House of Commons

Science and Technology Committee

Government proposals for the regulation of hybrid and chimera embryos

Fifth Report of Session 2006–07

HC 272–I

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Report

Summary

We have conducted this inquiry in response to the publication of Government proposals to prohibit the creation of human-animal chimera or hybrid embryos for research for the time being. We have also taken account of recent applications from researchers for licences to create human-animal cytoplasmic hybrid embryos for research.

There have been significant developments in science and medicine since the passing of the Human Fertilisation and Embryology Act in 1990, and we recognise the need for revised legislation in this area of research. We believe that public confidence in this area of research must be encouraged and that the Government should ensure wider public understanding in this area through increased education and dialogue. We find this of particular importance in respect of the sincere ethical and moral concerns associated with the creation of human-animal chimera or hybrid embryos for research.

We find that the creation of human-animal chimera or hybrid embryos, and specifically cytoplasmic hybrid embryos, is necessary for research. However, we maintain the view of the previous Science and Technology Select Committee that development of human-animal chimera or hybrid embryos past the 14-day stage should be prohibited and that a prohibition should be put in place on the implantation of human-animal chimera or hybrid embryos in a woman.

We are critical of the Human Fertilisation and Embryology Authority for delaying assessment of applications for licences to create cytoplasmic hybrid embryos for research. It is the role of HFEA to make judgement in areas considered within the spirit of the HFE Act and we find delay of assessment of these applications by HFEA inappropriate once the Authority had established that such research is within its remit.

We find the Government proposals prohibitive, notwithstanding the provision of powers to allow future regulation in this area at an unspecified date. Some research practices should be permitted under licence immediately. We recommend that the Government build upon its previous, successful, record through regulation of embryo research and we propose mechanisms for legislation and regulation of the creation of human-animal chimera or hybrid embryos for research. We are critical of the Government for not clearly setting out the areas of research practice intended to fall under the proposed legislation and suggest that greater attention should be paid to implications of the proposals for current research practice and the UK research base.

1 Introduction

Motivation for this inquiry

1. On 14 December 2006 the Government published its proposals for revision of the Human Fertilisation and Embryology (HFE) Act (Cm 6989), including proposals aimed at clarifying Government policy on the creation of human-animal hybrid or chimera embryos. The White Paper explained that the Government had found that the current law does not refer to more novel processes of embryo creation that have been developed since the 1990 HFE Act was passed, and which, in theory, could be used to create embryos combining human and animal material. The Government proposed to clarify the extent to which the law applies to such entities, but also to prohibit their creation, whilst leaving the door open at some future unspecified date to regulate for circumstances in which they may be allowed under licence.

2. The Science and Technology Select Committee has long been an involved participant in debates regarding the use of human reproductive technologies in research, as demonstrated by the previous Committee's 2005 report into *Human Reproductive Technologies and the Law*.[1] We followed up this Report in the current Parliament by taking evidence from the Minister for Public Health, Caroline Flint MP, on how the Government intended to take forward regulation in this area, and were therefore interested in the Government proposals for revision of the HFE Act. The proposed policy on the creation of embryos containing human and animal material for research (human-animal chimera or hybrid embryos) struck us, in particular, as being at odds with the recommendations of the Committee in the last Parliament.

3. Coincidentally, we had been aware for some time that the Human Fertilisation and Embryology Authority (HFEA) was anticipating applications from researchers from King's College London and Newcastle University for licences covering an area of research which would fall within the remit of the Government's proposed legislation. Soon after the publication of the Government's proposals for future legislation, the HFEA decided in mid-January 2007 to defer consideration of the licence applications, pending the outcome of a major public consultation on the creation of human-animal hybrid and chimera embryos for research purposes. It was these two threads – the general Government proposals and the specific research applications – which combined to make a compelling case for an urgent Committee inquiry.

Terminology

4. We recognise that it is essential from the outset to be absolutely clear in our use of terminology in discussing these issues. The Government's proposals cover 'hybrid' and 'chimera' embryos. The entities envisaged in the proposals from the two groups of researchers have attracted various names. The Government Chief Scientific Adviser, Professor Sir David King, has argued that these should not be described as either

1 House of Commons Select Committee on Science and Technology, Second Report of Session 2006-07, Human Reproductive Technologies and the Law, HC 67-I

chimeras or hybrids. In the course of our inquiry, Professor Shaw of King's College London referred to such entities as 'pseudo-hybrids';[2] Dr Lyle Armstrong of Newcastle University told us that "we, in our research group, refer to them as "interspecies embryos";[3] and Professor Austin Smith of the University of Cambridge thought that they would be better termed 'cybrids'.[4] In this Report, we have decided to follow the example of Sir David King and use the term 'cytoplasmic hybrid embryo' to describe what would result from the proposals to create embryos through somatic cell nuclear transfer of human genetic material into animal ova from which the main source of genetic material has been previously removed. The term 'cytoplasmic hybrid embryo' will be used to describe such entities throughout the remainder of this Report.

The inquiry

5. We launched our inquiry on 10 January 2007, with terms of reference intended to reflect the Committee's interest not only in the current Government proposals, but in the impact of these proposals on UK science.[5] The inquiry was to focus upon the appropriateness of the proposals for legislation of the creation of human-animal chimera or hybrid embryos for research purposes, as set out in the Government's recent White Paper, *Review of the Human Fertilisation and Embryology Act: Proposals for revised legislation (including establishment of the Regulatory Authority for Tissue and Embryos) (Cm 6989)* and on the impact of these proposals upon stem cell research in the UK.[6]

6. The briefing which accompanied the announcement of the draft Human Tissues and Embryology Bill in the Queen's Speech indicated that the Bill would be introduced in mid-March and sent to a joint Committee of both Houses for pre-legislative scrutiny. The date for its appearance has since been revised to May 2007.[7] Since we were keen that our inquiry should be useful in informing the preparation of the draft Bill, it was essential that we conducted and reported on this inquiry as rapidly as our need for thoroughness would allow. Consequently, we announced the inquiry immediately (in January 2007) and were obliged to give short deadlines with regard to receiving submissions of written evidence and limited notice to those witnesses required for oral evidence sessions. We appreciate that some difficulties may have been caused by our tight deadlines and are most grateful for the efforts of all contributors to work within the necessary timescale. In particular, we would like to place on record our thanks to the secretariat of the Human Fertilisation and Embryology Authority which has responded to our many requests for information efficiently and promptly.

2 Q 14

3 Q 5

4 Q 15

5 Press release No. 11 of session 2006-07, www.parliament.uk/parliamentary_committees/science_and_technology_committee/scitech100107b.cfm

6 Government proposals for the regulation of hybrid and chimera embryos ,terms of reference, www.parliament.uk/parliamentary_committees/science_and_technology_committee/scitech100107b.cfm

7 Q 338

7. We held a private seminar at the start of the inquiry to enable us to learn more about the scientific issues surrounding the subject area from: Professor Ian Wilmut FRS (University of Edinburgh), Dr Stephen Minger (King's College London) and Dr Justin St. John (Birmingham University). We later visited the facilities for stem cell research at Dr Minger's laboratory. An informal meeting was also held with Professor Hui Z. Sheng, Professor in developmental biology at the Shanghai Jiao Tong University, School of Medicine and Dr Robin Lovell-Badge, the National Institute for Medical Research, UK. We are particularly grateful to Professor Sheng for discussing her own research in this area so frankly and for giving us her informed views on the UK regulatory structures, as well as on the science.

8. We held three oral evidence sessions, during which we heard from the following:

- Dr Lyle Armstrong from the Institute of Human Genetics, Newcastle University, Professor Chris Shaw of the Institute of Psychiatry, King's College London and Professor Austin Smith, Wellcome Trust Centre for Stem Cell Research, University of Cambridge.
- Ms Shirley Harrison, Chair of the HFEA, Angela McNab, Chief Executive of the HFEA and Professor Neva Haites, a Member of the HFEA.
- Dr David King, Human Genetics Alert, Dr Calum MacKellar, Director of the Scottish Council on Human Bioethics and The Right Reverend Dr Lee Rayfield, Bishop of Swindon, representing the Church of England.
- Mr Simon Denegri from the Association of Medical Research Charities and Professor Raanon Gillon, Emeritus Professor of Medical Ethics at Imperial College London and former editor of the Journal of Bioethics.
- Professor Colin Blakemore, Chief Executive of the Medical Research Council, Professor Martin Bobrow, Deputy Chairman of the Wellcome Trust and Mr David Macauley, Chief Executive of the UK Stem Cells Foundation.
- Caroline Flint MP, Minister of State for Public Health, Sir Liam Donaldson, the Chief Medical Officer and Mr Mark Bale, Deputy-Director of Scientific Development and Bioethics at the Department of Health.

The transcripts of these sessions are published with this Report, together with the written submissions received in response to our call for evidence and requests for supplementary information.

9. Finally, we held an additional public seminar to explore the wider issues raised by the inquiry with: Professor Sir David King, Government Chief Scientific Advisor, Professor Lord Winston, Emeritus Professor of Fertility Studies, Imperial College, London, The Rt Revd Lord Harries of Pentregarth, Chairman of the Human Fertilisation and Embryology Authority Law and Ethics Committee, the writer AN Wilson and Dr David Jones, Academic Director of the School of Theology, Philosophy, and History at St Mary's University College, Twickenham. This is the first occasion upon which we have held such an event and we found it to be of great value in our deliberations.

10. We are grateful to all who contributed to this inquiry. We would like to place on record our thanks to our specialist adviser in law and ethics, Professor Roger Brownsword, King's College London, and in scientific issues surrounding the inquiry, Dr Valerie Wilson, University of Edinburgh. We also received valuable assistance from the Scrutiny Unit and Legal Services Office in the House of Commons in the course of this inquiry.

2 Background

Regulation

The Human Fertilisation and Embryology (HFE) Act 1990

11. The creation of the Human Fertilisation and Embryology (HFE) Act 1990 (hereafter known as the HFE Act) was stimulated by the report of the Committee of Inquiry into Human Fertilisation and Embryology which was chaired by Baroness Warnock and reported in 1984.[8] Warnock's Committee was set up by the Government following the birth of the first 'test tube' (*in vitro* fertilisation) baby in 1978 since it was considered that the new methods of assisting conception raised legal, social and ethical issues which needed to be addressed.[9]

12. The HFE Act was originally introduced to bring within regulation three aspects of assisted reproduction where there were ethical or patient issues to be addressed, namely:

- the creation or use of embryos outside the body (i.e. *in vitro* fertilisation, hereafter known as IVF) ;
- the use of donated eggs or sperm in treatment; and
- the storage of embryos, sperm or eggs.

The Act also covered the use of human embryos in research. Since 1990, there have been significant developments both in medicine and science that have made it necessary to modify the original legislative scheme in this area. Most significantly, in 2001, regulations were introduced to extend the list of purposes for which such research could be licensed by the HFEA. Under these amendments, the use of human embryos for research was to be licensable not only for the essentially reproductive purposes as set out in the 1990 Act, but also for increasing knowledge about the development of embryos, increasing knowledge about serious disease, and enabling any such knowledge to be applied in developing treatments for serious disease. The 2001 provisions allowed for 'therapeutic cloning' i.e through cell nuclear replacement (CNR), the creation of an embryo by taking an egg (or oocyte) from which the nucleus had been removed, and replacing it with the nucleus of a donor cell (e.g. a human skin cell). Work such as this is designed to facilitate the production of stem cells from early-stage embryos which could be used to grow perfectly matched brain cells, blood, heart muscle and other tissue for treatment or repair in disease.[10] To date, the HFEA has awarded licences for therapeutic cloning via CNR to two UK research groups.[11]

8 Department of Health and Social Security, *Report of the Committee of Inquiry into Human Fertilisation and Embryology* ("The Warnock Report"), Cm 9314, July 1984

9 Ibid

10 "UK gives go-ahead for human cloning", *New Scientist*, 27 February 2002,http://www.newscientist.com/article.ns?id=dn1975

11 Use of animal eggs in embryo research, http://www.hfea.gov.uk/cps/rde/xchg/SID-3F57D79B-949AF4FE/hfea/hs.xsl/377.html

13. Under the current law, research must relate to one or more of the following purposes:

- to promote advances in the treatment of infertility;
- to increase knowledge about the causes of congenital diseases;
- to increase knowledge about the causes of miscarriage;
- to enhance knowledge in the development of more effective contraception;
- detection of genetic or chromosomal abnormalities before implantation;
- to increase knowledge about the development of embryos;
- to increase knowledge about serious disease; or
- to enable any such knowledge to be applied in developing treatment for serious disease.[12]

14. There are strict limits on what the HFEA can licence. The legislation prohibits placing in a woman (a) a live embryo other than a human embryo, or (b) any live gamete other than human gametes. In addition, under the HFE Act, a licence cannot authorise:

i. keeping or using an embryo after the appearance of the primitive streak;

ii. placing an embryo in any animal;

iii. keeping or using an embryo in any circumstances in which regulations prohibit its keeping or use; or

iv. replacing a nucleus of a cell of an embryo with a nucleus taken from a cell of any person, embryo or subsequent development of an embryo.[13]

The primitive streak is taken to have appeared in an embryo not later than the end of the period of 14 days beginning with the day when the gametes are mixed, not counting any time during which the embryo is stored, interpreted as meaning that there is a prohibition on keeping an embryo for more than 14 days.[14] It is also of interest to note that reproductive cloning (placing in a woman a human embryo produced through methods other than fertilisation) is prohibited since this is illegal in the UK under the Human Reproductive Cloning Act which was passed in November 2001.[15]

15. The question of the creation of animal-human hybrid or chimera embryos is not addressed in the HFE Act, although the mixing of human and animal gametes is

12 The HFE Act was amended in 2001 through the Human Fertilisation and Embryology (Research Purposes) Regulations 2001 (SI 2001/188), www.opsi.gov.uk/SI/si2001/20010188.htm

13 The Act specifies the replacement of an embryo's nucleus and therefore does not cover therapeutic cloning which uses an enucleated egg.

14 Human Fertilisation and Embryology Act 1990.

15 Human Reproductive Cloning Act 2001, www.opsi.gov.uk/acts/acts2001/20010023.htm

prohibited, with a provision to allow testing fertility of human sperm through fertilisation of a hamster egg (the 'hamster test'). Where an area of research practice does not fall within the scope of the HFE Act or other legislation, for example under the Home Office through the Animals (Scientific Procedures) Act 1986, the implication is that such research could be undertaken free from regulation.[16]

The Human Fertilisation and Embryology Authority (HFEA)

16. The HFEA, a statutory body and the first of its type in the world, was created in 1991 following the passing of the HFE Act in 1990. The recommendation for a regulatory body of this nature had also originally been made by the 1984 report of the Committee of Inquiry into Human Fertilisation and Embryology (the Warnock Report).[17] The HFEA regulates and monitors each of the clinics providing IVF, donor insemination and/or the storage of human ova, sperm or embryos in the UK. In addition, the HFEA is responsible for licensing and monitoring all UK human embryo research. [18]

17. The HFE Act requires centres undertaking research involving the creation and/or use of human embryos to first obtain a licence from the HFEA. Licences for the creation and use of human embryos for research are awarded by the HFEA after evaluation by an HFEA Research Licence Committee and peer review, initiated by the HFEA regulation department, to determine whether an application:

- comes within the statutory requirements of the HFE Act;
- requires human embryos to fulfil its aims and objectives;
- requires the numbers and types of embryos described in the application; and
- meets the requirements of the HFEA code of practice.

The HFEA has the power to grant research licences for up to three years for individual research projects.[19]

The effectiveness of the UK regulatory system

18. The UK is recognised as a good example of how to develop workable regulation in this area of research. For example, Professor Anne McLaren of the Wellcome Trust Gurdon Institute has told us that the UK has a "sensible and scientifically-based regulatory system that has functioned with few major problems for the past 16 years".[20] From an international perspective, Professor Hui Z. Sheng of the Shanghai Jiao Tong University, School of Medicine, China, also supported the UK regulatory environment

16 Ev 127

17 Department of Health and Social Security, *Report of the Committee of Inquiry into Human Fertilisation and Embryology* ("The Warnock Report"), Cm 9314, July 1984

18 What is the role of the HFEA, www.hfea.gov.uk/cps/rde/xchg/SID-3F57D79B-13B4CD03/hfea/hs.xsl/385.html#What_is_the_role_of_the_HFEA

19 How to apply for a research licence, www.hfea.gov.uk/cps/rde/xchg/SID-3F57D79B-E00DEEE7/hfea/hs.xsl/376.html

20 Ev 52

in this area of research. Professor Sheng told us that the UK is "currently a world leader not only in embryological research and cloning, but also in policy making in this field". She explained that the UK Government "has established an image to be able to balance scientific development and ethical issues with confidence and vision" and that "its regulatory policy in embryological research has provided a permissive but strictly regulated environment". Moreover, Professor Sheng believed that "UK policy has positively influenced the policy making in other countries, including China, Japan, USA *et al*".[21]

Public consultation on review of the HFE Act

19. The Government announced in 2004 that it intended to review the provisions of the Human Fertilisation and Embryology Act 1990 (the HFE Act), and in preparation, held a public consultation exercise which ran from 16 August to 25 November 2005. This posed a range of questions about how the law might be updated, including how it deals with issues such as embryo screening for inherited disorders, sex selection and possible future technologies such as artificial gametes. Specifically with relevance to this inquiry, the Government asked whether:

i. there is a case at present for either an extension or a reduction to the 14-day time limit for keeping an embryo;[22]

ii. research undertaken on embryos using the cell nuclear replacement technique for the purpose of studying mitochondrial diseases should be permissible in law, subject to licensing.[23]

In addition, the Government invited views on

i. removing the current prohibition on "replacing a nucleus of a cell of an embryo with a nucleus taken from the cell of any person, another embryo or a subsequent development of an embryo" for research purposes, subject to licensing;[24]

ii. whether the law should permit altering the genetic structure of an embryo for research purposes, subject to licensing;[25]

iii. whether the law should permit the creation of human-animal hybrid or chimera embryos for research purposes only (subject to the limit of 14 days culture *in vitro*, after which the embryos would have to be destroyed);[26]

iv. whether the current list of legitimate purposes for licensed research involving embryos remains appropriate;[27]

21 Ev 148

22 Department of Health, *Review of the Human Fertilisation and Embryology Act: A Public Consultation*, November 2005, Para 9.15, www.dh.gov.uk/en/Consultations/Closedconsultations/DH_4123863

23 Ibid, para 9.22

24 Ibid, para 9.23

25 Ibid, para 9.28

26 Ibid, para 9.35

v. whether the purposes for which research using embryos may legitimately be undertaken should, as now, be defined in law and research projects should continue to be approved by a national body in order to ensure compliance with the law, national consistency and appropriate ethical oversight;[28]

vi. whether additional regulatory requirements should apply to the procurement and use of gametes for purposes of research;[29] and

vii. on the desirability of allowing the creation of embryos for the treatment of serious diseases (as distinct from research into developing treatments for serious diseases which is already allowed).[30]

The outcome of the consultation

20. The White Paper which eventually resulted from the consultation and the review of the legislation covered many issues, but of central interest to this inquiry is the Government's response to the question of hybrid and chimera embryos. The Government stated that:

> The extent to which the law and regulation would apply to embryos created in these circumstances is not sufficiently clear, although the law would clearly prevent such embryos being placed in a woman. In some circumstances the embryo created could be, genetically speaking, almost entirely human and therefore could fall within the regulatory controls applicable to human embryos.[31]

It therefore proposed that "revised legislation will clarify the extent to which the law and regulation applies to embryos combining human and animal material".[32] Moving on to what the policy should be towards such embryos, the review concluded that:

> The Government will propose that the creation of hybrid and chimera embryos in vitro, should not be allowed. However, the Government also proposes that the law will contain a power enabling regulations to set out circumstances in which the creation of hybrid and chimera embryos in vitro may in future be allowed under licence, for research purposes only.[33]

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27 Department of Health, *Review of the Human Fertilisation and Embryology Act: A Public Consultation*, November 2005, Para 9.15, www.dh.gov.uk/en/Consultations/Closedconsultations/DH_4123863, para 9.38

28 Ibid, para 9.41

29 Department of Health, *Review of the Human Fertilisation and Embryology Act: A Public Consultation*, Para 9.45, www.dh.gov.uk/en/Consultations/Closedconsultations/DH_4123863

30 Ibid, Para 9.47

31 Department of Health, *Review of the Human Fertilisation and Embryology Act: Proposals for revised legislation* (including establishment of the Regulatory Authority for Tissue and Embryos), Cm 6989, December 2006, Para 2.82, www.hfea.gov.uk/cps/rde/xbcr/SID-3F57D79B-9E450A32/hfea/White_Paper_Dec_06_web_version.pdf

32 Ibid

33 Department of Health, *Review of the Human Fertilisation and Embryology Act: Proposals for revised legislation* (including establishment of the Regulatory Authority for Tissue and Embryos), Cm 6989, December 2006, Para 2.82, www.hfea.gov.uk/cps/rde/xbcr/SID-3F57D79B-9E450A32/hfea/White_Paper_Dec_06_web_version.pdf

Stem cell research

21. Within this Report we discuss the creation of human and animal chimera or hybrid embryos for a number of purposes, a prime example of which is for the derivation of stem cells. Most cells found within adults are specialised cell types, for example, muscle, skin or hair. Stem cells, however, are unique in that they can both multiply to produce more stem cells and 'differentiate' into specialised cell types as they multiply. This ability makes stem cells potentially important for use in medicine as it opens up the possibility that these cells may be used to create any type of cell for use as a treatment to replace diseased and damaged cells. There are three broad categories of mammalian stem cells:

i. Pluripotent stem cells. These can differentiate into the many cell types of the body. Embryonic stem cells, derived from the inner cell mass of blastocysts (see diagram 1) are the best known example. Embryonic stem cells are 'immortal', which means that they can be multiplied in the laboratory for many years to produce very large numbers of cells. These cells can also be directed to differentiate *in vitro* into clinically relevant cell types (e.g. for the heart muscle, nerve or skin). Embryonic stem cells, however, do not have the capacity to develop into a functional human embryo.

ii. Tissue stem cells. These are found in adult tissues, for example, in the bone marrow where the adult stem cells differentiate to produce the many blood cell types e.g. red blood cells and white blood cells of the immune system such as lymphocytes. Adult stem cells are presently much less able to multiply, and are generally not able to differentiate into as many cell types as embryonic stem cells. In adult organisms, stem cells act as a repair and regeneration system for the body, replenishing specialized cells.

iii. Cord blood stem cells, which are found in the umbilical cord.

22. As discussed above, embryonic stem cells may be obtained from blastocysts. The term 'blastocyst' refers to the human embryo approximately five days after fertilisation and is the stage of development that the embryo must reach before it can implant in the uterus. The structure of the blastocyst is more complex than earlier embryo stages because as well as increasing in cell number, the cells have become organised into two types: the trophectoderm, whose main role is in implantation into the uterine lining, and the inner cell mass which will give rise to the foetus itself, and from which embryonic stem cells may be derived. See Figure 1.

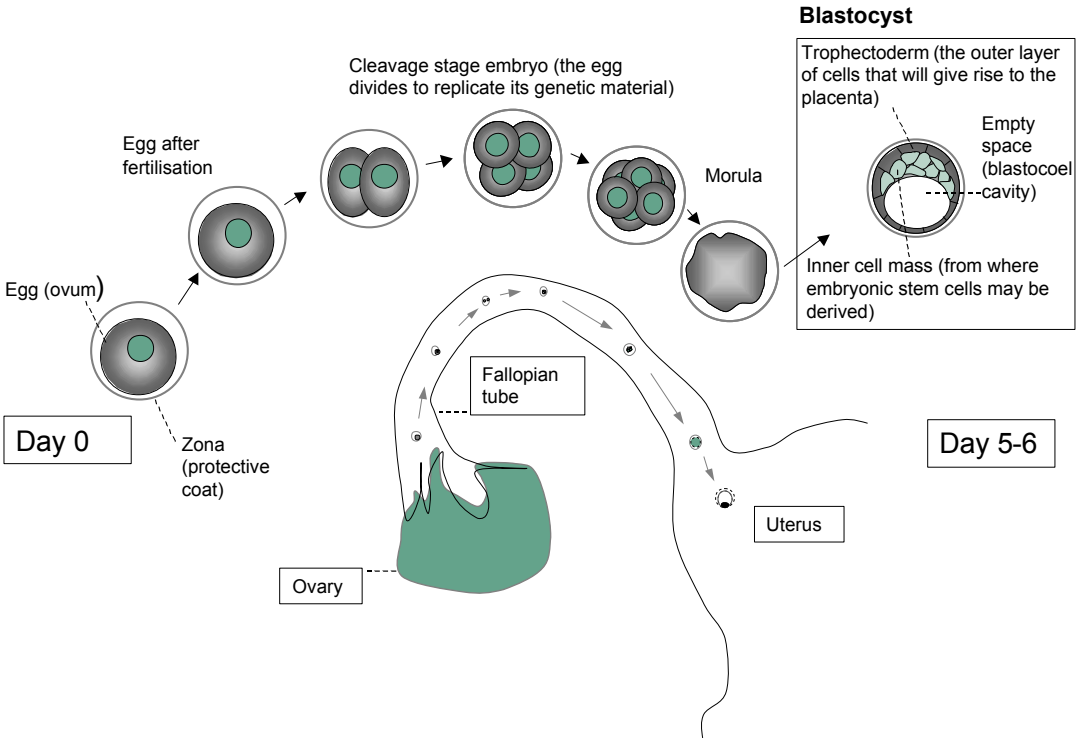

Figure 1: Schematic diagram to illustrate blastocyst formation. The diagram demonstrates cell division after fertilisation and through to the morula stage (in which 16 -32 cells are present) until the blastocyst is created. The stages of development depicted usually occur within the fallopian tubes. Blastocyst formation is required prior to implantation of the embryo within the uterus.

23. Currently, human embryonic stem cell lines are primarily derived from 'spare' human embryos under licence from the HFEA.[34] Under such licence, for example, researchers in the UK derive stem cells from human embryos screened out for implantation in a woman after pre-implantation genetic diagnosis (PGD). Such embryos include those which will not be implanted into a woman undergoing IVF since they may carry the genetic instructions responsible for causing diseases such as cystic fibrosis.[35] There is a high wastage rate. Most of the embryos used in attempts to derive stem cell lines will not yield results: according to Dr Lyle Armstrong at Newcastle University, "on average, 15% of embryos will give rise to a ESC [embryonic stem cell] line".[36] Other avenues for the production of human stem cells include through therapeutic cloning, and the HFEA has, to date, granted two licences to enable researchers to study the derivation of human embryonic stem cell lines using this method.[37]

24. Because of their ability to reproduce themselves, and to differentiate into other cell types, stem cells offer the prospect of developing cell-based therapy to treat a wide range

34 The HFEA has, however, granted two licences to enable researchers to study the derivation of human embryonic stem cell lines using nuclear transfer (therapeutic cloning).Information is available from the HFEA website at: http://www.hfea.gov.uk/cps/rde/xchg/SID-3F57D79B-7821EC74/hfea/hs.xsl/377.html

35 Ev 129

36 Ev 79

37 Use of animal eggs in embryo research, www.hfea.gov.uk/cps/rde/xchg/SID-3F57D79B-7821EC74/hfea/hs.xsl/377.html

of degenerative diseases, such as Parkinson's disease and muscular dystrophy.[38] Stem cell therapy may also be of use as a mechanism for repair or replacement of damaged tissues, and we heard from Cancer Research UK that future stem cell research could "uncover ways of improving outcomes after treatment for cancer, potentially providing us with the ability to regenerate or replace normal tissue following surgical removal of cancerous tissue, or its destruction by chemotherapy or radiotherapy".[39] Furthermore, as detailed by the House of Lords Select Committee on human cloning and stem cell research, "stem cell treatments, unlike most conventional drugs treatments, have the potential to become a life-long cure",[40] and stem cell research has been heralded by the UK Stem Cell Initiative as representing "a substantial opportunity for future innovation in the life sciences".[41]

Previous interest in the area

Chronology of relevant reports and developments

25. There have been a number of reports and developments of interest to this inquiry. Some have been mentioned earlier but it may be helpful to set them out here in order to provide a chronology of developments. This illustrates how recent has been the growth of awareness of the potential of animal-human hybrid and chimera embryos for research purposes and of concern about this issue.

i. Report of the Committee of Inquiry into human fertilisation and embryology (Cm 9314), 1984. The Warnock report. (See paragraph 11)

ii. *Human Fertilisation and Embryology: A Framework for Legislation (Cm 259*). This White Paper, which was published in November 1987, preceded the HFE Act and indicated Government commitment to legislation in this area.

iii. *Human Fertilisation and Embryology Act 1990*. The Act provided for regulation of the creation or use of embryos outside the body; the use of donated eggs or sperm in treatment; and the storage of embryos, sperm or eggs.

iv. *Stem Cell Research: Medical Progress with Responsibility.* Sir Liam Donaldson chaired the report of this expert advisory group, commissioned to assess the anticipated benefits of research on stem cells and cell nuclear replacement and to advise whether further research uses of embryos should be permitted. Recommendations of the report included to extend the purposes of permissible research via affirmative regulations to those detailed in the subsequent 2001

38 Ev 72

39 Ev 102

40 House of Lords, *Stem Cell Research,* First Report from the Select Committee on Stem Cell Research, Session 2001-02 HL Paper 83-i, www.parliament.the-stationery-office.co.uk/pa/ld200102/ldselect/ldstem/83/8301.htm

41 UK Stem Cell Initiative: Report and Recommendations, November 2005, www.advisorybodies.doh.gov.uk/uksci/uksci-reportnov05.pdf

revisions stated below. The report also recommended that "mixing of human adult (somatic) cells with the eggs of any animal species should not be permitted".[42]

v. *The Human Fertilisation and Embryology (Research Purposes) Regulations 2001.* Extended the purposes for which research licences could be authorised namely: increasing knowledge about the development of embryos; increasing knowledge about serious disease; or enabling any such knowledge to be applied in developing treatments for serious disease (see paragraph 12).[43]

vi. *The Human Reproductive Cloning Act 2001.* This Act created an offence of placing a human embryo in a woman other than created by fertilisation.[44]

vii. House of Lords Select Committee report on *Stem Cell Research* (2002).[45] In direct reference to human embryos only, the Committee believed that "embryos should not be created specifically for research purposes unless there is a demonstrable and exceptional need which cannot be met by the use of surplus embryos".[46] The Committee also discussed the issue of animal-human hybrid and chimera embryos and took issue with the suggestion of Sir Liam Donaldson's expert group that there is a need for an outright ban on such research.[47]

viii. House of Commons Science and Technology Select Committee report on *Human Reproductive Technologies and the Law,* 2005.[48] See below.

ix. *UK Stem Cell Initiative. Report and Recommendations.* The UK Stem Cell Initiative was chaired by Sir John Pattison and reported in November 2005. In response to the report's recommendation that stem cell research needed sustained and increased funding, the Government increased its funding over the two year period 2006-07 to 2007-08 from £50 million to £100 million.[49]

x. Government Consultation on the Review of the Human Fertilisation and Embryology Act. Launched in August 2005, the consultation posed a wide range of questions about how the law might be updated.[50]

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42 Department of Health,*Stem Cell Research: Medical Progress with Responsibility*, July 2000, www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4065084

43 www.opsi.gov.uk/SI/si2001/20010188.htm

44 www.opsi.gov.uk/acts/acts2001/20010023.htm

45 www.parliament.the-stationery-office.co.uk/pa/ld200102/ldselect/ldstem/83/8301.htm

46 HL Paper (Session 2001-02) 83-i, para 4.28

47 House of Lords Select Committee report on Stem Cell Research (2002), Para 8.18 – 8.19

48 House of Commons Select Committee on Science and Technology, Fifth Report of Session 2004-05, *Human Reproductive Technologies and the Law,*HC 7, para 67, http://www.publications.parliament.uk/pa/cm200405/cmselect/cmsctech/7/7i.pdf

49 UK Stem Cell Initiative: Report and Recommendations, November 2005, www.advisorybodies.doh.gov.uk/uksci/uksci-reportnov05.pdf

50 Information on the consultation available at: http://www.dh.gov.uk/Consultations/ResponsesToConsultations/ResponsesToConsultationsDocumentSummary/fs/en?CONTENT_ID=4132358&chk=CnrKSR

xi. *Review of the Human Fertilisation and Embryology Act: Proposals for revised legislation (including establishment of the Regulatory Authority for Tissue and Embryos) (Cm* 6989). December 2006.

Previous Science and Technology Select Committee interest

26. As indicated above, the House of Commons Science and Technology Select Committee reported on *Human Reproductive Technologies and the Law in* 2005. Within this report, and with respect to human-animal chimera and hybrids, the Committee recommended that new legislation was required to (a) define the nature of these creations, (b) make their creation legal for research purposes if they are destroyed in line with the current 14-day rule for human embryo cultures, and (c) prohibit their implantation in a woman.[51] In addition, the Committee was of the opinion that there was a need for "a new Parliamentary Standing Committee on Bioethics" to undertake annual scrutiny of the Regulatory Agency for Fertility and Tissues [the White Paper's proposed replacement of the current HFEA], make recommendations on the need to amend or introduce legislation and scrutinise draft legislation brought before Parliament.[52] These recommendations are the starting point for our current inquiry.

51 HC (2004-05) 7, para 67, www.publications.parliament.uk/pa/cm200405/cmselect/cmsctech/7/7i.pdf

52 HC (2004-05) 7, para 399

3 Human-animal chimera or hybrid embryos and research

Chimera and hybrid models in research

27. The term 'human-animal chimera or hybrid embryos' can be applied to a wide range of creations, both in general in relation to the Government proposal and specifically, in relation to the recent research proposals submitted to the HFEA for the creation of cytoplasmic hybrid embryos. Hybrids and chimeras are distinct types of entities. A chimera is composed of a mixture of cells derived from two different individuals, either from the same or different species, whilst a hybrid is an entity in which each cell carries genetic material from two individuals, either from the same or different species.[53]

28. Use of hybrid and chimera animal models in research is both legal and relatively common practice. With specific regard to human-animal hybrids, it is currently lawful (and recognised practice) to insert segments of human chromosomes into animal embryos which are then implanted and bred to create transgenic species, for example, mouse models of human blood disorders[54] or of Down's Syndrome.[55] Table 1 describes a number of hybrid models, including transgenic organisms, how such creations are made and the purposes for which they may be used.

Table 1. Examples of hybrid models used in research

Type	Definition	How is it made?	Example of purpose	Example
'True' hybrids	Organism created by the mixing of gametes from more than one strain or species	Fertilisation	To create animals/plants with characteristics of more than one strain or species	Mule (donkey-horse hybrid)
Somatic cell hybrids	Tissue culture cell containing chromosomes of more than one strain or species	Often through fusing two cell types together (in vitro) and selecting for those cells containing DNA from both sources. NB: The term 'somatic' may be misleading since one, or both of the cells could be an embryonic stem cell or germ cell[56]	To look for the properties of one cell that alter the properties of the other, or to find which genes lie close to one another on a chromosome[57]	Hamster-human hybrid tissue culture cells used to map genes on human chromosomes. So far this has only been done in tissue culture[58]

53 Ev 67

54 Wallace, H.A.C., Marques-Kranc, F., Richardson, M., Luna-Crespo, F., Sharpe, J.A., Hughes, J., Wood, W.G., Higgs, G.R. and Smith, A.J.H. *Manipulating the mouse genome to engineer precise functional syntenic replacements with human sequence. Cell* (2007) 128: 197-209.

55 Public Health Genetics Unit, www.phgu.org.uk/ecard?link_ID=1427

56 Ev 69

Type	Definition	How is it made?	Example of purpose	Example
Cytoplasmic hybrids	Cells made of the cytoplasm from one cell and the nucleus of the other. Cytoplasmic hybrids can be derived from the same species or different strain/species in which case they would be termed 'interspecies/inter-strain cytoplasmic hybrids	Similar to above, but created by fusion or through injection of the nucleus of one cell into the cytoplasm of another cell in which the nucleus has been previously removed. This process is referred to as 'cell nuclear transfer' and may involve somatic or germ cells (as depicted in Figure 2)[59]	To make cloned animals or to make embryonic stem cells which are clones of the donor individual[60]	'Dolly' the sheep, other cloned animal species. Therapeutic cloning.[61]
Transgenic animals NB: transgenic animals are not routinely referred to as 'hybrids' but do contain a mix of DNA	Individual containing DNA introduced from outside so that all of their cells contain the genetic modification	Can be created by injecting DNA from one species into a single cell embryo. The resultant creation can then be bred to create a chimera (see below)	To study the effect of a gene modification, to produce proteins of interest for biotechnology[62]	Transgenic mice e.g. mouse models of human blood disorders[63] and Down's Syndrome[64]
Gene Therapy	Introduction of DNA into a number of target cells of recipient	DNA is introduced via a fusion agent to selected cells	To alleviate genetic disease[65]	None in general use but clinical trials for various genetic disorders have been carried out e.g. cystic fibrosis[66]

29. The use of chimera models in research is also relatively widespread and legal under current legislation. The term 'chimera' can be used to describe a number of entities, for example, a species created from two cell types such as a sheep/goat or a duck/quail.

57 Ibid

58 Ev 69

59 http://en.wikipedia.org/wiki/Somatic_cell_nuclear_transfer

60 Ibid

61 Campbell KH, McWhir J, Ritchie WA, Wilmut I. Sheep cloned by nuclear transfer from a cultured cell line, Nature, 1996 Mar 7;380(6569):64-6.

62 Expression of Human Anti-Hemophilic Factor IX in the Milk of Transgenic Sheep. A. J. Clark, et al. (1989) Bio/Technology7, 487

63 Wallace, H.A.C., Marques-Kranc, F., Richardson, M., Luna-Crespo, F., Sharpe, J.A., Hughes, J., Wood, W.G., Higgs, G.R. and Smith, A.J.H. Manipulating the mouse genome to engineer precise functional synthetic replacements with human sequence, Cell (2007) 128: 197-209.

64 Public Health Genetics Unit, www.phgu.org.uk/ecard?link_ID=1427

65 Human Genetics and Medical Research, http://history.nih.gov/exhibits/genetics/sect4f.htm

66 Griesenbach U, Geddes DM, Alton EW. Gene therapy progress and prospects: cystic fibrosis. Gene Therapy. 2006 Jul;13(14):1061 7

With specific regard to human-animal chimeras, current legislation allows for their creation, for example, in implanting human neural cells into mouse brains or spinal cords to test whether they can produce functional nerves.[67] It may also be of interest to note that, technically speaking, human recipients of donor organs, either from a different human or animal (for example, a pig heart valve transplant) could be referred to as a 'chimera'. Table 2 describes a number of chimera models, how they are made and the purposes for which they may be used.

Table 2. Examples of chimera models used in research

Type	Definition	How is it made?	Example of purpose	Example
Blastocyst injection or aggregation chimera	A chimera containing a mixture of cells throughout its body	Mixing pluripotent cells from i) two or more early embryos or ii) embryonic stem cells and an early embryo	Research to study the effects of the cell mixture and as a route to the production of transgenic mice[68]	Mixing mutant cells (which carry a gene altered by mutation) with wild type ones (the 'normal' form of the cell) to study whether wild type cells can rescue the phenotype (observable traits) of the mutant cells.[69]
Interspecies chimera	Chimera containing a mixture of cells from two species	Mixing pluripotent cells from i) two or more early embryos or ii) embryonic stem cells and an early embryo	Research to study differences in organism development, some researchers have suggested that injecting human embryonic stem cells into a developing animal embryo would enable testing for pluripotency[70]	Sheep/goat[71] and Duck/quail chimeras[72]
Transplant recipient	Individual that has received cells or organ (s) from another individual, either the same or another	Transplantation of cells or organ(s) from one individual to another	Used in: i) medicine for replacement of damaged organs or tissues[73]; ii) clinical research to test the properties of cells including human embryonic stem cells[74]; and iii) for testing of stem cell lines[75]	i) human bone marrow or pig heart valve transplant into human[76] ii) to test whether stem cells can alleviate symptoms of Parkinson's disease in mice[77] iii) to determine whether

67 Ev 68

68 Ibid

69 http://en.wikipedia.org/wiki/Chimera_(genetics)

70 Ev 68

71 Fehilly, C.B. et al. (1984) Interspecific chimaerism between sheep and goat, Nature 307, 634-636

72 Development, "The bills of qucks and duails", Science,24January 2003, www.sciencemag.org/cgi/content/full/299/5606/523

73 Ev 67

74 Brustle O. Building brains: neural chimeras in the study of nervous system development and repair. Brain Pathol. 1999 Jul;9(3):527-45.

75 Thomson JA, et al. Embryonic stem cell lines derived from human blastocysts, Science, 1998 Nov 6;282(5391):1145-7.

76 http://en.wikipedia.org/wiki/Bone_marrow

Type	Definition	How is it made?	Example of purpose	Example
	species			embryonic stem cells can differentiate into different cell types *in vivo*, as demonstrated through the creation of human embryonic stem cell derived tumours in mice[78]

30. Within this extensive catalogue of models for research, a number of creations which may be directly termed 'human-animal chimera or hybrid *embryos*' are found. For example, the initial entity required for creation of a transgenic animal, in which DNA from a human is injected into a single cell mouse embryo is a human-animal hybrid embryo .[79]

Cytoplasmic hybrid embryos

31. Cytoplasmic hybrid embryos are created through the transfer of genetic material from one cell, for example, a human skin cell, into an oocyte (egg) from which the main source of genetic material has been previously removed. This process, which is termed somatic cell nuclear transfer (SCNT), can occur through direct transfer of the nucleus from a human cell, as illustrated by figure 2, or through fusion of a somatic cell with the recipient oocyte. In the case of the applications from King's College London and Newcastle University, it is proposed that animal oocytes should be used. These animal eggs will have had their nuclear genetic material previously removed and are hence referred to as 'enucleated animal ova'.

77 "Stem cell therapy for Parkinson's", June 2004, BBC News, http://news.bbc.co.uk/1/hi/health/3853791.stm '

78 Thomson JA, et al. Embryonic stem cell lines derived from human blastocysts, Science, 1998 Nov 6;282(5391):1145-7.

79 Wallace, H.A.C., Marques-Kranc, F., Richardson, M., Luna-Crespo, F., Sharpe, J.A., Hughes, J., Wood, W.G., Higgs, G.R. and Smith, A.J.H. Manipulating the mouse genome to engineer precise functional syntenic replacements with human sequence. Cell (2007) 128: 197-209; Public Health Genetics Unit, www.phgu.org.uk/ecard?link_ID=1427.

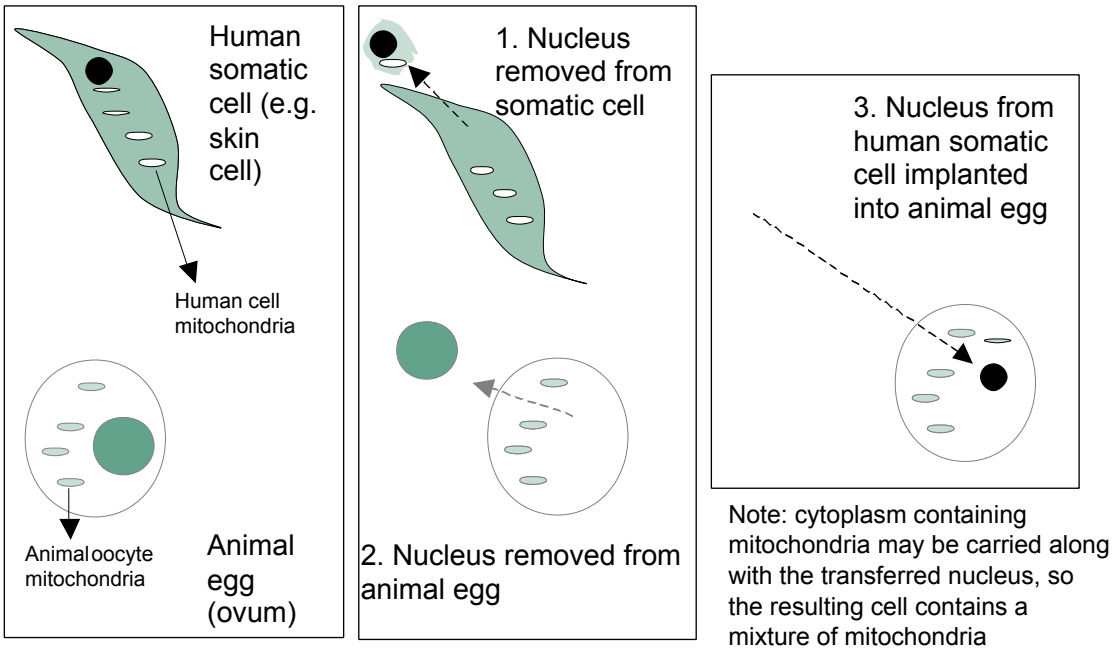

Figure 2: Schematic diagram to illustrate somatic cell transfer of human genetic material into enucleated animal ova.

Are they human?

32. There has been debate over whether human-animal chimera or hybrid embryos, including cytoplasmic hybrid embryos, should be considered 'human'. This is important for the purposes of current regulation, as discussed in the following chapter. However, the question of what it means to be 'human' goes beyond legal definitions to reach some of the ethical and moral objections to this area of research. For example, the Scottish Council on Human Bioethics (SCHB) told us that "in crossing the species barrier, the general understanding of what it means to be a human person would no longer be clear cut".[80]

33. To understand what it means to be 'human' is a complex process since whether or not something is human may be described in a number of ways by different bodies. In scientific terms, how 'human' an entity is could perhaps be described through determination of its percentage of human genetic material. Scientists have shown that humans are 96 per cent similar to chimpanzees,[81] whilst genetic similarity between humans and rabbits, based on gene comparisons, is around 80 per cent.[82] Theological and philosophical arguments may also be used to determine whether or not a creation is 'human'. For example, as we heard from the Rt Revd Lord Harries of Pentregarth during our recent public seminar, questions may be asked regarding whether or not a creation is able to fulfil human attributes such as thinking or feeling. There are clearly many views on what it means to be 'human'. It is right that the Government should take

80 Ev 57

81 "Chimps, Humans 96 Percent the Same, Gene Study Finds", National Geographic News. August 31 2005,http://news.nationalgeographic.com/news/2005/08/0831_050831_chimp_genes.html

82 Local Hypomethylation in Atherosclerosis Found in Rabbit ec-sod Gene. Arteriosclerosis, Thrombosis, and Vascular Biology, http://atvb.ahajournals.org/cgi/content/full/19/9/2171

account of the views of representatives from a range of communities, for example scientists, theologians and philosophers, to help develop a better understanding of what a 'human embryo' represents and to ensure that these views are taken into account when proposing revised legislation in this area.

Ethical and moral points of view

34. Whether or not the creation of human-animal chimera or hybrid embryos in research should be allowed has been the subject of much debate. Ethical and moral views surrounding this research area generally feature either within arguments for and against research using human embryos (for example, in the destruction of human embryos for research) or in arguments for and against the mixing of human and animal material (for example, in the formation of human-animal embryos). In very broad terms, the main arguments for and against the creation of human and human-animal embryos can be divided into three categories: arguments which take into account potential violation of human rights; arguments which centre on the value of the research; and arguments which consider the impact of such research on human dignity.

35. There is an argument that this research cannot be against *human rights* on the assumption that the embryos would not become/are not intended to become human, and hence no human 'rights' could be violated. The argument can also be given that this research should be actively encouraged since such research promotes human rights through the development of treatments and thus enhances human capability. However, once the intention to create a viable embryo is demonstrated, it could be argued that this research is against human rights; for example, if it were ever to be suggested that an embryo should be created and allowed to go to term from a diseased cell line, which would limit the capability of the resultant human.

36. There is an argument that the value of this research depends on its *utility*. Arguments within this school of thought centre on weighing up the potential value of a technology (for example, in this case for the eventual treatment of disease), with the reasons for not doing so. Arguments within this category may also take into account the 'slippery slope': i.e. some may argue that whilst they accept the creation of human-animal chimera or hybrid embryos for their immediate purpose (to produce embryonic stem cell lines), there are concerns at what may follow: perhaps in this case, that allowing scientists to create human-animal chimera or hybrid embryos may eventually result in the birth of such creations.

37. There is also an argument that research of this nature compromises *human dignity*, and it is this argument which has formed the basis for much of the opposition evidence we have received in this inquiry. For example, we heard from the Scottish Council on Human Bioethics (SCHB) that "the creation of certain kinds of human-nonhuman embryonic combinations could seriously undermine the whole concept of human dignity".[83] However, what is meant by the phrase human 'dignity' is vague. Professor Raanon Gillon told us that "the concept of human dignity is a very complex one and

83 Ev 57

people have different accounts of what they mean by it".[84] The SCHB told us that "in this regard, it should be remembered that the concept of human dignity is not a scientific one. No individual will ever be able to prove whether or not a person possesses human dignity".[85] Human Genetics Alert (HGA) is also against the creation of human-animal chimera or hybrid embryos because they feel that "the strong public concern about the unnaturalness of creating human/animal hybrids is valid and must not be ignored",[86] an argument which generally fits into the dignitarian approach.

38. With respect to memoranda received by this inquiry detailing ethical and moral concerns about the creation of human-animal chimera and hybrid embryos for research, we have found that, in some cases, opposition appears to be specific to the mixing of human and animal material, whilst in others, such opposition relates to all research using human embryos. Establishing where there is specific opposition to the creation of human-animal chimera or hybrid embryos for research purposes is important if an accurate assessment is to be made of whether there is significant opposition to this research from those who, like the Government, otherwise support human embryo research. As the Minister, Caroline Flint MP, told us "if you are having a discussion and people are fundamentally opposed to something … any variation is linked to their fundamental opposition" and "there is not much room for debate in that".[87]

39. We have received evidence in which opposition to the mixing of human and animal material appeared to stem directly from general opposition to the use of human embryos in research. For example, the watchdog group, Human Genetics Alert (HGA) opposes "the creation of embryos purely for purposes of research",[88] and Dr Stephen Brennan, Master of the Guild of Catholic Doctors, told us that "human life is sacred and should not be used in this way".[89] In addition, we heard from the public interest group Comment on Reproductive Ethics (CORE) which is opposed to the creation of human-animal chimera or hybrid embryos for research, at least at present, and reiterated its opposition to destructive [human] embryo research.[90] We have also received evidence from the Linacre Centre for Healthcare Ethics which is "opposed to all research involving a lethal attack on a human moral subject, of any age or stage of development".[91]

40. We have also heard from a number of parties who are specifically against the mixing of human and animal genetic material, not all of whom are clearly opposed to research with human embryos, although since this question was not posed in our call for evidence, it is impossible to be sure. Donald Bruce of the Church of Scotland Church and Society Council told us that whilst the Society believes that research "should not be allowed that involves the mixing of animal and human reproductive cells to create an

84 Q 211

85 Ev 58

86 Ev 132

87 Q 298

88 Ev 132

89 Ev 62

90 Ev 97

91 Ev 119

embryo-like entity", this does not "spring from a rejection of all research on the human embryo".[92] The Church of England takes a similar view.[93]

41. Defining views clearly in an area such as this is essential. To date the most extensive study of public opinion in this area stems from the Government's 2005 public consultation on review of the HFE Act. In order to ascertain whether there was strength of opinion specifically against the creation of human-animal chimera or hybrid embryos, we asked the Minister for a breakdown of the responses. We were told that of the 336 responses that specifically addressed the question of whether or not the creation of human-animal chimera or hybrid embryos should be allowed, 277 were opposed. It is worth noting that included in the 59 other responses, most of which were in support of research using hybrid and chimera embryos, were responses that represented the collective views of multiple membership organisations. The Minister went on to explain that the consultation document did not seek views on embryo research *per se*, as "the Government had made clear its intention not to propose changes to the fundamental aspects of the current law, including the permissibility of embryo research". However, 227 of the respondents opposed to hybrids and chimeras also stated opposition to human embryo research, or such opposition may reasonably be inferred.[94] **We regret that the Department of Health did not seek to specify more clearly in its consultation what views it was seeking, nor to evaluate fully the responses of the public consultation exercise. We recommend that in future a more systematic statistical or scientific approach is developed to quantify and qualify the results of public consultation.**

42. We take the ethical and moral concerns with respect to work of this nature very seriously and we are in full agreement with Dr David Jones and colleagues of St Mary's University College London who told us that "in a democratic society, ethical and moral arguments both secular and religious should be considered".[95] Indeed, we fundamentally believe that such views have an important role in the debate regarding whether or not the creation of human-animal chimera or hybrid embryos should be allowed for research in the UK and that they must be taken into full account when drafting legislation, particularly in areas of research such as this. **We recognise the sincere ethical and moral concerns associated with research of this nature and are therefore concerned that, to respond to these concerns, any regulatory framework associated with use of human-animal chimera or hybrid embryos in research should be transparent and workable.**

43. We have, however, been concerned to note that, in certain cases, the serious ethical and moral objections to work of this nature have been clouded through the raising of what appear at first sight to be scientific arguments to support such opposition but which do not stand up to scrutiny. Some of the opposition in responses which we received was based on hostility to science as against Nature. In addition, some throwaway statements concerning the scientific basis for proposed areas of research not only lack supporting evidence but may perhaps be better termed 'pseudo-science'. **We**

92 Ev 141

93 Q 154

94 Ev 168

95 Ev 50

are of the opinion that ethical and moral concerns should be considered within the context in which they are made, and that inappropriate use of science to justify ethical and moral arguments is unhelpful. Inappropriate use of science should be identified and disregarded by Government and other policy-makers.

44. In this context, we draw attention to the recommendation of the previous Science and Technology Select Committee that there is a need for a new Parliamentary standing Committee on Bioethics. This Committee would "undertake annual scrutiny of the Regulatory Agency for Fertility and Tissues, make recommendations on the need to amend or introduce new legislation and scrutinise draft legislation brought before Parliament within its remit".[96] **In line with the recommendation of the previous Science and Technology Committee, we recommend the creation of a new Parliamentary standing Committee on Bioethics.**

96 HC (2004-05) 7, para 399

Is it necessary to use hybrid and chimera embryos in research?

Use of human embryos

45. Under the HFE Act, the HFEA may only grant licences where the activity authorised by the licence is necessary *or* desirable for the purposes detailed in paragraph 13 above, including that such research is aimed at increasing knowledge about the development of embryos; increasing knowledge about serious disease or that the research will enable any such knowledge to be applied in developing treatment for serious disease.[97] In addition, the HFEA will not grant a licence using a human embryo unless it is fully satisfied that the use of human embryos is necessary for the purposes of the research.[98]

Progress in stem cell research

46. As previously discussed (paragraph 12), the HFE Act allows for the production of stem cells through therapeutic cloning using available human oocytes (eggs).[99] The recently submitted licence applications, from King's College London and Newcastle University, also request permission from the HFEA to derive stem cells from human-animal cytoplasmic hybrid embryos. The researchers want to use this methodology to enable them to produce lines of stem cells which are specific to patients with genetic diseases and to learn about how cells can be reprogrammed to become different cell types.[100] Production of stem cell lines through this method involves taking a somatic cell (e.g. a skin cell) from an affected patient and transferring its genetic material into an animal egg which has previously had its own genetic material removed, that is a cytoplasmic hybrid embryo, created by somatic cell nuclear transfer as described by Figure 2.[101] The newly created hybrid embryo is then allowed to develop until the blastocyst stage at which point embryonic stem cells can be removed.

47. The stem cells may have several purposes. In the first instance, it is hoped by many that production of stem cells from cytoplasmic hybrid embryos may contribute toward the development of treatments of diseases studied. For example, the Cystic Fibrosis Trust recognised "the important potential benefit to human health from being able to grow stem cells with specific genetic abnormalities, such as Cystic Fibrosis, improving the efficiency of therapeutic cloning techniques and establishing cell lines for the testing of new treatment".[102] Cancer Research UK highlighted that "future stem cell research could also uncover ways of improving outcomes after treatment for cancer, potentially providing us with the ability to regenerate or replace normal tissue following surgical removal of cancerous tissue, or its destruction by chemotherapy or radiotherapy".[103] The

97 The HFE Act was amended in 2001 through the Human Fertilisation and Embryology (Research Purposes) Regulations 2001 (SI 2001/188).

98 HFEA code of practice, http://www.hfea.gov.uk/cps/rde/xbcr/SID-3F57D79B-7D1AC70F/hfea/Code_of_Practice_Sixth_Edition_-_final.pdf

99 The HFEA has awarded two licences for such work, as indicated by the HFEA website at:http://www.hfea.gov.uk/cps/rde/xchg/SID-3F57D79B-76554CE3/hfea/hs.xsl/377.html

100 Q 2

101 Ev 76; Ev 128

102 Ev 51

103 Ev 102

Multiple Sclerosis and Alzheimer's Societies also argued that such technologies show "great potential as laboratory tools to explore early processes that lead to neurological conditions".[104]

48. Secondly, stem cells produced through somatic cell nuclear transfer may also be useful in drug discovery and are a potential replacement for animal use, for example in some toxicity testing. Recommendation 1 of the UK Stem Cell Initiative, set up by the Government, identified disease-specific stem cell lines as an important contribution to drug discovery and as potential alternatives to animal testing.[105] The Muscular Dystrophy Campaign has told us that "stem cells could be used as a source of pure populations of human cells to be used in drug testing". The Campaign argued that "the use of animals for the toxicity testing of new drugs does not always highlight potential problems so using these populations of cells, high throughput drug screens could be designed to screen drug effects in specific human cell types especially those that may be vulnerable to toxicity or those that form the drug's target tissue".[106] The Institute of Biology also considered that stem cells produced through somatic cell nuclear transfer "should reduce the need for research on live animals as models for certain diseases".[107]

49. Additional reasons for the creation of cytoplasmic hybrid embryos include increasing knowledge about cell reprogramming. Whilst each cell contains all of the genetic material needed to build a completely new organism, different cells express only the genes necessary for the function required within the tissue or organ in which they are based.[108] If stem cells are to be of use as treatments of disease, increased knowledge about how these cells are directed into different cell types, and how they might be 'reprogrammed' is desirable. Dr Lyle Armstrong of Newcastle University told us that if we can understand how the reprogramming process occurs in cytoplasmic hybrid embryos, "we might be able to reproduce it" and that "the possible implications of such understanding are great indeed".[109]

Animal eggs as a replacement for human eggs

50. Use of human eggs for research into stem cells is legal under licence from the HFEA. However, such research practice requires large numbers of human eggs, availability of which is limited.[110] Use of human eggs for research has also raised concerns about whether it is appropriate to encourage women to undergo an invasive and potentially harmful procedure, such as is required for the collection of eggs, without any direct medical benefit to the donor.[111] It has therefore been argued, for example by the Cystic Fibrosis Foundation, that by allowing insertion of animal eggs with human genetic

104 Ev 61

105 UK Stem Cell Initiative, Report and Recommendations, November 2005, http://www.advisorybodies.doh.gov.uk/uksci/uksci-reportnov05.pdf, recommendation 1 and paragraph 2.3

106 Ev 72

107 Ev 63

108 Ev 78

109 Ev 80

110 Ev 105, 101

111 Ev 130

material, researchers could potentially increase the number of stem cell lines available for research,[112] far in excess of those which would be available from human eggs alone.

51. An extremely large number of eggs is also claimed as essential for the development of the practical techniques which will be necessary for the eventual production of embryonic stem cell-based therapies from human embryos and eggs (through therapeutic cloning). Currently, the efficiency of production of embryonic stem cells through somatic cell nuclear transfer is low. Dr Lyle Armstrong of Newcastle University told us that "we would need in excess of 30 oocytes [eggs] to have a reasonable chance of producing an ESC [embryonic stem cell] line for each patient".[113] We also heard from Dr Stephen Minger at King's College London that "until the efficiency of successful SCNT [somatic cell nuclear transfer] in humans can be increased significantly (to perhaps 10-20%) alternative sources of oocytes specifically for SCNT are needed".[114] It has therefore been suggested, for example by the BioIndustry Association (BIA), that use of animal eggs should be allowed to enable researchers to develop the techniques required for the production of stem cells.[115]

Potential problems with this research

Mixing animal and human material

52. We have received submissions which suggest a number of risks potentially associated with work involving the mixing of human and animal material. The Scottish Council on Human Bioethics (SCHB) believes that by undertaking such work, scientists risk creating new diseases. They told us that it is "well known that many animals may harbour in their organs, cells and genome, microbiological and other entities which may cross the species barrier and develop in the host",[116] for example, Creutzfeldt-Jakob disease. This view is supported by Christian Action Research and Education (CARE) who wrote of the "real risk of disease transmission from viruses crossing the species barrier and developing in the host".[117]

53. The SCHB has also claimed that human-animal chimera or hybrid embryos may be subject to a greater number of developmental problems,[118] presumably limiting their effectiveness as models in research. A similar view was expressed by Peter McCullagh, an Australian expert, who believes that data produced from human-animal chimera or hybrid embryos will be of little use. Mr McCullagh explained that, given the complete lack of knowledge of how the development and function of the human/animal entity will resemble that of either contributing species, "the experimental data will predictably

112 Ev 51

113 Ev 79

114 Ev 130

115 Ev 108

116 Ev 58

117 Ev 82

118 Ev 58

be quite uninterpretable" and that "the potential of an experiment, in any discipline, to add to the sum of knowledge is only as good as its capacity for interpretation".[119]

54. We recognise the scientific concerns associated with research of this nature. **In the event that research using cytoplasmic hybrid embryos is authorised, we urge the Government to ensure that appropriate risk management procedures are established and implemented**. Such procedures should complement those already in existence for working with human and animal material. In addition, we recognise concerns that data from human-animal chimera or hybrid embryos may be uninterpretable or of limited use. However, without the production of such data in the first instance, we find it difficult to comprehend how such claims can be realised. We recognise that issues such as data viability and interpretation would be considered during scientific peer review of any applications for research in areas such as this.

Specific problems potentially associated with cytoplasmic hybrid embryos

55. Whilst, as discussed previously, it is claimed that the creation of cytoplasmic hybrid embryos using animal oocytes is necessary, for example, for stem cell research, there is limited experience that this methodology will work. A team led by Professor Hui Z Sheng in China has successfully derived embryonic stem cells by the transfer of human somatic nuclei into rabbit oocytes. Further work was then carried out to show that the derived embryonic stem cells were human, for example based on studies to determine karyotype (the chromosomal characteristics of a cell), and that they have the ability to differentiate into different cell types.[120] There has been some disagreement over this work. Although Professor Sheng's team announced that it was generating stem cells by transferring nuclei from human skin into rabbit eggs (somatic cell nuclear transfer into enucleated rabbit ova) in 2001, the research was not published until 2003, when Cell Research, a peer-reviewed journal accepted it. That it took such a long time to publish the work is believed to result from a lack of conviction in the scientific community that the research had been successful. Scientists reported as concerned about Professor Sheng's work include Doug Melton, a cell biologist at Harvard University who, although believing that cells were produced, has said that "it would be very surprising if the cell lines were stable".[121] Rudolf Jaenisch, of the Whitehead Institute in Cambridge, Massachusetts, was also not convinced that the derived cells meet the usual criteria for embryonic stem cells. He has said that "an important criterion is indefinite growth", and that "this is not shown".[122] However, it should be noted that all the scientists to whom the Committee has spoken during this inquiry were fully supportive of Professor Sheng's work.

56. Other scientific objections to the somatic cell nuclear transfer of human genetic material into enucleated animal ova for creation of human-animal cytoplasmic hybrid

119 Ev 65

120 As detailed by: Embryonic stem cells generated by nuclear transfer of human somatic nuclei into rabbit oocytes (Cell Research, 2003 Aug;13(4):251-63).

121 "Chinese fusion method promises fresh route to human stem cells", Nature, 424, 711, 14 August 2003,http://www.nature.com/nature/journal/v424/n6950/full/424711a.html

122 Ibid

embryos came from Human Genetics Alert (HGA), which believes that the proposed experiments are of "little scientific value" since there is limited likelihood that embryonic stem cells will be obtained.[123] Furthermore, HGA is of the opinion that embryonic stem cell lines derived from human-animal chimera or hybrid embryos will be abnormal since "it is almost certain that they will contain subtle abnormalities in gene expression which will invalidate any experimental results obtained with them".[124] Professor Lorraine Young of Nottingham University also argued against the usefulness of the creation of cytoplasmic hybrid embryos, since her research has demonstrated that the DNA of eggs and sperm restructures after fertilisation of the egg and that some of the same restructuring applies to somatic cells after somatic cell nuclear transfer, and that "considerable species differences exist in this process".[125]

Mitochondria and mixed mitochondrial DNA

57. During this inquiry we also received evidence to suggest the effects of mitochondrial DNA on embryonic stem cells produced from cytoplasmic hybrid embryos. Animal eggs, as with all eukaryotic cells (which contain a nucleus and other membrane-bound organelles), have populations of mitochondria. Mitochondria produce the energy required to drive cellular processes and possess their own small genome which is known as mitochondrial DNA (mtDNA). In reference to the essential role of mitochondria in energy production, it is logical that mitochondrial defects can have serious implications, as is demonstrated by mitochondrial-based diseases, such as Lebers hereditary optic atrophy which causes degeneration of the optic nerves and retina.[126] According to Dr Justin St John from Birmingham University, "nuclear transfer can result in mixed populations of mtDNA being present in embryos".[127] Christian Action Research and Education (CARE) pointed out that "it is not fully understood" what effect this may have on cytoplasmic hybrid embryos.[128] However, rather than deem this a reason not to conduct such research, Dr St. John believes that the creation of human-animal chimera or hybrid embryos may actually "offer us the opportunity to elucidate some of the causes of mitochondrial DNA disease" and that "not to allow this work to go ahead would considerably disadvantage experimental work in these fields".[129] **Research, by its very nature, is aimed at enhancing knowledge. Whilst we recognise scientific debate about the potential usefulness of cytoplasmic hybrid embryos in research, we do not believe that the existence of differing views of whether a methodology is workable before it has been sufficiently tested is reason enough to prohibit such research from taking place.**

123 Ev 132–33

124 Ibid

125 Ev 152

126 As described by Leber Hereditary Optic Neuropathy, available from the On-line Mendelian Inheritance in Man (OMIM) web site on the National Center for Biotechnology Information, http://www.ncbi.nlm.nih.gov/entrez/dispomim.cgi?id=535000LHON

127 Ev 129

128 Ev 81

129 Ev 129

Scientific opposition to research involving hybrid and chimera embryos

58. In order to determine whether there may be additional scientific problems associated with research of this nature, we were keen to hear opposition to the creation of human-animal chimera or hybrid embryos from scientists and experts in either stem cell research or embryology. We received no such views in response to our initial call for evidence. The Minister in her letter to *The Observer* of 21 January 2007, referred to the lack of "a firm consensus within the scientific community about precisely which human-animal creations should be allowed, any immediate imperative for doing so, or the availability and interpretation of supporting evidence",[130] and the HFEA made a similar reference in announcing its consultation.[131] To track down evidence of this lack of consensus, we contacted experts who had not already contributed to this inquiry and who attended a meeting at the HFEA in November 2006 to discuss this area, to ask them if they believed that current Government proposals to prohibit the creation of human-animal chimera or hybrid embryos for research were appropriate. While there was clearly debate about the likelihood of the method working or producing useful results, support for the Government proposals was extremely limited, and many of those responses focused specifically on the creation of cytoplasmic hybrid embryos. **We recognise the scientific debate among experts about the potential usefulness of the research under discussion in this Report but we conclude that the scientific community as a whole is supportive of the work being licensable, even where there may be doubts about its likely success.**

Conclusions on the desirability and necessity of hybrid and chimera embryo research

59. The strength of support for production of stem cells via this methodology has convinced us that this technique is both necessary and desirable as detailed by current HFEA conditions for use of human embryos in research.[132] **We believe that the creation of human-animal chimera or hybrid embryos, and specifically cytoplasmic hybrid embryos, is necessary, for example in the pursuit of knowledge about the genetic basis of disease and the direction of stem cells into future cell-based therapy. Furthermore, we recognise that stem cells produced through this methodology may be useful in drug discovery and that they may lead to the eventual reduction of animal use, for example in toxicity testing.**

60. We are convinced of the need to use animal eggs in the creation of cytoplasmic hybrid embryos for the derivation of stem cells. **We believe that use of animal eggs in the creation of cytoplasmic hybrid embryos will help to overcome the current shortage of human eggs available for research and that use of animal eggs is required to enable**

130 "The door is still open for research", Caroline Flint, Letters, The Observer, 21 January 2007

131 HFEA press statement regarding Human-Animal Hybrid Research, 11 January 2007, http://www.hfea.gov.uk/en/1478.html

132 As detailed in the HFE Act 1990 and the HFEA code of practice, www.hfea.gov.uk/cps/rde/xbcr/SID-3F57D79B-7D1AC70F/hfea/Code_of_Practice_Sixth_Edition_-_final.pdf

researchers to develop the practical techniques which may be required for eventual production of cell-based therapy through this method using human eggs.

4 The HFEA and the current regulatory framework

Current applications to the HFEA

61. On 7 November 2006 the HFEA received two separate applications for licences to allow researchers from King's College London and Newcastle University to transfer human genetic material from human somatic cells into animal ova (eggs) from which the main source of genetic material had been previously removed.[133] Within this Report, we refer to such creations as 'cytoplasmic hybrid embryos'. In this chapter we focus on whether or not these research proposals should be assessed for licensing by the HFEA and whether HFEA has acted appropriately in its management of these applications in respect of its current role and remit. The timetable for the steps taken by the HFEA in relation to these applications is set out below for ease of reference.

Table 3: Timescale of events with respect to when and whom HFEA consulted in its decision-making process regarding whether or not the creation of human-animal chimera or hybrid embryos, and specifically cytoplasmic hybrid embryos, falls within its remit.

Date	Action	Conclusions and notes
November 2005	HFEA responds to Government consultation on the HFE Act	The HFEA states that creation of human-animal chimera and hybrid embryos for research purposes should be permitted[134]
Early 2006	Scientists state that they may wish to create cytoplasmic hybrid embryos[135]	
26 April 2006	HFEA Scientific and Clinical Advances Group (SCAG) asked to consider whether cytoplasmic hybrid embryos would fall within HFEA remit	SCAG forms the general opinion that cytoplasmic hybrid embryos should be classified as human embryos[136]
17 May 2006	HFEA Ethics and Law Committee (ELC) asked to consider whether cytoplasmic hybrid embryos would fall within HFEA remit	ELC agrees that embryo containing human nuclear DNA and mitochondria of animal origin should be regarded as an 'embryo' for the purposes of the 1990 Act[137]
6 July 2006	HFEA receives legal opinion on whether cytoplasmic hybrid	The legal opinions provided by HFEA are confidential but

133 Ev 127

134 HFEA response to Department of Health consultation on the Review of the Human Fertilisation and Embryology Act, http://www.hfea.gov.uk/docs/ReviewoftheActResponse.pdf

135 "Stem cell experts seek rabbit-human embryo", 13 Jan 2006, The Guardian,www.guardian.co.uk/science/story/0,3605,1685534,00.html

136 Ev 127

137 Ev 127

Date	Action	Conclusions and notes
	embryos should be regarded as 'human' for the purposes of the HFE Act and whether such creations would be prohibited or licensable under the Act	summarised within the evidence published alongside this report[138]
7 November 2006	HFEA receives applications from researchers at King's College London and Newcastle University for licences to create cytoplasmic hybrid embryos for research purposes	
30 November 2006	HFEA Horizon Scanning Expert Panel sought for advice on whether cytoplasmic hybrid embryos would fall within HFEA remit	Those who responded agreed that this type of hybrid embryo would contain a complete human genome[139]
5 January 2007	HFEA receives revisited legal opinion on whether cytoplasmic hybrid embryos should be regarded as 'human' for the purposes of the HFE Act and whether such creations would be prohibited or licensable under the Act	The legal opinions provided by HFEA are confidential but summarised within the evidence published alongside this report[140]
10 January 2007	Summary of advice and opinions presented to Authority	
11 January 2007	HFEA releases statement indicating that the creation of cytoplasmic hybrid embryos potentially falls within its remit to regulate and licence	

The role of the HFEA in regulating research

62. The HFEA is responsible for licensing research within the scope of the HFE Act and, if it is accepted that an application for research falls within HFEA remit, such an application must go to the HFEA Licence Committee for consideration. The HFEA has faced difficulties in the regulation of research, and the interpretation of the HFE Act has been at the centre of a number of legal challenges in recent years.[141] Cases against the HFEA include that brought by Bruno Quintavalle, a campaigner for the Pro-life Alliance, where it was argued that organisms created by cell nuclear replacement did not fall within the definition of 'embryo' in the HFE Act.[142] The Quintavalle challenge was successful in the High Court but failed on appeal before both the Court of Appeal and

138 Ev 158

139 Ev 127

140 Ev 158

141 HC (2004-05) 7, www.publications.parliament.uk/pa/cm200405/cmselect/cmsctech/7/7i.pdf

142 R v Secretary of State for Health, ex parte Bruno Quintavalle (on behalf of Pro-Life Alliance) [2001]

the House of Lords. According to the Law Lords, the HFEA has regulatory jurisdiction over human embryos, irrespective of whether such embryos are produced by fertilisation or by a process involving cell nuclear transfer. This ruling, though, does not explicitly settle the question of whether a human-animal chimera or a hybrid embryo would fall within the HFEA remit. Reflecting the lack of legal certainty on this particular matter, the HFEA has stated that it considers the law in this area to be "far from explicit".[143]

Do these applications fall within HFEA remit?

63. The HFE Act makes provision for the creation, storage and use of human embryos. Under the HFE Act, provisions are limited to the use of exclusively human embryos, with a single exception for the hamster test. Whether or not the creation of cytoplasmic hybrid embryos falls under the HFE Act has been questioned since when the HFE Act was approved, the requirement for human-animal chimera or hybrid embryos in research had not been anticipated.[144] Mr Mark Bale from the Department of Health told us, in specific relation to the creation of cytoplasmic hybrid embryos, that "this certainly was not a technique that was envisaged when the White Paper that preceded the Act was put together".[145] We also heard from Caroline Flint MP, the Minister of State for Public Health, that the Act could not determine whether or not use of human-animal chimera or hybrid embryos should be allowed in research because "it was not something that was part of that discussion".[146] Consequently, the HFEA has consistently called for Parliament to decide on this issue, starting in July 2002 when the then Chief Executive of the HFEA, Maureen Dalziel said that "new, clearer legislation is desperately needed that takes into account the massive scientific advances that have taken place since the last Act was drafted and is less open to misinterpretation".[147] More recently, in response to the Department of Health 2005 consultation on the review of the HFE Act, the Authority recommended that "hybrids and chimeras are defined in the new Act".[148]

64. Whilst accepting that the HFE Act is not clear in this area, the HFEA has recognised the "very clear responsibility" it has in acting under current law and that, should a decision be reached that these applications fall within its regulatory remit, they must be assessed accordingly.[149] It is important to recognise that the HFEA was created to take difficult decisions in areas where the precise meaning of the law was unclear and, as the Minister explained, "the regulator has been given certain powers to make judgments outside of what the legislation provides for within the spirit of the legislation".[150] Past experience indicates a greater willingness on the part of the HFEA to fulfil this role than

143 HFEA Press statement Regarding Human-Animal Hybrid Research, 11 January 2007, http://www.hfea.gov.uk/cps/rde/xchg/SID-3F57D79B-5B6A0790/hfea/hs.xsl/1478.html

144 Not published

145 Q 302

146 Q 303

147 Ev 160

148 Ibid

149 Q 99

150 Q 305

it perhaps displayed on this occasion. For example, the BioIndustry Association argued that:

> in the HFEA, the UK has a world class regulator in this area. The HFEA has shown genuine leadership on the challenges it has faced. Now, in the face of this challenge, we need the HFEA to lead and to ensure there is a robust regulatory system that inspires public confidence and is supportive of groundbreaking medical research. [151]

We agree with HFEA that the wider issue of whether human-animal chimera or hybrid embryos should be allowed for research should be decided by Parliament. However, it is the role of HFEA to make judgements in areas considered within the spirit of the HFE Act where its legal advice indicates that it is reasonable to do so. Not to do so undermines the effectiveness of an independent regulator.

65. For the HFEA to determine whether applications for the creation of cytoplasmic hybrid embryos should be put forward for licence consideration, a "key question" for the Authority was whether hybrid embryos fall within its jurisdiction under the 1990 Act. The HFEA stated that:

> as it is the nature of the embryo, and not the process by which it is created, that is critical to the question of whether it falls within the scope of the Act, it was important to understand whether hybrid embryos could properly be categorised as "live human embryos".[152]

The current legal basis for definition of an embryo derives from the HFE Act which states that 'embryo' means "a live human embryo where fertilisation is complete and references to an embryo include an egg in the process of fertilisation".[153] With respect to whether or not cytoplasmic hybrid embryos should be regarded as "human embryos", we were told in written evidence by HFEA that:

> if there was scientific agreement that a hybrid embryo contained a full human genome, a reasonable interpretation of the Act would be that such embryos should be treated as live human embryos unless it could be clearly proved that the embryo could never be viable.[154]

We discuss below the two aspects of (a) whether or not cytoplasmic hybrid embryos contain a full human genome and (b) the appropriateness of using viability as a criterion to determine fit within HFEA remit.

Do cytoplasmic hybrid embryos contain a full human genome?

66. Alerted to expected applications for the creation of human-animal chimera or hybrid embryos, in April and May 2006 the HFEA requested that its Scientific and Clinical Advances Group (SCAG) and Ethics and Law Committee (ELC) consider

151 Ev 108

152 Ev 127

153 Section 1 of the HFE Act 1990 . Meaning of "embryo", "gamete" and associated expressions, www.opsi.gov.uk/acts/acts1990/Ukpga_19900037_en_1.htm

154 Ev 127

whether or not cytoplasmic hybrid embryos could be deemed 'human', suggesting that "anything which has a complete human genome should be classed as human".[155]

67. Since cytoplasmic hybrid embryos consist of primarily human genetic material from the nucleus of a human somatic cell, many experts consider such creations to contain a 'full human genome'. For example, in evidence submitted to this inquiry we have heard from the Biosciences Federation (BSF), representing experts in the biological sciences, that "the only nuclear DNA [in a cytoplasmic hybrid embryo] would be derived from the inserted human nuclei" and thus "all cells in the developing embryo would have the same human DNA".[156] However, we have also received evidence to suggest that there would not only be nuclear DNA present but also mitochondrial DNA, as discussed previously in paragraph 57. When questioned about the potential impact of mitochondrial DNA on cytoplasmic hybrid embryos, Dr Lyle Armstrong of Newcastle University argued that:

> there is DNA from the mitochondria from the animal oocyte, but really that has very little contribution to the actual information content of the final cell. It would not instruct the embryo on how to produce an embryonic stem cell or how to make the distinction between the different types of cell you would find at the blastocyst stage embryo.[157]

Professor Austin Smith of Cambridge University agreed, saying that "you have only a small component, which is the mitochondrial component".[158]

68. The HFEA's Scientific and Clinical Advances Group, which also considered the potential impact of mitochondrial DNA on cytoplasmic hybrid embryos, offered the general opinion that "this type of hybrid embryo should be classed as human".[159] The Authority's Ethics and Law Committee "agreed that an embryo containing human nuclear DNA and mitochondria of animal origin should be regarded as an 'embryo' for the purposes of the 1990 Act".[160] A third source consulted, experts at the HFEA horizon scanning meeting on 30 November 2006, reached a similar conclusion.[161] Angela McNab, Chief Executive of HFEA, summarised the evidence before the Authority on this issue by stating that "there was, from those scientists we consulted, a view that the entity or the embryo that would be produced would be likely to have the full human genome within it".[162] This decision that cytoplasmic hybrid embryos can be classed as 'human embryos' would bring them within the jurisdiction of the HFE Act. **We support the decisions of the HFEA Science and Clinical Advances Group, Ethics and Law Committee and Horizon Scanning Group that an embryo containing human nuclear**

155 Ev 127

156 Ev 54

157 Q 6

158 Q 7

159 Ev 127

160 Ibid

161 Ibid

162 Q 83

DNA and mitochondria of animal origin should be regarded as a human embryo for the purposes of the 1990 Act.

Embryo viability

69. However, the HFEA considered also a second facet of whether the hybrid embryos would be *live* human embryos with the condition that under the Act "embryos should be treated as live human embryos unless it could be clearly proved that the embryo could never be viable".[163] Angela McNab, Chief Executive of HFEA, told us that viability "is the second test in order for it to be within our scope".[164] The HFEA intends to include viability within its consultation on research in this area, discussed below.[165] This introduces greater uncertainty into the application of the Act to these embryos since it is not clear that cytoplasmic hybrid embryos are viable.[166] The HFEA told us that they "were unable to obtain a clear idea from scientists on this: there was not a consensus, from those experts we consulted, about the viability, whether or not it would be able potentially to implant and be viable".[167]

70. The reliance on viability, or the 'normal' potential to develop, of cytoplasmic hybrid embryos to determine whether such creations fall within their jurisdiction for regulation of research does not derive directly from the HFE Act but results from later attempts to define further what is meant by a 'live human embryo'. The scope of what is meant by the term 'human embryo' was discussed within the judgement of the House of Lords in the "Quintavalle case", which examined whether live human embryos created by cell nuclear replacement (CNR) fall outside the regulatory scope of the Human Fertilisation and Embryology Act 1990 and whether licensing the creation of such embryos is prohibited by the Act.[168] During this case, one of the Law Lords (Lord Millett) attempted to define further what is meant by the term 'human embryo', stating that "in the case of a human embryo, it is a live human organism containing within its cell or cells a full set of 46 chromosomes with the normal potential to develop and, if planted in a woman, to become a foetus and eventually a human being".[169] The HFEA appeared to rely on this sentence in interpreting its legal advice regarding a test of viability. However, that sentence is ambiguous as to whether implantation is a necessary component of the test of viability.

71. That scientists are unable to determine whether or not cytoplasmic hybrid embryos would be 'viable' can come as no surprise since it is surely impossible to determine whether or not an embryo is viable without first implanting it in a woman to determine whether it will develop. Since implantation of embryos created in this way is illegal,

163 Ev 127

164 Q 83

165 Ev 128

166 Q 84

167 Q 83

168 R v Secretary of State for Health (Respondent) ex parte Quintavalle (on behalf of Pro-Life Alliance) (Appellant), [2003] UKHL 13, http://www.publications.parliament.uk/pa/ld200203/ldjudgmt/jd030313/quinta-1.htm

169 R v Secretary of State for Health (Respondent) ex parte Quintavalle (on behalf of Pro-Life Alliance) (Appellant), [2003] UKHL 13, http://www.publications.parliament.uk/pa/ld200203/ldjudgmt/jd030313/quinta-1.htm, Paragraph 43.

embryo viability is impossible to prove categorically and as such, this is a circular argument. In addition, we were interested to note recent scientific studies relating to the creation of blastocysts which have been genetically altered to inhibit implantation.[170] If the HFEA is to take viability as an indicator to determine whether something should be classified as a 'human embryo', then it would be interesting to establish whether embryos inactivated in this way would fall under regulation. **We understand that some form of viability test will have been subject to the legal advice sought by the HFEA on this issue. Nevertheless, we have grave scientific concerns about its validity. We do not believe that it is appropriate to use viability as a mechanism for determining whether or not a creation is human, particularly since attempts to prove viability through implantation in a uterus would be unlawful. Furthermore, were the viability test to be failed, this would mean that such research would be completely unregulated, which case law has found to be unsatisfactory.**

The HFEA decision of 10 January 2007

72. Having taken advice from its Committees and others on cytoplasmic hybrid embryos, the HFEA concluded on 10 January 2007 that "in the light of current scientific opinion, it believes it is probable that hybrid embryos are within its scope".[171] **We support the decision of the HFEA that these sorts of research would probably fall with the remit of the HFEA to regulate and license and would not be prohibited by current legislation. Although we have received submissions from those who do not believe that this is the case, the weight of scientific and legal argument is in favour of treating these embryos as human. We accept that this decision might leave the HFEA open to legal challenge that it was acting *ultra vires* in considering the applications. However, given the accepted desirability for legal clarification in this area, we view legal challenge as highly likely but also potentially helpful in establishing the limits of the HFEA's remit.**

73. The second stage in the HFEA's decision of 10 January was less courageous. Since HFEA had reached agreement that the creation of cytoplasmic hybrid embryos falls within its remit, the Authority was obliged to put the applications received forward for licence consideration and indeed, Angela McNab, Chief Executive of the HFEA, accepted that the Authority has "a responsibility to respond and deal with applications that come to us, and so we must do that".[172] However, rather than take this line of action, the Authority made the decision to "to delay reaching a policy position and consideration by licence committee pending a full public consultation".[173]

74. It appears that the HFEA may have made the decision to delay assessment until public consultation had been held in an attempt to forestall giving rise to grounds for a legal challenge. Angela McNab told us that "if we make a decision based on shaky ground, then we would be open to challenge and we would not want to do that".[174] Ms

170 "Politically Correct Human Embryonic Stem Cells?" Davor Saltor. A Perspective article, New England Journal of Medicine. N Eng J Med 353:22 December 1 2005.

171 Minutes of HFEA Authority meeting, 10 January 2007, para 8.36

172 Q 91

173 Ev 127

174 Q 81

Harrison added that the decision to delay assessment until such time when public consultation had been held was "really to do with being fair to everybody".[175] Ms Harrison explained that:

> part of our legal advice was, in order to make a decision which fairly gave everybody the opportunity, both proponents and opponents of something which is after all extremely novel and where there has been quite a lot of misinformation, and so on, in the media [that] it was important to air those issues and give everyone the opportunity, in a fair and transparent way, to input into the evidence.[176]

Indeed, it can be seen from the publicly available summary that the legal advice given to HFEA indicated that "one of the classic grounds for a Judicial Review would be when a public body makes a decision by an unfair process".[177]

75. There also seems to have been an element of doubt within the HFEA about its own decision on its remit. Ms Harrison, the Chair of HFEA, told us that "part of the consultation we are trying to establish is does what is being proposed fall within our remit".[178] We do not believe that a public consultation will in any way clarify the legal questions regarding the HFEA's remit. However, we recognise that, having received legal advice that a public consultation process was necessary, it would have been irresponsible of the HFEA as a public body to discount it. **It would have aided transparency and public and parliamentary debate on this subject if the HFEA's legal advice had been published.**

76. There is a second purpose of the public consultation with which we have more sympathy. The Authority had decided to use this consultation to develop a broader policy in this area. Ms Harrison told us that "we do have two specific licence applications in front of us but we want to have our policy to be able to cover possible future applications that may come to us. We want to have some broad guidelines".[179] We were, however, surprised that HFEA waited until it was in receipt of the research applications from King's College London and Newcastle University for licences to allow the creation of cytoplasmic hybrid embryos to initiate this exercise. When questioned on why the HFEA waited to hold consultation in this area, rather than do so early in 2006 when suggestions that this area of research may become required were first made,[180] Angela McNab told us that "in an ideal world" horizon scanning would show a variety of areas where future applications might be expected and that "one would be developing a well formulated, well evidenced policy in advance of that happening".[181] However, Ms McNab continued, "our resources are limited and we have to make a judgment call about which of those horizon scanning issues we are going to be able to

175 Q 93

176 Ibid

177 Minutes of the HFEA Authority meeting held 10 January 2007,www.hfea.gov.uk/cps/rde/xbcr/SID-3F57D79B-81AC88E5/hfea/2007-02-21_Authority_Minutes__10_01_07__Non-Confidential_353(1).pdf

178 Q 79

179 Q 80

180 Ev 127

181 Q 92

pursue, in terms of opening the full policy, and at what stage".[182] Given the near certainty of the applications and the predictable reaction to them from opponents of embryo research, we find this attitude short-sighted. **We view public consultation in this area as valuable. However, we are of the opinion that this exercise should have been undertaken when the HFEA first received information to indicate that applications for licensing the creation of human-animal chimera or hybrid embryos could be expected.**

Delay in assessment of the applications

77. It is clear that the delay to science caused by the HFEA decision to delay assessment may have a detrimental impact. Professor Shaw of King's College London told us "we cannot start" and "this is a really important area". He added that "if we cannot work in the field and do not have access to human eggs, I cannot see how we can go forward".[183] We also heard from Dr Armstrong of Newcastle University, who supported these claims and stated that "we cannot [currently] answer all of the questions which we would like to ask in an animal model".[184] We deprecate the delay in considering the applications. We note the HFEA's assurances that the applications will be considered in September at the end of the consultation. However, we also note that Ms Harrison told us "we are going to make a decision based on the law as it stands at the moment"[185] and that "the advance of the science, and the scientists wishing to proceed, obviously makes this an issue we have a responsibility to deal with now".[186] This does not fit easily with arguing a need for consultation on the basis of legal issues. **While we agree with the HFEA that the general issues of hybrid and chimera embryos should be dealt with by Parliament, we consider that it is the role of the HFEA to deal with the applications for the creation of cytoplasmic hybrid embryos under current legislation with due speed and process.**

182 Ibid

183 Q 62

184 Ibid

185 Q 111

186 Q 92

5 Future regulation of research involving the creation of human-animal chimera or hybrid embryos

The parliamentary process

78. As previously indicated, embryo research is currently regulated under the HFE Act (paragraph 12), and through case law (paragraph 62). However, embryo research has progressed significantly since the creation of the original HFE Act in 1990 and calls for revised legislation have been made, including from the HFEA[187] and the previous Science and Technology Committee.[188] We are therefore supportive of the Government's intention, highlighted in its review of the Human Fertilisation and Embryology Act 1990, that "revised legislation will clarify the extent to which the law and regulation applies to embryos containing human and animal material".[189] **We agree that there is a need for revised legislation, decided by Parliament, to regulate for current developments in the creation of human-animal hybrid and chimera embryos and to provide a future framework under which regulatory authorities can operate.**

79. The Government has announced its intention to present a draft Bill, expected in May 2007, for pre-legislative scrutiny.[190] During oral evidence to the Committee, Caroline Flint MP, the Minister of State for Public Health, told us that with the "number of issues" that the review of the HFE Act covers, "it is important to have this pre-legislative scrutiny".[191] This will be welcome as adding to the debate in this area. The HFEA consultation will feed into the process, according to Ms Harrison who told us that HFEA "will share the results of our consultation and our evidence gathering with the department and hope that it informs the pre-legislative scrutiny stage".[192] We also intend our own Report to make a significant contribution to the process in this area. **We support the Government's intention for pre-legislative scrutiny of the draft Bill and encourage the Government to take advantage of all possible sources, including this Report and that of our predecessor Committee, to inform the debate.**

Definitions and terminology in the draft Bill

80. Throughout this inquiry we have battled to develop a clear understanding of what the Government means by its use of the term 'hybrid and chimera embryos'.[193] It has

187 Q 91

188 HC (2004-05) 7, recommendation 9, www.publications.parliament.uk/pa/cm200405/cmselect/cmsctech/7/7i.pdf

189 Department of Health, Review of the Human Fertilisation and Embryology Act: Proposals for revised legislation (including establishment of the Regulatory Authority for Tissue and Embryos), Cm 6989, December 2006, www.hfea.gov.uk/cps/rde/xbcr/SID-3F57D79B-9E450A32/hfea/White_Paper_Dec_06_web_version.pdf

190 Ibid

191 Q 295

192 Q 125

193 Department of Health, Review of the Human Fertilisation and Embryology Act: Proposals for revised legislation (including establishment of the Regulatory Authority for Tissue and Embryos), Cm 6989, December 2006, para 2.85

become clear as we have progressed that, in some cases, individuals interpret the Government proposals as exclusive to the creation of cytoplasmic hybrid embryos. For example, Professor Lorraine Young, when asked whether she supported the Government proposals, referred only to the creation of cytoplasmic hybrid embryos.[194] In fact, the memoranda submitted into this inquiry indicate that many respondents have interpreted the Government proposals in this way,[195] perhaps as a result of the significant media coverage of the research applications from King's College London and Newcastle University immediately prior to our inquiry.[196]

81. However, other respondents to our call for evidence interpreted the Government proposal as inclusive of a wider range of creations. Some of these witnesses are concerned about the potential wider implications for prohibition with the terminology currently used. Dr Stephen Minger of King's College London urged us to consider carefully what the consequences of a ban on creating "hybrids" or "chimera" would entail, citing the creation of transgenic mice and telling us that "the commercial and academic scientific community have generated over 20,000 strains of mice and rats which contain human disease genetic material, and many of these are important research tools for developing new therapies against cancer and other important human diseases".[197]

82. We are concerned that there is discrepancy between the understanding of scientists and Government in the terminology used. Dr Lyle Armstrong of Newcastle University told us that "a hybrid is essentially an organism which is formed by the mixing of the chromosomes of two separate organisms".[198] As detailed in Chapter 3, the term 'hybrid' can be used to encompass a range of creations from cytoplasmic hybrid embryos to transgenic models of Down's Syndrome. It is therefore a matter of concern that the Minister's definition of a human hybrid was offered simply as an entity "formed by fertilisation of a human egg by an animal sperm".[199] Similarly, on chimeras, Ms Flint told us that "in terms of a human chimera we have used the formation of a chimera by taking a human embryo and adding animal cells".[200] Dr Armstrong, on the other hand, defined "a chimera is essentially an organism which is formed by the mixing of the cell types from two separate organisms".[201] This may seem a subtle difference perhaps, but Dr Armstrong's definition covers a range of useful research tools, such as the formation of blastocyst or aggregation chimera used as a route to the production of transgenic mice (as detailed in table 2, chapter 3), which would not be included in the Minister's understanding of the terminology but which might be covered in the proposed legislation.

194 Ev 152

195 E.g. Ev 51, 64

196 e.g. "Scientists fear ban on cloned embryo research", Financial Times, 5 January 2007 and "Nobel scientists urge fertility watchdog to back hybrid embryos", The Times, 10 January 2007

197 Ev 131

198 Q 5

199 Q 269

200 Q 269

201 Q 5

83. The Minister has acknowledged difficulties in regard of the terminology used within the Government proposals. She told us that "what this debate we are having has shone a light on is the different interpretations of what is meant by a hybrid or a chimera".[202] Later, she clarified that the terminology used in the review was based on that used in previous reviews and reports, and that it was intended to cover the following:

- mixing of human and non-human gametes;
- embryos resulting from combination of haploid sets of human and animal chromosomes;
- embryos created by placing a human cell or cell nucleus in an enucleated animal egg;
- fusing of a human embryo with animal cells and;
- creation of a "transgenic" human embryo (e.g. by addition of a non-human gene or genes).[203]

84. The Minister's supplementary evidence provided clarification that the scope of the legislation was not intended to extend to entities such as required in the creation of transgenic mice (for example, those currently used in the study of Down's Syndrome.[204] Whilst we appreciate that Ms Flint may have intended that the terminology used in the White Paper should refer to the creations she has detailed above, this has only been established in response to our inquiry and we find it difficult to understand why this was not explicitly stated at time of its publication. We remain unconvinced that the Government fully understood the scope and implications of its proposals at publication.

85. The difficulties of definition have long been recognized, including by our predecessors in the last Parliament who, for want of better guidance, used the definitions enshrined in Canadian law.[205] The Academy of Medical Sciences in the UK has recently launched a study which aims to:

i. agree definitions of embryos combining genetic material from more than one individual, particularly those combining human and non-human material;

ii. identify relevant research protocols;

iii. identify key opportunities for research using such embryos, and cells derived from them, together with an assessment of how these opportunities are balanced by safety and ethical concerns; and

iv. to provide recommendations to Government to further inform revised legislation in this area.[206]

202 Q 268

203 Ev 169

204 Ibid

205 HC (2004-05) 7-I

206 Academy of Medical Sciences, www.acmedsci.ac.uk/p47prid51.html

We are critical of the Government for not clearly setting out areas of research practice intended to fall under the proposed legislation. Much confusion has thus been caused. However, we accept that this lack of clarity may result from the lack of understanding more generally with regard to the potential for this area of research and what the term 'human-animal chimera or hybrid embryos' may cover. We welcome moves by the Academy of Medical Sciences to address this problem and we urge the Government to work with the Academy, HFEA and other stakeholders to ensure that the scope of research practice intended to be covered by legislation is clearly defined in the draft Bill.

The proposed prohibition

86. The Government has proposed that the creation of human-animal chimera or hybrid embryos *in vitro* should not be allowed in the first instance, but that the law should contain a power enabling regulations to set out circumstances in which the creation of hybrid and chimera embryos *in vitro* may be allowed in the future. This two-step approach has been widely interpreted – both by opponents and supporters of the policy – as a prohibitive one.

87. The proposal has met with significant opposition, including from within Government, research funders and the regulator itself. The Department for Trade and Industry, responsible for the support of UK science and technology, told us that it "supports the view that, with appropriate regulation, the creation of hybrid stem cells for research purposes should be permitted".[207] We also heard from Professor Colin Blakemore, Chief Executive of the Medical Research Council (MRC), that he hopes for "permissive legislation, in which areas of research that are not considered to be acceptable necessarily might not be allowed, but the generality would be".[208] The position of the HFEA, which is responsible for regulating this area of research, has remained quite clear throughout: it "would like to see this research permitted within the usual restrictions, within the usual controls".[209] This view is supported by scientists, such as Dr Robin Lovell-Badge of the National Institute for Medical Research (NIMR), who argued that "it is far better to control such research activities under a good regulatory system through careful consideration of proposed experiments by scientific and ethical review panels, than it is by prohibitive laws that are likely to be both too restrictive and leave dangerous loopholes, especially in this rapidly advancing field of science".[210] Even the Prime Minister was recently quoted in *The Times* as saying that the Government was "not dead set" against the King's College London and Newcastle experiments, "in fact the opposite", and whilst "there were difficult issues surrounding creating the embryos", he added that "I'm sure that research that's really going to save lives and improve the quality of life will be able to go forward".[211]

207 Ev 147

208 Q 243

209 Q 145

210 Ev 72

211 "Nobel scientists urge fertility watchdog to back hybrid embryos", The Times, 10 Jan 2007, embryoshttp://www.timesonline.co.uk/tol/news/article1291238.ece

88. In the face of this broad spectrum of opposition, the Minister claimed that her policy had been misrepresented and that her real intention was to 'leave the door open' to such areas of research. Caroline Flint told us that "we are actually proposing a liberalisation of where we are now".[212] When pressed on how banning an area of science could be seen as a 'liberalisation', Ms Flint told us that "we are not banning science and that is very clear in the White Paper".[213] She added that "we have not shut the door, in fact we have moved further forward than we have ever been before in this particular area of science"[214] and that "the White Paper makes it absolutely clear that we think there needs to be a door open to be able to deal with these processes and how they develop".[215] Given that a prohibition will ban research that the HFEA – the Government's own advisor – feels is probably licensable and believes should be permitted, we believe that the Government's proposals are indeed prohibitive. Even if that were not the case, we find it astounding that the Minister could have allowed such misinterpretation to take so strong a hold in all sections of the community to the extent that none of the evidence received by our inquiry, either for or against the proposals, reflects the Minister's own view of the regulatory regime her proposals are intended to create. **We find the Government proposals in the White Paper unnecessarily prohibitive and recommend the Government ensure that its draft Bill reflects the liberal view it claims to be taking in opening the door to research using human-animal chimera or hybrid embryos.**

Allowing for such research in the future

89. The Minister's claims for her policy to be regarded as permissive rest upon the inclusion within the White Paper of the proposal that the law should contain a power enabling regulation of the creation of human-animal chimera or hybrid embryos in the future. This claim is rather undermined by the Department of Health's admission that the "Government has not taken a view on whether or when such regulations may be made".[216] In other words, there are no plans to allow any such work, however defined, immediately or in the foreseeable future. We note that the process of making regulations would necessarily involve a considerable length of time, once a decision had been taken by the Government to utilise this power in any given circumstance.

90. The North East Stem Cell Institute (NESCI) took "issue" with the wording of the White Paper, which proposes an outright ban on the creation of hybrid embryos, but then indicates in "very vague terms" the possibility that their creation may be permitted by further legislation in the future for research purposes.[217] It explained that "not only does this cause confusion, but it comes across as a strategy to appease public concern whilst not totally closing the door on what is clearly recognised as exciting and useful science" and that "this approach would simply delay the inevitable debate that will need to be had".[218] We agree. It makes no sense to delay research which is needed

212 Q 276

213 Q 277

214 Q 282

215 Q 274

216 Ev 113

217 Ev 67

218 Ibid

immediately, as detailed previously (for example, paragraphs 59 and 77) and which the Government accepts has the potential to "offer huge benefits".[219] **We believe that there is a need to allow research using some forms of human-animal chimera or hybrid embryos, including but not exclusively cytoplasmic hybrid embryos, to proceed immediately. We recommend that the Government propose draft legislation which is immediately permissive, through regulation, to those areas of research it deems acceptable.**

Drawing the line: acceptable research practice

91. Whilst we are of the opinion that the creation of human-animal chimera or hybrid embryos should be allowed for research, we believe that such research should be tightly regulated to ensure that only legal and appropriate research practice is allowed. Clear regulation in terms of what may and may not be permissible is necessary, for example in alleviating possible public fear that research of this nature may lead to the creation of half animal-half humans. As Sir Liam Donaldson, the Chief Medical Officer, told us, "some people might have a problem" with the concept of a hybrid in which human sperm were mixed with animal eggs.[220] We agree, and we therefore consider it useful for a line to be drawn between what is and is not acceptable.

The 14-day rule

92. One consideration is the length of time for which such entities may need to be allowed to develop. Currently, under the HFE Act, whilst the creation of a human embryo is licensable for research, the licence cannot authorise "keeping or using an embryo after the appearance of the primitive streak".[221] The primitive streak is to be taken to have appeared in an embryo not later than the end of the period of 14 days beginning with the day when the gametes are mixed, not counting any time during which the embryo is stored.[222]

93. In the inquiry in the last Parliament into *Human Reproductive Technologies and the Law*, the Committee found no benefit in keeping human-animal chimera or hybrids for longer than the 14-day limit imposed upon embryos consisting of only human material.[223] We deemed it important to establish during this inquiry that this was still the case. Dr Stephen Minger of King's College London told us, with specific reference to cytoplasmic hybrid embryos, that he "can see no reason for culturing the embryo beyond the 14 day limit as set out in the HFE Act".[224] Other experts agreed. Dr Robin Lovell-Badge at the National Institute for Medical Research did not "see any need to take them [cytoplasmic hybrid embryos] past the 14th day" and saw "no reason" to take human-animal chimera embryos, more generally, beyond 14 days *in vitro*. Again, Professor

219 Q 269

220 Q 318

221 Human Fertilisation and Embryology Act 1990, activities governed by the Act, Section 3: Prohibitions in connection with embryos.

222 Ibid

223 HC (Session 2004-05) 7–I, recommendation 9

224 Ev 165

Ian Wilmut of the University of Edinburgh did not "envisage a benefit" in keeping the embryos beyond day 14. Professor Wilmut expanded this view, telling us that "in the great majority of studies the period of culture would be for 6 or 7 days" since, in the case of cytoplasmic hybrid embryos, this "is sufficient time for the embryo to reach the stage from which stem cells may be derived".[225] **We believe that, in general, the creation of all types of human-animal chimera or hybrid embryos should be allowed for research purposes, if appropriately regulated. However, in line with the recommendation of the previous Committee, we see no benefit from allowing the development of human-animal chimera or hybrid embryos past the 14 day stage *in vitro* and recommend that such practice is not licensed unless it is proved necessary.**

Implantation of human-animal chimera or hybrid embryos into a woman

94. The HFEA Act 1990 states that "no person shall place in a woman a live embryo other than a human embryo".[226] We have received no evidence during this inquiry to suggest that such practice would be beneficial or desirable or that researchers would like to attempt such experiments. **In line with the recommendations of the previous Science and Technology Committee, we recommend that legislation prohibit the implantation of human-animal chimera or hybrid embryos in a woman.**

Injecting cells derived from human-animal chimera and hybrid embryos into animal models

95. Some scientists also identify a need to inject cells derived from human-animal chimera or hybrid embryos into animal models. These experiments may be required to enable researchers to prove that stem cells produced from cytoplasmic hybrid embryos are truly pluripotent, that is that they have the ability to differentiate into different cell types. Such experiments include the 'teratoma assay', which we are told by Dr Robin Lovell-Badge is "a common test of human ES [embryonic stem] cell potential".[227] During this test, researchers inject the cells into a genetically immunocompromised mouse (for example the 'Severe Combined Immunodeficiency Disease [SCID] mouse' which has no protection against infection and cannot reject transplanted tissue) where the cells are likely to form teratomas, tumours which contain many different cell types.[228]

96. We have also heard from Dr Minger that there are other instances where "implantation of human embryonic stem cell-derived populations into experimental animals will be necessary".[229] Dr Minger explained that these could include experiments for "assessing the contribution of stem cells to repair of the damaged spinal cord, and determining the ability of stem cells to integrate into damaged myocardium".[230] At

225 Ev 162

226 Human Fertilisation and Embryology Act 1990, activities governed by the Act, Section 3: Prohibitions in connection with embryos.

227 Ev 156

228 Ev 156

229 Ev 165

230 Ibid

present, such research in the UK is regulated through the Home Office under the Animals (Scientific Procedures) Act 1986, and we agree with Dr Minger that there is little difference between these experiments and "traditional preclinical testing of human cell populations in experimental animals".[231] We believe that this is acceptable research practice. However, the current lack of clarity with regard to what the Government means in its proposals leaves us concerned that the terminology used could be extended to cover research practice currently allowed under the Home Office, despite an assurance from the Minister that this will not be the case.[232] **We recommend that care be taken by the Government to ensure that the draft Bill does not prohibit research using human embryonic stem cell lines where such research is currently regulated through the Animals (Scientific Procedures) Act 1986.**

Development of human-animal chimera or hybrid embryos past the 14 day limit in vivo

97. We have also received evidence to suggest that there are occasions when it may be "useful or desirable" to allow development of certain types of human-animal chimera beyond 14 days in an animal's uterus, and even for the chimeras to be born.[233] Within the evidence we have received, it has been made clear that such techniques are, at present, only thought to be of potential use in further determining pluripotency of stem cell lines, and not in the development of the human-animal chimera or hybrid embryos themselves. We recognize that this is an important distinction. The proposed experiments would involve the introduction of labelled human stem cells, such as may be derived from cytoplasmic hybrid embryos, into the developing blastocyst of an animal. The blastocyst could then be implanted into a surrogate uterus to further determine pluripotency by looking for the presence of marked cells throughout the organs and tissues of the resultant embryo or adult organism.

98. In general, we have found little support for such practice or that there is a need for such research to be currently undertaken. For example, we have heard from Professor Ian Wilmut that he does not know "of any laboratory that envisages inserting human embryo stem cells into an animal blastocyst"[234] and that "it should be emphasised that no studies of this kind are envisaged at present".[235] Dr Minger told us that, for his own experiments he "will rely solely on the use of teratomas and *in vitro* differentiation to assess pluripotency".[236] Whilst we see no immediate benefit from the implantation of cells (for example, stem cells derived from cytoplasmic hybrid embryos into animal embryos), we consider it important that this door is left open to allow for such research practice, should it become necessary in the future. **We recommend that legislation allow for regulation of the implantation of human stem cells, whether created from human embryos or human-animal chimera or hybrid embryos, into animal blastocysts.**

231 Ev 165

232 Ev 167

233 Ev 156

234 Ev 163

235 Ev 164

236 Ev 165

Legislative and regulatory structure

99. **We have made it clear that we regard the current Government proposals as overly prohibitive and that there should be regulation of this research area through licensing. The new legislative structure should permit the creation of animal-human hybrid and chimera embryos for research purposes, subject to regulation, and should aim to reduce the risk of litigation on borderline cases.**

100. Through consultation with the legal services available to us, we have reached the conclusion that it is possible to create a legal framework within which anything which fell into this or a related category would be capable of being licensed, by the HFEA or proposed RATE, for example. On the pattern of the existing HFE Act, this would start with a general prohibition to which exceptions apply through licences awarded by the authority but, unlike the Government proposals, it would be clear that the assumption was that the Authority would consider anything for a licence which was not specifically ruled out. As indicated above, we recommend ruling out keeping embryos beyond 14 days and implantation of the embryo in a woman. Similarly, it would be possible to ensure that specific existing practices or proposals, for example human-animal cytoplasmic hybrid embryos created by somatic cell nuclear transfer, could be included in the new framework as soon as the Bill came into force. Finally, to provide time for the Secretary of State to decide whether to make regulations to ban a novel process, the framework could also contain a provision to enable the Secretary of State to put a stop to the procedure for a limited period while deciding whether or not to make regulations. In each case, the regulations on a particular process would be subject to the affirmative procedure, in other words they could only be made if approved by both Houses of Parliament. Figures 3a and 3b illustrate our interpretation of how such a legislative structure may work.

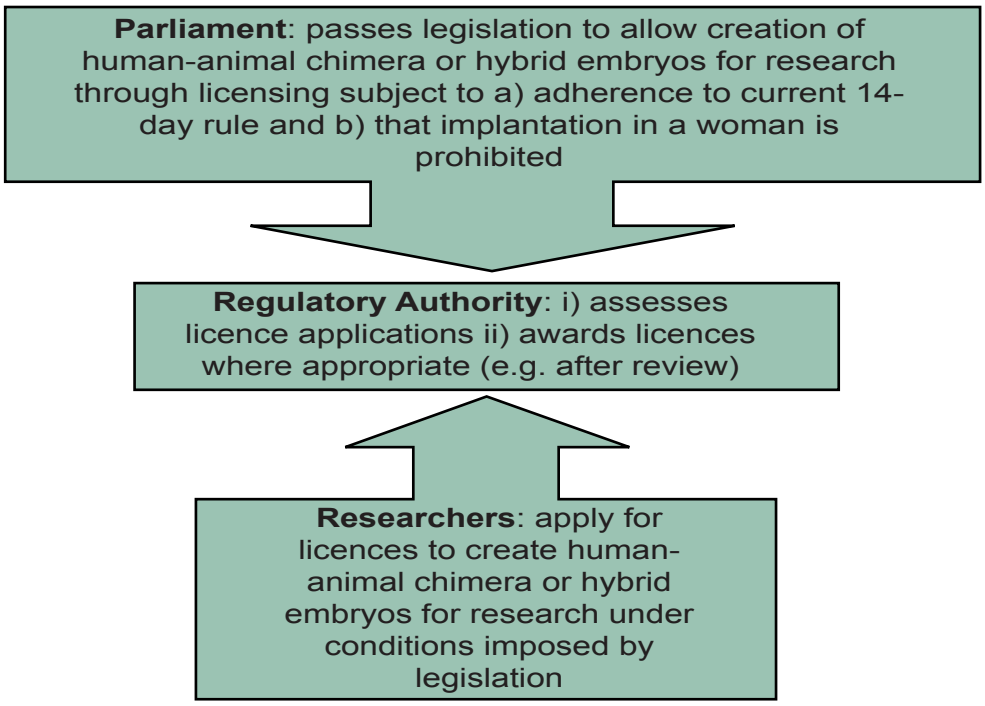

Figure 3a: Proposed immediate situation: Legislation agreed which covers currently understood use of human-animal chimera or hybrid embryos for research, for example in the creation of cytoplasmic hybrid embryos.

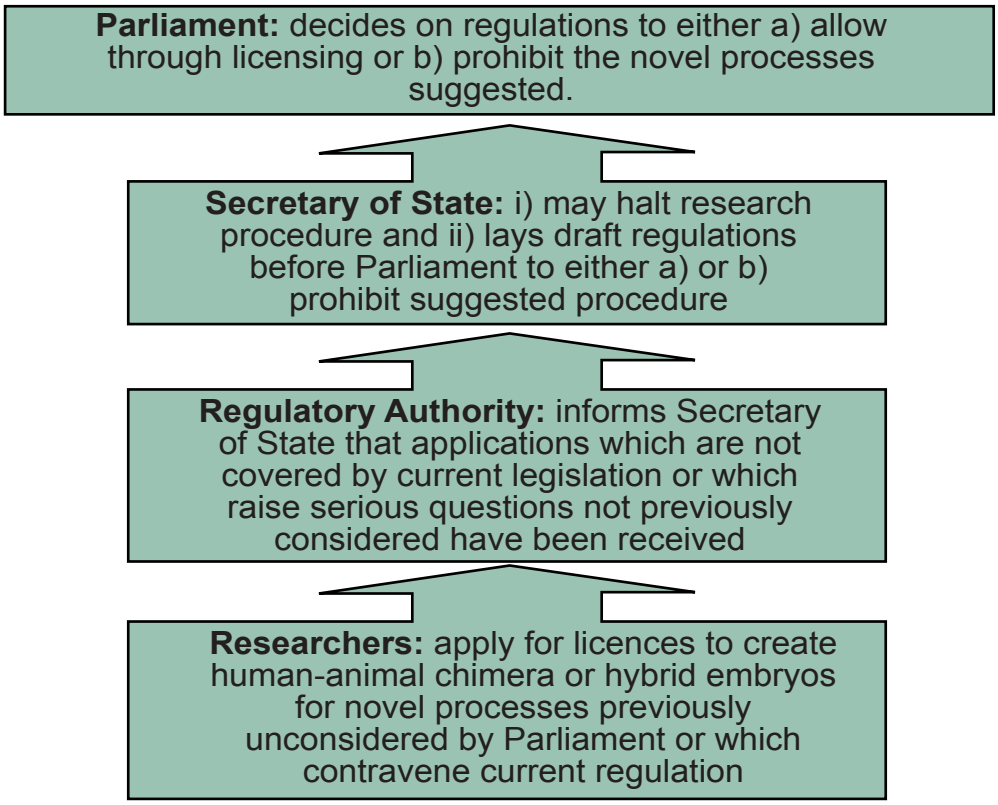

Figure 3b: Proposed mechanism for revising legislation in consideration of developments in research.

101. We recognise that it will be necessary to define within the legislative framework the potential types of embryo and process to which it would apply. The definition would need to be wide enough to encompass all known and potential forms of animal-human hybrid, chimera and cytoplasmic hybrid embryos. We expect the Government to draw on the work of the Academy of Medical Sciences in this regard.

102. **We recommend that the Government proposals in the draft Bill for the regulation of the creation of animal-human chimera and hybrid embryos be based on the legislative structures outlined in paragraph 100 of this Report.**

Impact of the legislative structure on UK science

103. One consideration in establishing a legislative structure for research should be the impact which it may have on UK science. As we have seen earlier, the UK's regulatory system has traditionally been viewed as an important element in the pre-eminency of the UK in this scientific field. It has been viewed with envy by researchers from countries with more restrictive regimes and it has been influential in the development of policy-making in other countries.[237] There have to be concerns that changes to the regulatory system should not harm the reputation and make-up of the UK science base but should encourage it to develop in order to realise the expectations placed on it in terms of knowledge and tackling disease.

104. The current Government proposals have led some in both Government and industry to express concerns about their impact. The Department for Trade and Industry argued that the policy "may damage the widespread international view that the UK has one of the best regulatory systems in relation to stem cell research".[238] This is supported by the BioIndustry Association who told us that the Government's proposals to prohibit the creation of human-animal chimera and hybrid embryos for research "would halt current innovative research into diseases such as Alzheimer's and motor neurone disease" and that it would "send out an incredibly negative message about the UK as a location for stem cell research and innovative biomedical research". The Association argued that "the BIA does not believe that this is compatible with the Government's aim of ensuring the UK is a world leader in this field".[239] We believe that the term 'prohibition' used in the Government proposals can be taken to imply a negative approach to research in areas such as this, as opposed to the positive connotations implied through regulation of such research practice. **A ban and the prospect of a ban in draft legislation on human-animal chimera or hybrid embryos would undermine the UK's leading position in stem cell research and the international reputation of science in the UK.**

105. There are also issues in respect of the current competitive advantage UK scientists have in stem cell research. The DTI reported "strong views" from industry that a regulatory ban on the use of hybrids for research may harm the climate for both

237 Ev 148

238 Ev 147

239 Ev 108

company and academic research".[240] One scientist, Professor Anne McLaren of the Wellcome Trust Gurdon Institute, commented that "no doubt this research would eventually be carried out in other countries, but at present UK scientists have a competitive advantage". [241] This was echoed by Professor Colin Blakemore of the MRC who believed that "the pace of progress in this field" is "really quite extraordinary". He thought that the UK had "an advantageous position in this through a relatively liberal approach but with a very firm regulatory environment" and that this put the UK in a strong position, "but with a lead which will very, very easily be lost, given the rate of progress".[242] He considered prohibitive legislation in this area to be "a serious disadvantage in a very competitive and exciting area of science.[243] When asked if it were possible to quantify the UK lead in this area, Mr David Macauley, Chief Executive of the Stem Cell Foundation claimed that "at the moment, the analogy is we are watching this like sand running though our fingers, our competitive advantage, and this proposed ban does nothing but accelerate that".[244]

106. One further possible negative impact on future competitiveness was raised with us by Professor Martin Bobrow, Deputy Chairman of the Wellcome Trust. He was concerned that "the long-term effect of creating an unpleasant public atmosphere needlessly around issues of this sort is that it discourages very able, young researchers from entering the field, and it can take a very long time to reverse that sort of trend, if it becomes established".[245]

107. We asked the Minister for her views on the suggestions that the UK may lose its competitive advantage in stem cell research in response to a ban on the creation of human-animal chimera or hybrid embryos for research, but were unable to obtain a clear response.[246] **We are concerned that a ban or a proposed ban may not only encourage researchers to leave the UK in order to undertake their research in a more permissive regulatory regime, but it may also inhibit early stage researchers entering the field. Whilst we do not believe that UK competitiveness should dictate policy in a research area, we believe that the Government should consider this as a contributory factor and we recommend that the Government ensure that it is properly briefed on potential implications from future legislation in this area.**

240 Ev 147

241 Ev 52

242 Q 251

243 Q 255

244 Q 253

245 Q 251

246 Q 331-335

6 Public engagement

Public confidence

108. Professor Sheng of Shanghai told us that the UK Government is considered as one which has established an image to be able to "balance scientific development and ethical issues with confidence and vision" in the area of embryology.[247] We believe that the UK Government has, to date, been effective in building the trust of the public in the regulation of developments in embryology and stem cell research. **Public awareness of the need for and benefits of research in this area should be encouraged, alongside an understanding of the reasons for the requirement to update legislation. We regard it as the responsibility of the Government and HFEA to keep the public informed in respect of developments in legislation related to the creation of human-animal chimera and hybrid embryos for research.**

109. For public confidence to be enhanced, with regard to future legislation in this area, it is essential that the views of the public should be considered fully. However, we are not convinced that the views of the wider public in relation to this area of research are clear. To date, public opinion in this area of research has been primarily obtained through the Government consultation on the review of the HFE Act. The Government received 535 responses, from a range of stakeholders and individuals.[248] According to the Department of Health, the "overall tenor of responses to the consultation was opposed to the creation of hybrids and chimeras".[249] However, as we have discussed previously, much of this opposition appears to stem from the belief that all research using human embryos should be prohibited and it is thus difficult to extrapolate from this information to give a clear representation of specific objection to the creation of human-animal chimera and hybrid embryos for research.

110. The wording of the Government consultation was also raised as an issue by witnesses. We were told that the consultation lacked detail and that, with regard to whether or not the creation of human-animal embryos should be allowed for research, this was "a blunt question" which got a "blunt answer",[250] for example, from the Church of England who may not have answered in the negative had more information on what was proposed been available.[251] The Right Reverend Dr Lee Raysfield, Bishop of Swindon, told us that "there is an openness to considering this line, if it might decrease the use of human embryos" but that, at the moment, he thinks that the Church "would take the position that we need a bit more reflection and some caution and we should not rush in to embrace what is potentially an awkward area".[252] We consider this view rather

247 Ev 148

248 People Science & Policy Ltd, Report on the Consultation on the review of the Human Fertilisation & Embryology Act 1990, www.peoplescienceandpolicy.com/projects/human_fertilisation.php

249 Ev 112

250 Q 176

251 Q 155 and Q 173

252 Q 155

more open than the Church's response to the consultation would suggest, and question whether other responses may have been influenced in a similar fashion.

111. The reliance on this self-selecting sample as representative of public opinion has also attracted the ire of witnesses. The UK Stem Cell Network argued that the small number of responses received during this consultation "can in no way be viewed as a representative cross-section of the UK population",[253] whilst the BioIndustry Association claimed that the Government's public consultation "was not what we would call a representative poll of the country at large" and that "the Government has based its decision on an unrepresentative consultation, where the views of individuals have been given the same weight as the collective views of established scientific bodies".[254] **We take these criticisms of the Government's consultation seriously and we recommend that they be taken into consideration both in relation to the proposals for revised legislation in this area and in future consultation exercises.** We draw attention to the comments we made in our recent Report on Scientific Advice, Risk and Evidence Based Policy-Making which recognised the problem that responses to the public consultation were self-selecting.[255]

Defining public opinion

112. We were also interested to establish how public opinion may be appropriately defined and represented. Within the evidence received into this inquiry, we found a range of views with the general division that scientists and those representing medical research bodies (for example, charities) are generally supportive of this research, whilst those expressing views based on ethics and moral arguments tend to be against it. It is not, and cannot be, clear from this whether the views expressed into this inquiry are directly indicative of those of the wider public, and indeed whether respondents should consider themselves qualified to pronounce on what public opinion truly is. We heard from Dr David King of Human Genetics Alert that he thinks "public opinion on this is very strongly against allowing this kind of research".[256] When we asked Mr King for evidence to support his claim, he referred to the results of the Government's 2005 consultation, supported by his "gut reaction" that "because scientists have a different world view, they do not share the public's view on the importance of species barriers".[257] Not surprisingly, the BioIndustry Association took the opposite view, saying that "there is widespread scientific and public support for this ground-breaking medical research".[258]

113. We have seen no conclusive evidence to indicate the true state of public opinion on the creation of animal-human chimera and hybrid embryos for research purposes. It is,

253 Ev 104

254 Ev 108

255 Seventh Report of Session 2005-06, para 136, http://www.publications.parliament.uk/pa/cm200506/cmselect/cmsctech/900/900-i.pdf

256 Q 196

257 Q 199

258 "UK chimeric stem cell research in the balance", 12th Jan 2007,Drug researcher website,www.drugresearcher.com/news/ng.asp?n=73327-hfea-stem-cells-chimeric-embryo

however, interesting to note that the media coverage has been broadly positive and that there have been no significant write-in campaigns to our inquiry, despite the high profile reporting which it has attracted. **We find it unhelpful that witnesses on both sides of the argument have claimed to represent the public view, where supporting evidence for this is lacking.**

Public understanding

114. The concept behind the creation of chimera and hybrid embryos is a complex one but this does not obviate the need for greater public understanding of what scientists propose and why, as well as the ethical and other arguments surrounding the issue. For example, Dr Calum MacKeller, from the Scottish Council on Human Bioethics, identified a need "to develop discussion amongst the general public relating to the creation of animal-human combinations, chimeras, hybrids or cybrids [another term for cytoplasmic hybrid embryos]".[259] From a different perspective, the UK Stem Cell Network told us that "it is the view of several stem cell researchers in the UK that once the nature of the research and its aims are explained properly ... then a large proportion of the general public will be supportive".[260] It would be impossible for both these parties to be satisfied with the results of greater public understanding but we are impressed by their unanimity on this point. **Accomplishing effective public engagement in this debate may be difficult, but significant effort must be made to this end. We believe that additional education is required to enhance public understanding of the techniques proposed by this area of research and its associated potential achievements and problems, including scientific, ethical and moral concerns.**

115. The HFEA's public consultation has a major part to play in this. It is intended to go wider than the two specific licence applications which prompted it to "address all types of chimera and hybrid embryos, i.e. embryos which contain some elements of animal DNA".[261] The Authority expects the consultation to run from late April to late July and intends to use the results to arrive at a policy position at its meeting on 5 September 2007. The HFEA is liaising with recognised experts in the fields of embryology and stem cell research in drafting this consultation. During the course of our inquiry, the Government also announced that it would aid the provision of education to enable informed public response to the consultation through the DTI's Sciencewise initiative, in which the Chief Executives of the Medical Research Council and the Biological and Biotechnological Sciences Research Council will lead a public dialogue on stem cell research, under an RCUK (Research Councils UK) umbrella and supported by a DTI grant.[262] **Notwithstanding the accompanying delay in consideration of the King's College London and Newcastle University research applications, we welcome the HFEA proposed consultation on general principles and commend steps taken by the Authority to ensure appropriate drafting. We also commend the Government for allowing funding to be allocated toward education in this area.**

259 Q 203

260 Ev 104

261 Ev 127

262 Ev 147

7 Conclusion

116. Our inquiry has focused on the particular issue of the creation of human-animal chimera or hybrid embryos for research purposes, using the specific example of cytoplasmic hybrid embryos to assess whether such research is desirable and necessary now. We have found the Government's published proposals for future regulation in this area to be unacceptable and potentially harmful to UK science. The Minister has strongly protested that the general interpretation of what the Government is seeking to do is mistaken, and also that she is prepared to revise the proposals for inclusion in the forthcoming draft Bill. We urge the Government to take our Report into consideration in preparation of the draft Bill.

Conclusions and recommendations

Ethical and moral points of view

1. We regret that the Department of Health did not seek to specify more clearly in its consultation what views it was seeking, nor to evaluate fully the responses of the public consultation exercise. We recommend that in future a more systematic statistical or scientific approach is developed to quantify and qualify the results of public consultation. (Paragraph 41)

2. We recognise the sincere ethical and moral concerns associated with research of this nature and are therefore concerned that, to respond to these concerns, any regulatory framework associated with use of human-animal chimera or hybrid embryos in research should be transparent and workable. (Paragraph 42)

3. We are of the opinion that ethical and moral concerns should be considered within the context in which they are made, and that inappropriate use of science to justify ethical and moral arguments is unhelpful. Inappropriate use of science should be identified and disregarded by Government and other policy-makers. (Paragraph 43)

4. In line with the recommendation of the previous Science and Technology Committee, we recommend the creation of a new Parliamentary standing Committee on Bioethics. (Paragraph 44)

Potential problems with this research

5. In the event that research using cytoplasmic hybrid embryos is authorised, we urge the Government to ensure that appropriate risk management procedures are established and implemented (Paragraph 54)

6. Research, by its very nature, is aimed at enhancing knowledge. Whilst we recognise scientific debate about the potential usefulness of cytoplasmic hybrid embryos in research, we do not believe that the existence of differing views of whether a methodology is workable before it has been sufficiently tested is reason enough to prohibit such research from taking place. (Paragraph 57)

Scientific opposition to research involving hybrid and chimera embryos

7. We recognise the scientific debate among experts about the potential usefulness of the research under discussion in this Report but we conclude that the scientific community as a whole is supportive of the work being licensable, even where there may be doubts about its likely success. (Paragraph 58)

Conclusions on the desirability and necessity of hybrid and chimera embryo research

8. We believe that the creation of human-animal chimera or hybrid embryos, and specifically cytoplasmic hybrid embryos, is necessary, for example in the pursuit of knowledge about the genetic basis of disease and the direction of stem cells into future cell-based therapy. Furthermore, we recognise that stem cells produced through this methodology may be useful in drug discovery and that they may lead to the eventual reduction of animal use, for example in toxicity testing. (Paragraph 59)

9. We believe that use of animal eggs in the creation of cytoplasmic hybrid embryos will help to overcome the current shortage of human eggs available for research and that use of animal eggs is required to enable researchers to develop the practical techniques which may be required for eventual production of cell-based therapy through this method using human eggs. (Paragraph 60)

The role of the HFEA in regulating research

10. We agree with HFEA that the wider issue of whether human-animal chimera or hybrid embryos should be allowed for research should be decided by Parliament. However, it is the role of HFEA to make judgements in areas considered within the spirit of the HFE Act where its legal advice indicates that it is reasonable to do so. Not to do so undermines the effectiveness of an independent regulator. (Paragraph 64)

11. We support the decisions of the HFEA Science and Clinical Advances Group, Ethics and Law Committee and Horizon Scanning Group that an embryo containing human nuclear DNA and mitochondria of animal origin should be regarded as a human embryo for the purposes of the 1990 HFE Act. (Paragraph 68)

12. We understand that some form of viability test will have been subject to the legal advice sought by the HFEA on this issue. Nevertheless, we have grave scientific concerns about its validity. We do not believe that it is appropriate to use viability as a mechanism for determining whether or not a creation is human, particularly since attempts to prove viability through implantation in a uterus would be unlawful. Furthermore, were the viability test to be failed, this would mean that such research would be completely unregulated, which case law has found to be unsatisfactory. (Paragraph 71)

13. We support the decision of the HFEA that research involving the creation of cytoplasmic hybrid embryos would probably fall with the remit of the HFEA to regulate and license and would not be prohibited by current legislation. Although we have received submissions from those who do not believe that this is the case, the weight of scientific and legal argument is in favour of treating these embryos as human. We accept that this decision might leave the HFEA open to legal challenge that it was acting ultra vires in considering the applications. However, given the accepted desirability for legal clarification in this area, we view legal challenge as highly likely but also potentially helpful in establishing the limits of the HFEA's remit. (Paragraph 72)

14. It would have aided transparency and public and parliamentary debate on this subject if the HFEA's legal advice had been published. (Paragraph 75)

15. We view public consultation in this area as valuable. However, we are of the opinion that this exercise should have been undertaken when the HFEA first received information to indicate that applications for licensing the creation of human-animal chimera or hybrid embryos could be expected. (Paragraph 76)

Delay in assessment of the applications

16. While we agree with the HFEA that the general issues of hybrid and chimera embryos should be dealt with by Parliament, we consider that it is the role of the HFEA to deal with the applications for the creation of cytoplasmic hybrid embryos under current legislation with due speed and process. (Paragraph 77)

The parliamentary process

17. We agree that there is a need for revised legislation, decided by Parliament, to regulate for current developments in the creation of human-animal hybrid and chimera embryos and to provide a future framework under which regulatory authorities can operate. (Paragraph 78)

18. We support the Government's intention for pre-legislative scrutiny of the draft Bill and encourage the Government to take advantage of all possible sources, including this Report and that of our predecessor Committee, to inform the debate. (Paragraph 79)

Definitions and terminology in the draft Bill

19. We are critical of the Government for not clearly setting out areas of research practice intended to fall under the proposed legislation. Much confusion has thus been caused. However, we accept that this lack of clarity may result from the lack of understanding more generally with regard to the potential for this area of research and what the term 'human-animal chimera or hybrid embryos' may cover. We welcome moves by the Academy of Medical Sciences to address this problem and we urge the Government to work with the Academy, HFEA and other stakeholders to ensure that the scope of research practice intended to be covered by legislation is clearly defined in the draft Bill. (Paragraph 85)

The proposed prohibition

20. We find the Government proposals in the White Paper unnecessarily prohibitive and recommend the Government ensure that its draft Bill reflects the liberal view it claims to be taking in opening the door to research using human-animal chimera or hybrid embryos. (Paragraph 88)

21. We believe that there is a need to allow research using some forms of human-animal chimera or hybrid embryos, including but not exclusively cytoplasmic hybrid embryos, to proceed immediately. We recommend that the Government propose

draft legislation which is immediately permissive, through regulation, to those areas of research it deems acceptable. (Paragraph 90)

Drawing the line: acceptable research practice

22. We believe that, in general, the creation of all types of human-animal chimera or hybrid embryos should be allowed for research purposes, if appropriately regulated. However, in line with the recommendation of the previous Committee, we see no benefit from allowing the development of human-animal chimera or hybrid embryos past the 14-day stage *in vitro* and recommend that such practice is not licensed unless it is proved necessary. (Paragraph 93)

23. In line with the recommendations of the previous Science and Technology Committee, we recommend that legislation prohibit the implantation of human-animal chimera or hybrid embryos in a woman. (Paragraph 94)

24. We recommend that care be taken by the Government to ensure that the draft Bill does not prohibit research using human embryonic stem cell lines where such research is currently regulated through the Animals (Scientific Procedures) Act 1986. (Paragraph 96)

25. We recommend that legislation allow for regulation of the implantation of human stem cells, whether created from human embryos or human-animal chimera or hybrid embryos, into animal blastocysts. (Paragraph 98)

Legislative and regulatory structure

26. We have made it clear that we regard the current Government proposals as overly prohibitive and that there should be regulation of this research area through licensing. The new legislative structure should permit the creation of animal-human hybrid and chimera embryos for research purposes, subject to regulation, and should aim to reduce the risk of litigation on borderline cases. (Paragraph 99)

27. We recommend that the Government proposals in the Bill for the regulation of the creation of animal-human chimera and hybrid embryos be based on the legislative structures outlined in paragraph 100 of this Report. (Paragraph 102)

Impact of the legislative structure on UK science

28. A ban and the prospect of a ban in draft legislation on human-animal chimera or hybrid embryos would undermine the UK's leading position in stem cell research and the international reputation of science in the UK. (Paragraph 104)

29. We are concerned that a ban or a proposed ban may not only encourage researchers to leave the UK in order to undertake their research in a more permissive regulatory regime, but it may also inhibit early stage researchers entering the field. Whilst we do not believe that UK competitiveness should dictate policy in a research area, we believe that the Government should consider this as a contributory factor and we recommend that the Government ensure that it is properly briefed on potential implications from future legislation in this area. (Paragraph 107)

Public confidence

30. Public awareness of the need for and benefits of research in this area should be encouraged, alongside an understanding of the reasons for the requirement to update legislation. We regard it as the responsibility of the Government and HFEA to keep the public informed in respect of developments in legislation related to the creation of human-animal chimera and hybrid embryos for research. (Paragraph 108)

31. We take criticisms of the Government's consultation seriously and we recommend that they be taken into consideration both in relation to the proposals for revised legislation in this area and in future consultation exercises. (Paragraph 111)

32. We find it unhelpful that witnesses on both sides of the argument have claimed to represent the public view, where supporting evidence for this is lacking. (Paragraph 113)

Public understanding

33. Accomplishing effective public engagement in this debate may be difficult, but significant effort must be made to this end. We believe that additional education is required to enhance public understanding of the techniques proposed by this area of research and its associated potential achievements and problems, including scientific, ethical and moral concerns. (Paragraph 114)

34. Notwithstanding the accompanying delay in consideration of the King's College London and Newcastle University research applications, we welcome the HFEA proposed consultation on general principles and commend steps taken by the Authority to ensure appropriate drafting. We also commend the Government for allowing funding to be allocated toward education in this area. (Paragraph 115)

Glossary

Blastocyst	The preimplantation embryo of mammals consisting of a sphere of cells with an outer cell layer that forms the placenta (trophectoderm) and a cluster of cells on the interior called the inner cell mass that forms the embryo and from which embryonic stem cells may be derived
Cell nuclear replacement (CNR)	The process whereby a nucleus (which contains almost all the DNA of the human/animal in question) is placed in an egg in which the nucleus has been removed. This process of cell nuclear replacement led to the birth of the sheep Dolly and since then CNR has been successfully used to generate clones of other animal species
Chimera	In experimental embryology, the term 'chimera' refers to a single individual made by combining two or more embryos, or mixing pluripotent cells from more than one embryo, either of the same or of another species
Cytoplasmic hybrid embryos	The term used in this report to describe embryos created through somatic cell nuclear transfer into enucleated ova, and specifically in relation to recent applications from researchers at King's College London and Newcastle University to create such entities through transfer of human genetic material into enucleated animal ova.
Differentiate	The term used to describe the progressive cellular changes

	required to become a more specialized cell type and the process cells undergo as they mature into normal cells. Differentiated cells have distinctive characteristics and perform specific functions
Deoxyribonucleic acid (DNA)	The material inside the nucleus of cells that carries genetic information
Embryo	An animal in the early stage of development before birth. In humans, the embryo stage is the first three months following conception
Enucleated animal ovum (EAO)	An egg from which the nucleus has been previously removed
Eukaryotic cell	A cell which contains a nucleus and other membrane-bound organelles (e.g. mitochondria)
Hybrid	1. Offspring produced from mating plants or animals from different species or varieties. 2. cell produced by fusing cells of two different origins, usually of two different species. Usually referred to as 'somatic cell hybrid'. 3. In the context of this inquiry, the term 'hybrid' is used to describe the creation of an embryo after implanting human DNA into an enucleated animal ovum.
Gametes	Male or female reproductive cells i.e. the sperm or the egg
In vitro	Literally, "in glass." The term used to refer to experiments performed in a test tube or other laboratory apparatus.

In vitro fertilisation (IVF)	A method of assisted reproduction involving combining an egg with sperm in a laboratory dish. If the egg fertilizes and begins cell division, the resulting embryo can be transferred into the woman's uterus where it may implant in the uterine lining and develop.
In vivo	Refers to biological processes that take place within a living organism or cell and is the term used to describe experiments carried out in living organisms
Mitochondria	Structures (found within the cell) responsible for providing the cell with energy. Mitochondria have their own DNA, distinct from the nuclear DNA in the cell.
Morula	The ball of cells which forms at about 4 days after insemination of the egg.
Mutant cell	A cell which differs from the wild type because it carries one or more genetic changes in its DNA.
Nucleus	The part of the cell that contains the majority of the genetic material (DNA).
Ova (plural), Ovum (singular), Oocyte (additional term)	A female sex cell, or egg
Pluripotency	The ability to develop into multiple cell types
Preimplantation Genetic Diagnosis (PGD)	A technique in which embryos are tested for specific genetic disorders before being implanted into the uterus.

Somatic	Any type of cell other than that used in reproduction (i.e. egg or sperm)
Somatic cell nuclear transplantation (SNCT)	The process by which a cell nucleus is removed and placed into an enucleated animal ovum
Stem Cell	Cells that can give rise to other types of cells; they are produced both during embryonic development and in the adult body.
Therapeutic cloning	The use of somatic cell nuclear transfer to produce embryonic stem cells suitable for differentiation into tissues that are a perfect match to treat disease in the person who provided the cell nucleus used.
Wild-type cell	The normal, non-mutant form of a cell

Abbreviations used in report

ELC	HFEA Ethics and Law Committee
HFE Act	Human Fertilisation and Embryology (HFE) Act 1990
HFEA	Human Fertilisation and Embryology Authority
MRC	Medical Research Council
NIMR	National Institute for Medical Research
RATE	Regulatory Authority for Tissue and Embryos. RATE is proposed as the replacement for HFEA in the Government proposal for revised legislation.[263]
SCAG	HFEA Scientific and Clinical Advances Group
S&T	Science and Technology
White Paper	Refers, in the context of this Report, to the policy document issued by the Government in December 2006 to explain proposals for revised legislation in respect of review of the HFE Act.

263 Department of Health, Review of the Human Fertilisation and Embryology Act: Proposals for revised legislation (including establishment of the Regulatory Authority for Tissue and Embryos), Cm 6989, December 2006, www.hfea.gov.uk/cps/rde/xbcr/SID-3F57D79B-9E450A32/hfea/White_Paper_Dec_06_web_version.pdf

Formal minutes

Wednesday 28 March 2007

Members present:

Mr Phil Willis, in the Chair

Adam Afriyie	Chris Mole
Dr Evan Harris	Graham Stringer
Dr Brian Iddon	Dr Desmond Turner

The Committee deliberated.

Draft Report, *Government proposals for the regulation of hybrid and chimera embryos,* proposed by the Chairman, brought up and read.

Ordered, That the Chairman's draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 116 read and agreed to.

Summary read and agreed to.

Glossary and abbreviations read and agreed to.

Resolved, That the Report be the Fifth Report of the Committee to the House.

Ordered, That the Appendices to the Minutes of Evidence taken before the Committee be reported to the House.

Ordered, That the Chairman do make the Report to the House.

Ordered, That embargoed copies of the Report be made available, in accordance with the provisions of Standing Order No. 134.

[Adjourned till Wednesday 18 April at Nine o'clock.

Witnesses

Wednesday 31 January 2007

Monday 5 February 2007

Wednesday 28 February 2007

Written evidence

Reports from the Science and Technology Committee in the 2005 Parliament

Session 2006–07

First Report	Work of the Committee in 2005-06	HC 202
Second Report	Human Enhancement Technologies in Sport	HC 67
Third Report	The Cooksey Review	HC 204
Fourth Report	Research Council Institutes	HC 68–I
Fifth Report	Government proposals for the regulation of hybrid and chimera embryos	HC 272–I
Sixth Report	Office of Science and Innovation: Scrutiny Report 2005 and 2006	HC 203
First Special Report	Scientific Advice, Risk and Evidence Based Policy Making: Government Response to the Committee's Seventh Report of Session 2005-06	HC 307

Session 2005–06

First Report	Meeting UK Energy and Climate Needs: The Role of Carbon Capture and Storage	HC 578-I
Second Report	Strategic Science Provision in English Universities: A Follow–up	HC 1011
Third Report	Research Council Support for Knowledge Transfer	HC 995-I
Fourth Report	Watching the Directives: Scientific Advice on the EU Physical Agents (Electromagnetic Fields) Directive	HC 1030
Fifth Report	Drug classification: making a hash of it?	HC 1031
Sixth Report	Identity Card Technologies: Scientific Advice, Risk and Evidence	HC 1032
Seventh Report	Scientific Advice, Risk and Evidence Based Policy Making	HC 900–I
First Special Report	Forensic Science on Trial: Government Response to the Committee's Seventh Report of Session 2004-05	HC 427
Second Special Report	Strategic Science Provision in English Universities: Government Response to the Committee's Eighth Report of Session 2004-05	HC 428
Third Special Report	Meeting UK Energy and Climate Needs: The Role of Carbon Capture and Storage: Government Response to the Committee's First Report of Session 2005-06	HC 1036
Fourth Special Report	Strategic Science Provision in English Universities: A Follow–up: Government Response to the Committee's Second Report of Session 2005-06	HC 1382
Fifth Special Report	Research Council Support for Knowledge Transfer: Government Response to the Committee's Third Report of Session 2005–06	HC 1653
Sixth Special Report	Watching the Directives: Scientific Advice on the EU Physical Agents (Electromagnetic Fields) Directive: Responses to the Committee's Fourth Report of Session 2005–06	HC 1654