time period.[28] Some would see this as an instance of the Trolley Problem. In the Trolley Problem one is asked whether it is more ethical to kill a fewer number of people than a greater number of people.[29] This speaks to the question of whether human life is additive or whether it is not. If human life is additive (and if the additive assumptions are correct, viz., that non-combatants and combatants are to be viewed as equally viable military targets), then clearly dropping the atomic bomb is morally justified. However if human life is not additive (meaning that it is just as horrific to kill one immorally as to kill ten immorally) or if there is a hard and fast distinction between combatants and non-combatants, then there are no moral criteria to justify dropping the atomic bomb.

One might effectively ask whether any scientist recruited at the beginning of the Manhattan Project would have the sort of information that President Franklin Roosevelt cum President Harry Truman did when he made the executive order to drop the bombs. For all these scientists might have known, the death toll could have been in the tens of millions. All that they knew was that they were engaged in the creation of a weapon of mass destruction. How many people might be murdered or killed in violation of the rules of war was entirely unclear. Also, it is unclear how many soldiers would have been killed if the United States adopted another strategy. In 2001 during a Faculty Ethics

Seminar I co-ran, one participant was a former general in the Air Force who said that she had studied a US Military generated account of an alternate strategy of setting an extended siege and conventional bombing campaign against military targets in natural-resource-poor Japan before setting forth on a land invasion. The numbers of American soldiers to be killed under this strategy were fewer than 100,000 – far less (even under the aggregative strategy) than dropping the two atomic bombs.[30]

Thus, if even the best argument for the development and deployment of the atomic bomb is suspect, the scientists must have seen what they were doing as either an instrument of very heinous evil or else as part of a marginal call (at best). Be this as it may, the first rebuttal against the sanction of scientists on the Manhattan Project would be one of consequential comparative advantage.

The second rebuttal centers around a person who joined the project with the purpose of sabotaging it (at least from the most evil excesses). This sort of 'fifth column' approach works like this. Mr. X is invited to be a part of the Manhattan Project. He knows that though the proximate guise of the project is to extend basic research in Physics, but the ultimate goal is the creation of a weapon of mass destruction. Mr. X believes that the creation of a weapon of mass destruction is an immoral ultimate goal, but he also realizes that if he checks out of the project, there will be many others who are anxious for admittance. These others may be morally blind to what they are doing. They may be so wrapped up in the proximate ends of advancing fundamental knowledge in Physics (the Principle of Plenitude) that they do not contemplate the implications of what they are ultimately doing (viz., creating a weapon of mass destruction). Because of this moral blindness, such scientists may allow the worst possible scenarios to occur. If the team contains at least a few people of good faith (i.e. ethical scientists who are sensitive to how their research is being put to use), then it is possible that – even if bad politicians try to misuse the atomic bomb – the scientists of good faith (members of the fifth column) might be there to sabotage the process.

The fifth column approach has been occasionally used in the political sphere. In one prominent case, Dietrich Bonhoeffer (a Protestant Christian Theologian) pretended to be a Nazi in order to join in a plot to kill Adolf Hitler. Unfortunately for Bonhoeffer, the plot failed and Bonhoeffer was executed.[31]

The problem with the fifth column approach is that (at least in the short run) a person participates and supports a system that has an immoral end. Because of this the saboteur is in the position of having to defend that which is really evil. He works and helps bring about evil, and if he, like Bonhoeffer, is unsuccessful in his act of sabotage, then the net effect of his action is actually to have promoted evil.

This can be particularly troubling in cases in which there is a significant resistance movement that has taken it as their mission to work *outside* the system in order to bring about its demise. If the resistance movements are almost effective, but need just a few more committed individuals, then the fifth column advocates deny the resistance fighters their point of inertia. In the Manhattan Project, J. Robert Oppenheimer might be called a fence sitting fifth column advocate. Oppenheimer forever felt some conflict about his role as scientist and as a man of conscience who might engage in a fifth column effort to abort the project.[32]

This author would say that there may be situations in which the strategy of the fifth column may seem to be the only way to overturn the immoral system (or research program), but it is a highly risky tactic that has many inherent drawbacks.

In the contemporary context, some of these principles can be readily applied. For example, instances of relative immoral ends might include the cloning of whole humans. Because the present (2011) state of cloning of whole organisms is so crude, it would be immoral to saddle an infant with the probability of a quick and painful death simply to satisfy the principle of plentitude. It is possible that some time in the future that this approach will be perfected on other animals such that the application to humans no longer poses such risks. In this event, cloning may simply be another (albeit very costly) option for infertile couples or single women. This is a case of 'relatively' immoral ends that are relative when measured against our current state of knowledge.

When one envisions the cloning of another person (generally a twin of a sibling needing a vital organ) merely as a means of saving a brother or sister when that sacrifice entails the cloned donor's own death, then we are engaged in a *per se* immoral end. If we all agree to the principle that all people count equally, then to bring a new person into the world solely to harvest his or her organs for the sake of a sibling is to fail to respect the donor's basic rights. Just as in the Tuskegee case, the end is absolutely immoral and therefore should not be pursued. Protocols that seek to explore this sort of organ transplant strategy ought not be pursued.

In conclusion, though the Principle of Plenitude is very alluring because it appeals to the mind's eternal quest for knowledge, it is not conclusive. There are moral constraints upon the quest for scientific knowledge. These include: (a) instances in which the means of obtaining the scientific ends are immoral; and (b) instances in which the ends themselves may clearly be seen to be involved in a larger context that is, itself, immoral. Both of these situations dictate that scientists should take the advice of Odysseus who ordered his men to stop their ears with beeswax and bind him to the mast of the ship as they passed the region of the Sirens. Odysseus knew that knowledge had its limits and though he was compelled to listen to the melody, he took precautions against his ability to act.[33] Odysseus knew that there are limits to the Principle of Plenitude. Modern scientists must also learn this lesson.

15

What's Special about *Scientific* Freedom?

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Introduction

It is fashionable to consider scientific inquiry as something that is in itself due particular privilege; to claim that there is special reason to protect scientific freedom. At the same time, it is common in arguments that consider whether any fetters should be placed on scientific activity to note that something at least approximating a 'public interest' test suggests that some limits to scientific freedom are legitimate. This chapter explores these questions with a view to understanding how protagonists might seek to defend scientific freedom in a morally diverse, politically ordered society. It begins by examining the nature of scientific freedom as conceived within the bounded territory of science itself. This permits a view of 'science ethics', but also shows how it is not something that can be presumed necessarily to be intrinsically good. It then considers arguments for why scientific inquiry might be subject to external control or limitation. This provides the context for an analysis of scientific freedom as a political claim for the protection or assurance of the conditions in which science may be undertaken. Following a discussion of the role of moral theory in political philosophy, it moves to an assessment of whether champions of scientific inquiry should be concerned to see it protected in a right to scientific freedom. In a context where science is valued in large part according to the benefits to which it can lead, subject to legitimate restriction in so far as it may lead to harms, and in a situation where it can rightly compete with alternative goods, the essay concludes with an argument that whilst scientific inquiry should be a priority, it is appropriately protected without recourse to a specific right to scientific freedom. This approach affords due consideration to alternative concerns, and guarantees a wider base for protecting the distinct matters that we might wish to protect under the broad heading of science.

Science ethics and general morality

Values in science

Neutrality, openness, and scientific uncertainty may be considered the hallmarks of good science. It is adherence to these that sustains a clear commitment to advancing knowledge and understanding. Whatever the specific methods or parameters of particular branches of scientific inquiry, common to them all is a dedication to establishing truth. In this sense, it is possible to recognise a straightforward 'science ethics'; a code intrinsic to science itself. Hans Jonas alludes to this in his seminal analysis of scientific freedom:

> What are the points of contact between science and morals? At first glance there seems to be none, beyond the internal morality of keeping faith with the standards of science itself. Its sole value is truth, its sole aim the knowledge of truth, its sole business the pursuit of knowledge. This, to be sure, imposes its own code of conduct which can be called the territorial morals of the scientific realm[.][1]

Jonas accordingly describes the familiar facets of this 'internal morality', stressing how science ethics retains its 'territorial' nature; noting how *within* science there are virtues and imperatives that allow us to judge good science and good scientists on (as it were) science's own terms. These things are exemplified by a scientist's:

> [A]biding by the rules of evidence and method, not cheating oneself and others, for example, by sloppy reasoning or experiment, let alone falsifying the latter's outcome… . [This of itself] implies no extrascientific commitment. The same is true for personal virtues of dedication, persistence, discipline, and the strength to resist one's own prejudices—again simply conditions of success within the vocation, if also praiseworthy qualities in general. Finally, [there is] the duty of sharing one's results and evidence with the scientific community…[2]

Jonas stresses how all of these ethical demands and constraints exist purely within, and are implied by, science itself: the morality remains bounded; 'territorial'. It 'stipulates no obligation of the scientific fraternity beyond itself.'[3] Although any of the virtues and practices listed may obtain elsewhere, they are found as particular instances contained by science.

If, as seems reasonable, we accept this point, and conceive of science as bounded by its own self-defining codes, *this* is no affront to the idea of scientific freedom. It does, of course, imply restrictions on what scientists can do *qua* scientists. However, just as a philosophical anarchist need not be morally anarchic – he can find restraints in morality even as he shuns the idea of prescriptive codes beyond those contained within morality itself, and thus shuns the idea of externally imposed laws[4] – a scientist does not have an unfettered licence to act or reason in any way he might choose: to act morally, an agent is required to conform with the intrinsic demands of morality; to act scientifically, an agent is required to conform with the intrinsic demands of science.

Thus to be engaged in the very process of 'doing science', compliance with a code is necessary. Failure to conform with its norms renders something as not scientific. So the free scientist is not anarchic. It is important to make this point as some observers point to the apparent paradox in the idea of a free moral agent; we at once conceptualize something as free and yet define and understand the strength of its freedom by its capacity to obey moral 'laws'. This is no paradox and nor is it a paradox to suggest that free scientific inquiry is only this when it conforms with the norms entailed in the very concept of science.

However, while concepts of science, scientific method, and scientific inquiry may imply particular and identifiable standards, which we may label 'science ethics', they do not in themselves give a means of *evaluating* the moral quality of science ethics. In other words, whilst we can envisage science ethics in the sense of the internal code described by Jonas, this does not necessarily provide a *good* or *defensible* code other than on its own terms. Simply given science ethics, we have no reason automatically to believe that 'good science' is ethically defensible or otherwise valuable. This issue is reflective of a similar problem that John Gray identifies in relation to evaluations of political liberalism: the *internal* measures implicit in a theory can not be used as *external* judgements of it.[5] So we can conceive of science as pursuit of truth and we can investigate what this entails, and from there understand various norms intrinsic to scientific inquiry. However we do not know *ex ante* or by simple reference to science that the end (pursuit of truth) and the norms that are conducive to this (abiding by rules of evidence, *etc.*) are good or worthy things. So, we can understand what free science requires, but we need more before we can judge whether scientists should be free to 'do' science.

This issue perhaps comes to the fore most clearly when we follow Harvey Brooks and distinguish judgements of science's utility and judgements of scientific merit.[6] Considering the problem of how to assess the relative values of distinct scientific endeavours, Brooks notes that:

> Priorities in science cannot be set without bringing in considerations external to science itself, especially if the projects compared are only distantly related. There is nothing inherent in scientific logic which can say that molecular biology is more important than elementary particle physics, or cosmology more important than evolutionary biology, although some distinctions can be made on criteria such as degree of generality, philosophical implications, or elegance and simplicity. These, however, are primarily aesthetic rather than rational criteria.[7]

Brooks' evaluation is useful because it stresses the complexities of assessment when different questions are raised both about whether science should be supported in a specific instance, and about how priorities between different scientific endeavours should be judged. As he says, 'the complementarity between usefulness and scientific merit is not complete.'[8] We know that sometimes science that receives support because of its probable utility can also lead to important advances in knowledge, and that 'blue-skies research' can sometimes lead to unforeseen applications or advances of high utility.[9] However the distinction between assessments based on scientific merit and those based on the utility of science help us to view the possible bases on which we might assess what is special about scientific freedom, and explore whether scientific inquiry should be privileged. It leads us to the question of how and why we (members of human societies) should value science in the first place, to how we can establish what obligations we owe to each other in regard to supporting science, and what constraints might be imposed on scientific inquiry.

Valuing science

The argument in the previous section suggests that a person may be considered to be acting freely as a scientist only when he respects the various constraints demanded by a commitment to a pursuit of the truth. In this sense, science ethics allows us to judge whether something is 'good science', or if someone is a 'good scientist', but we have seen too that this gives us no indication in and of itself that science is good other than on its own terms, or that scientists deserve special treatment. Yet where we are entreated to respect scientific freedom, this is not generally meant as a claim against scientists urging their conformity with science ethics (though this will surely be its own form of concern).[10] A demand for scientific freedom is not widely thought of as a plea to recognise and follow the internal codes of science. It is normally a claim made by or on behalf of scientists that *the conditions* should be provided to allow them to direct their scientific inquiry without restraints *external* to 'science ethics'. This is evident across various definitions of scientific freedom: for example, Mary Cheh's definition of scientific freedom as 'the freedom to think, to learn, to conduct research, and to report one's findings';[11] and Lewis Mainzer's, which says that '[s]cientific freedom is usefully conceived as discretion for the scientist in making decisions respecting his research'.[12]

A demand for the protection of scientific freedom, then, is a claim for the protection or assurance of the conditions in which science may be practised. It is clearly possible in principle to respect the various liberties that fall under the heading 'scientific freedom' by maximally assuring such conditions, but why should anyone give such respect? Several authors who have considered this question note that frequently it is answered by reference to the benefits that are *consequent to* scientific inquiry, as opposed to the intrinsic good of scientific inquiry itself. That is to say, whilst some may point to the pursuit of knowledge as a particularly important end in itself, widely science is valued (and 'sold') as a means to the potential benefits to which it will give rise (or denial of such potential benefits is threatened against a failure to support scientific inquiry). However, where the consequent benefits of science become *its* value, divisions between thought and action, and between science and technology, become unclear, or even rendered otiose. Even if in theory it remains possible to distinguish science and application,[13] the relevant issues to consider are more than just allowing a particular mode of critical thought or dissemination of knowledge. The practical implications, both of conducting scientific research, and of its results, provide the practical context of any normative evaluation of science. Jonas therefore argues that it is disingenuous to deny that theory and practice 'are now fused in the very heart of science itself,' giving the lie to 'the ancient alibi of pure theory and with it the moral immunity it provided'.[14] He considers it essential to stress that pro-science arguments largely rest on claims about utility, putting the point in strong terms:

> Sincere as this homage to disinterested knowledge may often be, it would be hypocritical to deny that in fact the emphasis in the case for science has heavily shifted to its practical benefits.[15]

Where science is valued because of the good it leads to, Jonas argues, we need to ask questions about its effect, wary too of the *bad* it might result in:

> For whatever of human doing impinges on the real world and thus on the welfare of others is subject to moral assessment. As soon as there is power and its use, morality is involved. The very praise of the benefits of science exposes science to the question of whether *all* of its works are beneficial. It is then no longer a question of good or bad science, but of good or ill effects of science (and only "good science" can be effectual at all). Clearly, taking credit for the benefits means also taking blame for the damages; it would be better for science to do neither, but this option may be [and, according to Jonas' argument, is] closed.[16]

Valuing science according to its effects, rather than because of some pure commitment to its intrinsic value, necessarily produces reasons to doubt its being something that should always be prized. Peter Singer, who also makes this point, demonstrates how easy it is to argue in favour of side-constraints on scientific freedom, even in regard to research whose scientific merit and social utility would be great, where these will cause harms to persons or (more controversially, on some counts) animals.[17] For Singer, the important ethical question is therefore not *whether* limits should be put on scientists' freedom, but *when* and *why* they should be. Science poses risks, and causes harms. These must be accounted for, and may disvalue scientific inquiry in some instances.

In similar vein, Heather Douglas urges that analysts distinguish scientists' 'role responsibilities' (their responsibilities within the territory of science ethics) and their 'general responsibilities' (their responsibilities assumed by virtue of their membership of society; i.e. given social ethics).[18] Her argument makes clear how an assessment of scientists' responsibilities can not be exhausted by mere examination of their duties *qua* scientists. They assume relevant moral identities that extend beyond their roles as scientists. 'If the primary goal of science,' she argues, 'is to develop knowledge about the world, then the role responsibilities of scientists should be structured around this goal.'[19] However, she goes on, before we accept this bounded commitment, derived from science's internal norms, we need to ask whether it 'obliterates other responsibilities scientists have as human beings and capable moral agents'.[20] Douglas rebuts the view that scientists' pursuit of knowledge or truth can be considered a paramount value that should be unhindered. Most forcefully she appeals to a widely acceptable point about the *relative* value of science:

> [K]nowledge (or the pursuit of truth) does not trump all other values. If it did, we would happily submit our children to scientists who wished to use them for biochemical testing and no moral limits on methodologies would be in play. But truth is not so valuable to us that we are willing to do this, despite the fact the controlled human testing would be the best and perhaps only way to fully understand the full biological impacts of chemical substances, for example. That there are prices we are not willing to pay for knowledge, or the search for truth, means it is not an ultimate value existing on a plane above all others. The categorical pursuit of truth is unacceptable. This does not mean that the pursuit of truth is not valuable, or that it is not one of the preeminent values of our society. It simply means that, in general, other values deserve to be considered as well.[21]

Douglas reinforces her concern by reference also to the nature and presentation of knowledge consequent to scientific research. The social and ethical impact of advances of new knowledge has potential implications quite apart from any technological development. Scientists, she argues, have epistemic responsibilities from *without* science to be careful with their choice of research, and the presentation of its findings.[22]

Finally here we might consider the way that Sissela Bok frames the point.[23] As in the arguments of Douglas, Singer, and Jonas, Bok stakes her position by contextualising scientific inquiry in a social context that is not narrowly bounded by science's internal norms, and notes the potential effects of science. She too finds the crux of moral concerns regarding acceptable scientific inquiry to be at the point of causing or risking harms to others. Her analysis is wide-ranging, and demonstrates clearly why it is too simplistic, and thus wrong, to accept a generalized postulation that scientific research poses no risk to anyone. Rather some clearly will, some will clearly not, and there is a central cluster of hard cases where careful value judgments need to be made. Where there are risks, Bok argues that there is no reason to treat them as less problematic simply because they are posed in pursuit of science as opposed to some other end.

In common with the other authors cited in this section, Bok presents a complex situation for practical philosophy: whilst there is widespread – possibly universal – recognition that pursuit of knowledge is not consistently the supreme end, there is widespread disagreement about when and why brakes should be placed on scientific freedom. So if we are persuaded by these authors, we come to the view that scientific freedom, conceived as protection and assurance of the conditions in which science can 'happen', is only *special* in so far as science itself is valuable in a given situation. And how special science ever is is a contextual question, to be judged by its (possible and probable) consequences. The principled questions surrounding the estimation of scientific freedoms' value are perhaps most acute where legal or political constraints are placed on scientists' freedom; where there is not simple statement of moral obligation, but the institution of policy to enforce the exercise of particular responsibilities. It is to these questions that we now turn.

Valuing science and values beyond science

Many theorists, including those discussed in the previous section, make clear cases that scientific inquiry is not a supreme value, and that it is therefore right both that external constraints should (in some instances) be placed on scientists' freedom, and that where there is competition between science and another value, science will not always win. Things become complicated, however, when we move from these generally acceptable propositions to specific arguments about placing fetters on, and estimating the relative value of, scientific inquiry. This is principally because whilst their conclusions are similar, different theorists at times employ radically distinct reasoning to reach them. Furthermore, the weight and scope of specific values are the subject of disagreement. 'We' may all agree that science is important, but 'we' do not all agree on why, on how important it is, or on what else is or is not important. Furthermore, 'science' is an umbrella term that encapsulates a vast range of methodologies and can concern an enormous diversity of matters that might be researched, and there is fundamental disagreement too on the value of specific things that might be the subject of scientific inquiry (think, for example, of the human embryo, or knowledge of the moons of Jupiter). There is not, therefore, a straightforward move (theoretical or practical) from the general proposition that science is important but not the highest end, to specific conclusions on when the conditions that allow a specific instance of scientific inquiry should be provided. A large body of the academic literature treats this question as essentially a public interest issue; in other words, this becomes an evaluation in political philosophy. It is useful therefore to separate purely moral arguments about what people should do given some framework of reasoning, and approaches to the development of policy that provides for institutionally protected freedoms and obligations that people have.[24]

We saw how the previous section prompts us to address two distinct sources of norms. First, we have the duties and virtues implicit within the bounded concept of science ethics. Second, we have the wider demands of morality, and an apparent consensus that once this is appropriately understood, the freedom to act in accordance with science ethics is subject to limitation by the higher demands of general morality: as Singer puts it, 'science is properly regarded as subordinate to ethics'.[25] We now need to confront two more questions. How do we recognise the content and demands of general morality, and what do we do about people who will fail to meet their moral responsibilities, either through error, ignorance, or intentional wrong-doing? Bok is fiercely opposed to the idea that 'political clout will have to determine the outcome'[26] of the value-judgements under scrutiny here. Yet there will not be any substantive consensus on these matters, even within single jurisdictions, less still globally. In reality, there is a great plurality of competing, contradictory, exclusive moral theories, each of which presents different pictures of general morality. Furthermore, even according to any particular theory, myriad contradictory practical conclusions can be met on what should be done in a given instance. It is therefore inescapable that whilst a rationally coherent, comprehensive, general moral theory may be developed, its practical upshot will be curtailed by the realities of human society.

In exploring the accommodation of moral concerns in a political context, we therefore do well to draw from the general criticisms that Raymond Geuss makes of elisions of moral and political philosophy, using the specific example of John Rawls' presentation of his theory of justice.[27] Geuss presents and defends a view of political philosophy that suggests that political theorists should concern themselves with questions of history and anthropology, of understanding human power relations in a framework of political realism rather than by reference to idealized claims about the co-existence of abstract moral agents.[28] Although Geuss' resignation to real politics may seem pessimistic (he would argue it is simply realistic), he is surely right to question the universal acceptability of Rawls' theory, and the sort of understanding it can afford in practical philosophy. Whilst it, like other soundly constructed moral theories, is *in principle* universally acceptable, it is not *in fact* universally accepted. Geuss is forthright:

> To whom is the "we" supposed to refer in Rawls's claim that "we" have the intuitive conviction of the absolute primacy of justice? Does "we" mean "all empirical human beings"? Then the claim that "we" think justice has priority is certainly simply false. Does "we" in a Kantian mode purport to refer to "all rational creatures…"? To believe that Rawls's claim about "our" intuitions concerning the priority of justice in this sense is to subscribe to an extremely strong, and highly implausible—that is to say, almost certainly false—thesis about the universal structures of human rationality.[29]

Geuss' cynicism of the project of mainstream approaches in political philosophy provides healthy reason to recognize the limitations of an inquiry into (for example) scientific freedom from the perspective of some ideal type theory. I could attempt to present here a defence of Rawlsian justice, and then in its light try to provide an analysis of the rightful scope of scientific freedom. However, the theoretical upshot would not easily 'map on to' practical reality, and would clearly meet resistance from people committed to distinct concerns to Rawlsian justice. Nevertheless, Geuss does not give an entirely compelling argument for ignoring normative theory. He highlights the inadequacy of ideal-type political philosophy as a means of *understanding* human action, or mechanisms that would change the world. However, this does not preclude its potential to evaluate conduct or policy, or obstruct petitions to change policy for the better given concerns about, for example, Rawlsian justice. So we do well to heed Geuss' point, but approach the question of the proper scope of scientific freedom in the spirit advocated by Jonathan Wolff, who says:

> It would be absurd to argue that there is no place for speculation about ideals – of course this is necessary, otherwise there would be nothing to inspire or direct change. However, speculation about ideals is the start, not the finish, and if philosophers want to have an influence on the direction policy takes, then there is no alternative to accepting that the status quo does have a privileged position in the debate.[30]

According to this view, there is considerable merit in approaching and exploring questions such as the moral value of scientific inquiry. A moral philosopher such as John Harris will provide arguments about a background moral theory, and then seek to persuade his readers of the practical implications of this for their moral responsibilities in relation to science.[31] Other theorists will do the same, but on the back of competing understandings and defences of general morality, and the individual reader will have to choose between them.[32] However if we want such arguments to take effect within the relevant social or political forum, it is not sufficient simply to create a robust critical theory; it must also be addressed to the people and institutions that can allow it to find practical influence.

I do not propose to advance or defend any specific moral theory here. Instead, I want to focus on the move from a context where we find bald moral claims – which in essence serve as a means of entreating people (including scientists) to act in certain ways – and seek to advance them as political claims.[33] I therefore speak to a situation where we do not wish merely to make moral claims about the world and describe their implications, but where we seek to affect the practical, protected freedoms and obligations that exist within politically organized society. In this sense, we are not just interested in questions of whether, why, and how science is special; we are concerned with questions of enforcing a view of its importance on others *regardless* of their own evaluation of the matter. We are interested in science as an issue that is of concern politically, and protected and constrained in accordance with the public interest.

Where we are to approach political disagreements through reasoning based on ideals, we need to confront two distinct perspectives on the nature of political liberalism. According to the first perspective, morality obtains in a singular, unitary system. In this sense, provided there are no flaws in knowledge or reasoning, all moral agents would converge on the same answer about what is right or best in a given situation. This may be cast as the 'rational consensus' view of morality.[34] Its implications for politics are that we should pursue an understanding of the one moral truth, and guide our political associations best to reflect and respect this. The second perspective holds that there is a range of equally true or worthy, but mutually contradictory and exclusive moralities, all of which deserve equal respect. This is cast as demanding a politics of *modus vivendi*.[35] In this sense, the project of political society is not to establish *the* moral truth, and direct policy towards it. Rather, it is to allow harmonious co-existence between people who wish to live according to distinct ways of life. Elsewhere I have presented a defence of the second of these perspectives, which I will not reproduce here.[36] Suffice to say, regardless of the truth or *in se* desirability of each perspective, it is a 'practical truth' that we live in societies where people are free (within limits) to choose to live in accordance with their own distinct values, and in which there are no cast iron ways of demonstrating that some ways of life are 'right' to the rational exclusion of alternatives. There are also clear reasons for resisting state imposition of particular ways of life; well rehearsed arguments against the desirability of totalitarian, authoritarian systems, even where these are the product of benign government. Scientific practices – potential and actual – are therefore best viewed in a context where rational moral argument has a role, but in a context too where this will not account for everything. Concerns about the centralisation of power through non-state actors (for example large institutions such as business, religion, the media) suggest the desirability of regulatory interference to allow alternative perspectives to thrive. In this sense, we might find the basis of arguments in favour of creating the conditions in which scientific inquiry may take place, notwithstanding high-profile dissent against it. It should however be seen that similarly the liberal systems that permit this will sometimes justifiably also privilege the position of those whose views are antithetical to arguably reasonable claims in favour of an instance of scientific inquiry. This chapter is not intended to present substantive moral arguments in favour of a preferred weighting of scientific freedom. Instead, in the remainder I explore what it means to conceive of scientific freedom as a political category of concern, and how its protection may best be mediated through law.

Protecting scientific freedom

Scientific freedom, I have suggested, is most importantly conceived as a political claim to the conditions in which science can take place. Its merits in any given instance are thus to be assessed by reference to the public interest. Cheh expresses a view that may be taken as a caution against arguments in the name of the public interest (she refers to 'national security'): they can erroneously and even cynically lead to wrongful curbs on scientific freedom. As she puts it:

> The hard truth is that issues of national security cannot be resolved in the abstract. Suppression of ideas or scientific research to protect national security requires

> a case-by-case, fact-specific analysis to answer questions such as: what specific harms to national security are implicated; are these harms grave and imminent or only slight and speculative; are the particular controls thought necessary narrowly tailored to the harms alleged or are they broad prohibitions which compromise other, equally important interests. But, case-by-case analysis is hard work, and it is far easier to invoke national security as a blanket justification.[37]

The point Cheh makes here is important and persuasive: she is right to caution against the unthinking citation of national security as a reason to forestall scientific inquiry (and her argument applies with equal force to unthinking citation of the public interest). She is right too to hint at the way such a justification can become a dogma, which can then be deployed cynically. Whilst being persuaded by Cheh, however, it is crucial to note that the same manner of concern would apply if we exchanged the term 'national security' with 'scientific freedom', and reordered the specific concerns to apply to that case. Unthinking acceptance of national security claims is problematic and insidious, but so too would be unthinking acceptance of claims about scientific freedom and *its* apparent claim to trump other concerns. In *both* cases we should avoid the dogma, and instead make case-by-case analyses. We must accept that concerns about cynical use of apparently benign terms is as applicable to grandiose claims based on scientific freedom as it is to ones based on the public interest or national security Thus we need to ask, if scientific freedom is not always of compelling importance, should we translate it from an analytic political concept into a formalized, justiciable one: should we enshrine an explicit right to scientific freedom in law?

As we have seen, arguments differ about the content and basis of the public interest. Nevertheless, however it is established, the public interest is foundational. Whether it is reflective of a singular moral theory or of a means of achieving harmony between distinct moral theories, it denotes the touchstone by which the legitimacy of policies, freedoms, and obligations will be assessed. Necessarily views on its substance will differ, and if the arguments of protagonists in public debates are to be given effect, they need to take place within the social and regulatory structures of given social and political systems. At times, it will make sense to petition the courts in order to amend or bolster the *status quo*, to assure freedoms or enforce obligations. At times change will come through petitioning regulatory authorities, or by appealing to private actors. The best strategy will depend on the specific context, and when assessing this it should be remembered that scientific freedom is not merely a 'negative freedom': the conditions that allow science to take place do not simply require that scientists be free from external interference; positive measures and actions are also needed in many instances, both to provide the necessary infrastructure and technology, and to support scientists, for example by paying their salaries. The sorts of needs this gives rise to exist in a complex social and political network. In part, this network involves the potential for legal claims against others; it is neither purely private, nor completely public.

When considering how best to protect scientific freedom in a particular instance, it is useful to reflect that just as scientific freedom is not fundamental as a general ethical concept, so it need not be as a legal one. Various authors have asked whether and how scientific freedom may be grounded as a fundamental or constitutional right. There may therefore be a sense amongst some that where scientific freedom is not enshrined in law, it will not receive the protection it is due. This view, however, is to be doubted, as James Nickel demonstrates in his examination of the relevant issues in an analysis of the legal protection of religious freedom.[38] He frames his inquiry in 'the "basic liberties" approach to understanding liberty',[39] wherein different areas of liberty are listed, and combine to represent the scope of a legally protected framework of rights, obligations, and freedoms (the European Convention on Human Rights (ECHR) is given as a good practical example). Such a framework is naturally implicated in an examination of putatively special but not comprehensive or unqualified freedoms: artistic freedom, religious freedom, scientific freedom, and so on. Within the framework, Nickel's question is whether religious freedom should be treated as a fundamental right. In sum, he:

> [E]xplores and defends the idea that we do not need freedom of religion as a separate enumerated liberty. [He] does not propose that freedom of religion should disappear as a distinctive category; but argues that it could do without much loss.[40]

It is clear that at times a protagonist will wish to assure sufficient protection to scientists to conduct research in an area where there is considerable social, institutional, and even political pressure that bears against it. In parallel with Nickel's approach, the important question to ask is whether the right level of protection can be given to science if the list of basic liberties does not include explicit reference to scientific freedom. He enumerates nine fundamental liberties, on which he argues other due freedoms, including scientific freedom and religious freedom, are based:

1 Freedom of belief, thought, and inquiry.
2 Freedom of communication and expression.
3 Freedom of association.
4 Freedom of peaceful assembly.
5 Freedom of political participation.
6 Freedom of movement.
7 Economic liberties.
8 Privacy and autonomy in the areas of home, family, sexuality, and reproduction.
9 Freedom to follow an ethic, plan of life, lifestyle, or traditional way of living.[41]

His argument is attractive not just because it suggests that advocates for scientific freedom need not worry if it is not explicitly enumerated in law (although his paper is about religious freedom, he applies it explicitly too to scientific freedom). It at once permits protection of issues for which we may legitimately be concerned, whilst not exaggerating their importance. Nickel lists five particular advantages to accepting his view in regard to religion, which speak equally well to scientific freedom.[42] First, it affords due importance to some issues without precluding the importance of others. Second, it allows a broad scope to what might be protected; we do not face the danger of definitional or boundary problems of the concept under issue (i.e. we do not need to worry about finding a precise definition of science). Third, it avoids a narrow interpretation that would in practice *limit* scientific freedom, allowing recognition of its obtaining in, and highlighting the importance of, several quite distinct basic liberties. Scientific freedom need not be restrained by its finding a basis just on one of the liberties listed. Fourth, it grounds protection of scientific freedom in a way that is widely acceptable in a pluralistic society, rendering it more secure. Nickel says:

> If nonbelievers dislike religion [and we might say here, "if some citizens disvalue science"] and have no desire to protect it as such, reflection will nevertheless reveal to them that undermining religious liberties would come at the cost of undermining their own liberties of thought, expression, association, assembly, and so on. Thus, religious freedom does not depend on positive attitudes towards religion or some religions.[43]

And fifth, Nickel notes that deriving other special freedoms from the fundamental liberties guarantees their dual nature as freedoms both 'to accept and to reject particular religious propositions.'[44] Such a paired liberty applies equally in regard to science; citizens remain free to accept or reject particular scientific propositions.

Beyond these advantages, Nickel also pre-empts concerns that people might have with his argument. Of particular salience, he shows that worries about special exemptions from general legal obligations would not be under threat.[45] Not only is it still possible to grant exemptions (for example to allow scientists to be in possession of controlled or illicit substances), if questions concerning scientific freedom are under litigation, the courts are afforded greater latitude in finding their basis, whilst also being in a position to protect competing claims where this would be appropriate. Ultimately, he stresses a point that is reflective of the argument that I have sought to emphasize in this essay. It is better that social norms be governed according to a wider freedom (political liberalism), rather than according to the internal ethics of science. Just as we would (I trust) reject a theocracy, so we would a political regime governed according to the internal prescriptions of science.

To be clear, a list of basic liberties (and we might choose an alternative list to Nickel's) does not tell us each liberty's specific content or relative weight.

That remains to be argued. The discussion here illustrates, however, that even if we are very concerned to protect scientific freedom, we need not conceive of it as a basic or enumerated legal right. It can be the subject of legal and regulatory protections within the frames provided, for example, by the ECHR. Furthermore, there are good reasons to suppose that a wider range of scientific issues will receive better protection if they can be treated individually, and potentially on different grounds: a right to scientific freedom may not secure the widest protection of scientific inquiry.

Conclusions

A claim for scientific freedom is well conceived as a demand for the protection or assurance of the conditions in which science can be practised. The value of respecting this freedom is often relative not to the intrinsic value of acquiring further knowledge, but to the benefits or harms that are (likely) consequent to an instance of scientific inquiry. A right to scientific inquiry can potentially have both 'positive' and 'negative' aspects to it; claims to the means to pursue scientific endeavours, and claims to be left alone to do it. In principle, neither sort of claim is above the possibility of restriction if the public interest so dictates. When considering whether regulatory protections of scientific freedom are required, or limitations to scientific inquiry are needed, many specific issues require evaluation. A responsible regulator can, in principle, place curbs on specific research without implicating scientists as morally complicit in the probable consequences of the science; it can quite reasonably and rationally prohibit research because it is concerned about what *others* will do with the knowledge it produces. However, it is clear that strong justification will be needed in any case before a legitimate decision can be made not to allow scientific inquiry, especially if the specific claim to scientific freedom is largely framed as a need to protect negative liberty. Furthermore, we can agree that science is subject to ethics without concluding that every ethically problematic or controversial form of scientific inquiry should be the subject of restrictive regulation. That the science touches an area on which there is substantial moral disagreement does not automatically suggest that it should be banned or restricted.

I have therefore argued that whilst scientific freedom may be considered a special form of liberty, from a policy perspective it only deserves special treatment in so far as it conduces to benefit, and in so far as there are no countervailing concerns about undesirable consequences. Like other contributors to this volume, I would be keen to emphasize the many goods are only achievable in a society where scientific inquiry is highly valued, and in which the conditions for scientists to work are assured. To protect such conditions, we do not need a specific, enumerated right to scientific freedom. Indeed the very importance of science and scientific freedom allows us to find it grounded firmly in the public interest, and derivative of other fundamental freedoms enumerated in legal instruments such as the ECHR. We do not need to 'tie' scientific freedom to a specific, single right (such as the right to free expression), and would be wise not to do so. By understanding its breadth and diversity, we can see it securely founded on various grounds. These permit both curbs where this is necessary, but also as wide a protection as is desirable in a context where we value other things too.

Conclusion

A Short History of This Anthology

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The journey to this book[1]

This book began during a marathon, and so far, it ends with the Declaration on Freedom of Scientific Research, found in Appendix A. Let us begin with the end. The Declaration is the document signed by the participants to the World Congress on Freedom of Scientific Research. It is of course a succinct expression of a variety of values and beliefs, connected by the common denominator of faith in scientific progress. Although the Declaration perhaps is only a summary of much more elaborate arguments proposed in contributions such as those in this volume, we decided to add it here for two reasons. One is that it is an important symbol of the common effort of people coming from different states, religions, backgrounds and cultural context, to defend the progress of science. The other reason is that this Declaration highlights the importance of ethical and philosophical reasoning to political action. Politics provides the hinge joint that links theoretical debates to civil society. In the case of science, politics aims at ensuring that the potential beneficiaries of scientific development do actually obtain the advantages that science may promise, while also attempting, through regulation, to secure ethical practice in science.

It all began, we mentioned, while running a marathon, and not metaphorically. This is how we, as an Association, were born, and how this book was first thought of. Luca Coscioni (who funded the Association that took his name) was a university Professor of Economics as well as a marathon runner, involved in local politics in his native Viterbo as a member of the city council. In 1996, while training for the New York Marathon, he was diagnosed with amyotrophic lateral sclerosis (ALS). In five years, he was confined to a wheelchair. In 2000, Luca decided to bring his health situation to the general public as a political case, denouncing the lack of appropriate regulation and public funding for scientific research, in particular that on embryonic stem cells, in Italy. The same year, he was elected member of the General Council of a political organisation affiliated with Italy's Nonviolent Radical Party Transnational and Transparty (NRP). At the 2001 Italian parliamentary elections, Luca ran for the Chamber of Deputies in the same list as former European Commissioner Emma Bonino, who is also a contributor to this anthology. Although Luca was not elected to Parliament, he received the support of hundreds of scientists, physicians, patients as well as politicians and intellectuals, and fifty Nobel laureates. On that occasion the Nobel Laureate for Literature Josè Saramago wrote a message of support for Luca:

> Perhaps the support of a mere writer like me will seem a little or a lot out of place in a list of scientific leaders who, with their names and their prestige, seal the words spoken by Luca Coscioni. In any case, my name is at your disposal, so that the light of reason and human respect can illuminate the gloomy spirits of those who believe themselves to be, still and always, the masters of their destinies. For a long time we waited for the day to break, we were exhausted by the waiting, until all of a sudden the courage of a man, rendered silent by a terrible disease, gave us renewed strength.

In 2002, together with Emma Bonino and Marco Pannella, Luca founded the Luca Coscioni Association, with the aim of promoting freedom of scientific research not only in Italy, but internationally, with particular attention on research on embryonic stem cells, a technique that risked being severely hindered by a draft bill before the Italian Senate, and which has been widely debated and prohibited in many other countries.

In 2004 the Associazione Luca Coscioni and the NRP founded the World Congress for Freedom of Scientific Research as a permanent forum of activities to promote freedom of scientific research worldwide. The First World Congress was held in Rome in 2006. This is where this anthology began to be conceived.

At that time, Luca was President of the Association, and in spite of the severe degenerative illness that rendered him immobile, on the first day of the Congress, just days before his death, he eloquently expressed his appeal. This not only touched everyone present, but also reminded us all that when we talk about scientific research, we talk about real people, who have real lives, suffer real illnesses, and who are destined to die prematurely and in agony unless treatment is found – and hope for treatment for many degenerative diseases bears upon stem cell research. Luca made his appeal with these words:

> The first meeting of the World Congress for Freedom of Scientific Research comes at a particularly difficult time in my life… Amyotrophic lateral sclerosis does not limit intellectual skills, it makes you fully aware of feelings of despair and fear

> of lifetime. A time which is violently becoming narrower and which forces me to address the urgency of the price that millions of people around the world are paying and will have to pay to a culture of power, a culture of class…imbued with anti-scientific dogmas and prejudices, which exclude scientific knowledge and which exclude individual freedom to benefit from knowledge. Stakes are too high to let time pass, more time pass… To the violence of this cynical prohibition on scientific research and on the fundamental rights of citizens, I have responded with my body, which maybe many would have liked to see just as a hopeless prison, and today I respond with my thirst for air – because I am truly breathless – which is my thirst for truth, my thirst for freedom.

A unique feature of the First World Congress for Freedom of Scientific Research was that it represented a unanimous appeal coming from the Campidoglio, in Rome, in the very centre of the 'Eternal City'. The geographic location not only had symbolic but also political significance. The historical importance of the place is exemplified, for instance, by the choice of Campidoglio as one of the symbols represented on Europe's coin, the Euro. The Campidoglio was, before Christianity, the place where the pagans devoted their cult to the Goddess Juno, which, due to a peculiar incident, also became called Moneta. This is how the story, briefly, is said to have gone.

In the 390s B.C. Rome was besieged by the Gauls. Next to the Temple of the Goddess Juno, sacred geese were bred. One night, as the Gauls unexpectedly arrived, the sacred geese began to squawk so loudly that the Consul woke up and gave the alert. The attack was thus thwarted. It was believed to have been Juno who awoke the geese, and hence she also acquired the name *Moneta*, from the Latin *monere* – to warn, to caution. Over a century later, the mint was edified near to the temple, under the protection of the Goddess Juno, or *Moneta*. From this peculiar fusion, the word Moneta started to indicate the currency (hence the word 'money').

In addition to being rich in history, the place is of incredible artistic beauty; the main square was designed by Michelangelo Buonarroti and is a place of touristic, artistic and architectonic attraction, as well as of political decisions. However, what is perhaps even more striking is that this place, theatre of lay discussions, is just a few miles away from the Vatican, a small and influential state that has exercised enormous weight on other states' policies upon freedom of research. As is well known, the pope Giovanni Paolo II and now the pope Benedetto XVI, ex Cardinal Ratzinger, have solemnly condemned embryonic stem cell research, and their potent voice has been welcomed by the governments of several countries, such as Germany, Italy, France, Malta, and Ireland. It is significant that experts from all over the world came to oppose the papal anathema and to explain why freedom of research is so precious to all of us.

A second Congress was organized in Brussels in March 2009, at the European Parliament, and again was a forum of stimulating exchanges between world leading scientists, lay people, European politicians, economists, philosophers and jurists. At that point we decided to make the results of the meetings available to the international academic community. This volume is perhaps only a small contribution to the international debate on freedom of scientific research, but this, we believe, is not the end. In order to complete a marathon it is imperative to set small goals.

Freedom and science

In the remainder of these conclusions, we would like to offer some reflections on the concept of *freedom* of scientific research, which we also draw from the work of the authors who have contributed to this volume. The expression 'freedom of scientific research' usually elicits two opposing types of reservations. The first is that research is free in and of itself, and therefore it does not need anyone to 'free' it, rather it needs to be financed. The second is that research cannot be without limits, and needs to be regulated. Both are valid considerations. With regard to the first argument, of course freedom of scientific research includes freedom from financial impediments. However, as arguments in this volume have shown, that scientific research *should be funded* is not always uncontroversial. This issue has been raised, for example, by Piccirillo, in his interesting chapter on astrophysics. Oswald has also made important considerations on this point. Piccirillo in particular not only asked why public money should fund (potentially useless) base research to the detriment of technological applications which could save human lives directly, but even goes as far as suggesting that the choice of funding research may involve the sacrifice of human lives, to the benefit of perhaps greater numbers in perhaps remote future generations. This posits scientific research in the delicate ethical debate about which lives one should save, and poses further issues of whether it may be ethical to surely (or almost surely) lose real lives that could be saved today in order perhaps to improve our capacity to save greater numbers of potential lives in a remote future. We do not want to take a position on this issue: we just want to illustrate that freedom from financial constraints is not everything; of course, in a system of limited resources, financial constraints are inevitable, and the ethical problem arises as to what areas of science should be funded and why. However it can be argued that some financial constraints *should be* in place anyway, that some areas of research *should not be funded* – indeed the ethical suitability of science has to be established before funding is granted.

With regard to the second argument, freedom does not necessarily entail lack of regulation. Baron, Santosuosso and Devaney have made the point well, examining the issue of regulation from a legal perspective. Regulation is needed in every sector of scientific research, from clinical trials to animal testing, from research on nuclear to nanotechnologies, or research with human embryonic stem cells to brain imaging, and so on. The funding system and the technology and scientific knowledge transfer should be regulated, safety conditions should be checked and accountability to the public ensured, as people may be concerned with risks, be they social, environmental or related to healthcare.

Assessing the ethical suitability of scientific research, and regulating its development through sound and transparent legislation are problems that can be described as both theoretical and pragmatic. One of the authors of this paper, being directly involved with the European Parliament, has witnessed how often the ethical debate does not steer political decisions, but is rather silenced by strong ideological opposition. Political decisions are thus sometimes made without the direction of a serious ethical debate. Ethical analysis should help to evaluate the logical coherence of arguments for and against any given proposed procedure; it should help to evaluate the possible middle and long-term consequences of scientific developments for those involved and for society at large, including future generations and geographically distant populations; it should help to assess the consistency between the various possible options and social policies and laws in place in various countries; and it should help to disentangle which reactions and opinions are based on reasoned judgement, and which are based on superstition, fear or custom. It is the aim of ethical analysis to offer a thorough exploration of the various predicaments over which deliberators are called to make a choice. Politics, in this sense, should be guided by ethical debate, but instead, ethical confrontation is often absent from political debates, and silenced behind the thick wall of ideology. Arguments against (and even sometimes *for*) scientific research often rest on unrefined intuitions, unjustified fears of future catastrophic scenarios, or on declarations of the solemn anthems of Justice, Life, Rights, as resounding as empty, seldom explained or explored in any detail.

Scientific development calls not only for pragmatic action and appropriate regulation, but also reasoned judgement. Human intervention goes now from the initial to the final phases of life, for instance it can split reproduction from sexuality (see Carl Djerassi's contribution to this volume) and can preserve vital functions well beyond what was possible in the past. The possibility to interfere with the human genome means that human evolution is no longer tied to the mechanisms of 'natural' selection – instead it gives the opportunity to act directly and modify the genetic inheritance with no need to undergo the long ages of evolution. These new possibilities raise a set of ethical questions that should be explored rationally as political matters, not only as academic matters, and not be reduced to a confrontation between defendants of 'nature' (as an a-priori good and thus to be protected) and opponents to 'nature' (judged as dangerous and thus to be transcended). A more serious debate, which goes to the heart of the practical issues, and which evaluates the pros and cons of any given procedure for all those involved, is required in order to make sound political judgements. For example, the issues of social justice that can be raised in relation to the possibility of intervening with human genomes should be considered seriously in both theoretical and political debates. Social justice is (or should be) already at the core of healthcare and welfare policies as far as it concerns the access to traditional medical treatments, and politicians at an international level are acutely aware of issues of social justice, but the problem may become ever more critical when we consider new therapies. In fact since the attempt to ensure that everyone has access to adequate medical assistance is in the general interest, this attempt should be felt as more and more compelling when the issue at stake is not only the opportunity to be treated, but also the possibility to be genetically modified during that treatment.

It is a sadly known fact that the international community is unable to resolve the global imbalances between the vast majority of the human population suffering from treatable diseases and high premature mortality rates, and the small minority of the human population benefiting from the greatest share of healthcare resources. These social disparities may become real anthropological differences, going beyond the single life or generation and being genetically transferred to future generations. Although these issues are serious and should be addressed, they do not grant an absolute reason in favour of refusal of genomic intervention: indeed the ideological barriers sometimes built in front of such innovations prevent us from regulating them through equity and justice. The impoverishment of ethical debate at a political level has hideous consequences on science, and hence on society, because it impinges upon the resolution of the two important issues highlighted above: which areas of science should be given financial priority, and how they should be regulated (Baron and Devaney offer some suggestions in their contributions to this volume).

One final point. As is also pointed out by Corbellini, freedom of science is closely intertwined with the very essence of liberal democracies. This is why, we propose, such freedom does not entail a lack of regulation, but a rethinking of regulation, which makes scientific development ethical and efficient. Proper regulation and public accountability is indispensable to scientists and to citizens. Many in this volume have stressed the importance of a better dialogue between scientists and the general public, and the responsibility of the State, which ought to ensure that proper information about science development be provided to citizens.

The terrain we have covered, since Luca began running back in 2001, is remarkable. Luca himself was able to participate, with the NRP, in a transnational and transparty effort, and called on the European Union to fund research involving embryonic stem cells (Emma Bonino and Simona Giordano write about it in this anthology). Noting that one of the most promising fields in biotechnology is still that of stem cells and that research projects funded by the 7th Framework Program (FP) for Research and Technological Development offer hope and prospects to tens of millions of men and women, the Luca Coscioni Association and the NRP will soon call on the European Parliament, as they did on the adoption of the 7FP, to ensure that the 8th Framework

Program (2014–2020) confirms the funding of research projects on embryonic stem cells, as well as adult stem cells or induced pluripotent stem cells, but that the additional political evaluation – currently realized through a vote by EU national representatives – be abolished. Moreover, the Association and the NRP will urge that eligibility for funding should be extended to research projects based on cell nuclear transfer (often inappropriately called 'therapeutic cloning').[2]

We thus wish to reiterate that scientific research depends on the concerted efforts of many: of the scientists of course, but also of politicians, academics, and lay citizens. With this volume we aimed not only at disseminating the results of our Congress within the academic community, but at promoting a co-operation amongst experts with different backgrounds, one which could be accessible to a non-specialist audience, and that anyone with an interest in science could reach, whether philosopher, economist, jurist or lay person. With this volume, we hope we have stressed the importance of a serious ethical debate within politics, and, more importantly, the importance of sound politics to science and thence to human flourishing.

Appendix

Declaration of the second meeting of the World Congress for Freedom of Scientific Research?

We, the undersigned, women and men of science, politicians, citizens met at the headquarters of the European Parliament in Brussels 5–7 March 2009 for the Second meeting of the World Congress for Freedom of Research:

We welcome the continuation of the World Congress initiative, started with the Constituent Assembly meeting in October 2004 and continued through the first meeting in February 2006; those events were decisive for the success of the campaign at the United Nations against the proposal to ban embryonic stem cell research, as well as for the campaign in favour of the financing of such research by the European Union;

With the continuing attacks to free knowledge and research, freedom of conscience and religious freedom from various forms of obscurantism (political-ideological as well as dogmatic-religious), we feel it is urgent and necessary to make further steps towards the consolidation of the World Congress as the permanent forum for discussion and initiative for the human, civil and political rights of every citizen;

In particular, we need to respond systematically and in an organized way, to the great social issue of our time: that of disease and disability in an aging population, of the novel possibilities and prospects for care related to advances in bio-medical research, as well as the technological instruments and new form of self-managed assistance that increasingly permit recovery of lost faculties and the overcoming of disability; 'from the body to the body politic' is a program of action that we propose for today to scientists, patients, politicians and all people of good will.

We, the undersigned, identify the following specific objectives to be pursued at all levels, transnational, national and local:

- monitoring the state of freedom of research and care in the world, through an annual report, and a constant update of the comparison of laws and national policies;
- strengthening or creation of policies, rules and jurisdictions, including international and constitutional law to defend the freedom of research, which corresponds to a duty of States to promote free research and to disseminate the benefits of such research in an equitable manner for all citizens (Article 15, par. 1(b) and 3 of the International Covenant on

Economic, Social and Cultural Rights), including through cooperation with less developed area of the world;

- freedom of research on stem cells, including:
  1. overcoming the prohibitions placed by the EU on the eligibility for financing of research obtained by the technique of cell nuclear transfer;
  2. overcoming the prohibitions proposed, although in a non-binding document, at the United Nations;
- the creation of an international network to help disseminate accurate information about access to treatment in the world and protect patients from any violation of the right to a safe and efficacious treatment, an international service of 'civil emergency' providing guidelines as the ones prepared by the International Society for Research on Stem Cells on clinical translation of stem cell research;
- the promotion of the scientific teaching method, both for its practical value, and for its decisive role in the defence of the democratic method and tolerance;
- the affirmation of the right to self-determination on treatments, according to the principle that no one shall be subjected to treatment against his will, and everyone can decide when and how to begin, continue or discontinue therapy, even in the case that the suspension would lead to death;
- the implementation of the UN Convention on the rights of people with disabilities, in particular in less developed countries.

To organize specific campaigns on the above objectives, we the undersigned:

- confirm the Association Luca Coscioni's role as Organizational Secretariat;
- is committed to creating networks and working groups bringing together scientists and Nobel laureates, patients, non-governmental, political and institutional representatives, in collaboration with the Nonviolent Radical Party, Transnational and Transparty (non-governmental organization with consultative status at the United Nations).

Brussels, 7 March 2009*

List of signatories

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Betty Williams, Nobel Prize in Peace, 1970

**the World Congress Secretariat will further explore some of the issues that have emerged during the debate, such as:*

- *the issue of funds for military research and the possibility of partially diverting it into research for civilian purposes;*
- *the implications of neurosciences;*
- *the implications of nanotechnologies;*
- *the genetically modified foods;*
- *free access to scientific knowledge.*

Notes

Chapter 1: Can research be forbidden?

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Chapter 6: Freedom of research and constitutional law: Some critical points

1 Earlier research on the themes of this chapter was published in A. Santosuosso, V. Sellaroli & E. Fabio 'What Constitutional Protection for Freedom of Scientific Research?' *Journal of Medical Ethics,* 2007; 33 (6):342–344.
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4 This chapter does not aim to be a full review of constitutions worldwide. It rather focuses on some aspects of freedom of research and, in this light, some constitutions simply work as a point of view or starting point in order to illuminate those aspects.
5 However, some authors question the existence of something called 'scientific speech' that merits distinctive constitutional treatment: see below under par. 3.
6 The Italian *Assemblea Costituente* discussed in depth the opportunity to introduce an explicit provision in order to protect freedom of scientific research. Some were critical about the possibility of dedicating a part of the constitutional text to liberties of culture and thought, considered different from the traditional constitutional rights. Others doubted the need of consecrating too gravely such an activity that is free *in* itself, so diminishing its own value. Ultimately, the importance of letting the social community be free from the fascist cultural subjection prevailed and article 33 of Italian Constitution was introduced, protecting freedom of art and science and their teaching as means assuring human cultural and spiritual growth. More about the debate that took place in *Assemblea Costituente* can be found in Chieffi L. *Ricerca scientifica e tutela della persona*. Napoli: Edizioni scientifiche italiane, 1993:28 ff.

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15 Congregazione per la Dottrina e la Fede, *Donum Vitae*, Introduction, n. 4, quotation from Roberto Colombo in *L'Osservatore Romano*, *Weekly Edition in English*, 1 October, 2003:9. See also Regulations of Scientific Speech and Scientific Research (Post CIT p. 435): Fundamental to all versions of First Amendment doctrine is the distinction between speech and conduct. Murder does not trigger First Amendment coverage, even if the murder is by a terrorist seeking to communicate a message of hostility. It is not the case that the distinction between speech and conduct depends upon properties in the world, such that all instances of 'speech' have certain properties in common that instances of 'conduct' do not, or vice versa. It is rather the case that those forms of behaviour that serve the purposes of the First Amendment are classified as 'speech'. Parades consist of conduct, but courts will nevertheless classify parades as 'speech' because they serve values protected by the First Amendment. They are recognized media by which public opinion is informed

and engaged. The point of distinguishing the regulation of 'scientific speech' from the regulation of 'scientific research' is that research seems to involve what most would regard as conduct. Yet different forms of scientific research will possess different constitutional properties that will raise different constitutional questions. A law banning the 'research' of a mathematician, for example, would seem to prohibit reading and would for that reason likely trigger First Amendment coverage. A law banning the use of anthrax bacteria, by contrast, would likely not trigger First Amendment coverage, even though it may shut down the research of particular scientists. 'Scientific research,' in other words, is not a single, coherent constitutional category. It embraces many different phenomena that are differently connected to First Amendment values.

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23 Italian L.n.40/2004, at articles 12 and 13, provides several administrative fees and criminal imprisonment for physicians, researchers and even for couples who perform assisted reproduction violating the very strict law provisions, such as the prohibition of gamete donors, selection of embryos, surrogate motherhood and so on. Researchers who make research on embryos may be imprisoned for eight years.

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(1) Everyone has the right freely to participate in the cultural life of the community, to enjoy the arts and to share in scientific advancement and its benefits.

(2) Everyone has the right to the protection of the moral and material interests resulting from any scientific, literary or artistic production of which he is the author.

International Covenant On Economic, Social And Cultural Rights, *New York 1966* (Article 15):

1. The States Parties to the present Covenant recognize the right of everyone:

(a) To take part in cultural life;
(b) To enjoy the benefits of scientific progress and its applications;
(c) To benefit from the protection of the moral and material interests resulting from any scientific, literary or artistic production of which he is the author…

26 On May 12, 2009, the ACLU (The American Civil Liberties Union) and the Public Patent Foundation (PUBPAT) filed a lawsuit in New York Federal Court. 'The lawsuit, Association for Molecular Pathology, v. U.S. Patent and Trademark Office, was filed on behalf of researchers, genetic counselors, women patients, cancer survivors, breast cancer and women's health groups, and scientific associations representing 150,000 geneticists, pathologists, and laboratory professionals. The lawsuit was filed against the U.S. Patent and Trademark Office, as well as Myriad Genetics and the University of Utah Research Foundation, which hold the patents on the genes, BRCA1 and BRCA2. The lawsuit charges that patents on human genes violate the First Amendment and patent law because genes are "products of nature" and therefore can't be patented': Dov Greenbaum, 'Patentable Subject Matter: Morally Neutral and Context Free', in *Recent Patents on DNA & Gene Sequences* 2011, 5, 72–80. See also Mildred Cho, 'Patently unpatentable: implications of the Myriad court decision on genetic diagnostics', Trends in Biotechnology (Article in Press, at July 17, 2011).

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Chapter 7: Legal methodologies for maximizing freedom of scientific research

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Chapter 8: Human tissue providers for stem cell research: Freedom, fairness and financial recompense

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Chapter 9: Ideology, fundamentalism and scientific research

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Chapter 10: The future of scientific research: compromises or ways forward?

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Chapter 11: Science, society and democracy: freedom of science as a catalyzer of liberty

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Chapter 12: Religion and scientific freedom

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21 This way of defining a secular state also allows for states with an established religion to be counted as secular. Norway and Denmark are thus secular according to this definition, despite having an established religion, because the democratic machinery is fully secular. In contrast the UK is not secular since some English bishops hold automatic seats in the House of Lords.

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24 It is worth noting that Audi, who is himself a practising Christian believes that the requirements embodied in the two principles can, in most cases be fulfilled by religious protagonists in the debate.

25 Audi R, Wolterstorff N. *Religion in the Public Square,* p. 28.
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35 Even if I am uniquely talented and could make a great contribution to society by pursuing this specific career.
36 I will here leave aside the issue that many politicians are mendacious and untrustworthy and that there is no guarantee that they will actually pursue the policies they claim they will pursue before an election.
37 In a fully deliberative democracy that was also fully participative this issue would not arise, since every citizen would be fully engaged in the actual decision making and would not need representation.
38 We seem even sometime to forgive politicians for lacking this understanding, especially if they are just 'ordinary' politicians and not specialists in taxation etc.
39 Examples include the 'Christian Motorcyclists Association UK' the 'Maccabi Southern Football League' and the 'Islamic Foundation for Ecology & Environmental Science' just to mention a few.
40 Here it is important not to get confused by the fact that some religious groups claim that you can never really exit. You may be 'lapsed' but you still belong. This is a spiritual and not a sociological claim. Even from those groups it is clearly possible to exit in a social sense.
41 The ideal deliberative democracy would not require every person actually to participate and would not rule out, for instance a system of representation. It would require each and every citizen to have equal, effective access to the public debate leading to decision making.
42 Apart from the issue of whether religious reasons are different which we have discussed previously.
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Chapter 13: Should we strive for total scientific freedom?

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31 Different ethical issues, outside the scope of this chapter, arise with privately-funded projects.
32 http://www.ushmm.org/wlc/en/article.php?ModuleId=10005168.

Chapter 14: The ethical limitations on scientific research

1 My exposition of the Principle of Plenitude is not meant to be a faithful representation of Lovejoy's intent in his expression of the principle. Rather, I am taking his principle and applying it to the issue of how scientists view their mission in their activity in the context of Lovejoy's principle. Arthur O. Lovejoy, *The Great Chain of Being* (Cambridge, MA: Harvard University Press, 1936).
2 There has been much written about scientific revolutions. One starting point is with Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962). Two prominent critiques of Kuhn's notions are Imre Lakatos and Alan Musgrave, eds., *Criticism and the Growth of Knowledge,* (Cambridge: Cambridge University Press, 1970) and Karl Popper, *Conjectures and Refutations: The Growth of Scientific Knowledge* (New York: Harper and Row, 1965), esp. 232ff.
3 The rise of individualism and its corresponding corollaries (such as the depiction of private property) has been documented by Matthew H. Kramer, *John Locke and the Origins of Private Property: Philosophical Explorations of Individualism, Community and Equality* (Cambridge: Cambridge University Press, 1997).
4 Unless one is an extreme act utilitarian.
5 'Herophilus and Erasistratus acted in by far the best way: they cut open living men—those who were condemned criminals released by the king for such purposes. These prisoners were observed while they still breathed: their body parts previously hidden were now exposed … to cut open a living man is cruel and unnecessary, but to cut open the dead is essential for medical students.' Celsus, '*Prooemium' in De Medicina* ed. by F. Marx (Leipzig: Teubner, 1915): 23, 74. The translation is mine.
6 Michael Boylan and Kevin E. Brown, *Genetic Engineering: Science and Ethics on the New Frontier* 2nd edition (Upper Saddle River, N.J.: Prentice Hall, 2012), ch. 2.
7 The word 'primary' here denotes one subclass of the basic goods of agency. The primary goods of agency are universal and can be defined scientifically according to the parameters of human necessity. For example,

humans generally die when their core temperature drops below a certain temperature for a given interval. Humans also, for the most part, die when they do not receive x amount calories per kilogram of weight. Likewise, humans generally lose their ability to maintain mental health when they are subject to y amount of gratuitous violence and fear. All of these can (within certain ranges) be defined for all humanity. A second level of basic goods is relative to each society. These are the goods necessary to be an effective agent within that society. For example, in the United States today it is hard to be an effective agent without a certain level of education and the protection of basic human rights (including the right not to be used as a means only). For more discussion on this see Michael Boylan, *A Just Society* (Lanham, MD and Oxford: Rowman and Littlefield, 2004) and Michael Boylan, *Morality and Global Justice: Justifications and Applications* (Boulder, CO: Westview, 2011).

8 Of course, as further advances in technology have occurred, investigators have been able to use even less invasive techniques so that patient risk has dropped substantially. This is always important, since risk to patient health is a relative snapshot of the state-of-the-art that researchers should always strive to improve.

9 Two contemporary discussions of the Tuskegee experiment that fill out the horrific details are: James Howard Jones, *Bad Blood, The Tuskegee Syphilis Experiment* (New York: Free Press, 1993) and Susan Reverby and James H. Jones, eds., *Tuskegee's Truths: Rethinking the Tuskegee Syphilis Study* (Chapel Hill, NC: University of North Carolina Press, 2000).

10 There are, unfortunately, many such examples. The United States asked military personal to act as guinea pigs during atomic bomb testing in order to determine the effect of radiation upon unprotected human subjects. This was an inhumane and immoral action comparable to the vivisection cases discussed earlier. Similar atrocities have been committed against citizens of many different countries who have tested biological and chemical warfare agents upon their own citizens.

11 Henry Beecher, 'Ethics and Clinical Research' *New England Journal of Medicine,* 274 (1966):1354–60.

12 Ezekiel J. Emanuel and Christine Grady 'Four Paradigms of Clinical Research Oversight' *Cambridge Quarterly of Healthcare Ethics.* 16 (2006): 82–96.

13 Sheryl Gay Stolberg, 'U.S. AIDS Research Abroad Sets Off Outcry Over Ethics' *New York Times,* September 18, 1997: A 32–33.

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20 Deryck Beyleveld and Shaun Pattinson, 'Precautionary Reason as a Link to Moral Action' in Michael Boylan, ed. *Medical Ethics* (Upper Saddle River, N.J., 2001): 39–52.

21 Secondary goods are those goods that are less necessary for basic human action than are other sorts of goods. For a discussion of this see Boylan (2004) and Boylan (2011).

22 Boylan 2004 Ch. 5.

23 Joseph Cirincione, Jon B. Wolfisthel, and Miriam Raikuman, *Deadly Arsenals: Nuclear, Biological, and Chemical Threats,* revised edition. (Washington, DC: The Carnegie Endowment for Peace, 2005) and Edward M. Spiers, *A History of Chemical and Biological Weapons* (London: Reaktion, 2010).

24 This is because the atomic bomb is not a *target bomb.* It cannot be used surgically against a particular target, but instead is broad in its effects killing and destroying everything within a given radius.

25 This argument depends upon an understanding of traditional Just War Theory. For a survey of some important issues at stake see: Michael Walzer, *Just and Unjust Wars* (New York: Basic Books, 1977); Richard B. Miller, *Interpretations of Conflict: Ethics, Pacifism, and the Just War Tradition* (Chicago: University of Chicago Press, 1991); A. J. Coates, *The Ethics of War* (Manchester, UK: University of Manchester Press, 1997); F.M. Kamm, 'Failures of Just War Theory' *Ethics* 114.4 (2004): 650–692; Jeff McMahan, 'The Ethics of Killing in War' *Ethics* 114.4 (2004): 693–733; David Rodin, 'Terrorism Without Intention' *Ethics* 114.4 (2004): 752–771; C.A.J. Coady, 'Terrorism, Morality, and Supreme Emergency' *Ethics* 114.4 (2004): 772–789; Seumas Miller, *Terrorism and Counterterrorism* (Malden, MA and Oxford: Blackwell, 2009).

26 Most philosophers consider the work of Willard Van Orman Quine to be pioneering with respect to opaque contexts. Basically, an opaque context is created when a construction resists the substitutivity of identity. Quine uses the example, (1) '"Tully was a Roman" is trochaic'. (1) is a true proposition. Now Tully is identical to Cicero, so it would seem as if you could create the proposition (2) '"Cicero was a Roman" is trochaic.' But (2) is false since 'Cicero' is a dactyl. For a more complete discussion see: Willard Van Orman Quine, *Word and Object* (Cambridge, MA: M.I.T. Press, 1960), pp. 141ff.

27 According to the *Encyclopedia Americana* (Danbury, CT: Grolier, 1995), the number of people killed at Hiroshima was 271,000 and at Nagasaki 71,000. For further background on this devastation see: John Hershey *Hiroshima* (New York: Vintage, rpt. 1989); Robert Jay Lifton and Greg Mitchell *Hiroshima in America: A Half Century of Denial* (New York: Avon, 1996), and Kyoko Selden Mark Selden, eds., *The Atomic Bomb: Voices from Hiroshima* Armonk (NY: M.E. Sharpe, 1997).

28 Michael Boylan, *Basic Ethics* 2nd edition (Upper Saddle River, NJ: Prentice Hall, 2009).

29 The situation of the Trolley Problem is this: you are the engineer of a trolley and the trolley has gotten almost out of control. You cannot stop your trolley. You are approaching Lincoln Junction. On the right track is a school bus filled with children. On the left track is a homeless person whose poorly fitting shoes have caught in the track. As the engineer, you have the choice of moving your lethal train from the right track to the left. This is your only choice. What do you do? Is there an ethical justification for your choice?

30 The numbers of civilian Japanese casualties would have been miniscule. Even including the deaths of Japanese combatants, this strategy would have killed the fewest number of people. Yet, few know about this option.

31 Dietrich Bonhoeffer, *Letters and Papers from Prison,* Eberhard Bethge ed. (New York: Macmillan, 1997) and Eberhard Bethge and Victoria J. Barnett, eds., *Dietrich Bonhoeffer: A Biography* (Philadelphia: Fortress Press, 2000).

32 J. Robert Oppenheimer, *Atom and Void: Essays on Science and Community* (Princeton, NJ: Princeton University Press, 1989).

33 Of course there are some that believe that the sin of Odysseus was thirst for knowledge. Alfred Lord Tennyson frames his poem 'Ulysses' upon the thesis that the lack of self-control toward the acquisition of new knowledge was the cause of 'Ulysses' long journey home.

Chapter 15: What's special about *scientific* freedom?

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2 *Ibid*.

3 *Ibid*.

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5 John Gray, *Two Faces of Liberalism*, (Cambridge: Polity Press, 2000).

6 Harvey Brooks, 'The Problem of Research Priorities,' (1978) *Daedalus* 107:2, 171–190.
7 *Ibid*., pp. 171–172.
8 *Ibid*., p. 182.
9 *Ibid*.
10 I.e. there will be independent reasons why scientists (and others) will demand that their peers conform with the norms of science ethics.
11 Mary M Cheh, 'Government Control of Private Ideas—Striking a Balance Between Scientific Freedom and National Security,' *Jurimetrics Journal* (1982) 23, 1–32, p. 1.
12 Lewis C Mainzer, 'Scientific Freedom in Government-Sponsored Research,' *Journal of Politics* (1961) 23, 212–230, p. 213.
13 Loren R Graham, 'Concerns about Science and Attempts to Regulate Inquiry,' *Daedalus* (1978) 107:2, 1–21.
14 Jonas, 'Freedom of Scientific Inquiry and the Public Interest,' p. 16.
15 *Ibid*., p. 15.
16 *Ibid*., p. 16.
17 Peter Singer, 'Ethics and the Limits of Scientific Freedom,' *Monist* (1996) 79:2, 218–229.
18 Heather E Douglas, 'The Moral Responsibilities of Scientists (Tensions between Autonomy and Responsibility),' *American Philosophical Quarterly* (2003) 41:1, 59–68.
19 *Ibid*., p. 63.
20 *Ibid*.
21 *Ibid*., p. 64.
22 *Ibid*.
23 Sissela Bok, 'Freedom and Risk,' *Daedalus* (1978) 107:2, 115–127.
24 *Cf*. John Coggon, *What Makes Health Public?* (Cambridge: Cambridge University Press, 2012), chapter 7. See also Madison Powers, 'Bioethics as Politics: The Limits of Moral Expertise,' *Kennedy Institute of Ethics Journal* (2005) 15:3, 305–322.
25 Singer, 'Ethics and the Limits of Scientific Freedom,' p. 229.
26 Bok, 'Freedom and Risk,' p. 124.
27 See John Rawls, *A Theory of Justice – revised edition*, (Oxford: Oxford University Press, 1999).
28 Raymond Geuss, *Philosophy and Real Politics*, (Princeton and Oxford: Princeton University Press, 2008).
29 *Ibid*., p. 85.
30 *Ibid*.
31 See for example John Harris, 'Scientific research is a moral duty,' *Journal of Medical Ethics* (2005) 31:4, 242–248.
32 See Matti Häyry, *Rationality and the Genetic Challenge – Making People Better?* (Cambridge: Cambridge University Press, 2010).
33 See also John Coggon, 'Confrontations in "Genethics": Rationalities, Challenges and Methodological Responses,' *Cambridge Quarterly of Healthcare Ethics* (2011) 20:1, 46–55.

34 See Gray, *Two Faces of Liberalism*.
35 *Ibid*.
36 See Coggon, *What Makes Health Public?*, Part III.
37 Cheh, 'Government Control of Private Ideas,' p. 18.
38 James W Nickel, 'Who Needs Freedom of Religion?' (2005) *University of Colorado Law Review* 76, 941–964.
39 *Ibid*., p. 941.
40 *Ibid*., p. 943.
41 *Ibid*.
42 *Ibid*., pp. 950–951.
43 *Ibid*., p. 951.
44 *Ibid*.
45 *Ibid*., p. 959.

Conclusion: A short history of this Anthology

1 We wish to thank Silvia Celestini for reading and commenting on this contribution.
2 Further petitions will address the problem of clinical trials, sexual and reproductive rights, assisted reproduction and end-of-life decisions in Europe. Any citizen, acting individually or jointly with others, may at any time exercise his right of petition to the European Parliament under Article 194 of the EC Treaty. Our petitions can be signed on http://www.freedomofresearch.org/

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